University of Pretoria

PhD Thesis

On

STATISTICAL APPROACH TO PAYLOAD CAPABILITY FORECASTING FOR LARGE COMMERCIAL AIRCRAFT OPERATING PAYLOAD RANGE LIMITED ROUTES

S. A. H. Poprawa

2019

ABSTRACT

Large commercial aircraft by design typically are not capable of transporting maximum fuel capacity and maximum payload simultaneously. Maximum payload range remains less than maximum range. When an aircraft is operated on a route that may exceed its maximum payload range capability, environmental conditions can vary the payload capability by as much as 20%. An airline's commercial department needs to know of such restrictions well in advance, to restrict booking levels accordingly. Current forecasting approaches use monthly average performance, at, typically, the 85% probability level, to determine such payload capability. Such an approach can be overly restrictive in an industry where yields are marginal, resulting in sellable seats remaining empty. The analysis of operational flight plans for a particular ultra long routing revealed that trip fuel requirements are near exclusively predictable by the average wind component for a given route, at a correlation of over 98%. For this to hold, the route must be primarily influenced by global weather patterns rather than localised weather phenomena. To improve on the current monthly stepped approach the average wind components were modelled through a sinusoidal function, reflecting the annual repetitiveness of weather patterns. Long term changes in weather patterns were also considered. Monte Carlo simulation principles were then applied to model the variance around the mean predicted by the sinusoidal function. Monte Carlo simulation was also used to model expected payload demand. The resulting forecasting model thus combines supply with demand, allowing the risk of demand exceeding supply to be assessed on a daily basis. Payload restrictions can then be imposed accordingly, to reduce the risk of demand exceeding supply to a required risk level, if required. With payload demand varying from day of week to seasonally, restricting payload only became necessary in rare cases, except for one particular demand peak period where supply was also most restricted by adverse wind conditions. Repeated application of the forecasting model as the day of flight approaches minimises the risk of seats not sold, respectively of passengers denied boarding.

ACKNOWLEDGEMENTS

Starting research towards a doctorate when one is already in one’s fifties is, to state it mildly, not common. This is especially true when considering that I had obtained my Masters Degrees in Aeronautics and in Engineering in 1987, around thirty years earlier.

The idea of such an undertaking only really germinated in earnest after I had met Laurent Dala, then Professor at the University of the Witwatersrand, my first alma mater.

As such I have been very fortunate, in having found a doctoral advisor, a mentor, who was willing to undertake this journey with me and who ensured that I stayed on track throughout. Having someone knowledgeable believe in you is essential to such a journey.

Even when Laurent moved to the United Kingdom, the support and encouragement I received never waned.

Researching towards a doctorate is not possible a couple of hours at a time. Rather, one needs to find blocks of time, days at a time, to set aside to meaningfully immerse oneself in the work.

Special thanks therefore goes my spouse, Dina-Vera Schmittknecht, for patiently tolerating my “disappearing acts” into my study for extended periods, for never complaining about my extended absences.

Finally, I would not be where I am today, had it not been for my parents, Brigitte and Harry Poprawa, opening endless doors to my future over the years.

Thank you all!

S.A.H. P

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. NOMENCLATURE

1.1 Notation

a = speed of sound
C = cost or coefficient
C_D = coefficient of drag
C_F = cost of fuel per kg
CI = cost index
C_L = coefficient of lift
C_T = time-related cost per minute of flight
D = drag
E = error
F = fuel
f( ) = function of ( )
GS = ground speed
HWC = headwind component
h = fixed height above mean sea level
k = constant
L = lift
LF = load factor (%)
LW = landing weight
M = Mach number
m = median
MLW = maximum landing weight
MTOW = maximum take-off weight
MZFW = maximum xero fuel weight
OEW = operating empty weight
P_{SL} = sea level pressure
pax = passenger
R = range
R_0 = specific air gas constant = 287 J/kg/K
r = correlation coefficient of a sample distribution
SFC = specific fuel consumption (rate of fuel consumption per thrust unit)
S_R = specific range (distance per unit of fuel)
T = temperature (K)
T_{REF} = flat rated temperature
TAS = true airspeed (m/s or knots)
TOW = take-off weight
TWC = tailwind component

W	= weight
WC	= wind component, negative for HWC, positive for TWC
ZFW	= zero fuel weight
x_i	= ith value of the independent variable
$\bar{x}$	= Mean of the independent value
y_i	= ith value of a dependent variable
$\hat{y}$	= Estimated value of for a given x_i value
$\bar{y}$	= Mean of the dependent value
Z	= Number of Standard Deviations from the Mean
γ	= ratio of specific heats = 1.40 for air
θ	= Actual TAS over best range TAS
μ	= Mean of a Distribution
π	= Pi = 3.14157…
σ	= Standard Deviation of a Distribution
δ	= pressure ratio (= P/P_{SL})
ρ	= density (kg / m^3)
ΔF	= trip fuel
ΔT	= trip time

1.2 Subscripts and Superscripts

*	= optimum
a	= amplitude
av	= average
c	= constrained, calendar day, starting point
f	= final
i	= initial
max	= maximum
MR, mr	= maximum range
rel	= relative
T	= Time
TOC	= Top of climb
w	= wind
z	= zero point

1.3 Definitions

The following air transport related terminology is used in this thesis:

Air mass:	A volume of air defined by its temperature and water vapor content covering many hundreds or thousands of miles.
Air traffic control:	A ground-based service directing aircraft on the ground and through controlled airspaces, respectively providing advisory services to aircraft in non-controlled airspaces.
Air traffic management:	A system that assist aircraft to depart from an aerodrome, transit airspace, and land at a destination aerodrome, including air traffic control, airspace management and air traffic flow and capacity management.
Air transport:	Refers to the activities surrounding mechanical flight and the aircraft industry.
Average wind component:	The average value of the wind component along a route that accounts for the difference between actual flying time and the flying time in no wind conditions.
City pair:	Consists of a city of departure and a city of destination.
Constrained flight:	Flight along defined flight levels or at pre-imposed speeds
Cost index:	A ratio of time related aircraft operating costs to fuel costs.
Denied boarding:	When a passenger with a confirmed booking is not accepted on a flight, as a result of cancellation or overbooking.
Flight level:	Aircraft altitude expressed in hundreds of feet above the standard air pressure isobar of 1013.25 hPa, based on the International Standard Atmosphere. It is therefore not necessarily the same as the aircraft's actual altitude either above sea level or above ground level.
Flight management system:	A specialized computer system that automates a wide variety of in-flight tasks, including horizontal and vertical navigation along a predetermined flight plan, and optimization of a number of performance parameters such as altitude and speed.

Great circle distance:	The great-circle distance or orthodromic distance is the shortest distance between two points on the surface of a sphere, measured along the surface of the sphere (as opposed to a straight line through the sphere's interior).
Ground speed:	The speed of an aircraft over ground
Isobar:	A line connecting points of equal atmospheric pressure.
Isotherm:	A line connecting points of equal atmospheric temperature.
Isotach:	A line connecting points of equal atmospheric wind speeds.
Jetstream:	Fast flowing, narrow, meandering air currents in the atmosphere, mainly located near the altitude of the tropopause and all but one flowing largely west to east.
Large commercial aircraft:	An aircraft of more than 5700 kg maximum take-off weight, engaged in commercial aviation.
Load factor:	The ratio of passengers to the number of seats on an aircraft.
Maximum landing weight:	The structural limit up to which a landing is permitted.
Maximum take-off weight:	The structural limit up to which a take-off is permitted.
Maximum zero fuel weight:	The structural limit that an aircraft can weigh without usable fuel on board.
Operational flight plan:	The operator's plan for the safe conduct of the flight along a defined route based on consideration of the airplane's performance, other operating limitations, and relevant expected conditions on the planned route.
Payload:	The capacity of an aircraft to carry paying customers and / or revenue-generating cargo.
Payload memoranda:	Prediction by the Flight Planning Department of the expected payload capability per route and aircraft type, over a defined period.
Payload range:	The distance a given payload can be transported.

Operating empty weight:	The operating empty weight (OEW) is the sum of the standard empty aircraft weight, as manufactured, cabin furnishings and equipment and operational items such as engine oil, hydraulic fluid, water and the unusable fuel.
Outbound flight:	A flight from an airline's home base to a destination.
Return flight:	A flight from an airport to the airline's home base.
Restricted take-off weight:	The performance limit up to which a take-off is possible, less than or equal to the maximum take-off weight.
Specific fuel consumption:	The ratio of distance traveled per unit of fuel consumed, a measure of engine efficiency.
Step climb:	A climb during the cruise phase of flight to a higher flight level.
Stratosphere:	The stratosphere is the second major layer of Earth's atmosphere, just above the troposphere.
Tropopause:	The tropopause is the boundary in the Earth's atmosphere between the troposphere and the stratosphere. It marks where the temperature inversion begins.
Troposphere:	The troposphere is the lowest layer of the Earth's atmosphere, and is where nearly all weather conditions take place.
True airspeed:	The actual speed of an aircraft travelling within an air mass
Ultra-long range:	While there is no universally accepted definition for what is considered ultra-long haul, the term generally refers to flights that are 12 hours or longer.
Yield management:	A variable pricing strategy, based on understanding, anticipating and influencing consumer behavior in order to maximize revenue or profits from a fixed, time-limited resource such as airline seats.
Zero fuel weight:	The weight of an aircraft and all its contents, except for the weight of the usable fuel on board.

2 INTRODUCTION

Large commercial aircraft design requires compromise to contain operating and capital costs, whilst providing performance capability that accommodates the requirements of the majority of intended customers. One such compromise is the trade-off between range capability and payload capability: A large commercial aircraft, when uplifting maximum fuel capacity, is unable to carry maximum payload simultaneously and vice versa.

Airlines operating aircraft on routes longer than the design range for maximum payload capability therefore seek to maximise their sellable payload capacity on each flight. Continually varying environmental conditions challenge the performance analysts to provide accurate payload capability predictions for such routes. The airline's revenue team, however, needs to know months in advance how many seats are sellable to potential customers. The risk of flying with empty seats unnecessarily is as taxing to the airline as is the risk of denied boarding and dissatisfied customers.

Traditional approaches to this conundrum apply monthly average environmental conditions at a predetermined probability level, typically at 85%. Annual payload memoranda, depicting predicted monthly load capabilities, are published twice a year. The intent is to ensure that the predicted payload capability is equal to or better than published, at the predetermined probability level. Such an approach does not minimise the inherent risk mentioned adequately, though, of flying empty seats nor of having to turn passengers away at any particular day of operation.Nor can a monthly average prediction really be deemed representative of continually varying environmental conditions.

Currently, to establish the payload memoranda, operational flight plans are calculated by commercially available flight planning systems, utilizing the monthly average temperature and wind profiles, at the predetermined probability level. Then, the payload capability is calculated manually, given the fuel requirements per flight. Clearly, the approach and methodology are rudimentary and far from optimal. Nor is the process dynamic. The aim of this research, therefore, is to establish an improved dynamic forecasting methodology that minimises the risk of unfilled seats, respectively of denied boardings.

3 BACKGROUND

3.1 Performance Prediction Tools

The advances in computational methods concomitant with increases computational power allow for the modelling and simulation of increasingly detailed aircraft components up to even complete fully configured aircraft behaviour. Fillipone [1] found that such advances have not been fully integrated into the Flight Performance discipline seeking to support aircraft in service. Rather, perhaps resulting from aircraft technical data seldom being available in professional journals, the multi-disciplinary analysis of the in-flight performance of in-service aircraft still suffers from over-simplifications and closed-form solutions developed in the 1970s [1].

Where aerodynamics and propulsion are in themselves advanced disciplines capable of providing accurate predictions, flight performance is not, relying instead on empirical flight data, as far as available, for performance predictions. Fundamentally, flight planning is performed by utilizing an incremental table look-up routine that provides for typical flight profiles. Nevertheless, flight planning systems for pre-planning of flight missions and flight management systems on board newer generation transport aircraft appear surprisingly accurate as the author, an air transport pilot with over 30 years experience, can attest. But then air transport flights are flown as planned. In no way does this imply, therefore, that a flight mission was planned as optimally as possible.

McIntyre [2] bemoaned the lack of optimality of Flight Management Systems (FMS) twenty years ago, where such systems were originally designed for shorter range flights at constant speed. More modern Flight Management Systems, though, do increase cruise speed with increasing flight altitude, as with increasing aircraft gross weight [3], however such adjustments typically are small.

Yet the air transport industry is in urgent need of optimized flight execution in all phases of flight in order to minimize fuel usage and, of late, the associated amounts of carbon emissions. At US$ 150 per barrel of oil, as experienced beginning of the decade, the cost of fuel became one the highest, if not the highest, single cost element of air transport organisations. Nangia, Blake and Zeune [4] discussed this need in terms of both military and civilian transport aircraft. Such a need starts at the fleet type decision stage of any fleet renewal programs an air operator necessarily engages in from time to time. Flouris [5] as well as Justin and Marvis [6] highlight some of intricacies involved in such undertakings.

More recently, Filippone [7] presented a novel approach of integrating multidisciplinary aspects affecting aircraft flight, using first principle models combined with empirical data, into computer modelling. Such a software platform can become representative of the whole aircraft, able to analyse a multitude of aspects such as direct operating costs, trajectory optimisation, stability and control, performance verification, environmental and noise impact analysis, etc. However, the lack of available data, respectively the lack of data standardisation from reference documentation, remains challenging in such an integrated approach, often forcing the inference of data from statistical analysis in the alternative.

3.2 Optimization of Fuel Consumption

With fuel consumption accounting for a large and increasing portion of direct transport costs, Xiao et al [8] developed a mathematical optimisation model for a capacitated aircraft routing problem, to minimise fuel consumption. Their model could serve airlines to develop route schedules through better management of the trade-off between total distance and size of aircraft to be operated.

Shultz [9], Speyer [10] and Vankan et al [11] discuss further aspects of optimisation of the cruise phase of flight. Park and O'Kelly [12] evaluated the impact of seat configurations and stage length on fuel usage. Swan and Adler [13] analysed aircraft operating costs to generate an engineering approach to computing generalized aircraft trip cost functions, variable for seating density and stage length. They further computed a classic Cobb-Douglas cost function to provide a useful route network design tool. They showed that engineering data can be used to establish cost functions for differing aircraft sizes and operating ranges. As such the analysis is suited towards network planning rather than route optimisation.

Aircraft size naturally increases with distance flown, a result of the trade-off between the cost of loading / unloading and the cost of flying (Givoni and Rietveld [14]). Where the airlines have a choice, such choice is mainly influenced by route characteristics such as the distance, the level of demand and the level of completion, but not by airport characteristics. Where possible, airlines prefer to respond to growth in demand with in frequencies rather than aircraft size.

In-service aircraft deteriorate over time. Chang and Lan [15] investigated predicting the factors contributing to the degradation of aerodynamic efficiency in operation, utilizing actual flight data from flight data recorders for a twinjet transport aircraft. Their analyses suggested that to counteract the degradation of the lift-drag ratio in cruise an aircraft should fly at higher altitudes where the reduced lower dynamic pressure requires a higher angle of attack.

Chang [16] similarly presents a mathematical model, using fuzzy logic techniques, to identify excessive fuel consumption utilizing actual flight data. Specifically, the model is set to predict deficiencies in the lift-to-drag ratio relative to a reference lift-to-drag model, through sensitivity analyses. Ultimately, the model aims to identify variables that contribute to such deficiencies. Aileron and stabilizer angles were found to be among the most influential variables.

Chang and Tan [17] also used post-flight data to monitor angular positioning of flight control surfaces with the intent of detecting irregular displacements, primarily from a flight safety perspective. Flight efficiency benefits coexist here. A different empirical approach was discussed by Klein [18]. Also using flight data Klein [18] formulated a mathematical model approximating aerodynamic forces and moments using polynomials or splines, based on actual flight data.

A somewhat different aspect resulting from modern air traffic management requirements was investigated by Franco and Rivas [19]. They considered how to optimise the cruise phase of flight, at a constant altitude, including average wind effects, whilst still complying with a constrained time of arrival over a specified waypoint. Rather than flying at a fixed Mach number calculated from the average wind component to meet the stipulated arrival time, they found that the optimal trajectory requires for the Mach number to be varied as the head or tail wind varies throughout the flight.

Along similar practical lines, Collins [20] discussed an energy balance concept developed by the MITRE Corporation (a non-profit research and development organisation), applied to aircraft to define fuel conservation opportunities taking into account air traffic control requirements. Such a computer based concept could be used to define air traffic control procedural and regulatory effects on aircraft fuel consumption.

Martinez-Val et al [21] analysed splitting long range routes into two segments both for medium and large wide body aircraft, to determine whether environmental and operating cost savings could be realized. For shorter to medium length routes the fuel savings were negligible due to the duplication of non-cruise flight phases and additional routing. Even for longer routes the results were not entirely conclusive as the resultant fuel saving competes against increases in other operating costs (maintenance, crew, air traffic control and airport charges, etc.).

A further consideration, not discussed in this particular study, is customer response to such an intermediate stop, especially when such stops occur in the middle of the night. The ability to operate directly remains a competitive advantage over intermediate stops which in turn remains a competitive advantage over connecting flights. Airlines competing on city pairs are forced to offset such competitive advantages through noticeably reduced airfares firstly. Ultimately, an intermediate stop has both a cost and revenue impact associated with it. Poll [22] relatedly deliberated on the effect of stage length on air transport efficiency.

Singh and Sharma [23] recently reviewed and classified the literature on fuel consumption optimisation (FCO). They identified four principal dimensions related to FCO research: aircraft technology and design, aviation operations and infrastructure, socioeconomic and policy measures and alternative fuels and fuel properties, distributed over six categories of research methodologies: analytical-conceptual, mathematical, statistical, and empirical – experimental, statistical and case studies. Empirical research contributed 25% of publications, whilst analytical mathematical research dominated at 47%. FCO research is very topical evidenced by the significant increase in the number of publications in recent years [23].

Their research further revealed that there are considerable untouched research problems in the FCO area, such as the integration of aircraft technology and design, aviation operations and infrastructure, socioeconomic and policy measures and alternative fuels and fuel properties. The aviation sector's fuel efficiency improvements have slowed since the 1970s and 1980s resulting from slower technological developments in engine and aerodynamic designs and materials. Engine technology recently though took a leap forward again with the introduction of geared fans resulting in the main civil aircraft manufacturers re-introducing existing airframes with new engine technology.

FCO modelling needs to extend to include all the influencing dimensions: aircraft technology and design, aviation operations and infrastructure, socioeconomic and policy measures and alternative fuel and fuel properties. FCO models should further evaluate aircraft size in relation to market structures, impact of various policies on fuel burn, and potential alternate fuel options. Performance measures require broadening to address socioeconomic and political aspects.

3.3 Aircraft Trip Cost

Advanced airlines seek to operate their aircraft at minimum trip cost for a given route, taking into account the relationship between fuel related costs versus time related costs [3]. Fundamentally, the total cost (C) for a specific trip is the sum of the fixed and variable costs:

$$C = C_{\mathrm{F}} \times \Delta F + C_{\mathrm{T}} \times \Delta T + C_{\mathrm{C}} \tag{1}$$

Time related costs (T) typically include hourly maintenance costs, flight and cabin crew costs and other marginal costs. Fuel (F) costs are shown separately as are the fixed costs (C_C).

In order to minimise the direct cost of the flight a Cost Index (CI) is calculated for use in Flight Management Systems, scaled between 0 and 999 [3], depending on the system, to define the speed the aircraft is to be operated at. Cost Index is defined throughout the industry as:

$$Cost\ Index = \frac{cost\ of\ time}{cost\ of\ fuel} \tag{2}$$

As the cost of fuel increases the cost index decreases and flights slow down to conserve fuel. Thus, CI = 0 yields the maximum range for a given payload whilst CI = 999 minimises the flying time. Naturally, as the cost of fuel increases the optimum cost index decreases towards the maximum range cost index (CI = 0). When the barrel of oil sold at US$ 100 to US$ 150 on world markets, airlines were typically flying single digit cost indices.

3.4 Maximum Range

In order to achieve maximum range for a given payload, respectively maximum payload for a given distance of travel between two city pairs, an airline may be forced to fly at maximum range cruise speeds, i.e. Cost Index = 0, incurring a less optimal cost structure in the process. With yields in commercial aviation being marginal, maximising payload becomes paramount.

Torenbeek [24] found that, despite the abundance in literature, no undisputed generalized approach to determining optimum range performance existed at the time of publishing his paper. Starting from the Bréquet Range Equation he postulated an approach to calculating range based on power plant overall efficiency.

Torenbeek and Wittenberg [25] used logarithmic differentiation to establish generalized criteria for optimum cruise performance in quasi-steady flight, allowing for compressibility effects and engine characteristics. The optimum cruise condition as per their paper is either a fixed point in the unconstrained case or a combination of points in the constrained case, as will be elaborated from equation (4) onwards.

A different approach was taken by Menon [26] to studying aircraft cruise by deriving the Euler's necessary conditions for optimal long range cruise. Unlike for fighter aircraft, for transport aircraft Menon found that the classical steady state cruise point, lying on the flight envelope boundary, is not a singular point of the Euler necessary conditions, seemingly implying that optimal cruise flight occurs at maximum thrust.

Rivas et al [27] analysed maximising range (CI = 0) for a given cruise fuel load, taking wind effects into account, assuming the International Standard Atmosphere model. In their paper, Rivas et al found that, without wind effects, the unconstrained maximum range is attained by flying a cruise climb at constant optimum Mach number M at a constant optimum Coefficient of lift C_L. Torenbeek [24] concurs.

Optimum pressure ratio δ_{opt} (altitude) is determined from:

$$\delta_{opt}(W) = k\frac{1}{C_L}\frac{W}{(M)^2} \tag{3}$$

Once the wind effect is introduced, however, the optimum values of M and C_L no longer remain constant. Now M becomes weight dependent whilst δ no longer varies proportionally with weight. In the unconstrained case, i.e. full freedom of flight altitude and speed, the maximum range was shown to be:

$$R_{max} = \int_{W_{\text{f}}}^{W_{\text{i}}} S_{\text{R}}(M^*(W), \delta^*(W), W)dW \tag{4}$$

Volumes of traffic globally rarely allow aircraft to operate unconstrained in altitude. Crossing or opposite traffic forces aircraft into defined flight levels (height above the standard barometric level of 1013.25 hPa), though not necessarily the same flight level for the entire flight. Consequently, modern Flight Management Systems provide optimum altitude information in discrete steps of, typically 500 feet [3]. Where an aircraft can be operated within a block of flight levels typically a crew would climb in 500 feet height increments to stay as close as possible to the optimum flight level. In the altitude constrained case the maximum range is then determined from:

$$R_{max} = \int_{W_{\text{f}}}^{W_{\text{i}}} S_{\text{R}}(M_h^*(W), h_c, W)dW \tag{5}$$

In some high volume airspaces such as across the North Atlantic, aircraft may be separated not only by restrictions to flight levels, but further by being required to fly at a fixed Mach number. In the altitude and Mach number constrained case the maximum range is then determined from:

$$R_{max} = \int_{W_{\text{f}}}^{W_{\text{i}}} S_{\text{R}}(M_c, h_c, W)dW \tag{6}$$

Other than optimization through step climbing to various higher flight levels throughout the flight, maximum range in this instance essentially is purely dependent on the amount of fuel carried.

3.5 Approximate Methods to determine Range

Cavcar [28] traced the history of the well-known Bréquet Range Equation used for aircraft design:

$$R = \frac{TAS}{SFC}\frac{L}{D}\ln\left(\frac{W_i}{W_f}\right) \tag{7}$$

This equation, dating back to the early days of aircraft design before high speed high altitude flight, combines aerodynamic (L/D), propulsion (SFC) and structural (W_i / W_f) factors to model aircraft range, assuming a constant angle of attack, constant velocity flight throughout. As such it does not necessarily provide the maximum range possible. Further, due to the assumed continuous change in altitude the Bréquet Range Equation is not necessarily practical in the constrained air traffic environment (Cavcar [29]).

Given the complexity of the numerous equations involved, the Aircraft Motion Group [30] derived approximate methods for estimating cruise range and endurance, for aircraft with turbojet and turbofan engines. One aspect of their study concerns itself with maximising the specific air range in order to maximise the range itself. They show that, applying some simplifying assumptions, that air range R_a can be computed from:

$$R_a = \int_{W_f}^{W_i} \frac{1}{W} \frac{TAS}{SFC} \frac{L}{D} dW \tag{8}$$

At any given weight the maximum specific air range is then achieved when maximizing:

$$\frac{dR_a}{dW} = \frac{1}{W} \frac{TAS}{SFC} \frac{L}{D} \tag{9}$$

Representing drag as a parabolic dependence of lift,

$$C_D = k_1 + k_2 C_L^2 \tag{10}$$

they then go on to show how maximum specific air range can be determined in cruise for either a given True Airspeed, Mach number or flight altitude or constant Lift to Drag ratio. They do not present an approximate method for optimizing all parameters simultaneously.

Cavcar and Cavcar [31] showed that the classical approach assuming constant specific fuel consumption and uncambered wing drag polar results in higher optimum Mach numbers and shorter range predictions for turbojet / turbofan transport aircraft flying at constant altitude and airspeed. Cavcar and Cavcar [32] further thought to approximate range for cambered wing (high subsonic speed) transport aircraft flying at a constant altitude, albeit for the preliminary or conceptual design stage of a modern transport aircraft. They concluded that it is not possible to approximate long range cruise conditions by assuming a simple parabolic drag polar as a function of lift. Nor can compressibility effects be neglected. Bert [33] also assumed a parabolic dependence of drag on lift in his derivation of a range formula at a constant altitude, holding airspeed and the lift-to-drag ration constant.

3.6 Effects on Maximum Range

Rivas and Valenzuela [34] confirm that the optimum Mach number for constant altitude cruise gets overestimated when compressibility effects are neglected, as shown in Figure 1. They further demonstrate that the maximum range as a function of flight altitude presents a maximum, i.e. an optimum altitude exists for maximum range flying in compressible air. Graphically, at a given weight:

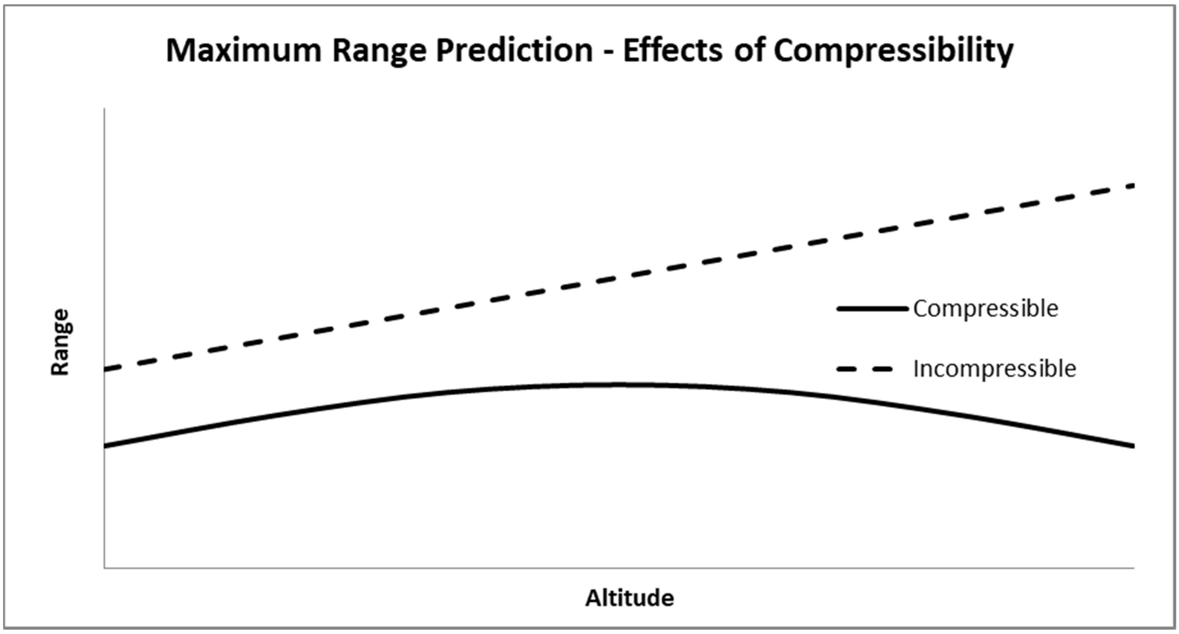

Figure 1 Maximum Range Dependence on Flight Altitude

On the other hand, compressibility effects ignored, maximum range would seem to be obtained by flying as high as possible, engine thrust limited, yielding an unrealistically high maximum range prediction.

Torenbeek [35] recently confirmed that comprehensively optimising high speed cruise requires the drag polars at different Mach numbers to be known. Drag polars at transonic Mach numbers can differ significantly from those classically assumed parabolic for subsonic flight. Figure 2, Figure 3 and Figure 4 graphically emphasize the dependence of range on a number of parameters [36], [37].

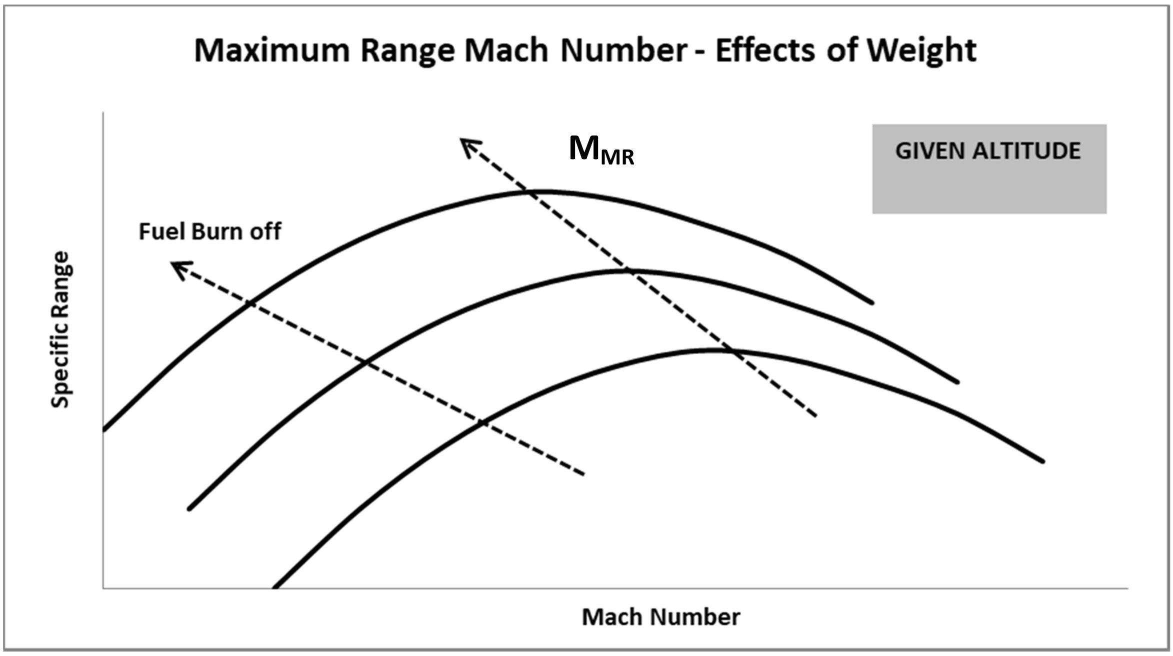

Figure 2 Maximum Range Dependency on Mach Number at a Given Altitude

As the aircraft weight reduces, fuel being burned off, to assure maximum range for the flight the optimal Mach number must steadily be decreased, when flying at a fixed altitude.

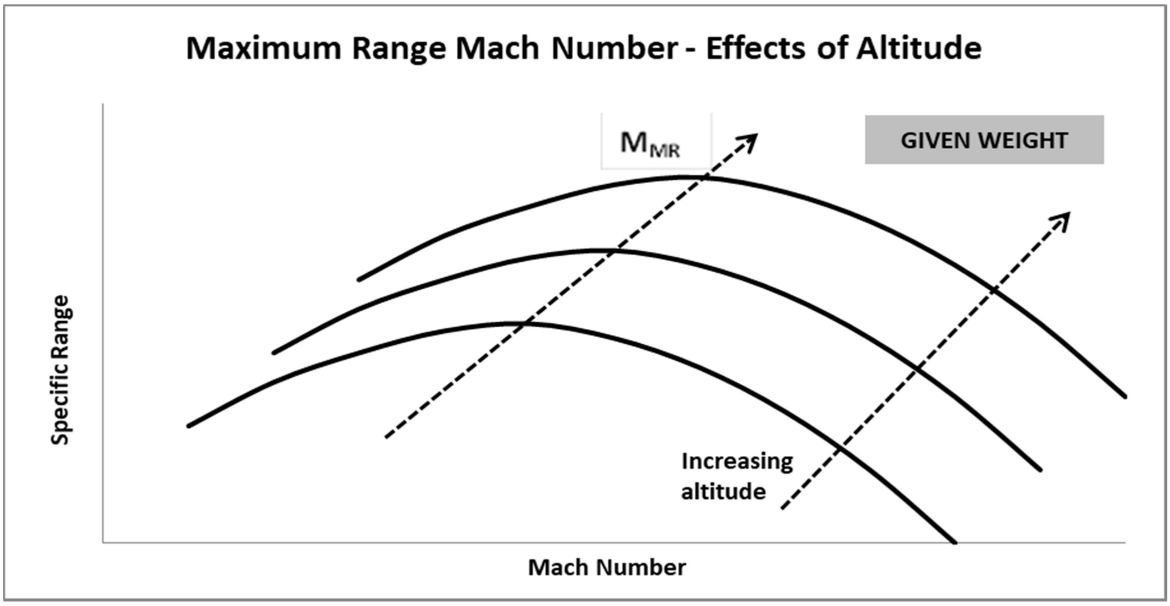

Figure 3 Maximum Range Dependence on Mach Number at a Given Weight

Conversely, for any given weight the optimal Mach number increases with increasing flight altitude.

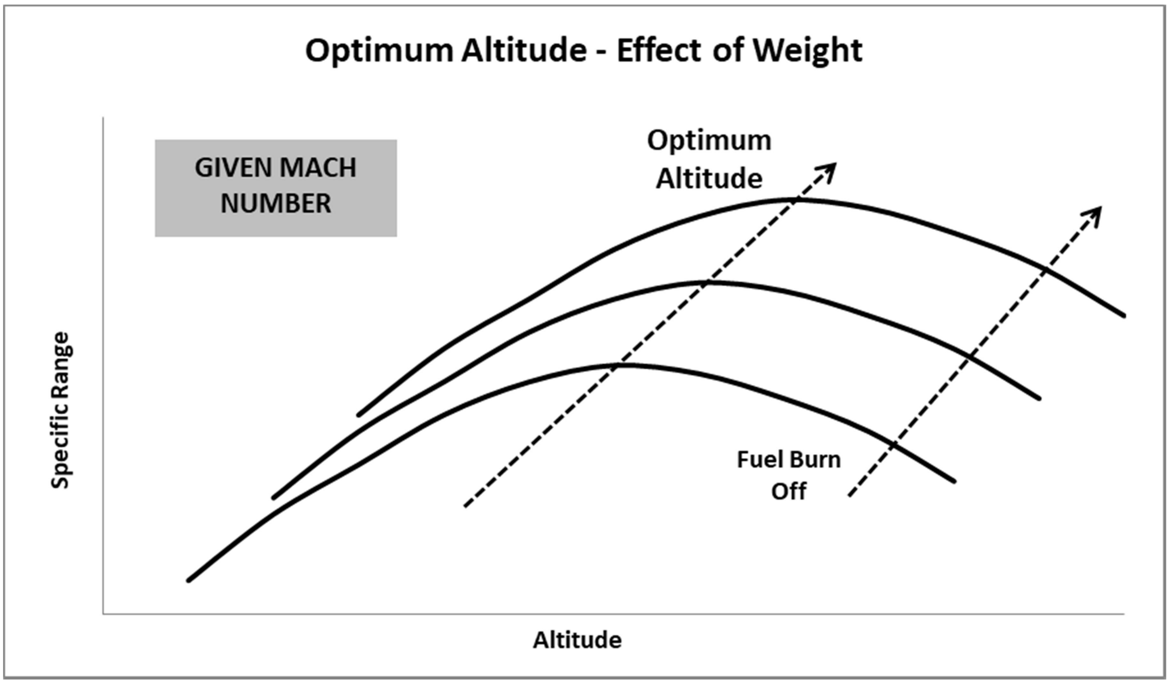

Figure 4 Maximum Range Dependence on Altitude at a Given Mach Number

In combination the graphs illustrate, when compressibility effects are considered for high speed high altitude flight, that:

1. Flight altitude should be steadily / continuously increased as fuel is burned off.
2. Mach numbers should be continuously adjusted as fuel is burned off, as well as for the increasing flight altitude. The effect of weight and altitude largely offset each other so that, in practical air transport operations a near constant Mach number is flown.

3.7 Practical Constraints to Cruise Flight

With the current world wide air traffic volumes and in the absence of better control mechanisms, aircraft in cruise are necessarily restricted to pre-determined flight levels (altitudes expressed in hundreds of feet about a common datum, standard atmosphere sea level barometric pressure of 1013.25 hPa), to ensure adequate separation. Such levels are typically separated by 1000 feet from opposing traffic, so that aircraft have a choice of flight levels 2000 feet apart for flight in their direction. Practically, therefore, flights can at best be operated close to optimum altitudes, by, for example, maintaining a flight level until 1000 feet below optimum (ideally) then climbing 2000 feet to the next flight level 1000 feet above optimum. This flight level is then maintained until sufficient fuel has been burned for the optimum altitude to have increased again to 1000 feet above the current flight level. The next step climb is then performed. The exact point at which to initiate a climb above optimum varies with aircraft type.

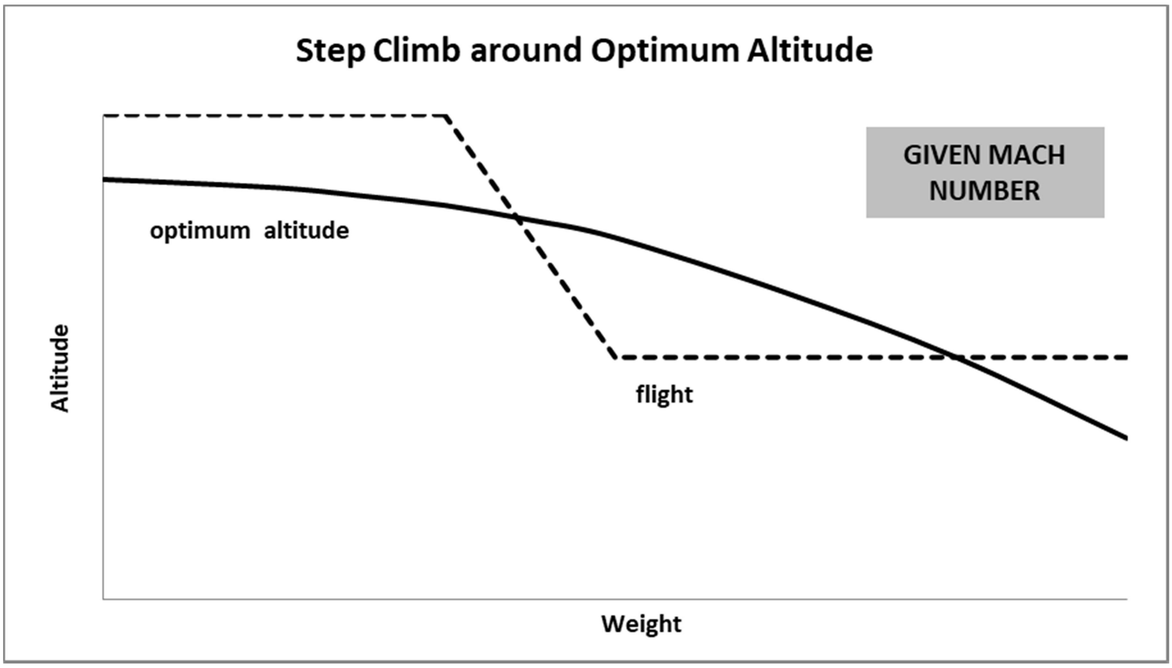

Figure 5 Step Climb around Optimum Altitude *at a Given Mach Number*

Consequently, the Mach number should also be steadily reduced whilst maintaining the flight level. Then, during the step climb the aircraft has to be accelerated again to maintain an optimum Mach number. Again, this is not necessarily practical, as aircraft at the same flight level require a minimum safe separation from one another, which could become compromised with continually varying speeds. Transport aircraft consequently can never be flown fully optimally thus can never attain their maximum range capability. More fuel is used and, possibly, less payload capability is available.

With such practicalities in mind Valenzuela, Rivas and Franco [38] evaluated whether it is still possible to optimise the cruise. Maximum cruise range at constant altitude without time constraint, maximum cruise range at constant altitude and minimum fuel cruise at constant altitude with fixed arrival times were analysed. They concluded that, even within the air traffic control constraints some optimisation is still possible, such as the optimized step climb process illustrated in Figure 5, or through the optimised step reduction of the Mach number as illustrated in Figure 6. By applying such optimisation the actual fuel used is close to the maximum range case. Costs of air traffic restrictions can be minimised respectively close to maximum payload range can be achieved. Unfortunately, current flight management systems do not fully allow for such speed optimisation strategies. Flight management systems continually evaluate the optimum altitude to be flown (at a given Mach number) leaving it up to the flight crew to monitor and implement.

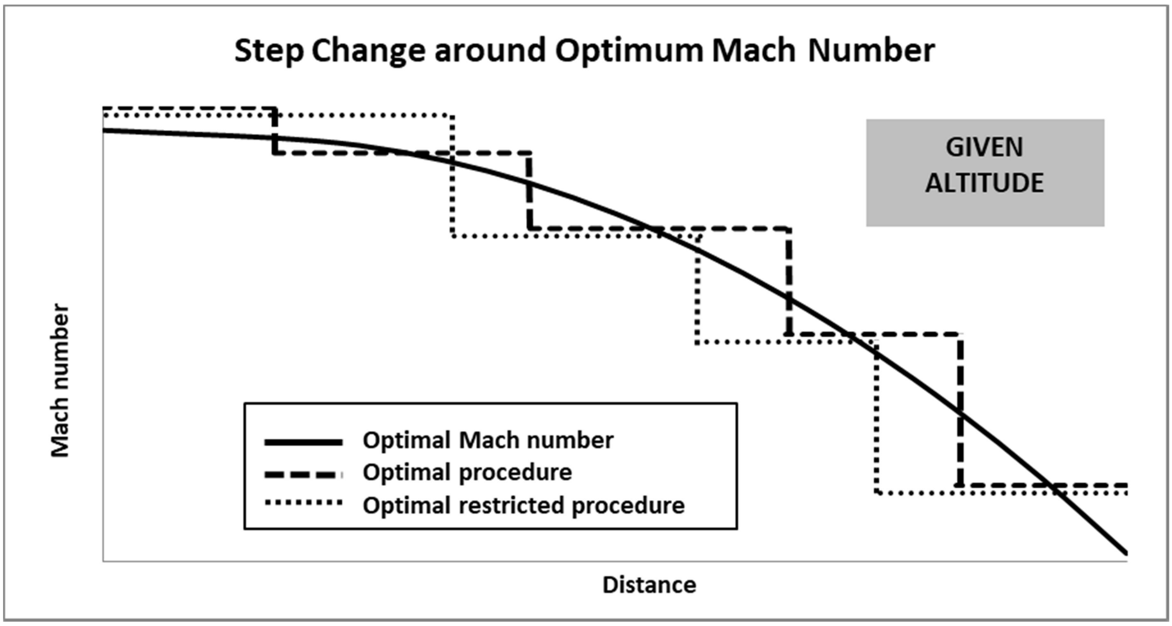

Figure 6 Maximum Range Cruise at Constant Altitude with a Fixed Arrival Time

Valenzuela and Rivas [39] analysed how optimal aircraft cruise procedures change when altitude and Mach number are restricted to discrete values. Specifically, they approached this from the airlines perspective, by how the cost index to be flown affects the discrete trajectory patterns. As confirmed in numerous other publications, the ideal trajectory is conducted as cruise climb with roughly constant Mach numbers.

The effect of cost index is to change the cruise Mach number of a flight, increasing cost indices resulting in a non-linear increase in Mach number. The increase in cost index has an additional effect in the constrained altitude case: When increasing beyond a certain value (aircraft type dependent), an abrupt change to a lower constrained optimum value is forced. Invariably, this also affects the range capability, alternatively the fuel burned over a given distance.

A similar abrupt change in optimum cruise level was demonstrated at a given cost index with increasing weight. Implicit here is, by applying a fixed economic cost index to a route the total direct costs may not necessarily be minimised. It might be prudent, close to the change-over point between two optimum levels, to consider a slightly lower cost index resulting in a higher optimum cruise level. Further analysis would be required here. The maximum range cruise remains unaffected, though, with cost index = 0.

3.8 The Payload Range Trade-off

Ackert [40] reflected on how an understanding the payload range capability assists both operators and financiers in matching the intended airline network with the optimum payload range of the aircraft to be deployed. With the growth in air transport requirements operating within constrained air traffic structures, ultrahigh capacity aircraft are increasingly becoming necessary. Martinez-Val et al [41] found that the most constraining factors to producing such aircraft are the wingspan limit imposed by on-airport manoeuvrability and the wing loading resulting from maximum zero fuel weight (maximum payload), within the current design capabilities. Depending on the span wise position of fuel tanks and the wing structure arrangement, bending moments at maximum zero fuel weight can become limiting even below maximum take-off weight.

Fuel capacity is primarily constrained by the available space within the wing structure (other than auxiliary tanks in the tail) which in turn is constrained by airport limitations. The combination of these two factors therefore affects the payload range capability of any large aircraft.

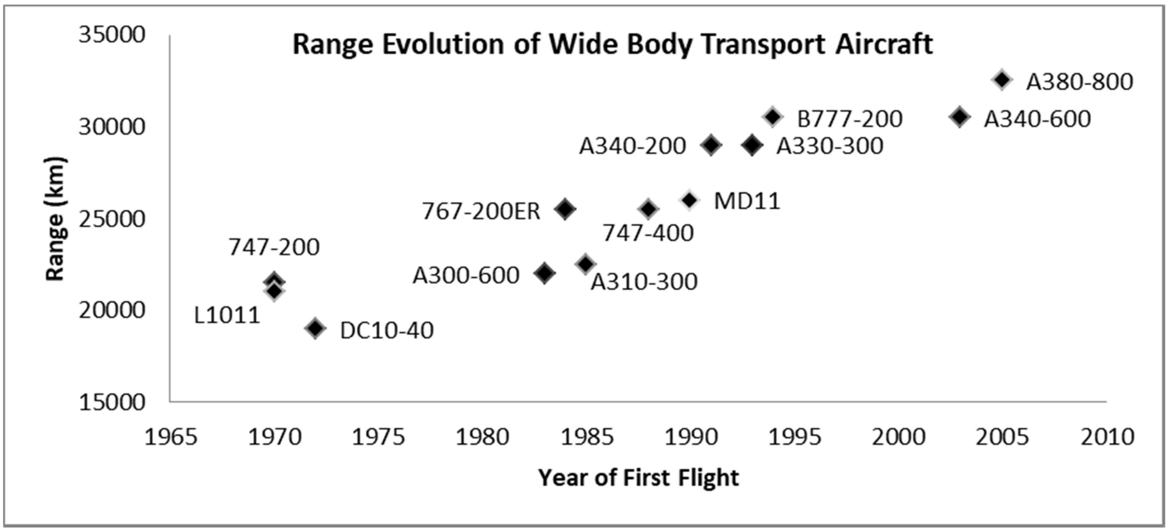

Figure 7 Range Evolution of Wide Body Transport Aircraft [42]

Within this context Martinez-Val, Palacin and Perez [42] traced the development of civilian jet transport aircraft (Figure 7) with reference to the payload range diagram, as representative of the range equation. Martinez-Val, Palacin and Perez [42] established that, in addition to the constant trend in improved performance with time, wide body (long range) aircraft types further added to performance improvements through size.

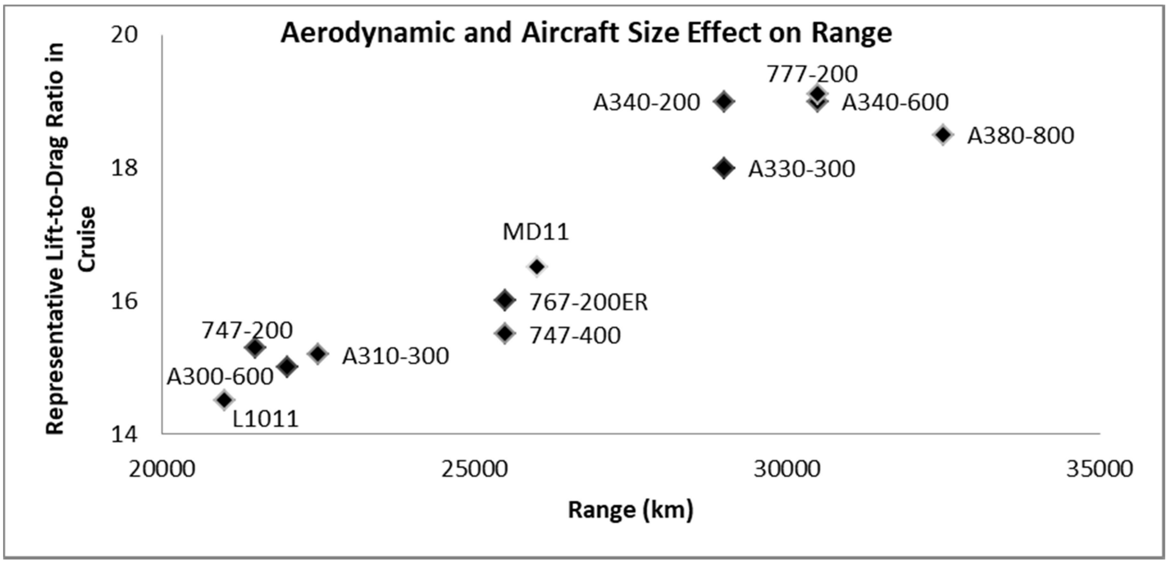

Figure 8 Aerodynamic and Size Range Evolution of Wide Body Transport Aircraft [42]

Figure 8 shows that the increased range from the 747-200 to the 747-400, as from the A340-200 to the A340-600, primarily results from an aircraft size increase and engine improvements. The MD11, however, derived from the DC10 more through aerodynamic and engine improvements. The A310, conversely, achieved its range improvement through a size reduction from the A300-600. The twin-engine A330, although transgressing into a very successful long range in recent times, was originally optimised to be the shorter range counterpart to the four-engine A340.

Mostly though, civil transport aircraft are operated well inside their payload range capability, implying that airlines are incurring extra costs, operating aircraft oversized in payload and / or fuel tank capacity. When analysing these factors Martinez-Val et al [43] established that significant cost benefit could be achieved through reducing the design range of aircraft closer to the required payload requirements. Martinez-Val et al further discussed the trade-off between cost and range during the design and operations of large aircraft [44] as well as the historical evolution of air transport efficiency [45].

The difficulty here is that the payload range requirements vary vastly between differing air transport organisations, whilst the developmental costs of a transport aircraft prohibit the development of a multitude of aircraft with differing payload range capabilities. Conversely, when aircraft are operated at payload range limits, such operations necessarily require an optimised operation.

Nangia [46] in looking at efficiency factors of modern commercial aircraft observed that, by increasing range capability, fuel efficiency becomes greatly reduced. If such long range aircraft are operated over shorter distances it follows that their fuel efficiency, all other things being equal, is not competitive relative to a right-ranged aircraft. Nangia et all [47] further compared operating efficiencies of military transport aircraft and later compared them with civil aircraft [48].

Figure 9 reflects the actual fuel requirements for a representative ultra-long range civilian transport aircraft. The relative magnitude of fuel required / payload carried is representative.

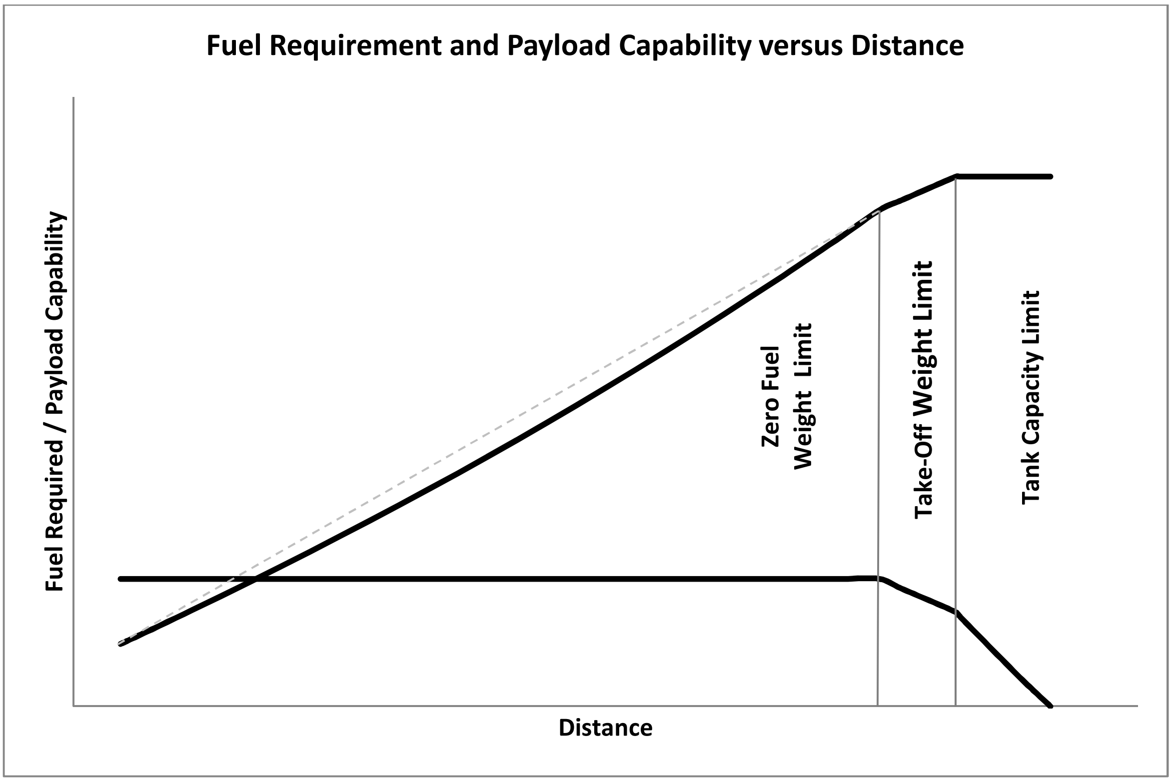

Figure 9 Actual Fuel Requirements and Payload Capability with Distance of a Representative Long Range Aircraft

The fuel graph initially shows an exponential increase in fuel requirements (a dashed straight line is shown to better illustrate this effect). This is expected since one burns fuel to carry fuel. The aircraft is operated at maximum structural payload capability until the combination of fuel and payload carried reaches maximum take-off limit. For farther flights payload capability must now be sacrificed to carry the necessary fuel. Eventually, fuel tank limits are reached and payload capability reduces rapidly.

In fact, aircraft are subject to a whole plethora of limiting constraints: load factor limits, bending moment limits, structural / weight limits, tank capacity limits, speed limits, to name a few. In the context of payload range limitations, though three overriding aspects dominate:

- Maximum Take-off Weight (MTOW) is a structural weight limitation at which the aircraft can be operated without exceeding design loads. This weight may require further reduction by performance limiting environmental conditions, typically, at airports elevated significantly above sea level combined with temperatures well above the international standard atmospheric conditions.

  On shorter flights the Maximum Landing Weight (MLW) may be limiting rather than the MTOW. In order to observe the MLW an aircraft can only take off at a weight that is less than or equal to the MLW plus the fuel burned from departure to destination. On long range flights, the focus of this study, this constraint is not normally a factor.

- Maximum Zero Fuel Weight (MZW) is similarly a structural load limit that determines the maximum permissible weight of an aircraft prior refuelling.

  The Zero Fuel Weight (ZFW) is the sum of the Operating Empty Weight (OEW) (Empty aircraft plus equipment plus catering plus crew) and the payload. Maximum Structural Payload (MSP) therefore is the difference between the MZW and the OEW.

- Maximum Tank Capacity is the volumetric limitation of the fuel tanks. The ability to carry fuel can become further limited, depending on the tank arrangements, when the aircraft centre of gravity position exceeds the controllability limits of the flight control capabilities.

The relation between these limits is best illustrated graphically, as shown in Figure 10. Figure 9 and Figure 10 are differing ways of displaying the same problematic: A full load of revenue generating load (passengers and / or cargo) can only, subject to winds and other atmospheric conditions, be carried so far. Further destinations can only be served with a reduced payload, limited either by the structural limits of the aircraft, trading off fuel required against payload carried, or by tank capacity limits beyond that. The ultimate limit in range is the ferry range capability, positioning an aircraft to a different destination without any payload.

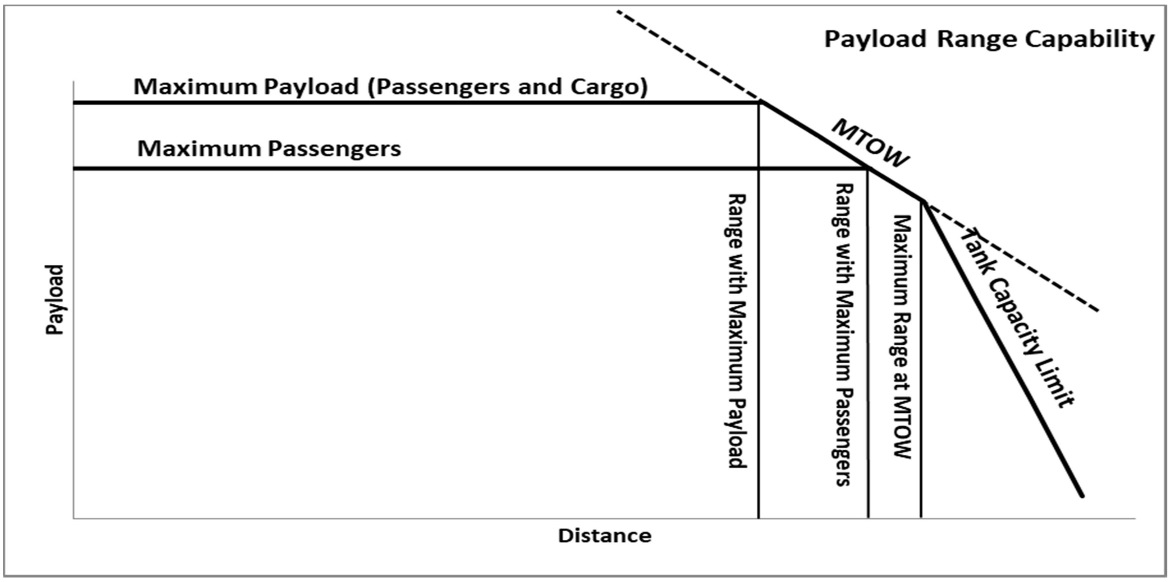

Figure 10 Payload Range Diagram

3.9 The Effect of Altitude on Range

Although more focused on reducing the probability of the creation of contrails through flying at lower levels, Filippone's [49] study on altitude flexibility of jet transport aircraft furthermore assessed the impact of fuel consumption. The increased fuel consumption resulting from reducing the flight altitude by 2000 feet can be offset by reducing the flight Mach number from Long Range Cruise (LRC) (defines as the specific range being 99% of maximum) to Maximum Range Cruise (MRC).

Reducing the flight altitude by 4000 feet would incur an approximate 1.5% penalty provided the aircraft is again slowed from LRC to MRC. However, as discussed in chapter 3.3, many airlines fly an economic Mach number determined by the cost index [3]. Economic range cruise is already lower than LRC, typically closer to MRC so that, practically, flying at lower levels will be penalizing to the airlines. For instance, for an A340-300, fuel consumption will increase as detailed in Table 1 [3] when flying at a prescribed cost index.

Flight Level	Fuel Flow Increment
Optimum + 2000 feet	+ 1.5%
Optimum Flight Level	-
Optimum - 2000 feet	+ 1.5%
Optimum - 4000 feet	+ 3.0%

Table 1 Altitude Effect on Fuel Consumption

3.10 The Effect of Wind on Range

Wind will have an effect on the maximum range Mach number to be flown, with an aircraft having to be flown faster into a headwind [36]. This is consistent with an earlier finding that M_{MR} increases with weight. For the same ground distance an aircraft flying into wind requires more fuel for the mission.

Wind can be noticeably different at different altitudes especially when flying close to any number of tightly focused jet streams permanently circling the earth, to the extent that the optimum altitude with wind effect can differ noticeably from that in still air conditions. Figure 11 presents the effects of wind on the maximum range Mach number.

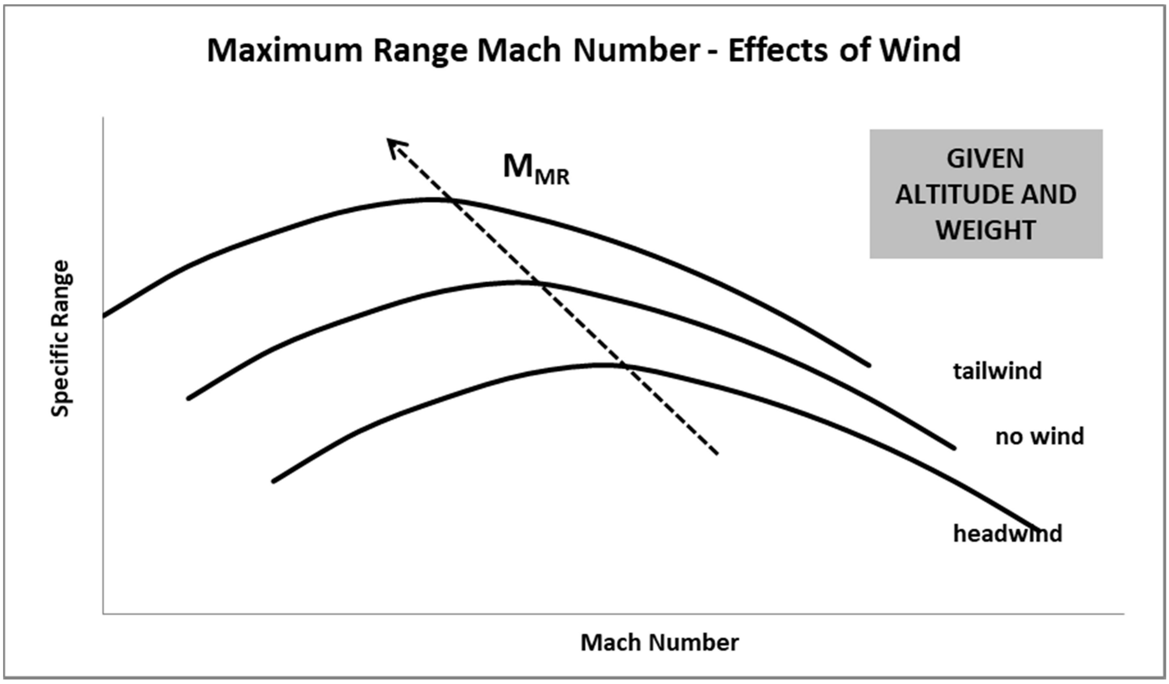

Figure 11 Maximum Range Mach Number Dependence on Wind

Assuming a parabolic drag polar (equation (10)), continuous cruise climb with negligible effects of crosswind components, Hale and Steiger [50] developed an estimation of the relative range of an aircraft with wind effects, starting from the Bréquet Range Equation (equation (7)). The equation, for a given weight, considers the relative airspeed parameter (θ) as the ratio of actual true airspeed versus the no wind best range true airspeed (V_{mr}):

$$R_{rel} = 4\left[\frac{\theta^2}{3\theta^4+1}\right]\left[\frac{\theta \pm \left(\frac{V_w}{V_{mr}}\right)}{1 \pm \left(\frac{V_w}{V_{mr}}\right)}\right] \tag{11}$$

Where the plus and minus denote tailwind and headwind respectively, and

$$\theta = \frac{V}{V_{mr}} \tag{12}$$

Best relative range is then achieved when $\theta = \theta_{mr}$ in accordance with Figure 11. Hale et al [51] found the improvement in range to be small, in the order of 2% for a wind fraction of 0.5 (V_w/V_{mr}) resulting from a speed reduction of around 10%. Conversely, a more noticeable improvement in relative range can be achieved through an increased true airspeed into headwind conditions, where such improvement is relative to the range at the zero wind maximum range true airspeed.

It is understood that the actual range into a headwind cannot be increased over the still air range capability. Rather, equation (11) illustrates that some of the effects of headwind can be reduced by increasing the true airspeed. However, long range aircraft are typically characterised by high wing loading and by high altitude cruising, with the no wind maximum range airspeed approaching the minimum drag airspeed, leaving little room for noticeable airspeed increases into headwind conditions.

3.11 Simplified Range Model based on Flight Data for Aircraft in Service

Randle, Hall and Vera-Morales [52] used actual flight data from Airbus A320, A330 and A340 and from Boeing 757, 767 and 777 aircraft to develop an improved simple model to predict aircraft fuel burn, taking into account environmental conditions.

Starting from the Bréquet Range Equation:

$$R = \frac{TAS}{SFC}\frac{L}{D}\ln\left(\frac{W_i}{W_f}\right) \tag{7}$$

This equation assumes that airspeed, lift-to-drag ratio and specific fuel consumption remain constant. In practical flight operations, these assumptions seems reasonable, given that, as discussed in chapter 3.10, long range aircraft characteristically cruise at high altitude with high wing loading [50].

If a Range Factor RF is now defined as

$$RF = \frac{TAS}{SFC}\frac{L}{D} \tag{13}$$

Fuel burn could then be predicted from:

$$\frac{W_i}{W_f} = exp^{\left(\frac{-R}{RF}\right)} \tag{14}$$

Combining with the fuel used W_{fuel}

$$\mathrm{W}_{fuel} = W_i - W_f \tag{15}$$

Equation (14) can be rearranged as:

$$W_{fuel} = W_i(1 - exp^{\left(\frac{-R}{RF}\right)}) \tag{16}$$

This equation is only applicable for the cruise phase of flight, so that the initial weight, W_i, equals the aircraft weight at top of climb, W_{TOC}. Further, this formula only considers engine efficiency and the aircraft cruise lift-to-drag ratio. As such, it is not suitable to short range flights with highly variable payloads, but can be expected to be representative for flights close to the payload range capability of the aircraft considered [52].

In order to study the effect of wind, consider that aircraft move within air masses. (In meteorology, an air mass is a volume of air defined by its temperature and water vapor content). The aircraft flies a given distance within these air masses. Simultaneously these air masses move over ground. Randle, Hall and Vera-Morales [52] found that, by considering the air distance flown, ground distance corrected for wind component, a far more accurate and consistent Range Factor could be derived from the flight data. Thus:

$$\mathrm{GS} = TAS + WC \tag{17}$$

This can be written as:

$$\mathrm{GS} = TAS\ (1 + \frac{WC}{TAS}) \tag{18}$$

And the air range is calculated from:

$$R_{air} = R_{gnd}\frac{TAS}{GS} = R_{gnd} / \left(1 - \frac{WC}{TAS}\right) \tag{19}$$

At high cruise altitudes the convention is to fly at Mach number rather than indicated airspeed, where:

$$TAS = M \times a = \; = M\sqrt{\gamma\, R_0\, T} \tag{20}$$

So that:

$$R_{air} = R_{gnd} / \left(1 - \frac{WC}{M\sqrt{\gamma\, R_0\, T}}\right) \tag{21}$$

And:

$$W_{fuel} = W_{TOC}(1 - exp\left\{\frac{-R_{gnd}}{RF[1 - \frac{WC}{M\sqrt{\gamma\, R_0\, T}}]}\right\}) \tag{22}$$

Equation (22) now allows for the atmospheric impact on range, correcting for wind and temperature variations. Naturally, the equation can also be applied to segments of the flight. Taking this one step further, defining a new Range Factor RF_0:

$$RF_0 = \frac{1}{SFC}\frac{L}{D} = \frac{RF}{TAS} \tag{23}$$

Equation (22) can be rewritten as:

$$W_{fuel} = W_{TOC}(1 - exp\left\{\frac{-R_{gnd}}{RF_0[M\sqrt{\gamma\, R_0\, T} - WC]}\right\}) \tag{24}$$

Then, only the specific fuel consumption and lift to drag ratio are assumed fixed. The effects of variations around wind, Mach number and flight temperatures can now be investigated.

In intending to determine the W_{TOC} Randle, Hall and Vera-Morales [52] in their study found that the amount of fuel used to climb to cruising altitude is fairly consistent across flights and aircraft types, averaging 1.52%. From their data, it can however be argued that the factors are around 1.48 for the long range aircraft (767, 777, A330 and A340) and 1.61 for the medium range aircraft (757, A320). It must be noted that these factors represent the difference in fuel that is actually burned during the climb and the fuel burned flying over the same distance at cruise level. Without therefore needing to correct for distance during the climb and by introducing a climb factor F_{clb} equation (24) can be re-written in terms of the take-off weight:

$$W_{fuel} = W_{TO}(1 - exp\left\{\frac{-R_{gnd}}{RF_0[M\sqrt{\gamma\, R_0\, T} - WC]}\right\} + F_{clb}) \tag{25}$$

Descents from cruising level are mostly performed using idle thrust. However, there will be phases of flight such as during approach procedures, where the aircraft requires some level of thrust above idle, typically at low levels where engine efficiency is low. Randle, Hall and Vera-Morales [52] found the fuel burn values relative to cruise flight over the same distance to range on average from 0.07% higher (medium range A320 and 757) to 0.19% lower.

Aircraft Type	Number of Flights	Bréquet Range Equation		Final Model	
		Mean Error %	Standard Deviation %	Mean Error %	Standard Deviation %
A330	1433	13.25%	13.33%	1.95%	4.32%
A340	1293	5.66%	20.11%	-1.15%	3.64%
777	966	8.86%	8.63%	0.37%	4.14%
ALL	**3692**	**9.44%**	**14.37%**	**0.45%**	**4.03%**

Table 2 Accuracy Comparison of Model equations versus Actual Flights [52]

The impact of the descent, given the variation, can be considered not significant when viewed against the accuracy of the model. Table 2 compares the accuracy of the Bréquet Range Equation and equation (25) against 3692 actual flights on 777, A330 and A340 as per the Randle, Hall and Vera-Morales [52] study.

3.12 Effect of Wind using the Simplified Range Model

It is instructive to next analyse the impact of environmental conditions on range, and compare these to the discussions in the preceding chapters. For this a representative range (for the subsequent research of this proposed thesis) of 7000 nm ground distance is considered, flown at M 0.83. The climb factor is assumed at 1.5%.

Interestingly, equation (25) does not require consideration of actual weight, rather the ratio of fuel burned to take-off weight suffices to perform such an analysis. Such a ratio of weight nevertheless is ultimately reflective of the aircraft design.

Assuming International Standard Atmosphere conditions (ISA), no wind, and a ratio of fuel burn to take-off weight of 33% allows the calculation the Range Factor RF_0. Wind component has thereafter been representatively considered up to ± 15 m/s (≈ 30 kts).

EFFECT OF WIND		
Wind Component	**Weight Ratio**	**Fuel Burn Impact**
-15 m/s	31.48%	-4.58%
-10 m/s	31.97%	-3.10%
-5 m/s	32.47%	-1.58%
0 m/s	32.99%	0.00%
5 m/s	33.53%	1.63%
10 m/s	34.08%	3.31%
15 m/s	34.66%	5.06%

Headwind component is positive
Tailwind component is negative

Table 3 Effect of Wind on Fuel Burn

As expected, the effect of wind can be quite noticeable. If the 7000 nm considered here are limiting, in still air conditions, in terms of the combination of maximum take-off weight and maximum payload, the payload range limiting point, then any headwind component requires an increased uplift of fuel at the sacrifice of payload. Equation (25) does not consider maximum take-off weight limitations nor tank capacity limits, a further impact on payload capability.

3.13 Effect of Mach Number using the Simplified Range Model

EFFECT OF MACH NUMBER		
Mach Number	**Weight Ratio**	**Fuel Burn Impact**
0.80	33.96%	2.92%
0.81	33.63%	1.93%
0.82	33.31%	0.96%
0.83	32.99%	0.00%
0.84	32.68%	-0.94%
0.85	32.38%	-1.86%
0.86	32.08%	-2.76%

Table 4 Effect of Mach Number on Fuel Burn

The effect of Mach number shown in Table 3 needs to be treated with caution. The results misleadingly seem to imply that fuel can be saved by flying faster. A shortcoming of equation (25) is that it does not recognise that there is an optimum Mach number to achieve maximum range. Flying faster or slower than the optimum Mach number requires more fuel to cover the same distance, be it due to the increased kinetic energy requirement of high speed or the increased form drag incurred at lower speeds. This is illustrated in Figure 12 [36]. Optimum Mach number maximises the spacing between available thrust and drag. Flying faster to increase range only applies when flying below the optimum Mach number.

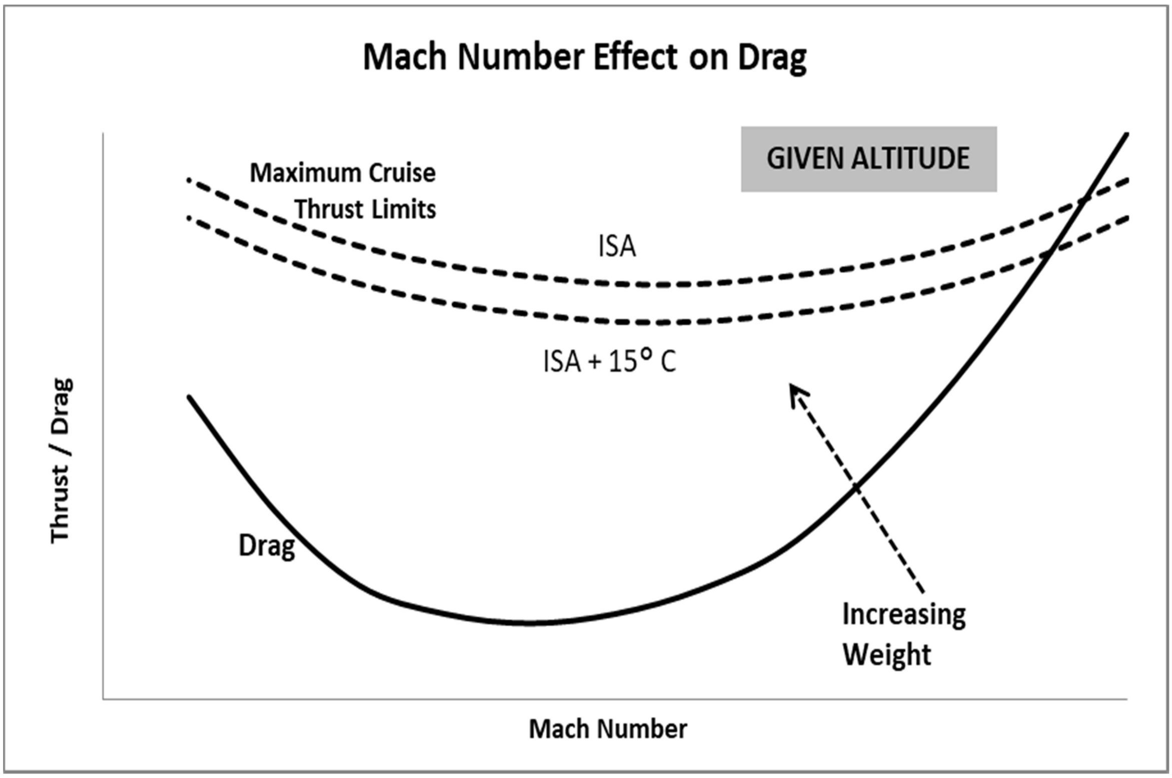

Figure 12 Mach Number Effect on Drag versus Available Thrust

3.14 Combined Effect of Wind and Mach Number using the Simplified Range Model

However, the situation changes when the combined effect of wind and Mach number is considered. Figure 11 reflects the impact of wind on the optimum Mach number, increasing into a headwind, reducing into a tailwind. This raises the question of how much the optimal Mach number changes as a result of wind effects. Figure 13 shows such variation in Mach number with wind effect for varying cost indices for an A340-313 [3] as considered in the study by Randle, Hall and Vera-Morales [52].

Cost index = 0 represents maximum range cruise. Long Range cruise cost index (1% reduction in range) for this aircraft is 50 kg/min with the economic cost index located between these two at current fuel prices. When flying for maximum range CI = 0 would be selected, and the optimum Mach number changes roughly linearly around ± 0.01 for ∓ 50 kts wind component. Table 5 shows the results of applying this principle to equation (25).

The extra fuel burn flying into headwind can be reduced slightly by increasing the cruise Mach number accordingly. Reducing the Mach number in tailwind conditions partly negates the fuel burn reduction, but benefits from an early arrival time. This seems consistent with the findings by Hale et al [50] [51]. Filipone [53] analogously discussed the potential benefits of flying at lower Mach Numbers. To get an accurate depiction of the combined optimal effect of wind and optimal Mach number requires the optimal Mach number to be determined for each aircraft type.

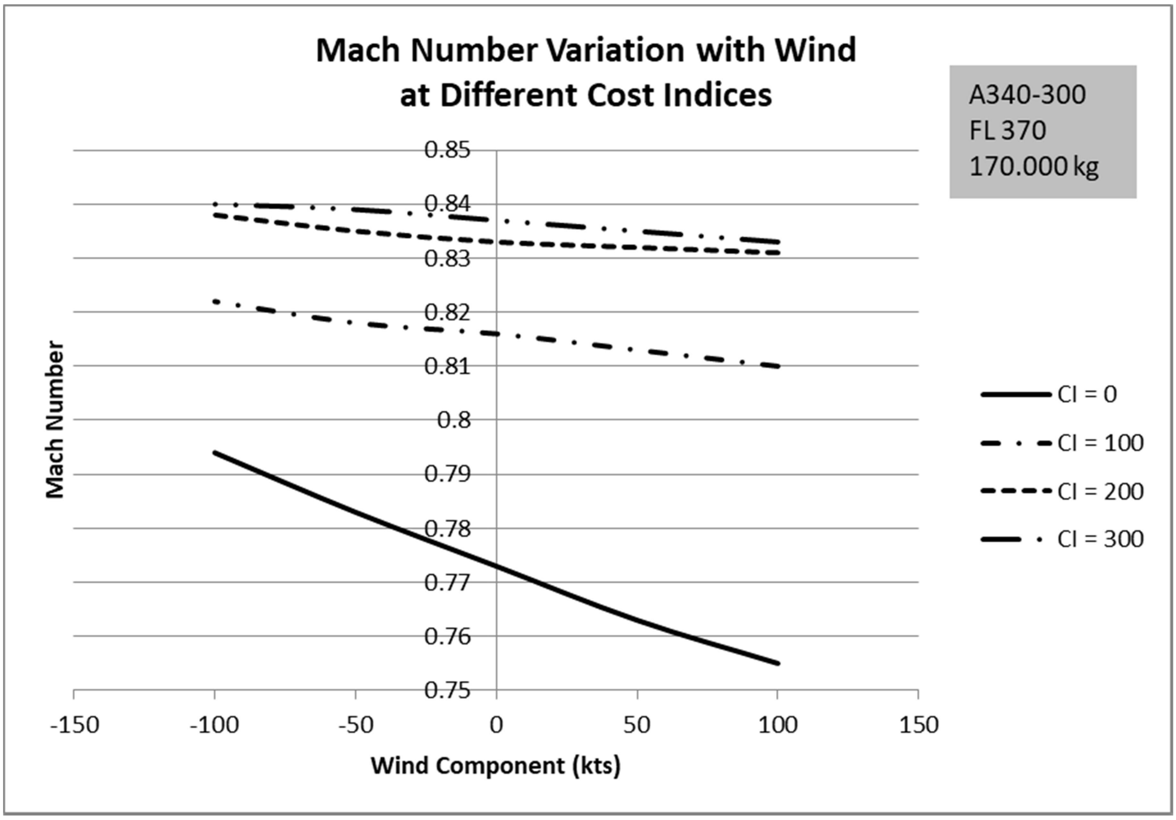

Figure 13 Variation of Mach Number with Wind Component at different Cost Indices

EFFECT OF WIND AND MACH NUMBER				
Wind Component	Mach Number	Weight Ratio	Range Impact	Change
-15 m/s	0.824	32.21%	-4.15%	-0.43%
-10 m/s	0.826	32.66%	-2.81%	-0.29%
-5 m/s	0.828	33.13%	-1.42%	-0.15%
0 m/s	0.830	33.61%	0.00%	0.00%
5 m/s	0.832	34.10%	1.47%	0.16%
10 m/s	0.834	34.61%	2.98%	0.33%
15 m/s	0.836	35.13%	4.54%	0.52%

Table 5 Combined Effect of Wind and Mach Number on Range

3.15 Effect of Temperature using the Simplified Range Model

Equation (25) seemingly also allows an assessment of temperature effects on fuel burn. The International Standard Atmosphere (ISA) stipulates that the temperature is a constant -56.5 °C above 36.090 feet. Variations of 5 °C were analysed around the ISA temperature. The results are presented in Table 6. The table implies that, flying in colder temperatures reduces the range, presumably due to air being denser, resulting in an increase in drag. According to the perfect gas law [54] (also known as the ideal gas law):

$$P = \rho \, R_0 \, T \tag{26}$$

Since aircraft fly along selected isobars, expressed as flight levels, above the mean sea level isobar (1013.25 hPa), density increases with decreasing temperature.

EFFECT OF TEMPERATURE		
Temperature	**Weight Ratio**	**Range Impact**
-71 ° C	33.93%	2.84%
-66 ° C	33.61%	1.86%
-61 ° C	33.29%	0.92%
-56 ° C	32.99%	0.00%
-51 ° C	32.70%	-0.89%
-46 ° C	32.41%	-1.76%
-41 ° C	32.13%	-2.60%

Table 6 Effect of Temperature on Range

At the same time, flying constant Mach number implies that the TAS decreases with decreasing temperature. In a sense, then, the impact is similar to flying into a headwind. The effect of a five degrees Celsius decrease in temperature can be approximately offset by a 0.01 increase in Mach number, according to equation (25).

Again, some caution is required as the effect on engine performance has not been considered here. Figure 12 would infer that engine performance reduces in warmer conditions, implying that the impact on fuel burn is overstated when temperatures increase and vice versa.

3.16 Optimum Altitude and the Simplified Range Model

A final limitation of equation (25) is its seeming independence of the (optimal) cruise altitude. Over a very long range flight as sampled here an aircraft will step climb repeatedly, typically starting at, wind dependent, around FL 310 or FL330 (31.000 or 33.000 feet above Mean Sea Level) and steadily climb in 2000 feet increments (within air traffic control structures) to FL 390 or FL410. Equation (25) should therefore be applied in accordance with these step climbs.

The (optimum) Mach number may vary for each altitude in addition to the air temperature, so that the true airspeed varies accordingly for each flight segment. Also, the climb factor, if not minimal, will require adjusting for each segment F_{clb}. Invariably, these factors contribute to the mean errors observed in Table 2. A 2% error may seem negligible in engineering terms but can translate into 20 to 30 passengers less on a flight.

3.17 The Payload Memoranda

Whilst last minute travel does occur, typically either for urgent business or as a result of last minute holiday package offers, this is not the norm at regular schedule airlines. Low cost carrier have a different business model and are currently only found in the short to medium range market segments.

Rather, given the cost, effort and distance of travel involved passengers tend to book well in advance. This creates a number of challenges for the air carriers. An aircraft seat is a perishable commodity: once flown it cannot be recovered. Airlines therefore seek to fill all seats on the aircraft for each flight.

Concurrently, airlines wish to maximise their revenue, e.g. the perishable commodity necessitates being priced “just right”, by pricing competitively but with due consideration of whether a market is under capacity, over capacity or balanced in supply and demand [55]. Airlines consequently utilize yield management systems to control demand through differential pricing.

With yield management systems pricing can be differential on a route depending on time of day (where there are multiple flights per day), day of week and season, to match supply and demand optimally. Supply is only adjustable in discrete batches, number of seats per aircraft. Where demand is hugely variable airlines can adjust using different types of aircraft, as available. On a daily multi-frequented route it might well be prudent to fly a combination of single aisle and wide body aircraft types, varying the discrete offering from 100 seats to 400 or more seats.

On long and very long routes flexibility diminishes, constrained by the range capability of the aircraft types available, flexibility becomes limited to, perhaps, 250 seats to 350 seats. On ultra-long range flights only one aircraft type in the fleet might be capable of servicing a particular route. Flexibility then only exists around the number of flights per day / week to match demand.

Complicating matters further are routes that are at the payload range limits of the aircraft types available. The aircraft may or may not be able to carry a full load of passengers (and cargo). Such additional constraints are typically seasonally variable. When flying westbound into the globally prevailing westerly wind system around the numerous permanent westerly jet streams the payload range capability can be impacted noticeably. Further, when operating from "hot and high" airfields an aircraft may not necessarily be able, due to engine performance limitations, to lift off at maximum structural weight limits.

Nevertheless, in order to utilize the yield management systems effectively, the airlines' revenue departments require, well in advance, the number of sellable seats for each flight. On regular scheduled air carriers flights open for booking up to a year in advance. To assist the revenue department the flight performance department of the air carrier therefore regularly produces payload memoranda, estimating the likely capability of each route over a set period. How this is achieved varies between airlines: An example would be that these payload memoranda get calculated bi-annually, analysing flight capabilities on a monthly or weekly basis over the review period, based on expected conditions over each sub-period.

Predicting six months or more ahead of the actual activity can only be based on long term forecasted environmental conditions. Depending on risk appetite, an airline needs to stipulate the probability level of forecasting. A higher probability reduces the risk of denied boarding of an overbooked flight when conditions are worse than forecast, but increases the airline's risk of flying empty seats on the day of operation, when conditions are better.

This is best illustrated utilizing the previous example of a 7000 nm ground distance route, applied to equation (25). To illustrate, the headwind is assumed normally distributed with a (representative) mean of 15 m/s and a standard deviation of 1.93 m/s. The results are shown in Table 7. In percentage terms, the impact appears small, 1.4% spread in weight ratio between the minimum and maximum likely headwind components. However, when a wide-body long range aircraft weighs, say, 300.000 kg at maximum take-off weight, 1.4% equates to 42 passengers and their bags, taken at an average of 100 kg per passenger. Further, when such an aircraft has 300 passenger seats, potentially 14% might not be fillable if the aircraft operates a route in the payload versus fuel trade-off part of the payload-range graph.

EFFECT AND PROBABILITY OF WIND		
Headwind Component (HWC)	**Probability of HWC equal to or less than**	**Weight Ratio**
9 m/s	0.1%	34.0%
11 m/s	1.9%	34.2%
13 m/s	15.1%	34.4%
15 m/s	50.0%	34.7%
17 m/s	85.0%	34.9%
19 m/s	98.1%	35.1%
21 m/s	99.9%	35.4%

Table 7 Sample Probability of Wind Distribution

If an airline plans, say, on a conservative 85% probability of winds in its payload memoranda then it risks operating with 27 empty seats that could have been filled, alternatively off-loading 15 passengers should the headwinds turn out stronger than expected. Regardless of the airline's risk appetite, the impact on a payload range critical flight can be significant, either through lost revenue, or through denied boarding compensation.

3.18 The Accuracy of Flight Planning Systems

On the day of operation commercially available flight planning systems are remarkably accurate. Utilizing predictive weather algorithms that are sufficiently accurate in the short term of up to eighteen to twenty four hours before the intended time of arrival at destination, long range intercontinental flight predictions are typically accurate to within less than five minutes in the author's experience, an accuracy of better than 1%.

More important, though, is the accuracy of the fuel prediction as this directly affects the payload that can be carried, particularly on payload range limited flights. Regulatory authorities require flights to carry contingency fuel to allow for unforeseen / unforeseeable events. Typically, this relates to weather avoidance / circumnavigation of thunderstorm activity, alternatively or additionally to air traffic control constraints such as an inability to fly at the optimum flight level for portions of the flight.

In its basic form, depending on the regulatory framework, a flight is required to carry five percent of the trip fuel as contingency, but not less than the fuel equivalent to five minutes cruise flight and not more than the equivalent of twenty minutes cruise flight. This can be reduced to three percent fuel contingency provided a suitable enroute alternative airfield, meeting a number of stringent conditions is available within the time frame of operation of the flight.

In an airline specific internal study some time ago, the author analysed approximately three thousand long range flights, between six and fourteen hours stage length. The results are presented in Figure 14. 38% of flights using less than the planned trip fuel could indicate that flight planning systems are conservative in their fuel predictions. However, some of these fuel savings can well result from routing short cuts. Such shortened routing is equally not predictable otherwise they would be considered during the planning phase. 96% of flights use less than 3% of their contingency fuel justifying the utilisation of the three percent contingency with enroute alternate option.

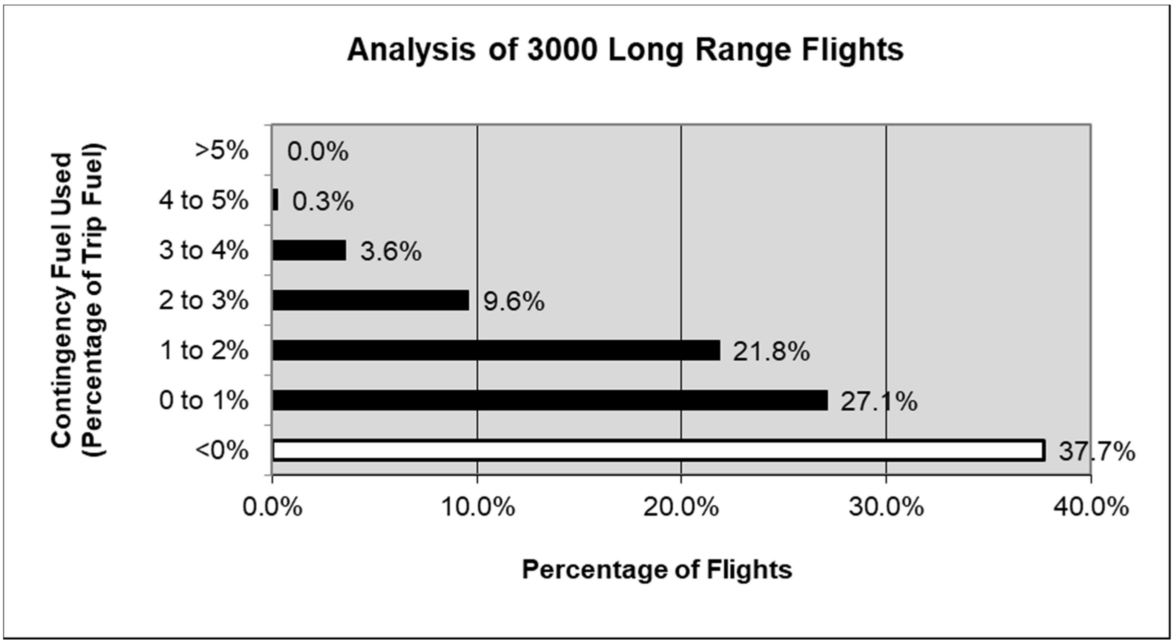

Figure 14 Study of Contingency Fuel Usage of 3000 Long Range Flights

Note: Exceeding the three percent contingency allowance does not necessarily result in an in-flight diversion. Depending on prevailing conditions the aircrew can assess the safety impact and continue to destination. Fundamentally then, modern flight planning systems seem sufficiently accurate within the regulatory prescribed fuel reserve to not place flights at risk yet not have flights carry excess fuel at the cost of payload.

4 RESEARCH RATIONALE

4.1 Statement of Problem

Where aerodynamics and propulsion are in themselves advanced disciplines capable of providing accurate predictions, flight performance is not, relying instead on empirical flight data, as far as available, for performance predictions. Fundamentally, flight planning is performed by utilizing an incremental table look-up routine that provides for typical flight profiles.

Semi-empirical approximations available in the literature require cautionary application with a full understanding of limitations resulting from the assumptions made. They thus do not currently offer more user friendly procedures for analysing thousands of flights or flight options. The flight performance analyst remains destined to calculate the regular payload memoranda required by revenue / yield management, flight by flight.

Depending on aircraft fleet size and mix, a mid-sized air carrier operating, say, fifty aircraft can easily complete 60.000 flights annually. Yet the flight performance department will consist of only a handful of specialists. Accordingly, neither the tools nor the capacity exists to continually refine the projected capabilities of aircraft on the air carrier’s network. Payload memoranda get calculated, typically, every half year, based on environmental conditions forecasted far ahead of the actual flight or groups of flights. Inevitably, predictions so far in advance are prone to inaccuracies, being based on historic observations without the foresight of any impending global weather patterns that might modify environmental conditions.

Typically, aircraft capabilities are presented in payload memoranda averaged over a specific week or month. Consequently, some tolerance around the predicted values is inevitable, with the inherent risk of either flying empty seats or having to refuse boarding. Both are financially unpalatable to a service industry having minimal margins, with the added risk of disgruntled customers that cannot get seats (even though available) or are denied boarding when seats available are less than expected.

Ideally, therefore, payload memoranda should be continually re-evaluated as a flight or series of flights draw closer, the available payload capacity continually being revised. This is currently not being done, not currently practically possible.

4.2 Research Objective

Currently, payload capabilities are forecast biannually for a six month period. Monthly average winds and temperatures are assumed at a chosen probability level, typically 85%, to determine fuel requirements. Assuming maximum take-off weight capability in each instance, the resultant payload capability translates into the number of passengers that can be carried per flight for the month. Where monthly average environmental conditions prevent carrying a full load of passengers, of filling all seats, the sellable seats get restricted to prevent overbooking. Such restrictions never get re-assessed until the day of flight, as there would be no value to do so. A repeat of the analysis closer to the time of departure would be based on the same monthly average environmental conditions and would thus yield the same monthly average payload capability.

As a result, experience has shown that aircraft leave with empty seats, which could have been sold. Alternatively, passengers are denied boarding as a result of environmental conditions being more restrictive on payload capability than originally anticipated. Either scenario has negative implications for any airline. A more refined dynamic approach is required to more optimally provide payload capability predictions.

The aim of this research is to develop a forecasting model that more readily allows for a continual in-depth re-evaluation of an aircraft's route capability so as to ultimately minimise the risk of flying with vacant seats that could have been sold, respectively to minimise the risk of denied boarding of passengers. Such a forecasting model must analyse capabilities daily rather than monthly.

To do so requires an analysis of how, and to what extent different contributing factors affect aircraft route performance, particularly fuel requirements. Since it is impractical to calculate large numbers of flight plans repeatedly, trip fuel requirements need to be determined empirically based on those environmental factors that influence trip fuel requirements as the independent variables. Further, such environmental factors need to be assessed for their predictability. Empirical estimations of such environmental factors need to be modelled. Finally, these combined empirical estimations will form the basis for scenario planning using Monte Carlo simulation.

4.3 Scope and Limitations

This research focuses on payload range limited routes where environmental factors at times prevent the aircraft being operated at maximum payload capacity. A particular ultra-long range route has been targeted. As the information pertaining to this route is commercially sensitive for the air carrier involved, the data is de-identified.

5 METHODOLOGY

5.1 Introduction

Any predictive framework to be developed here necessarily needs to be sufficiently accurate in output yet practical in application. Accuracy sufficiency requires inclusivity of all relevant parameters significantly influencing the overall flight performance. Accuracy sufficiency in this context is to be determined by the impact on the number of passengers that can be carried on the flight. Any parameter affecting the available passenger load by a percentage to be determined must be deemed to be of significant influence.

Utilizing parameters averaged for the entire flight, even with variance analysis, may possibly not be adequate when intending to determine optimized performance. An analysis per route segment may improve predictability, as environmental conditions may vary noticeably during the flight. This then poses the question of how to divide a route into segments. An option might be to analyse according to flown altitudes. Airliners do not have the luxury, given a variety of necessary air traffic control constraints, such as separation from other aircraft especially in non-radar remote environments (oceanic regions), of flying continuous cruise climb designed to sustain optimal flight levels at all times.

Typically, airliners will fly at fixed flight levels for extended periods, before climbing, occasionally even descending, to the next permissible flight level to again operate closer to the wind effect adjusted optimum. Throughout such route segments environmental conditions rarely remain sufficiently invariant to simply be averaged, without further thought. For instance an increasing head wind throughout the route segment will affect the fuel burn differently, albeit slightly, than a decreasing headwind, on average resulting in the same flight time. With weight reducing with fuel being burned, the thrust requirement to maintain the optimal speed, which in itself varies with wind, as depicted in Figure 11 and Figure 13, remains weight dependent. Varying temperatures can further complicate matters. Clearly, any analysis necessarily remains multi-variant and non-linear multi-dimensional. Necessarily, a sensitivity assessment of external dynamics on cruise phase variance is therefore a prerequisite component of any model construct.

Achieving the objective of maximised payload necessarily requires an iterative process for any given set of environmental conditions. Equation (25) derived in chapter 3.11 requires prior knowledge of the take-off weight to be available:

$$W_{fuel} = W_{TO}(1 - exp\left\{\frac{-R_{gnd}}{RF_0\left[M\sqrt{\gamma\, R_0\, T} - WC\right]}\right\} + F_{clb}) \tag{25}$$

Modern flight planning systems are capable of determining route performance maximum take-off weight capability, assuming no take-off runway capability limitations. Given the commercial nature of such analytical tools the underlying algorithmic processes are not transparent. Consequently, uncertainty remains as to the inherent depth of iteration. Nevertheless, the absence of a flight planning tool in any multi-fleet multi-route airline environment seems inconceivable particularly in an environment where fuel constitutes up to 30% of direct operating costs. Carrying an extra, say, 100 kg of fuel unnecessarily may not seem much. But when considered against the 12.5 million flights performed by IATA carriers in 2015 [56], such analytical tools amortise themselves literally within days.

Flight planning systems constitute a powerful tool to any air operator both in day-to-day operation and in forward planning. Yet the forward planning aspects seem to currently not be utilized optimally, as discussed in chapter 3.17 on Payload Memoranda. Fundamentally, the approach to forward planning invariably is to determine the most likely prevailing conditions on a given day of operation, applying these conditions in the flight planning tool, in an iterative process, to maximise the payload as the desired outcome of this study. This might not be practical though, as a concurrent sensitivity analysis around the determined mean is necessary. The analysis reverts back to multiple scenario planning with numerous flight plans needing to be calculated.

5.2 Data Analysis Requirements

Following on from the discussion in chapter 5.1, a necessary first step must be to analyse the inadequacies of the current methodology of deriving payload memoranda (refer Chapter 3.17). It is somewhat futile to engage in developing a new model if the practical impact of current practices is minimal on the operational reality or if the potential improvement from such a model is not significant.

A number of approaches are possible here: Foremost, an analysis of the deviance between actual performance on the day of operation and predicted performance capability is directly reflective of what an airline potentially faces. Such an analysis can, however, only be comprehensive if, in each instance, the aircraft is operated at maximum possible payload capacity. Invariably, not all flights are operated to maximum operational capacity; payloads vary seasonally and by day of week and are further dependent on variances in market mix, business versus leisure travel. It may thus become necessary to determine maximum payload capability retrospectively utilizing the actual meteorological conditions at the time.

Alternatively, forecast weather data from a number of meteorological centres typically is obtainable as mean and variance. It is therefore possible to (re)construct representative payload memoranda, using the prevailing methodologies, to achieve a comparable understanding of the magnitude of deviance between forecast and actual. A further consideration possibly worthy of analysis is the time effect of forecasting. Variance around the mean is likely to reduce with diminishing time frames.

Nevertheless, an analysis of actual flown flight data will be performed over an appropriate time interval. Where / if necessary, with the environmental factors identified at any given moment, it should be possible to reconstruct the actual performance capability limit retrospectively.

5.3 The Impact of Global Weather Patterns

Fundamental to any model to be developed is necessity. Therefore, establishing the requirement for a model construct necessarily requires some level of inadequacy of current methodologies. This needs to be established. Deterministic here, with reference to the required time interval, is whether a particular route under study is payload range limited throughout the year or only seasonally. For instance with prevailing jet streams, all but one circumventing the globe west to east, generally west bound flights affected by jet streams take longer than the reverse east bound flights following the same routing, such variances fluctuating seasonally.

A review of long and ultra-long airline scheduled flights quickly reveals a two hours or more difference between west bound and east bound flights, even if routings (where possible) are designed to maximise use of tail winds, minimise effects of headwinds. Examples are flights between Europe and Western North America, Europe and South America, Africa and South or North America, Africa and Australasia.

The predominant, but not exclusive, jet streams are the polar and subtropical jet streams found at heights between 10 and 15 km, at aircraft cruise levels, reaching speeds in excess of 300 km/h, as Figure 15 shows. During the respective winter months, the arctic and tropical air masses create stronger surface temperature differentials causing stronger jet streams. Conversely, during the summer months, when the surface temperature variation is less dramatic, the winds of the jet are weaker [57].

An aircraft type operated on an ultra-long route in a direction with a substantial westerly component consequently is likely to be variably affected throughout an annual cycle as the prevailing winds vary. Where such an aircraft type's payload range capability is reduced below maximum payload throughout the entire annual cycle, conceivably an airline may find it uneconomical to operate the route regardless, a 850 km/h still air cruise speed potentially affected by a 300 km/h headwind, even partially encountered, being substantial. Optimising flight altitudes and cruise Mach Numbers, as discussed in Chapter 3 (Figure 1,

Figure 2, Figure 11) are unlikely to be sufficiently effective to negate wind effects adequately.

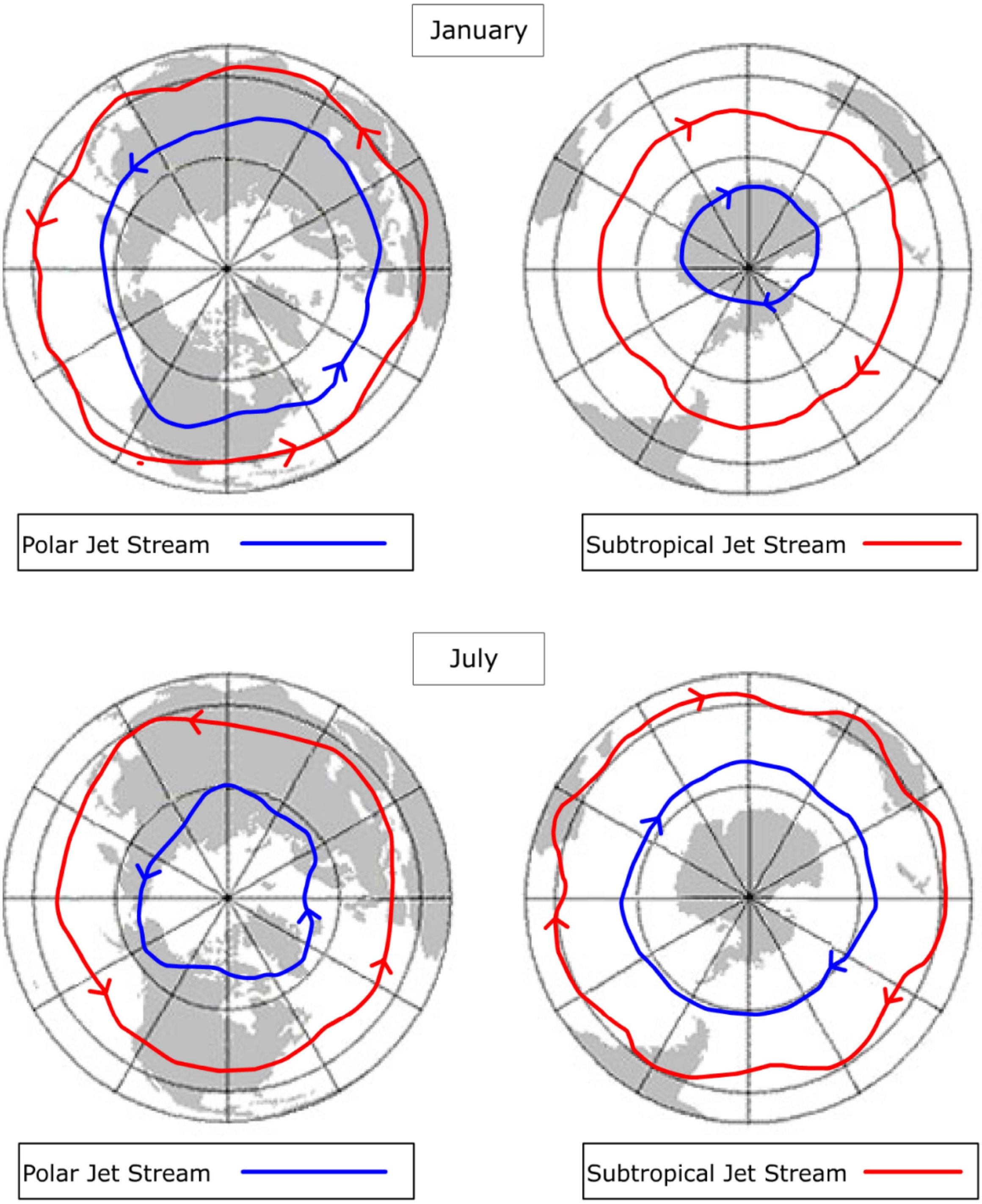

Figure 15 Northern and Southern Hemisphere polar views of the paths of Polar and Subtropical Jet Streams [58]

The circumstances differ for mostly north-south flights. The wind impact remains minimalistic even when crossing jet streams. Annual payload range capability can be expected to be reasonably consistent annually, presumably negating the essentiality for a more predictive model.

Invariably, sensitivity analyses, understanding the scale of different contributing factors to the aircraft performance, are paramount to the construct of an effective modelling tool and are therefore necessitated as part of the analytical component of this thesis.

5.4 Statistical Modelling

Evident from the discussion in this Chapter 5 the potential sources of variance are enormous, implying that potentially thousands of flight plans need to be calculated. Within a resource constrained flight planning department this becomes impractical especially when needing to be done on a repetitive basis. A once-off mammoth exercise could of course be conducted of calculating sufficient numbers of flight plans to provide data for a to-be-determined sufficiently large spread of possible combinations of influencing parameters and their variance, then “select” the one that represents the most likely scenario (or as close as possible there-to) on any given day. The prerequisite to determine the likely scale of influencing factors remains.

A convenient instrument in this regard, having found wide spread application throughout numerous disciplines, as discussed in detail in Chapter 10, is the Monte Carlo Simulation [59]: Using computer algorithms to simulate the variables in a complex problems, then running the algorithm relatively large number of times creates a statistical data set of model behaviour. On the basis that flipping a coin a sufficient number of times will ultimately produce an equal number of “heads” and “tails” the Monte Carlo Simulation presents a powerful tool for predicting likely outcomes of complex multifaceted problems.

In principle, the Monte Carlo method can be used to solve any problem having a probabilistic interpretation, as is the circumstance here. By the law of large numbers, integrals described by the expected value of some random variable can be approximated by taking the empirical or sample mean of independent samples of the variable [59].

In the context of this research, for each set of inputs randomly generated around each specific probability distribution a deterministic computation is performed. Starting with the assumption that the aircraft is maximum structural take-off weight capable at point of departure, the fuel requirements can be determined. Where the fuel requirements (including regulatory operational reserves) remain within the aircraft’s fuel capacity the available payload is easily determinable. Should the fuel requirements exceed capacity, however, an iterative process will need to commence, progressively reducing the actual take-off weight until the fuel requirement equals capacity. Available payload is then calculated.

These processes are repeated in sufficient numbers, to be determined, to obtain an aggregate of results of sufficient probabilistic reliability. The target probability levels are subject to the risk appetite of the operator; trading off the consequences of denied boarding resulting from actual payload capability less than predicted versus revenue loss from actual payload capability being more than predicted, where expected demand exceeds or can exceed supply.

The dependence on commercially available flight planning systems remains potentially constraining for practical application of Monte Carlo simulations on a repetitive continuous basis. Nevertheless, in order to compare any new method it remains useful to use “classical” methods.

5.5 Numerical Modelling

In September 2008 the EADS Foundation-Centrale Nantes Research Chair was created, aimed at structuring existing research and developing advanced courses and collaborative research projects on advanced modelling and simulation of materials and processes for the aerospace industry. For this purpose, strong collaborations with many outstanding researchers in the area of materials, processes and computational engineering was initiated to ensure a change of paradigm in the advanced modelling and simulation of complex materials and processes.

During the first four years of activity the work focused on the development of a new simulation paradigm allowing for the solving of models previously unresolved and introducing spectacular CPU time savings in the process. More recently a new paradigm has been proposed for simulation-based engineering sciences called Proper Generalized Decomposition, PGD [60].

Today many problems in science and engineering remain intractable, in spite of the impressive progresses attained in modelling, numerical analysis, discretization techniques and computer science during the last decade, because their numerical complexity, or the restrictions imposed by different requirements (real-time on deployed platforms, for instance) make them unaffordable for today’s technologies. Fundamentally, as one aspect, Proper Generalized Decomposition seeks to address the curse of dimensionality by reducing the number of degrees of freedom as much as possible.

Consider a flight made up of a number of n discrete flight segments x_i, each such segment being dependent on "m" external parameters "y", such that:

$$x_i = f(y_1, y_2, \dots y_m) \tag{27}$$

And:

$$Result \ = f(x_1, x_2, \dots x_n) \tag{28}$$

Then PGD seeks to approximate the Result as follows:

$$f(x_1, x_2, \dots x_n) \approx \sum_{i=1}^{N} F_i^1(x_1) \times F_i^2(x_2) \times \dots \times F_i^n(x_n) \tag{29}$$

Without knowing either the form of each approximation function F_i^n or the number "N" of approximation functions required upfront, the degrees of freedom nevertheless reduce substantially from m^n to m x n x N. The PGD approximation gets constructed by successive enhancement, whereby each functional product is determined sequentially.

All numerical experiments carried out to date [61] with the PGD demonstrated the number of terms N required to obtain an accurate solution is not a function of the problem dimension n, but rather depends on the regularity of the exact solution. The PGD thus appears to avoid the exponential complexity with respect to the problem dimension. In many applications studied to date [61], N is found to be as small as a few tens, and in all cases the approximation converged towards the solution, creating confidence about the generality of the approximation as shown by equation (29), but its optimality depends on the solution regularity and the nature of the differential operator. When an exact solution of a particular problem can be represented with enough accuracy by a reduced number of functional products, the PGD approximation becomes optimal [61].

The sensitivity analyses to be performed during the analytical section of this thesis, as alluded to in this chapter, will help guide the development of approximate functions. Further, conceivably the approximate functions will need to be developed first for application within the Monte Carlo simulation.

6 DATA ANALYSIS – OUTBOUND FLIGHT

An understanding of the payload capability dependency on environmental conditions is a prerequisite. A particular route of about 7000 nm from a specific home base with a strong west bound component into predominantly headwinds is considered. Invariably, the return flight benefits from predominantly tailwind components, resulting in related improved payload capabilities.

To obtain representative data, average environmental conditions (50% probability weather) and 85% probability weather conditions are conveniently considered monthly. Three routes are utilized outbound to moderate the effect of headwinds (of which one is utilized only during one season) and one route for the return flight. Accordingly, a total of 86 flight plans were analysed. The flight plans were obtained from the commercially available flight planning system by SITA, a company specializing in air transport communications and information technology.

The probabilities present the likelihood of the particular weather scenario (winds, temperatures) occurring, or (operationally) better. 85% probability is often used by airlines' flight performance departments to establish payload memoranda. In the context of this section of the analysis, though, these probabilities merely provide a means to generate a weather pattern for calculating aircraft performance.

The data is obtained using the flight planning tools available at the airline, whose route is being analysed. As the ultimate intent is to establish maximum payload capability, in each instance, maximum take-off weight is assumed, implying there are no performance limitations during the take-off phase further impeding aircraft capability. The flight planning tool is then allowed to optimise the flight in terms of routes flown and flight level variance throughout the flight.

Due to the sensitivity of the data, rather than considering actual weights and distances, the following relativity expressions will be utilized:

$$Payload\ Capability\ (\%) = \frac{Payload\ Capability\ (kg)}{Number\ of\ Seats \times Average\ Weight\ per\ Passenger\ (kg)} \tag{30}$$

$$Fuel\ Weight\ (\%) = \frac{Fuel\ Weigh\ \ (kg)}{Maximum\ Structural\ Take{-}off\ Weight\ (kg)} \tag{31}$$

$$Distance\ (\%) = \frac{Distance\ (nm)}{Great\ Circle\ Distance\ between\ Origin\ and\ Destination\ (nm)} \tag{32}$$

Such "normalization" of the data nevertheless remains unique to a specific aircraft type operated in a specific configuration by the air operator. The "normalized" data is displayed in Appendix 8 to Appendix 10 for the outbound flight.

Producing results larger than 100% hereby is not contradictory. For instance, large transport aircraft are capable of carrying the maximum certified passenger load as well as cargo. The difference between the structural maximum zero fuel weight limit and the operating empty weight (airline specific according to the chosen interior layout) determines the structural payload limit. For the aircraft type and configuration under consideration maximum structural payload capability exceeds 150% of maximum passenger load.

6.1 Climb and Descent / Approach Fuel Requirements

Appendix 1 tabulates the fuel requirements for the climb to the first enroute waypoint after the initial cruise flight level is reached, and the fuel requirements for the descent and approach from the last enroute waypoint where final cruise level had been maintained. The table in Appendix 1 further reflects the trip fuel requirements (excluding reserve fuel requirements) and, corrected for climb and decent / approach fuel requirements, the cruise fuel requirements.

The climb requirements, as expected since Maximum Structural Take-off Weight is assumed in each instance, are consistently 2.15% of MTOW with a negligible standard deviation of 0.01%. At first glance this would appear to differ from the findings by Randle, Hall and Vera-Morales [52] who in their study found that the amount of fuel used to climb to cruising altitude is fairly consistent across flights and aircraft types, averaging 1.52%. The approach taken here is slightly different, though, as the total fuel required to reach the first enroute waypoint where a cruise level is maintained is reflected in Appendix 1. Randle, Hall and Vera-Morales [52], on the other hand, analysed the additional fuel requirements for the climb without having to correct for distance flown. The descent and approach fuel, similarly established, constitutes 0.48% of MTOW, again with a negligible standard deviation of 0.01%.

Depending on time of year, three different routes are utilized for the outbound flight. Nevertheless, the first and last enroute cruise points are identical for all three routes.

6.2 Effect of Wind

It is instructive to establish which independent variables are deterministic in predicting fuel requirements, and to what degree. Reasonably, with the outbound flight planned block time being more than an hour longer than that for the return flight, wind effects are expected to be the primary determinant. As a starting point, therefore, the effect of the average wind component affecting the flight is analysed.

As the outbound flight has the choice of three different routings with different ground distances covered, the ground cruise distances between the common initial and final enroute cruise waypoints being 97.6%, 97.8% and 98.9% of the great circle distance between departure and destination, the data does not necessary allow direct comparisons of average wind effects. The same average wind component will result in more fuel burn over a longer distance travelled.

One approach therefore is to determine the equivalent ground distance the aircraft would have to traverse in still air conditions, to require the same amount of cruise fuel as for the average wind component, in accordance with:

$$Equivalent\ \ Ground\ Distance\ = \left(\frac{Ground\ Distance}{Cruise\ Time} - Wind\ Component\right) * Cruise\ Time \qquad (33)$$

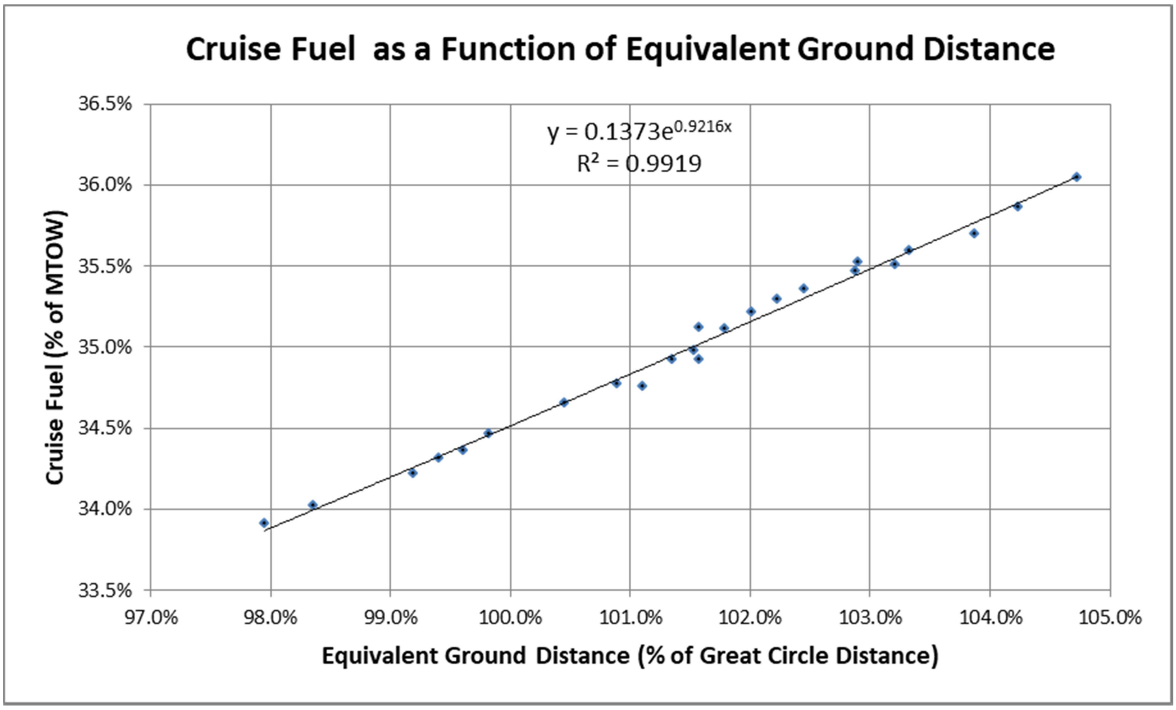

Figure 16 Cruise Fuel Requirements versus Equivalent Still Air Distance

Linear, second order polynomial and exponential trend lines yield identical R-Squared values. The exponential trend line was chosen in line with equation (25). This is further in line with Figure 9 indicating a mildly exponential increase in fuel requirements with distance travelled.

To recap, the correlation coefficient R-Squared interprets as the percentage of variability of the dependent variable (here cruise fuel requirements) that is explained by the independent variable (here equivalent ground distance) [62], expressed as:

$$R\ Squared = 1 - \frac{Sum\ of\ Squares\ Error\ (SSE)}{Sum\ of\ Squares\ Total\ (SST)} \tag{34}$$

Where:

$$SSE = \sum_{i=1}^{n} (y_i - \hat{y})^2 \tag{35}$$

And:

$$SST = \sum_{i=1}^{n} (y_i - \bar{y})^2 \tag{36}$$

R Squared consequently measures the predictability / dependence of the dependent variable on the independent variable. Necessarily always a value between 0 and 1, a value of 1 accordingly implies that the dependent variable is 100% explainable by the variation in the independent variable.

At 99.2% the results of the regression, subject to further analysis as below, certainly imply an exceptionally strong dependence on the effect of wind over all other factors. Naturally, the trend line equation is only applicable within the narrow band of cruise fuel requirement variation applicable to this particular city pair connection. Letting "x" be 0% in the trend line equation in Figure 16 would otherwise imply a cruise fuel requirement of 13.7% for no distance travelled.

Nevertheless, the use of the exponential trend line is justified since, from equation (25):

$$dW_{fuel} = -W_{TO} * exp\left\{\frac{-R_{gnd}}{RF_0\left[M\sqrt{\gamma\, R_0\, T} - WC\right]}\right\} dR_{gnd} \tag{37}$$

Based on the adage that fuel is burned to carry fuel, hence the exponential nature of fuel requirements, the extra fuel carried to counter headwinds results in further extra fuel usage for the fuel carried. Mitigating this effect, though, is the assumption of maximum take-off weight in each instance, so that any additional fuel burn is ultimately reflected in the duration of flight, again embodied by the equivalent ground distance adjustment.

The strength of the result is unanticipated, though, as the expectation would have been for less of a correlation to averaged wind conditions, as discussed under 5.1, reinforced by the discussion on jet stream seasonal variance under 5.2. Accordingly, it remains instructive to review the head- / tailwind component variance throughout the flight respectively the seasonal variation there-of.

This can only be done by route. The motivation for choosing differing routes is to minimise the time expended heading into the strongest headwinds, heading more westerly where the prevailingly westerly wind systems lessen, more northerly where they predominate. The outbound flight has three routing options:

- "Route 1", with the least ground distance, minimises fuel requirements most effectively June to December.
- "Route 2" yields the lowest fuel requirements in February to May.
- "Route 3", the longest in terms of ground distance, only really prevails in January.

Seasonally variant, the flight starts in geographic proximity of the southern tropical jet stream, passes through the equatorial regions and transgresses the area where the northern tropical jet stream is prevalent, as depicted in Figure 15. Appendix 2 and Appendix 3 reproduce the underlying data.

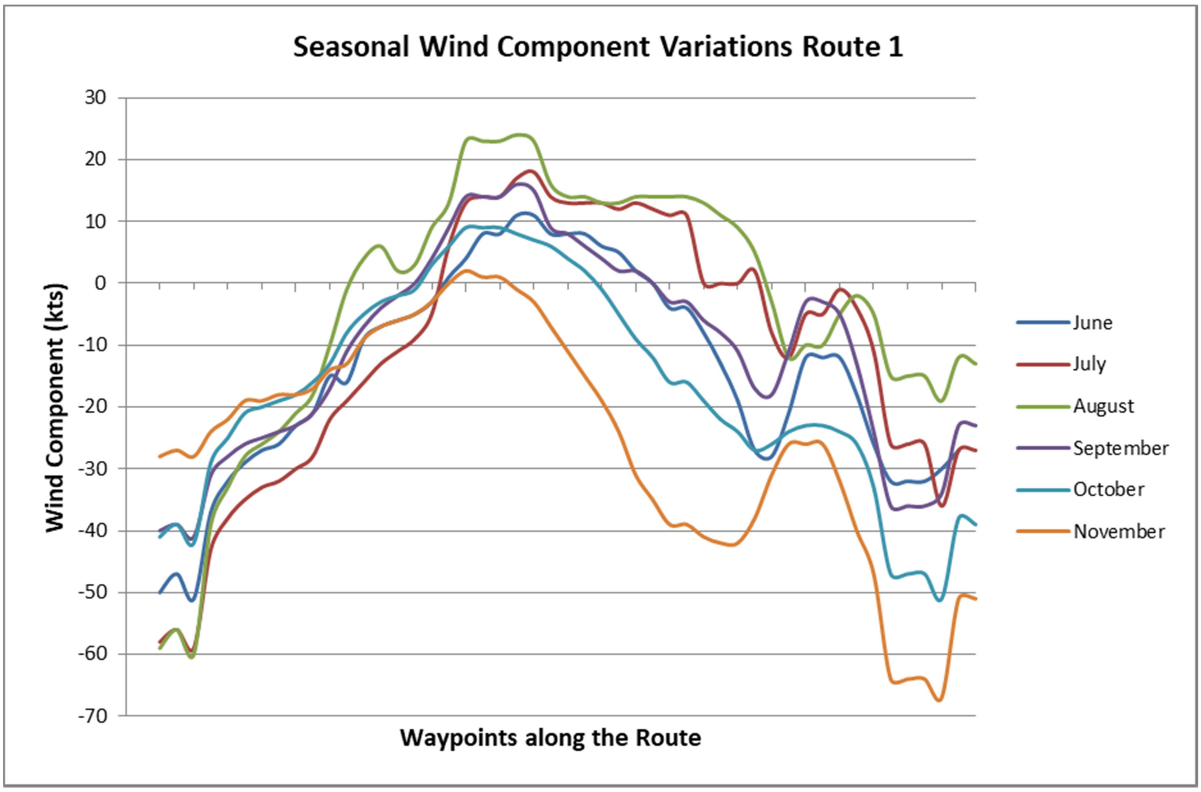

Figure 17 Seasonal Wind Component Variations along Route 1

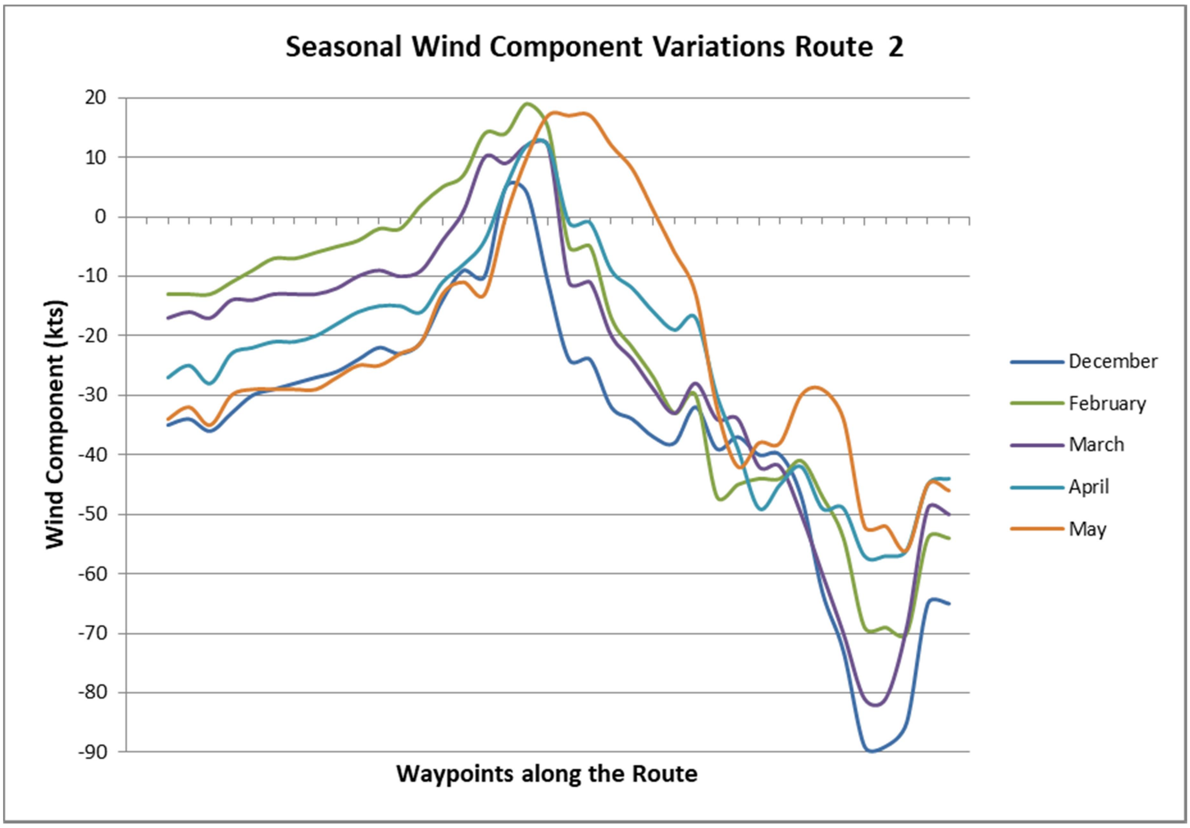

Figure 18 Seasonal Wind Component Variations along Route 2

Figure 17 and Figure 18 reflect an essentially vertical variation (change in wind strength) with no seemingly significant horizontal variation (change in wind patterns geographically). This implies minimal variation in wind pattern distribution around the average wind component, for a given route. Even between routes the variations geographically are not major, enforced by the limited capability of alternative routing without excessive track mile addition. If anything, Route 1 benefits more from tailwind components mid-flight, with headwind rapidly building during the last third, necessitating the changeover to Route 2 or Route 3.

Understanding this specious contradiction of the results of Figure 17 and Figure 18 versus the global wind pattern / jet stream variation depicted in Figure 15 requires an examination of the typical layout of a jet stream, as illustrated in Figure 19. The core of the jet stream is a narrowly focused fast flowing meandering air currents in the atmosphere at 9 km (30,000 ft, polar region) to 12 km (40,000 ft tropical region) above the surface of the earth just below the tropopause, reaching speeds of close to 200 kts [57].

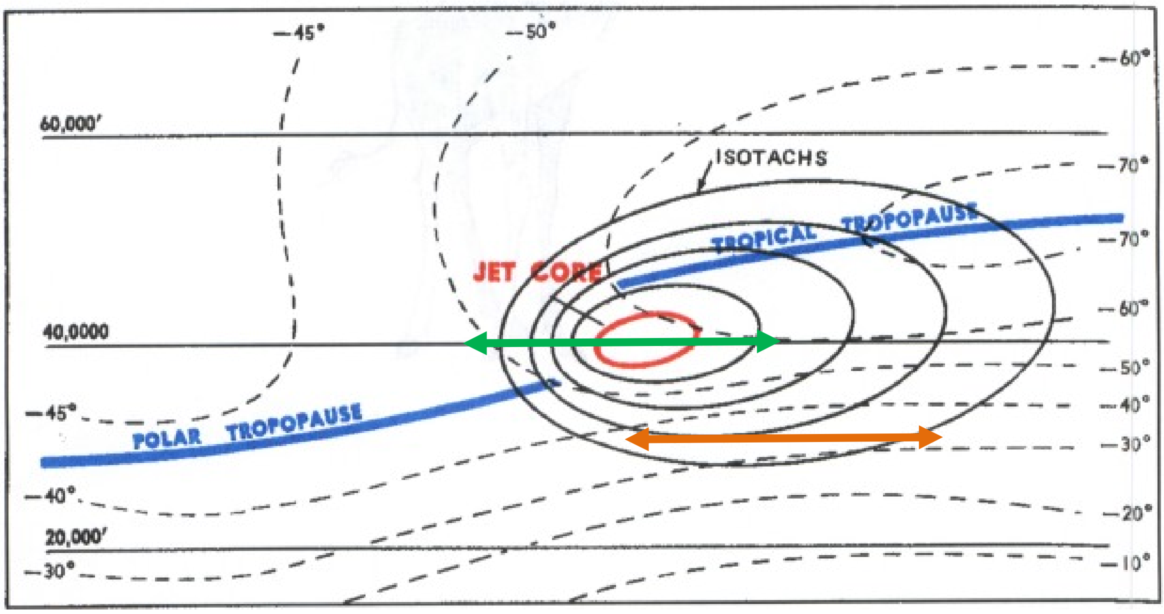

Figure 19 Structure of a Jet Stream *[63]*

When the flight is affected by the tropical jet streams, the seasonal location variations would typically be expected to be less of a factor at lower cruise levels (orange line) than at higher cruise levels (green line), where the isotachs are more closely spaced. Figure 17 and Figure 18 reflect this. At the beginning of the flight at the lower levels the geographic variations are more gradual. Towards the end of the flight, nearing maximum cruise levels, changes are more abrupt, necessitating circumnavigation, change in routing, as a mitigating strategy. This will be scrutinized further during the discussion around optimum altitudes (6.6).

6.3 Effect of Average Wind Component

Figure 16 requires knowledge of the cruise time in each instance in addition to the average wind component. Since Figure 16 demonstrated the practicality of using average wind component, it might abridge matters to plot cruise fuel requirements directly versus the average wind component, as shown in Figure 20. Again, for the reasons outlined in chapter 6.2, exponential trend lines are applied, with little difference in R-Squared versus linear or polynomial trend lines.

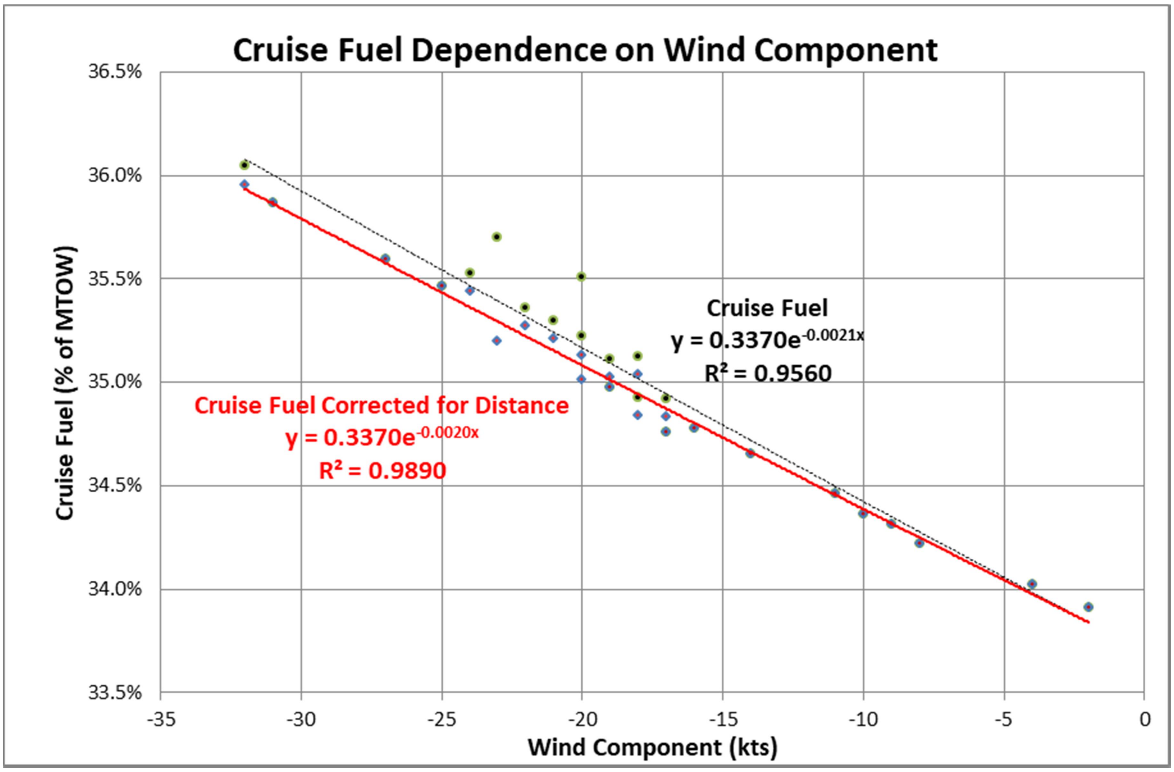

Figure 20 Cruise Fuel Requirements versus Wind Component

Average wind component predicts 95.6% of the variability of cruise fuel requirements. Whilst highly significant in statistical terms, the 4.4% as yet unaccounted for variance nevertheless can translate into 45 to 50 passenger difference in payload capability.

Invariably, ground distance flown varies the fuel requirements for a given average wind component. Adjusting the cruise fuel requirement by the ratio of reference ground distance to actual ground distance flown in cruise improves the predictability to 98.9%, marginally less than the 99.2% achieved in Figure 16, but with the advantage of having removed a variable (cruise time).

It is noteworthy that both trend lines yield a cruise fuel requirement of 33.7% when the average wind component is zero, as would linear trend lines. This is expected, consequential from Route 1 being the predominant shortest routing yielding the lowest fuel requirements at low headwind components. Route 2 and Route 3 substitute when the headwind component is sufficiently lower to offset the extra distance travelled, typically when headwinds are stronger generally.

The result is a representative approximation for the particular flight containing two variables and, combining climb and descent fuel, four constants, of:

$$Trip\ Fuel = F_{CLB} + F_{CRS} + F_{DEC} \tag{38}$$

$$Trip\ Fuel = k_1 + k_2 e^{k_3 WC} \frac{k_4}{Distance} \tag{39}$$

6.4 Selection of Outbound Route

The cruise fuel requirements along the three outbound routes are tabled in Appendix 5. Route 3, covering considerably more ground distance than the other two routes is only presented for the Northern Winter period, not adding value during the other seasons.

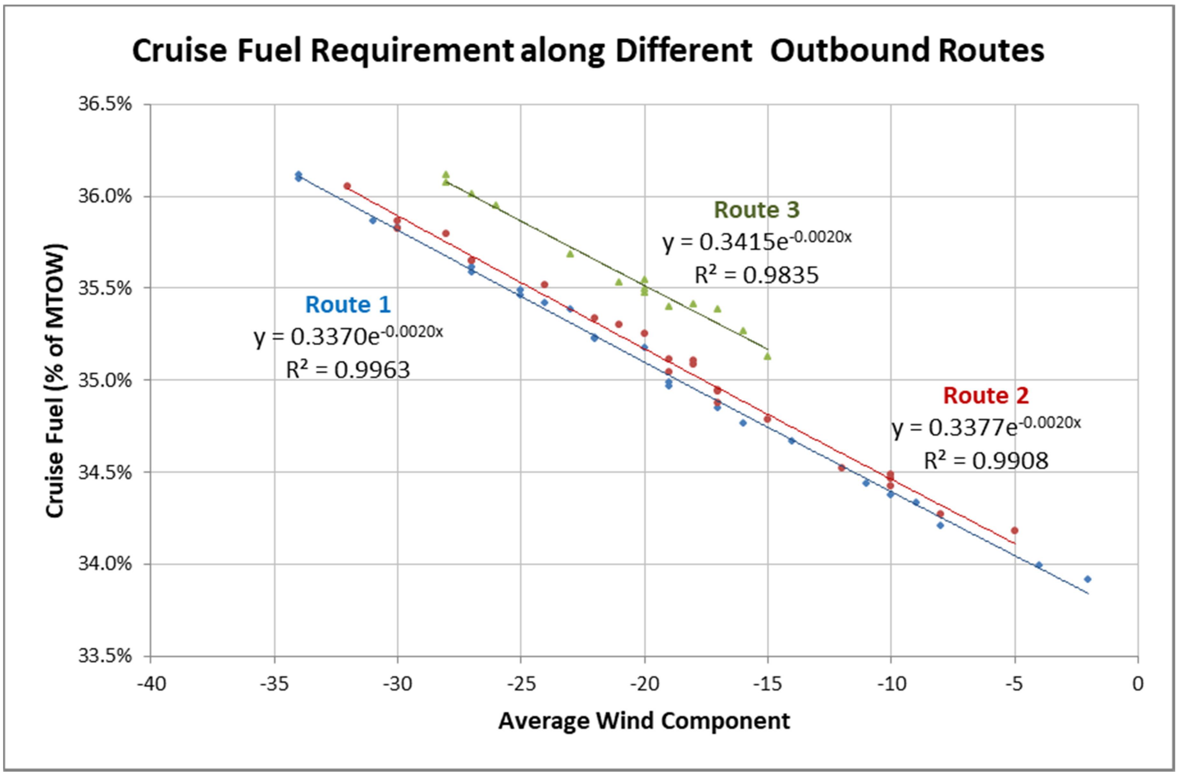

Figure 21 Cruise Fuel Requirements along the Outbound Routes

As expected, cruise fuel predominantly correlates with average wind component along the route, in excess of 99% for Route 1 and Route 2. Route 3 shows a slightly reduced correlation, consequential of less data points analysed. Such a high correlation is significant from two aspects: Firstly, it establishes average wind component as the predominant factor influencing cruise fuel requirements. Secondly, it implies very accurate predictions of payload capability based on the average wind component.

Route 1 covers the least ground distance, Route 3 the most. As shown in Figure 21, for Route 2 to have less cruise fuel requirements than Route 1 the average headwind component must be at least 1.0 kts less. Similarly, for Route 3 to prevail, the headwind component must be 6.6 kts less than for Route 1.

In context, the variation in average headwind component between 85% probability winds and average winds extends to 1 to 3 kts more headwind component, other than in January when the difference is 4 kts (Appendix 5). Conceptually then, variances around the mean seasonal wind component may result in alternating between Route 1 and 2, but is improbable to cause a shift to Route 3. A shift between routes has more prospective if such a shift reduces the headwind component noticeably. Equally for the 50% and 85% probability winds, the optimum routes appear to be (Appendix 5):

- Route 3 for January only.
- Route 2 for February to May.
- Route 1 for June to December.

Graphically, showing only the 50% probability winds for clarity:

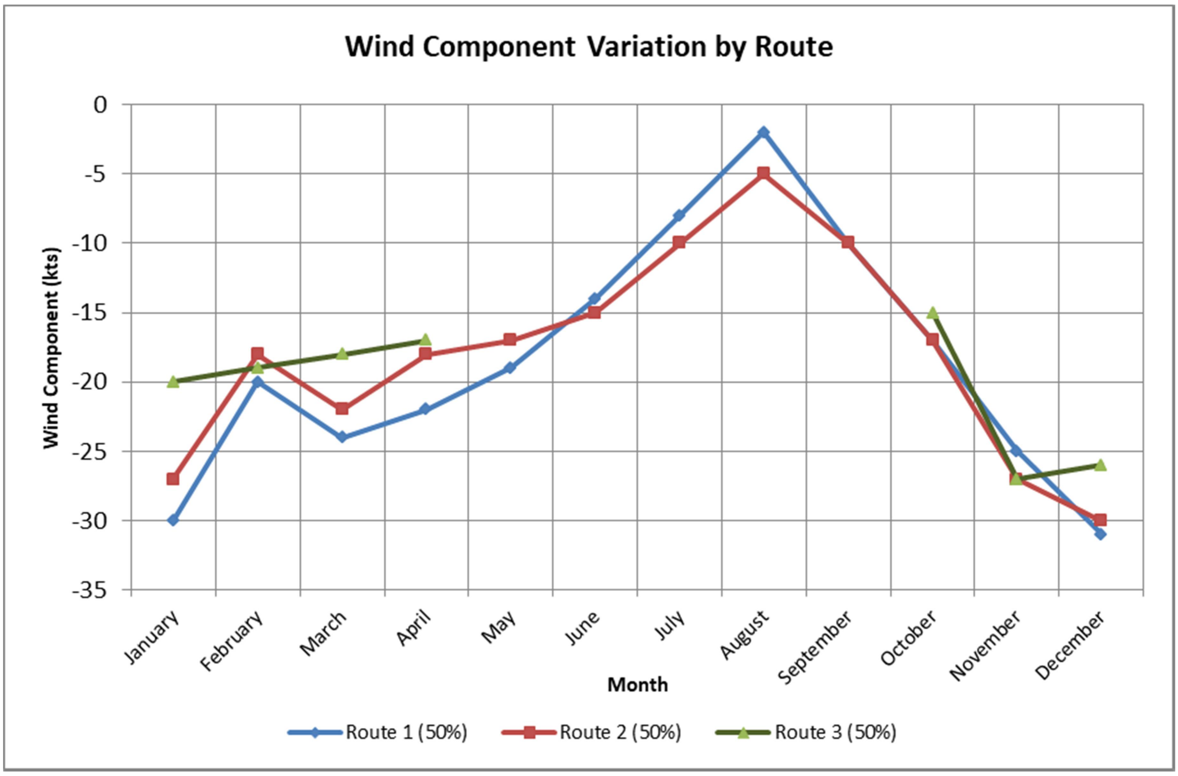

Figure 22 Average Wind Components Variation by Route

Route 3, requiring 6.6 kts respectively 5.6 kts less average headwind component than Route 1 and Route 2 to prevail, only contributes in January, presumably as it avoids the effects of the Northern Tropical Jetstream (at its most Southern latitudes - Figure 15) more effectively than the other routes, as can be seen in the data presented in Appendix 8 to Appendix 10 towards the end of the flight. Similarly, Route 2 prevails only from February to May, consistently having more than 1 kt less headwind component than Route 1.

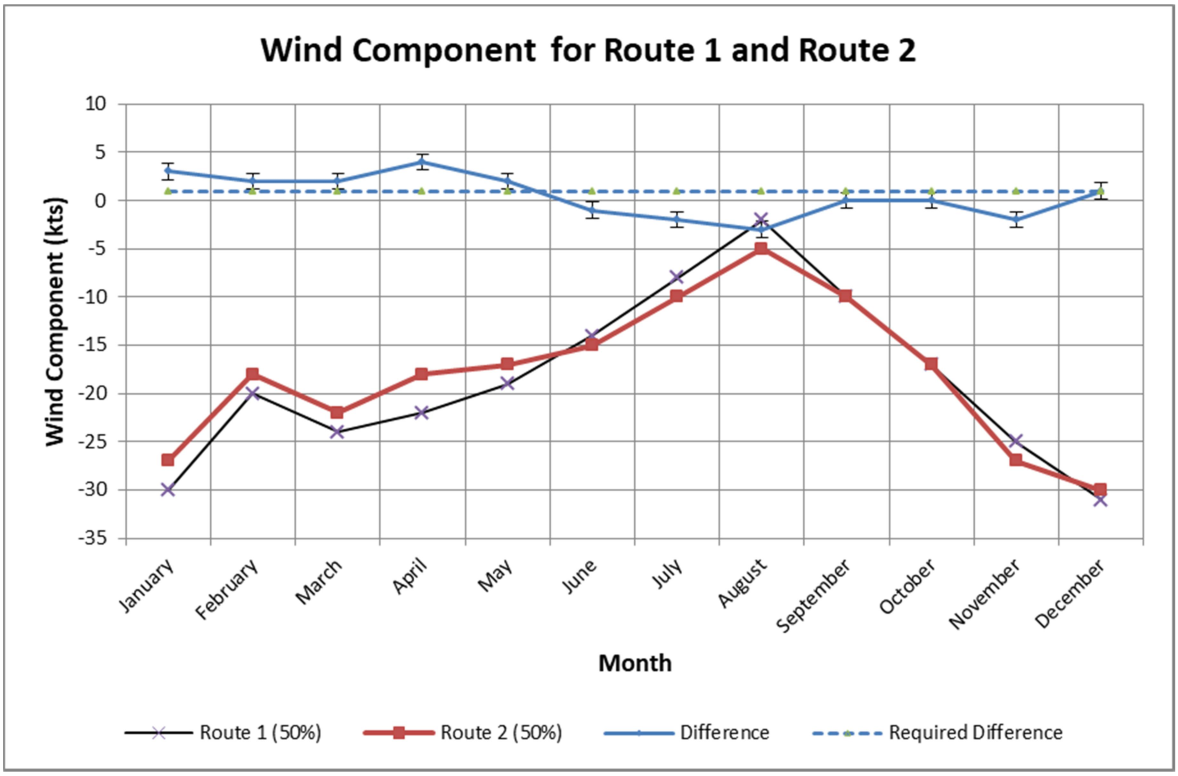

Figure 23 Wind Components Variation for Route 1 and Route 2

Figure 23 shows the average monthly wind components for Route 1 and 2, as well as the difference between them. For Route 2 to prevail the solid blue line needs to be above the dashed blue line and vice versa. For the difference between Route 1 and 2 to move towards the dashed line requires a variation from the mean in opposite direction, i.e. increasing headwind above the mean for the one route and / or decreasing headwind below the mean for the other route. The probabilities for each route become multipliable. The highest probability of a change-over, assuming normal distribution, occurs when both routes vary from the mean equally in magnitude opposite in direction.

The bands around the difference line show the 85% probability variation. Other than for December the probability of a change-over remains below 15%. This is consistent with the ground distance between the two routes being only 0.2% different and both routes only being around 2% longer than the Great Circle Distance (including track miles for take-off and landing positioning), making significant wind variation differentials between routes improbable. Other than in December, route selection evidently remains a seasonal consideration only.

Noteworthy are the three trend line equations in Figure 21, which take the form:

$$Cruise\ Fuel_i = k_{2_i} e^{k_3 WC} \tag{40}$$

Whilst k_3 remains equal for all three trend lines, k_{2_i} varies for each route, with:

$$\frac{k_{2_2}}{k_{2_1}} = 1.002 = \frac{Distance_2}{Distance_1} \tag{41}$$

$$\frac{k_{2_3}}{k_{2_1}} = 1.013 = \frac{Distance_3}{Distance_1} \tag{42}$$

Consequently, the distance correction in fact finds consideration in the trend line formulae. Therefore, equation (39) is better represented by

$$Trip\ Fuel_i = k_1 + \ k_{2_i} e^{k_3 WC} \tag{43}$$

The subscript “i” becomes referenced to the seasonal choice of route outbound, with k_1 and k_3 dependent on aircraft type only.

6.5 Accuracy of the Independent Variable

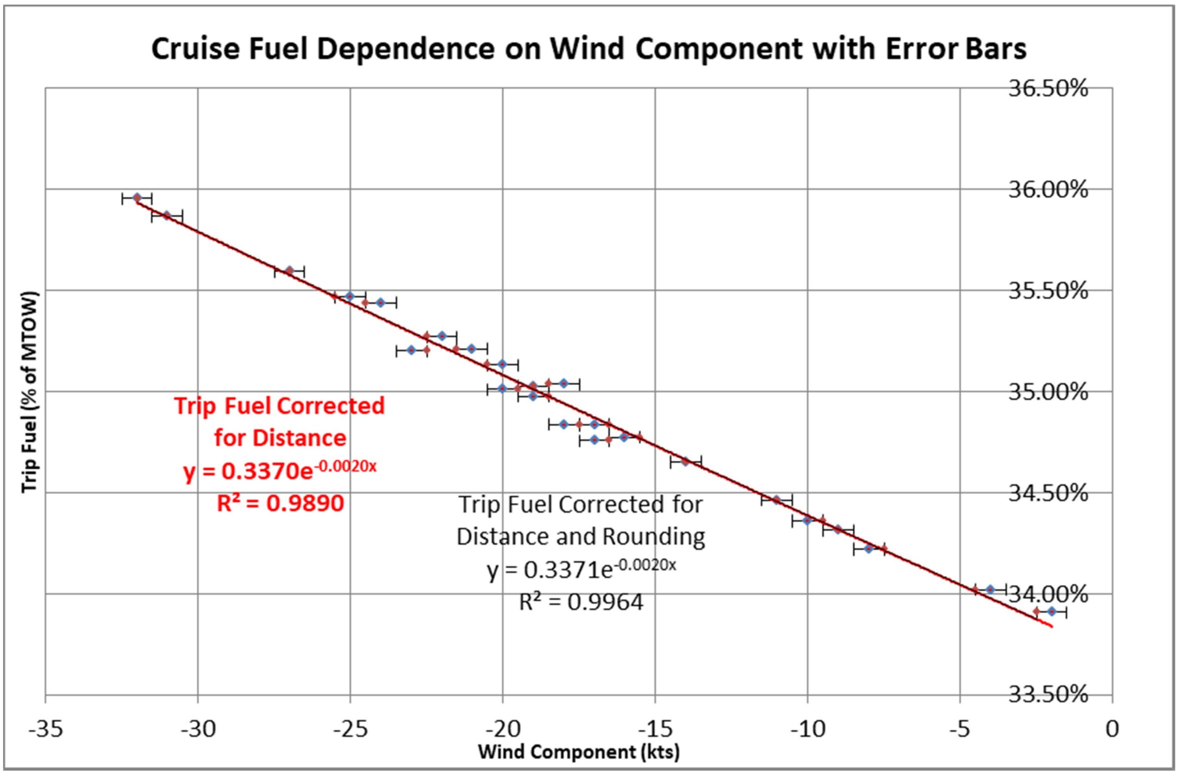

Figure 24 Error Bars for the Independent Variable, Outbound Route

The flight planning system being utilized for generating flight plans presents average wind components only as an integer on such flight plans, no decimal accuracy refinement. Any average wind component could therefore be variant ± 0.5 kts, best shown by horizontal error bars.

The trip fuel depicted in Figure 24 is identical as for Figure 20, namely the combined trip fuel for the three outbound routes, adjusted for distance. To establish the impact of variability in the independent variable, the wind components are adjusted (for purpose of this analysis only) towards the trend line within the constraint of ± 0.5 kts.

The resulting “new” trend line (“corrected for rounding”) yields a correlation coefficient of 99.6%, implying that virtually all variability in the dependent variable, trip fuel, is attributable to the independent variable, average wind component. The trend lines coincide with only a negligible 0.01% difference in the factor k_2. This becomes even more striking when observing the impact at an individual route level, as presented in Figure 25.

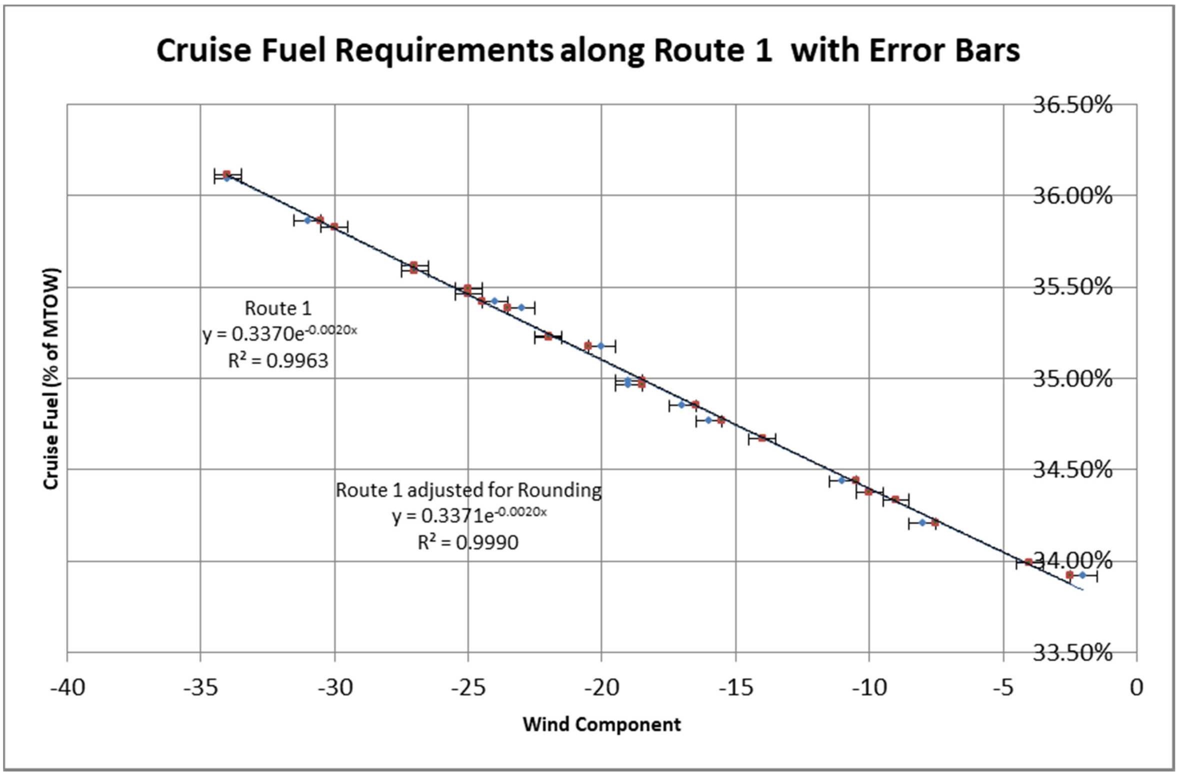

Figure 25 Error Bars for the Independent Variable, Route 1

6.6 Optimum Altitudes

Four vertical flight profiles, seasonally selected so as not to clutter the graph, are presented (Appendix 4), when the solar position is furthest north, south and when over the equator. Solar positioning largely influences global weather patterns, including the position of jet streams (Figure 15).

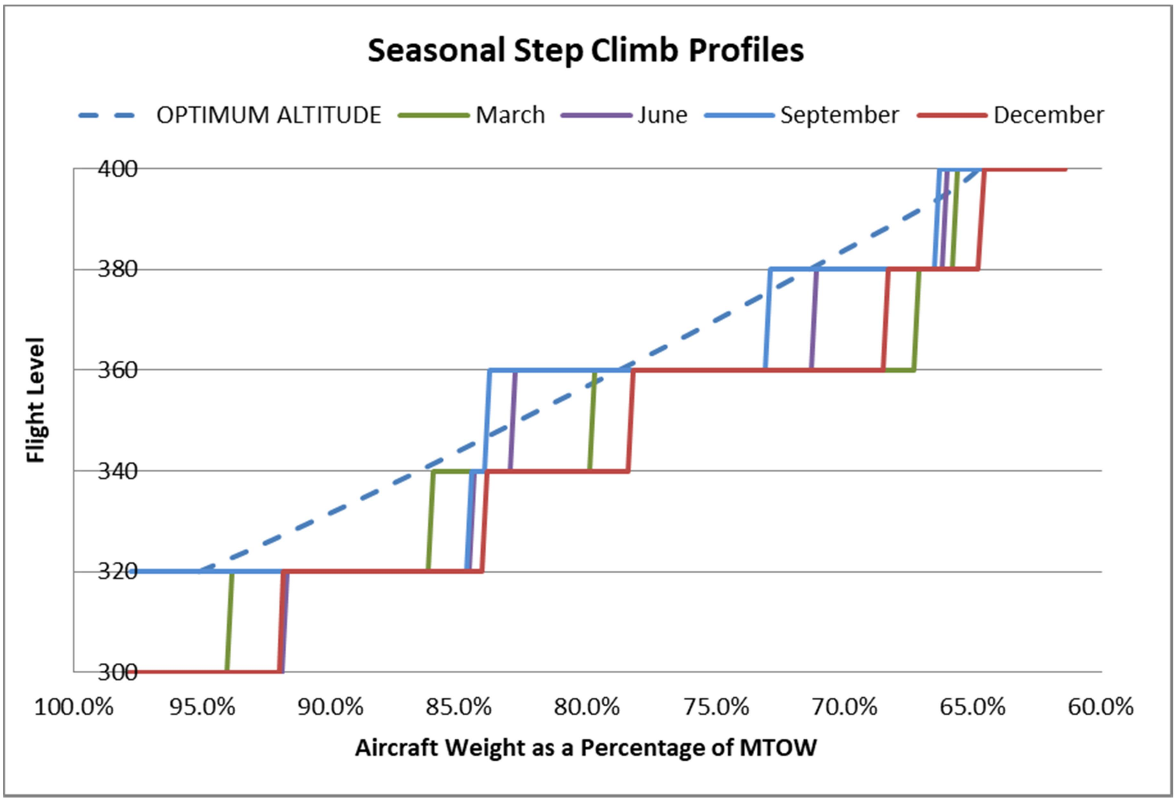

Figure 26 Seasonal Step Climb Profiles

Fundamentally, the aircraft under study is capable of reaching Flight Level 320 (32,000 ft) after a take-off at maximum structural take-off weight, being approximately 500 ft above optimum altitude at top of initial climb. This is certainly aligned with the discussion on altitude effect on maximum range (3.4), further illustrated in Figure 5, which advocates operating within ± 1000 feet of optimum altitude. Seemingly contrarily to the discussion on maximum range (3.4), though, throughout the seasons the flights operate well below the optimum altitude, up to 3000 ft, rarely climbing above.

With winds fluctuating with flight levels, particularly in the vicinity of jet streams (Figure 19) flying lower or higher than optimum becomes more efficient for a sufficiently large wind differential. The aircraft manufacturer [36] provides the following guiding parameters:

Wind Difference (kts)	Altitude Difference (feet)	
	Descent	Climb
5	-2000	1800
10	-3000	2300
20	-4500	3100

Table 8 Wind Altitude Trade-off [36]

Notably, the flights operate predominantly at Flight Levels 300 / 320 and again at FL 360 for a significant portion of the flight, consistent with avoiding the core of the tropical jet streams south and north (Figure 19). On several seasonal flight plans a 4000 feet step climb was observed.

The September profile has the lowest average headwind component of the four vertical profiles in Figure 26. Predictably this profile therefore most closely brackets the optimum altitude variation with weight, other than the early part of the flight still influenced by the southern tropical jet stream effects. Conversely, the December to March profiles illustrate the necessity to fly away from optimum, thereby reducing the negative impact of wind, most visibly.

Through such tactical variance of levels flown, the seasonal wind variations affecting flight become primarily magnitude variations rather than geographic variations, vindicating the use of average wind component as in Figure 16 indirectly and in Figure 20 directly, realizing the stipulated high variance correlation.

6.7 Mach Number Variance Analysis

Mach number across the different study plans is consistently 0.825 + 0.001 / - 0.002 at all cruise levels, for all wind conditions. This is consistent with concurrent slight temperature variations, with Mach number dependent on temperature measured in °K:

$$M = TAS \, / \, \sqrt{\gamma R T} \tag{44}$$

Slightly lower Mach numbers are observable where the aircraft step climbs from one flight level to the next, since the data in Appendix 8 to Appendix 10 represents average values between waypoints. The aircraft optimally climbs at a slightly lower Mach number of about 0.820, thereafter re-accelerating to 0.825.

Deterministic here, prioritising over Mach number optimisation for maximising range, is that the more sophisticated flight planning systems utilize the cost index stipulated by the customer airline as the starting point for flight optimisation (see chapter 3.3). Airlines wish to minimise their trip costs throughout their networks, the requirement to maximise range being exceptional and consequently incompatible with the overall operational requirements. Within this context, though, at current oil prices, airlines operate at cost indices well below long range cruise (defined as 99% of the maximum specific range to achieve a reduced flight time) and closer to maximum range cruise nonetheless. Airlines do have the option of choosing to fly at CI = 0, which simulates maximum range cruise flights.

From the discussion in chapter 3 (Figure 2, Figure 3), the expectation is for the Mach number to, generally, decrease with decreasing weight and increase with increasing altitude. This is, however, not observable in the study flight plan data where the Mach number remains largely constant.

To understand this seeming contradiction requires a review of the Mach number variation, at a given Cost Index, with weight and flight level. To illustrate, the example of an A340-313 is used [3]:

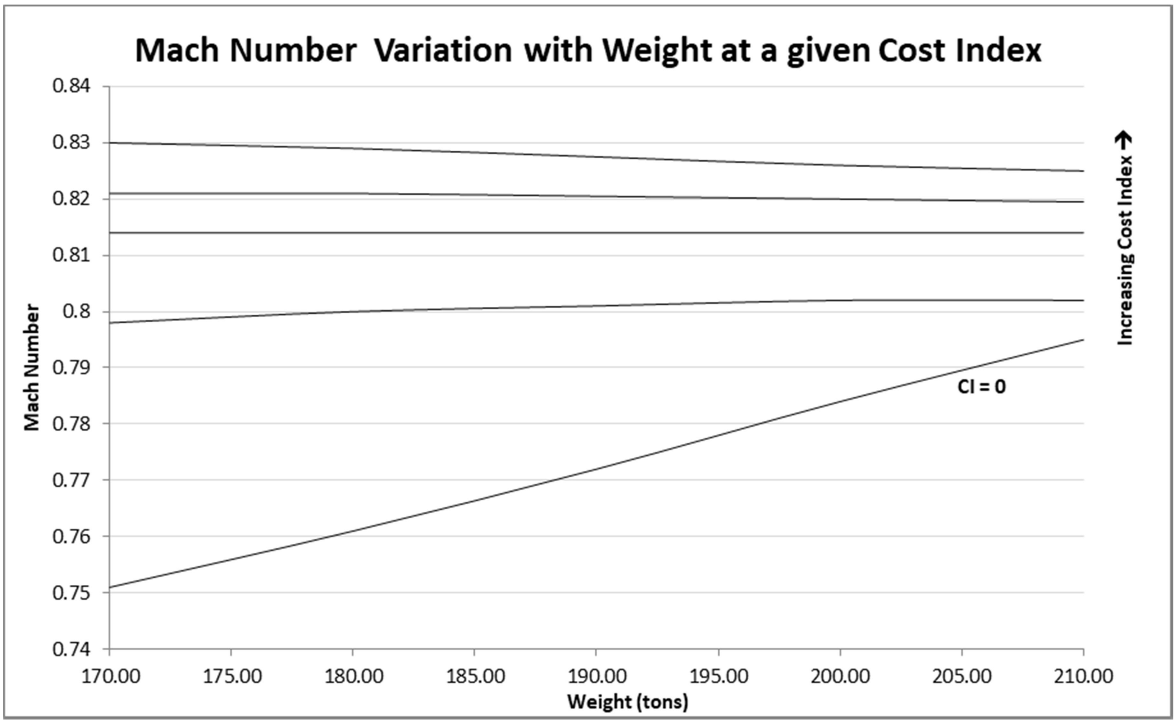

Figure 27 Variation of Mach Number with Aircraft Weight, dependent on Cost Index

At CI = 0, maximum range flying, there is no cost consideration. The aircraft is flown as fuel efficiently as possible. In this instance, the Mach number decreases noticeably with weight, as expected from the discussion in Chapter 3.

With the use of cost indices an additional set of variables gets introduced, non-fuel time related costs. When these predominate over fuel costs, resulting in increasing cost indices, the Mach number variation with weight greatly reduces, as depicted in Figure 27. This is a consequence of time related costs, unlike fuel, not being affected by weight. The data in Appendix 8 to Appendix 10 reflects this without negating the discussion in Chapter 3.

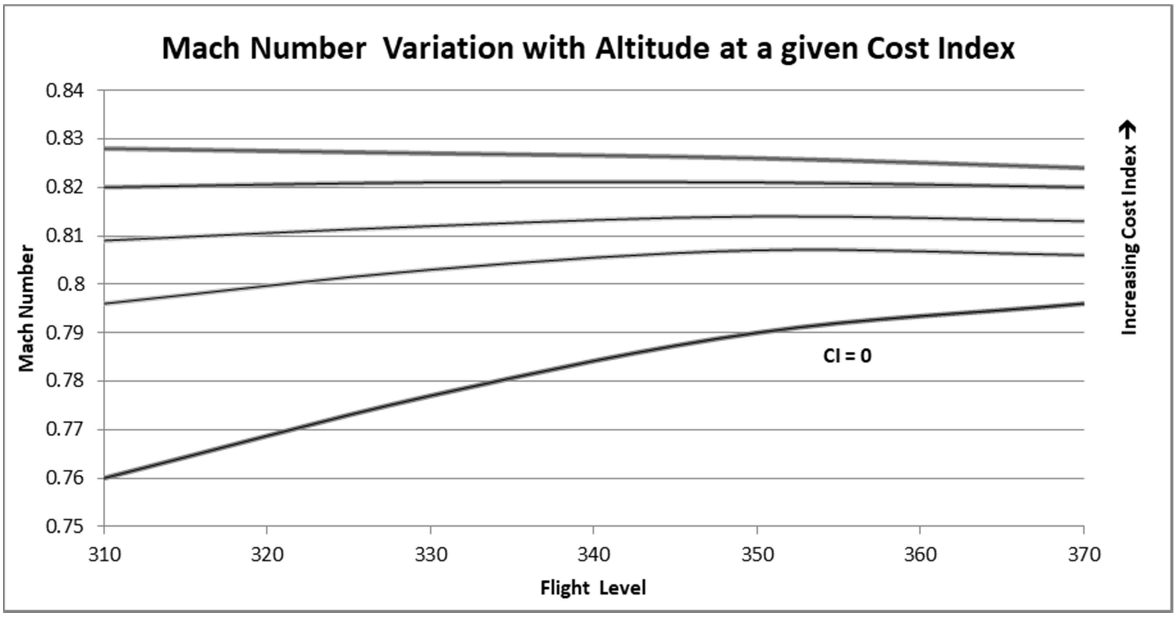

Figure 28 Variation of Mach Number with Flight Level, dependent on Cost Index

For purely fuel optimized flight (CI = 0) the optimal Mach number increases with flight altitude, as anticipated from Chapter 3. Non-fuel time related costs, however, increase if the aircraft flies slower at lower altitudes. As the cost index in use increases, therefore, the tendency for slower speeds at lower altitudes becomes increasingly negated, as evidenced in Figure 28. Again, the data in Appendix 8 to Appendix 10 reflects this.

Finally, Figure 11 suggests that the Mach number should increase with increasing headwind. The study flight plans in Appendix 8 to Appendix 10 do not replicate this. This appears counterintuitive to the preceding discussion on cost index flying. Contextually, though, modern long rang aircraft utilize supercritical wing design principles, enabling operations in the transonic speed range at high altitude typically between Mach number of 0.80 and the speed of sound [64].

Whilst the aircraft remains subsonic in the transonic speed range, part of the flow over the wing becomes supersonic with the associated shock wave. To delay the onset of the shock wave and reduce the aerodynamic drag associated with boundary layer separation, transonic aircraft have supercritical wing designs with essentially significantly reduced upper surface curvature [64]. Eventually, though, a weaker shock wave is formed at the rear of the wing to equalize pressure at the trailing edge (Figure 29). As this weak shock moves forward drag increases significantly.

With the aircraft operating close to its maximum operating Mach number of 0.86 in any case, any benefit of flying faster into headwinds is offset by the rapid increase in drag as the shock wave moves forward. Consequently, no variation in Mach number with changing headwind components is observable in the data in Appendix 8 to Appendix 10.

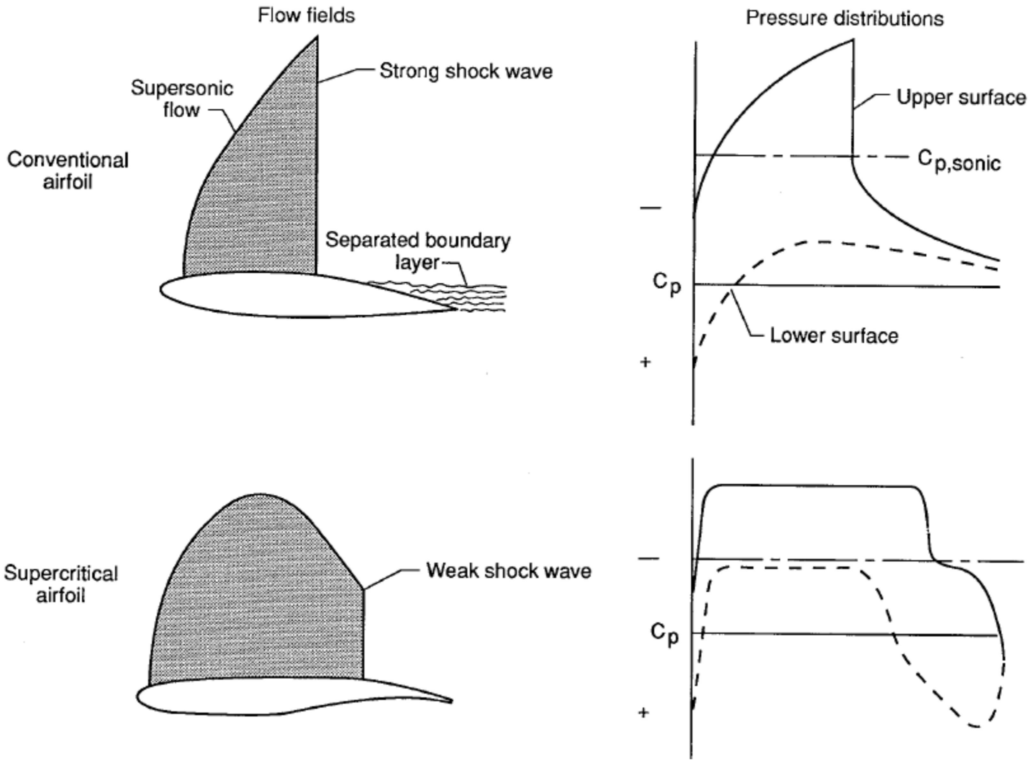

Figure 29 Flow over Conventional versus Supercritical Aerofoils [65]

6.8 Atmospheric Variance Analysis

From the discussions in Chapter 3, given that the data analysed here optimises the flight levels flown within practical constraints, the expected next influential factor leading to payload variance are changing atmospheric conditions (temperature, pressure, density).

Aircraft altitude, as displayed to the flight deck crew, is not geometric altitude. Rather, the anemometry systems aboard aircraft measure static outside air pressure for altitude indications, and dynamic air pressure compared to static air pressure for indicated airspeed respectively Mach number indications.

In maintaining a desired indicated flight altitude, the aircraft in reality is flying along an isobaric line. Assuming standard atmospheric conditions, the indicated altitude represents the height difference between the current isobaric line and the reference isobaric line, defined as 1013.25 hPa when flying flight levels. Consequently, even with standard atmospheric reduction in pressure with altitude increase, the indicated altitude does not necessarily provide the actual height above sea level. For a barometric pressure at sea level, say, 20 hPa higher, the aircraft would be flying approximately 560 feet higher than indicated. It is not unusual to observe several thousand feet difference between the indicated altitude and the GPS geometric altitude, when at cruising level.

An estimate of the actual altitude versus the indicated altitude above the standard sea level isobar can be obtained by [36]:

$$\text{True Altitude} = \text{Indicated Altitude} \times \frac{Actual\ Temperature\ (°C) + 273.15}{ISA\ Temperature\ (°C) + 273.15} \tag{45}$$

(The factor 273.15 converts the temperature from Celsius to Kelvin.) A 10 °C higher temperature at indicated 36000 feet yields an actual altitude 1660 feet higher.

The primary reason for flying along isobars, bearing in mind those aviation principles were developed long before the advent of computerisation and everything related thereto, is to have uniformity throughout the industry. Regardless of atmospheric variations from the defined standard, anemometry systems aboard proximate aircraft remain equally influenced and the required vertical separation between aircraft through a defined flight level system remains assured.

An added advantage for the performance analyst, given flight at a fixed barometric value, is that performance variations are directly linkable to temperature variations. From the perfect (ideal) gas law:

$$P = \rho\, R_0\, T \tag{26}$$

An increase in temperature reduces air density, thereby reducing drag but also reducing engine efficiency. The international standard temperature is set to be 15 °C at sea level, linearly decreasing by 6.5 °C per 1000 m to -56.5 °C at 11000 m (36089 feet) where-after the temperature remains constant within the stratosphere, or:

$$ISA\ Temperature = 15\,°C - 1.98\,°C\ \times Altitude\ (feet)/1000 \tag{46}$$

The following diagram illustrates the ISA temperature variation within the Standard Atmosphere [36]:

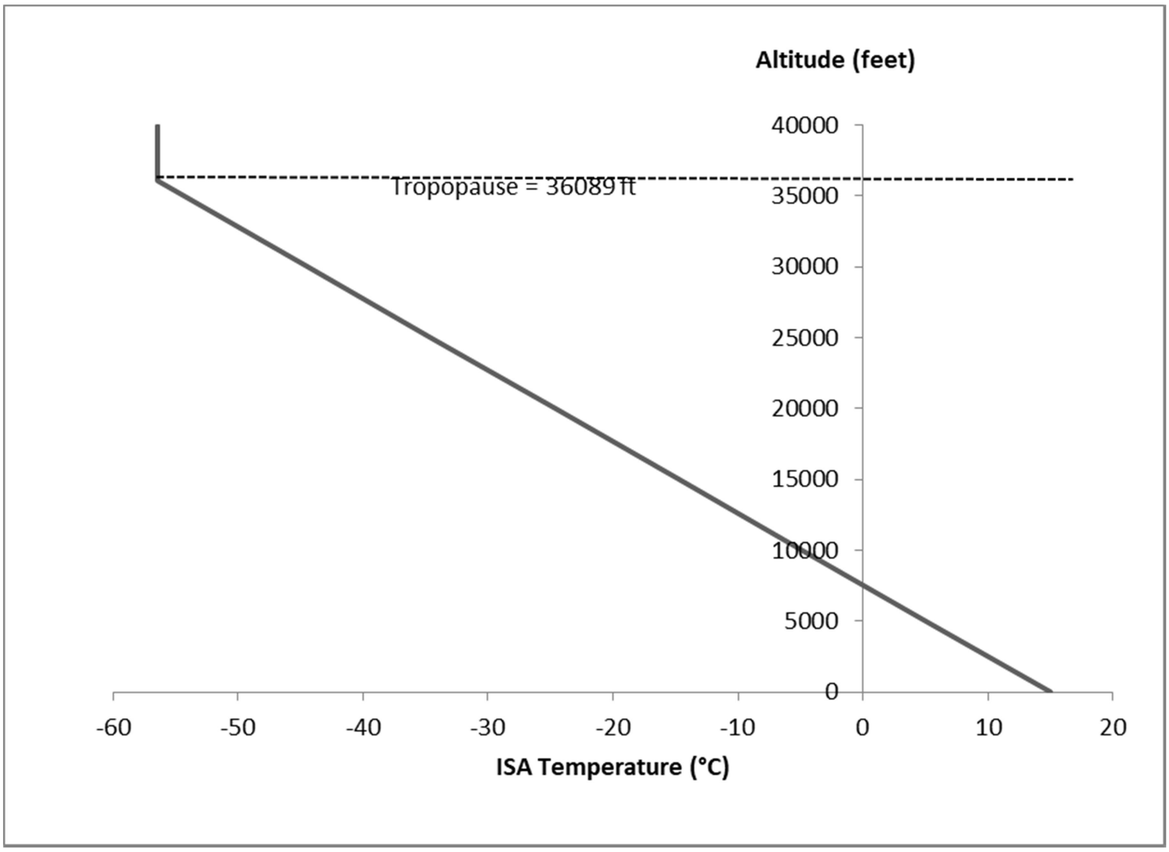

Figure 30 ISA Temperature Variations with Altitude

Aircraft flight performance data is characteristically presented relative to the standard atmospheric conditions; typically for a given flight level tables are presented at the respective ISA and ISA ± ΔT temperatures. Consequently, variation in ISA temperature deviation, per given flight level, extracted from Appendix 8 to Appendix 10, provide the relevant comparative basis. As before, only the four seasonal “midpoints” are considered, for clarity, presented in Appendix 6.

The outbound flight itself, additionally to being north westerly bound into headwind conditions, transgresses the equatorial region from one hemisphere to another. The flight is therefore exposed to both subtropical regions around the equator before progressing to the middle latitudes towards the end of the flight.

The seeming decrease in ISA Deviation during the later part of the flight (and with increasing flight altitude) is partially consequential of geographic location as schematically presented in Figure 19: Isotherms largely decrease in altitude away from the equator and towards the poles, other than where affected by a jetstream.

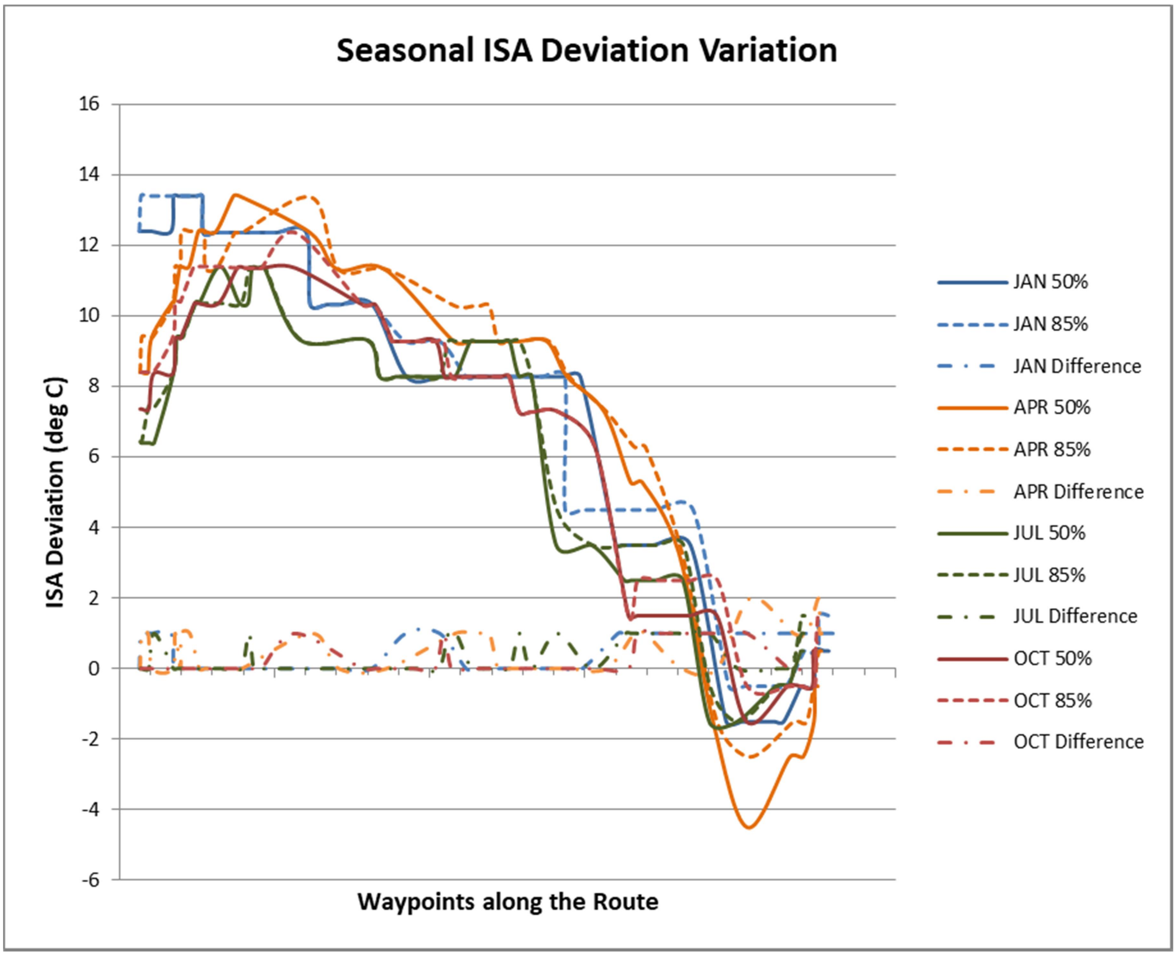

Figure 31 Seasonal ISA Temperature Deviation Variations along the Outbound Route

Figure 19 interpreted together with Figure 17 and Figure 18 suggests that the aircraft is noticeably exposed to the Northern Tropical Jetstream during approximately the last quarter of the flight, and partially exposed to the Southern Tropical Jetstream located mostly south of the point of departure. Figure 19 therefore suggests that the actual tropopause is above all the aircraft flight levels throughout the flight with the concomitant further decrease in temperature. Figure 32 then assumes the lapse rate continues to above the maximum flight level flown.

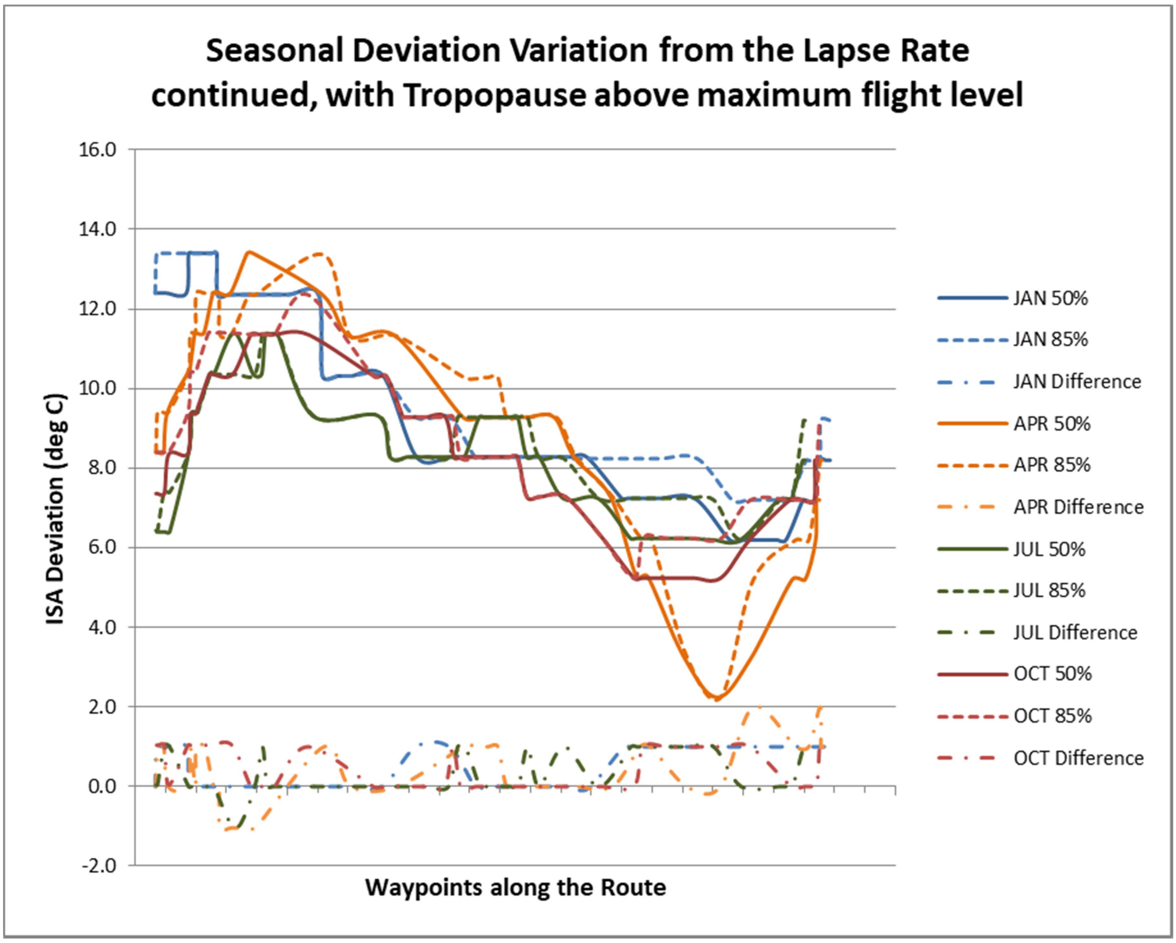

Figure 32 Seasonal ISA Temperature Deviation Variations along the Outbound Route, Tropopause above all flight levels flown

The trough in ISA Deviation in Figure 32 essentially coincides with the peaks in headwind components observed in Figure 17 and Figure 18, consistant with the isotherm patterns around the core of the jetstream, as depicted in Figure 19. The elucidation of the tropopause variation is thus corroborated. However, the performance impact of such tropopause variation requires further scrutiny, specifically since aircraft performance data is presented based on the ISA profile with temperature deviation around it.

As previously described, aircraft fly along isobaric lines, represented to the crew as flight levels. Consequently, when flying at FL380 or FL400, the aircraft is flying along the 206 hPa or 188 hPa isobaric lines [36], regardless of whether being below or above the local tropopause.

As before, from the perfect (ideal) gas law:

$$P = \rho \, R_0 \, T \tag{26}$$

This can be represented as:

$$P = \rho\, R_0\, (T_{ISA} + \Delta T) \tag{47}$$

Independent of any tropopause effects, with isobaric lines being fixed, assuming T_{ISA} to be fixed at – 56.5 °C above 36,089 feet, remains an inconcequential convention to performance data presentation. Representing temperature variations throughout the flight as in Figure 32 consequently merely serves to more succinctly highlight the temperature variations around a standard, separated from flight level variation, particularly emphasising the effects around a jet stream in concurrence with Figure 17 and Figure 18.

Both Figure 31 and Figure 32 indicate the temperature variation around the mean monthly average to be between 0 and 1 °C except:

- Near the beginning of the flight the difference in ISA Deviation is at times between -1 and 1 °C . Perusal of the data reveals that there is a Flight Level difference in those instances, indicative of the more sharply variant isotherms with height in close proximity of the Southern Tropical Jetstream, as illustrated in Figure 19.
- Near the end of the flight the difference in ISA Deviation is between 0 and 2 °C, proximate to the Northern Tropical Jetstream, reflective of isotherm curvature.

The annual average variation between the 50% and 85% weather prognosis is 0.31 °C. Assuming the data to be standard normally distributed yields a standard deviation of 0.30 °C, from:

$$z = \frac{x - \mu}{\sigma} \tag{48}$$

With the z value measuring the number of standard deviations between the mean and the value of interest, represented by the area of the bell shaped normally distributed curve symmetrical about the mean [62]. For a 99% probability the number of standard deviations below the curve are z = 2.327, implying a temperature variation of 0.70 °C.

Utilizing the simplified range equation (25), Table 6 presents estimations of range variance with temperature variations, essentially (near) independent of cruising level, flight at or near optimum flight level assumed. The effects shown in Table 6 are best reproduced graphically:

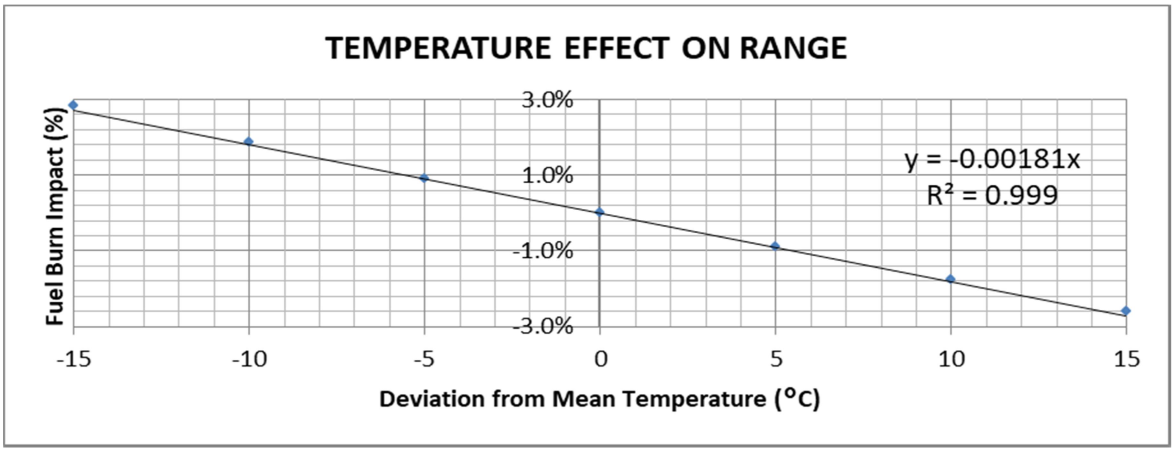

Figure 33 Estimated Temperature Effect on Fuel Burn

Applying a linear trend line yields an R-Squared of 99.9%. Accordingly, with small variations around the mean temperature profile at any given time of the year, the same linear variation can be assumed to be applicable. At a 99% probability level a 0.70 °C temperature increase above the mean temperature would therefore imply a 0.127% reduction in range. At the 85% probability a 0.31 °C increase reduces range by 0.056% (which is less than the weight of a single passenger). Applying this to the data in Figure 20 yields:

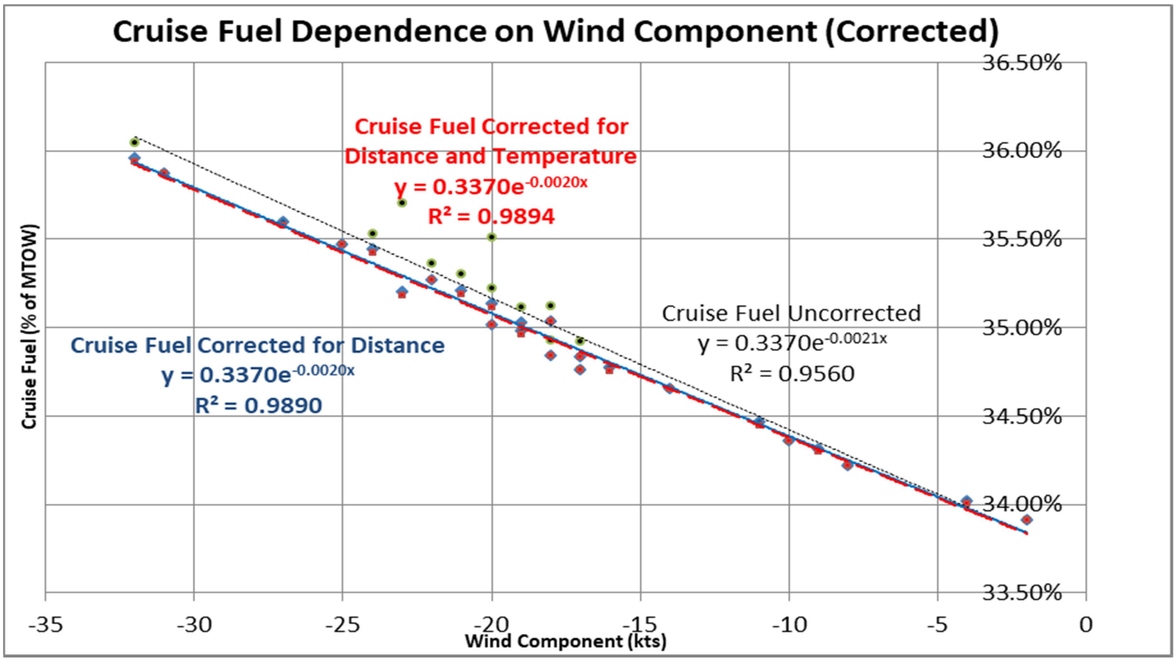

Figure 34 Cruise Fuel Requirements versus Wind Component (corrected for Distance and Temperature)

Temperature effects are clearly marginal, to the extent that the trend line equations are identical and the R Squared increase is only 0.04%. Nevertheless, the slight increase in R Squared remains reflective of a correlation of temperature variance resulting in cruise fuel variance.

6.9 Summary for the Outbound Flight

The analysis presented in this Chapter has shown:

1. Climb and Descent / Approach Fuel requirements to be constant at 2.1% and 0.48% of MTOW respectively, for MTOW departures.
2. Seasonal wind variations patterns, along a route, vary primarily in magnitude rather than geographic location, driven largely by the optimising of flight levels flown with due consideration for wind effects to avoid the core of jet streams.
3. Seasonal variance in the choice of routes flown in response to shifting wind patterns.
4. Atmospheric variations in temperature have negligible effects on range.
5. Average wind component to be the (near) exclusive predictor of cruise fuel requirements, with a correlation better than 99%.

Consequently, equation (43) becomes a powerful tool to predict trip fuel requirements along a given route:

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 \overline{WC}} \tag{43}$$

Or, more generically, re-writing equation (38):

$$Trip\ Fuel = f_{CLB}(aircraft) + f_{DEC}(aircraft) + f_{CRS}(WC) \tag{49}$$

Modelling trip fuel requirements has therefore been reduced to three degrees of freedom, two of which are functions of the aircraft type, whilst the average wind component accounting for > 99% of the cruise fuel requirement variance, for a given route. With no loss in predictability correlation, compared to modelling trip fuel against equivalent still air distance, which requires in each instance pre-determination of cruise time, equation (43) eliminates one order of magnitude.

6.10 Simplified Range Equation Revisited

Equation (22) from chapter 3.11 presents the relationship between the fuel requirements and wind component, all other factors remaining constant:

$$W_{fuel} = W_{TOC}(1 - exp\left\{\frac{-R_{gnd}}{RF[1-\frac{WC}{M\sqrt{\gamma R_0 T}}]}\right\}) \tag{22}$$

Although the convention is to fly Mach number at cruising level, equation (22) can nevertheless also be expressed as:

$$W_{fuel} = W_{TOC}(1 - exp\left\{\frac{-R_{gnd}}{RF[1-\frac{WC}{TAS}]}\right\}) \tag{50}$$

Figure 20 to Figure 22 reflect expected average wind components to be within approximately 30 to 35 kts. The aircraft type under consideration typically flies at a True Airspeed of ± 480 kts. The ratio WC / TAS is thus small. Where a ratio is small the following approximation holds:

$$\frac{1}{\left(1-\frac{WC}{TAS}\right)} \approx 1 + \frac{WC}{TAS} \tag{51}$$

Equation (50) can then be approximated by:

$$W_{fuel} \approx W_{TOC}(1 - exp\left\{k_a(1 + \frac{WC}{TAS})\right\}) \tag{52}$$

This can be further simplified as:

$$W_{fuel} \approx W_{TOC}(1 - k_b exp\{k_c WC\}) \tag{53}$$

Or:

$$dW_{fuel} \approx -k_d exp\{k_c WC\}) dWC \tag{54}$$

k_a to k_d are constants.

Consequently, the amount of fuel required does in fact vary exponentially with direct variations in average wind, where the ratios WC / TAS remain small. Here, average wind component was seen to be less than 40 kts whilst the aircraft cruises at a TAS of around 480 kts. The ratio of WC / TAS is thus less than 10%. Applying an exponential trend line to the underlying data is supported by the applicable theory.

7 DATA ANALYSIS – RETURN FLIGHT

7.1 Climb and Descent / Approach Fuel Requirements

Appendix 7 tabulates the fuel requirements for the climb to the first enroute waypoint after the initial cruise flight level is reached, and the fuel requirements for the descent and approach from the last enroute waypoint where final cruise level had been maintained. The table further reflects the trip fuel requirements (excluding reserve fuel requirements) and, corrected for climb and decent / approach fuel requirements, the cruise fuel requirements.

The climb requirements are 3.23% of MTOW with a standard deviation of 0.07%. The climb requirements, taken to the first enroute waypoint, are higher than for the outbound flight due to (a) climbing to a higher initial flight level (FL310 for the return flight versus FL300 for the outbound flight) and (b) the first enroute waypoint for level flight is further along the route at 4.6% of the total route versus 2.2% for the outbound flight.

Consequently, the return flight climb and initial cruise to the first enroute waypoint is more susceptible to wind variations, reflected in the higher standard deviation of 0.07% versus 0.01% for the outbound flight. An effect on the correlation between the cruise flight fuel requirements as a dependency on average wind component is accordingly expected.

The descent and approach fuel, similarly established, constitutes 0.51% of MTOW, with a negligible standard deviation of 0.02%, similar to the results for the outbound flights. The slight difference in percentage of MTOW results from differing arrival routings.

7.2 Effect of Average Wind Component

Consistent with the discussion in section 6.2 and 6.3, Figure 35 plots the cruise fuel requirements as a function of the average wind component for the route. To recap, cruise fuel requirements are considered between the first enroute waypoint where the first cruise flight level has been reached and the last enroute waypoint at final cruising level before descent for landing commences.

In keeping with the methodology applied for the outbound routes, an exponential best fit approximation is deemed the most appropriate representation of the data points, consistent also with the applicable theory on range determination (equation (25)). Consequently, the same principle equation as for the outbound flight applies:

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 WC} \tag{43}$$

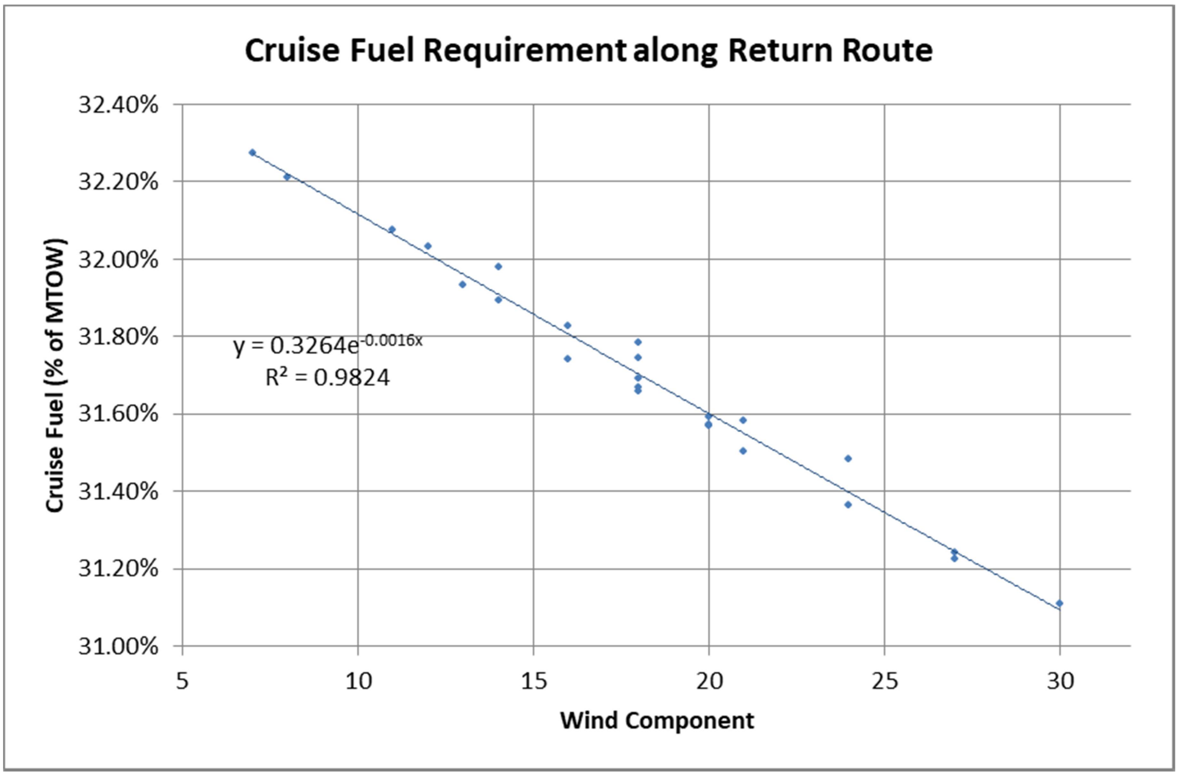

Figure 35 Cruise Fuel Requirements along the Return Route

7.3 Effect of Initial Wind Component on the Climb

The correlation coefficient R-Squared at 98.2% is less than for the outbound modelling (98.9%), attributable to the variance in climb fuel. As a consequence of the first enroute waypoint for level flight being further along the route than for the outbound flight (4.6% of the total route versus 2.2%), cruise wind effects influence more succinctly the climb segment fuel requirements, as evidenced by the noticeably higher variance of 0.07% of MTOW.

This is further aggravated by high tailwind conditions initially, compared to the average wind component (Table 9), which, when plotted against one another, yields a correlation coefficient of 65%. Consequently, for this particular case, average wind component is not a suitable descriptor of the wind effects on climb fuel. A different approach is required. Figure 36 plots the initial climb fuel requirements as a function of the initial wind component to the first enroute cruise waypoint. The correlation coefficient of 92.9% fortifies the contention that the climb fuel requirement variation is primarily wind dependent.

Period	Initial Wind Component (kts)	Average Wind Component (kts)
JAN 50%	94	24
FEB 50%	69	16
MAR 50%	73	20
APR 50%	56	21
MAY 50%	60	20
JUN 50%	31	18
JUL 50%	39	12
AUG 50%	25	8
SEP 50%	37	14
OCT 50%	53	20
NOV 50%	68	27
DEC 50%	85	30

Period	Initial Wind Component (kts)	Average Wind Component (kts)
JAN 85%	85	21
FEB 85%	59	14
MAR 85%	61	18
APR 85%	48	18
MAY 85%	54	18
JUN 85%	26	16
JUL 85%	34	11
AUG 85%	19	7
SEP 85%	31	13
OCT 85%	45	18
NOV 85%	59	24
DEC 85%	78	27

Table 9 Comparison of Average and Initial Wind Components for the Return Flight

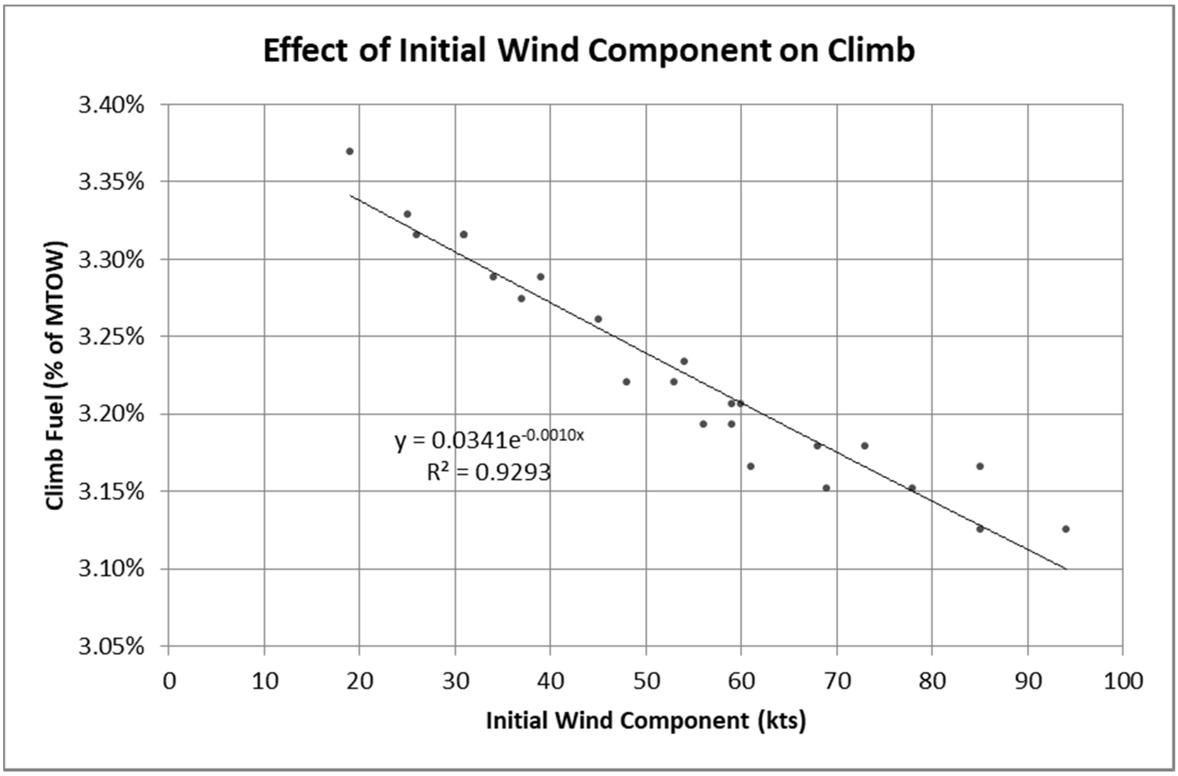

Figure 36 Effect of Initial Wind Component on Climb Fuel Requirements

Refining the predictive modelling of trip fuel requirements could accordingly be achieved through modelling the climb fuel requirements through an independent variable, the initial wind component, rather than assuming a fixed value as for the outbound flight case. Invariably, this complicates the modelling process, introducing a separate independent variable. Yet this proved unnecessary for the outbound flight with climb fuel requirements being consistent at 2.15% with a negligible variance of 0.01%. A review of the underlying data for the outbound flight analysis reveals no discernible variance in flight time to the first cruise waypoint, whilst for the return flight such variance is around 7%.

Consequently, it could be assumed that the return flight fuel to the first waypoint consists of a fixed amount for the climb (2.15% as for the outbound flight) plus a variable wind dependent amount to get to the first enroute waypoint. Such an assertion is fortified by the knowledge that, only close to cruising levels, do wind effects predominate as a result of jet stream influences. At lower altitudes during the climb (and the descent) winds effects are moderate in comparison.

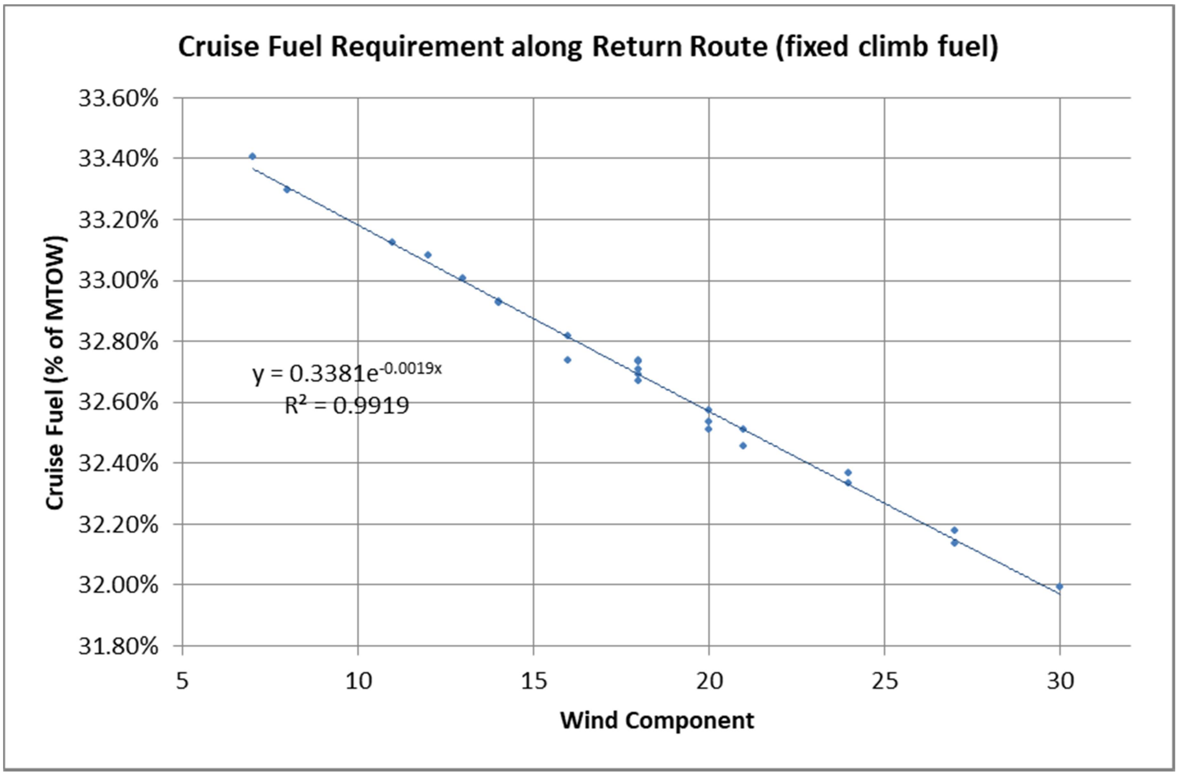

Figure 37 Cruise Fuel Requirement along Return Route (fixed climb fuel)

From the Flight Crew Operating Manual (FCOM), the fuel required to climb from sea level to an initial cruise level of FL310, from brake release at Maximum Take-off Weight, is in fact 2.24% of MTOW. Figure 37 encapsulates this approach. The data from Appendix 7 is utilized, adding the climb fuel requirement to the cruise fuel requirement, and then subtracting the fixed 2.24% to obtain the revised trip fuel requirements.

For comparison, for the outbound route the required fuel to climb from airfield elevation (not at sea level) to FL300 is 2.06% of MTOW (using FCOM data). The additional 0.09% is required to reach the first enroute cruise waypoint. Stated differently, the first enroute cruise waypoint on the outbound routing is reached just after reaching the initial cruise level. The difference is, in fact, about 15 nm, less than two minutes flight time. With the variance in fuel used to the first enroute cruise waypoint being negligible, using 2.06% or 2.15% for the climb fuel and adjusting the cruise fuel figures accordingly yields identical results of trip fuel prediction in the model.

The correlation coefficient for the return flight has now increased to 99.2% (comparable to the outbound correlation coefficient of 98.9%), validating the technique of a fixed climb fuel component. The effect-of-wind-component modelling has thus improved by moving the wind effect from the climb to the cruise phase of flight. The correlation to average wind component is greater for the return flight as only one route is involved.

As discussed in Chapter 6.4, a high correlation is significant in establishing average wind component as the predominant factor influencing cruise fuel requirements. Further, it implies very accurate predictions of payload capability based on the average wind component.

7.4 Accuracy of the Independent Variable

Using the identical approach as in chapter 6.5, the error bars on the independent variable, average wind component, can be displayed and adjusted for (again, for purposes of this analysis only), as shown in Figure 38. The resulting “new” trend line (“corrected for rounding”) yields a correlation coefficient of 99.8%, comparable to the results in Figure 24, implying that virtually all variability in the dependent variable, trip fuel, is attributable to the independent variable, average wind component. The trend lines coincide to the accuracy shown. The variance in trip fuel is, in statistical terms, adequately explained.

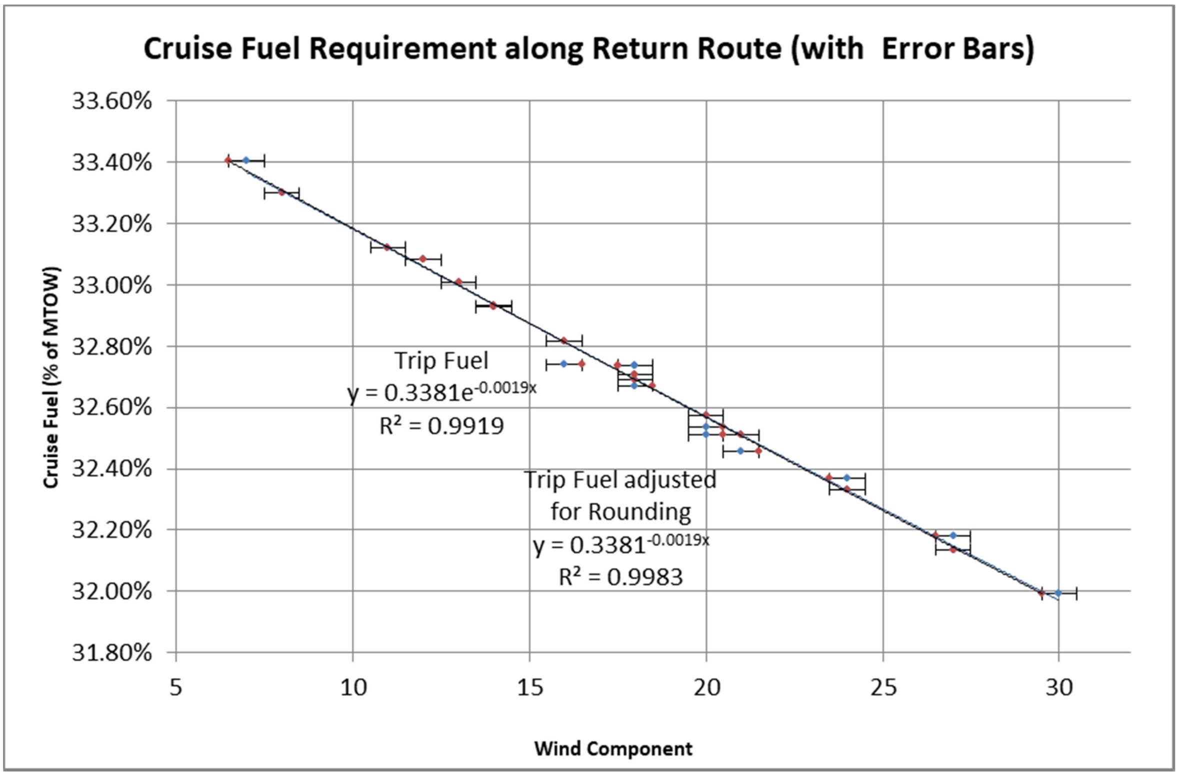

Figure 38 Error Bars for the Independent Variable, Return Flight

7.5 Optimum Altitudes

It is instructive to again view the vertical profiles flown versus the aircraft optimum cruise altitudes. As was done in chapter 6.6, four vertical flight profiles, seasonally selected so as not to clutter the graph (Appendix 4), are presented in Figure 39, when the solar position is furthest north, south and when over the equator. Unlike for the outbound flight, which largely operated below optimum altitudes as a headwind avoidance strategy, the return flight steps around the optimum altitude line as envisaged in Figure 5.

A review of the underlying data (Appendix 11) reveals that around halfway through the flight headwind components are observable. Consequently, as with the outbound flight, the return flight avoids headwind effects by delaying the climb from FL 350 to FL 370, as observable in Figure 39.

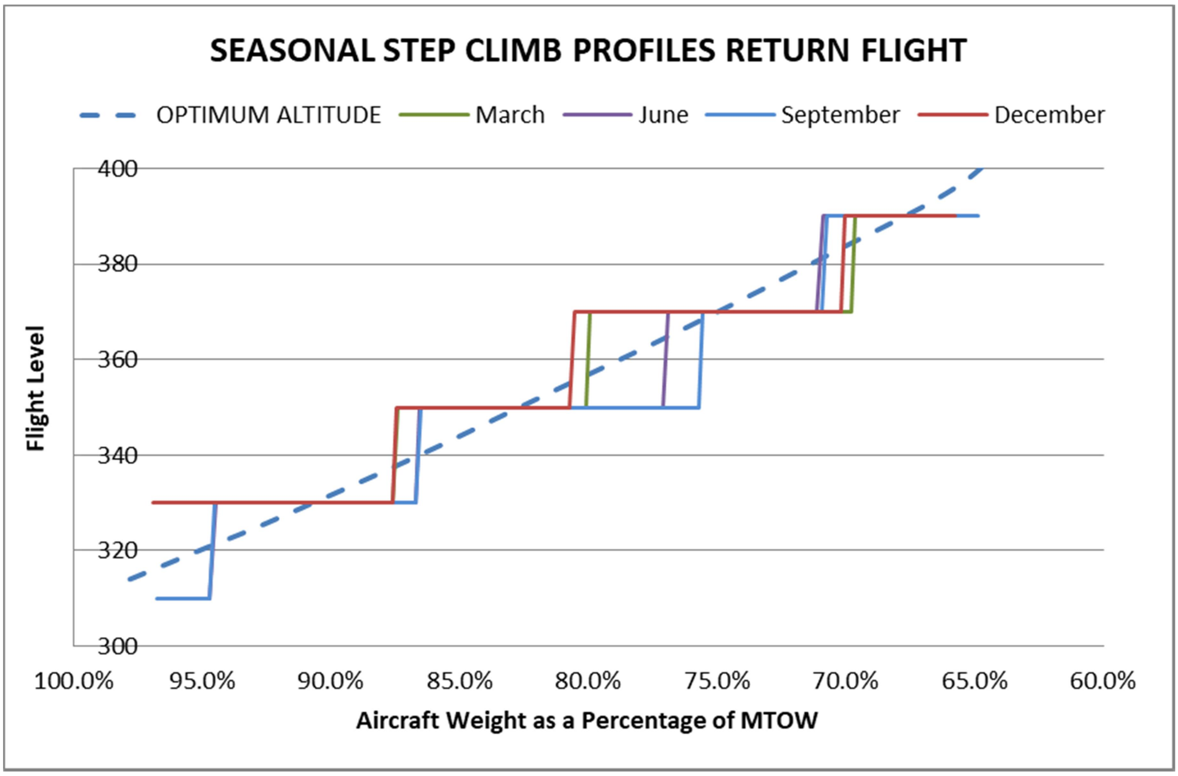

Figure 39 Seasonal Step Climb Profiles, Return Flight

7.6 Comparison of Outbound versus Return Estimations

A common-sense expectation would be that the outbound and return modelling yields similar results at the common point: zero wind components. Since the locations of the initial and final cruise points differ, such comparison necessarily needs to be for the trip fuel, inclusive of climb and descent fuel requirements.

$$Trip\ Fuel = F_{CLB} + F_{CRS} + F_{DEC} \tag{38}$$

For the outbound route, the trip fuel approximation (corrected for distance) (Figure 20):

$$\text{Trip Fuel}_{\text{Outbound}} = 0.0215 + 0.3370\, e^{-0.0020\, WC} + 0.0048 \tag{55}$$

For the <u>no-wind</u> case:

$$\text{Trip Fuel}_{\text{Outbound}} = 2.15\% + 33.70\% + 0.48\% = 36.33\% \tag{56}$$

And for the return route (Figure 35):

$$\text{Trip Fuel}_{\text{Return}} = 0.0224 + 0.3381\, e^{-0.00186\, WC} + 0.0051 \tag{57}$$

For the no-wind case:

$$\text{Trip Fuel}_{\text{Return}} = 2.24\% + 33.81\% + 0.51\% = 36.56\% \qquad (58)$$

However, with the base airport not at sea level, there is 0.10% of MTOW less in climb fuel requirement for the outbound flight, requiring correction to the outbound and return fuel requirements to be comparable:

$$\text{Trip Fuel}_{\text{Outbound (SL)}} = (2.15\% + 0.1\%) + 33.70\% + 0.48\% = 36.43\% \qquad (59)$$

A 0.13% variance between the results of equations (58) and (59) may be deemed statistically insignificant. It nevertheless remains instructive to understand whether any underlying contributors are causal of this variance.

A review of the monthly average flight plan data for the return route (Appendix 11) reveals a consistent adjustment of the Mach number in high tailwind conditions. The aircraft is being flown as slow as M 0.820 in the vicinity of the jet streams and accelerates back to $\pm$ M 0.825 in relatively calm wind conditions. Such is compliant with contemporary understanding that maximum range Mach number decreases with tailwind conditions, increases into headwind conditions, as portrayed in Figure 11.

Yet, for the outbound flight such increases in Mach number were not observable, as discussed in chapter 6.7, due to transonic operations. A reduction to M 0.820 was, however, observed whenever the flight step-climbed to the next cruise level, being the best rate-of-climb speed for the aircraft type, as per the aircraft's FCOM.

Therefore, whilst it might not be practical to increase speed into headwind conditions, a decrease of speed for tailwind conditions is conceivable and is in fact being applied where appropriate for the return flight. The fuel requirements will be affected accordingly. Table 3 provides some guiding approximation in this regard. A Mach number decrease of M 0.01 implies a 0.96% increase in fuel burn. This is not contradictory, as Table 5 attests, as the increase in fuel burn is more than offset by the corresponding benefit of the sufficiently large tailwind condition. It however becomes contradictory when the tailwind component is insufficient in magnitude to justify a Mach number reduction, such as is the case when the average wind component is zero.

The trend line best fit model of Figure 37 is based on data where there is variance in Mach number concurrent with high tailwind conditions over part of the flight. With the zero average wind component unlikely to consist of a combination of significant headwinds and tailwinds balancing out, given the prevailing permanent jet systems in the upper atmosphere, the trend line model becomes overstated in this instance.

From the data in Appendix 11, for the return flight, the time weighted average Mach number flown is around M 0.8225. Flying such a Mach number, instead of M 0.825, for the zero wind case, with reference to Table 3, can be approximated to increase the fuel burn by around 0.24%, i.e. the cruise fuel factor becomes overstated. Reducing the cruise fuel factor for the 0.24% so estimated changes equation (58) as follows:

$$\text{Trip Fuel}_{\text{Return (MN 0.825)}} = 2.24\% + 33.73\% + 0.51\% = 36.48\% \tag{60}$$

Now comparing this to equation (59):

$$\text{Trip Fuel}_{\text{Outbound (SL)}} = (2.15\% + 0.1\%) + 33.70\% + 0.48\% = 36.43\% \tag{59}$$

The remaining difference of 0.05% is well contained within the remaining uncertainty, of the models not accounting for 1.1% of cruise fuel burn variation outbound (Figure 20) and 0.8% for the return (Figure 37). The difference between the results of equations (56) and (58) has thus been reconciled, attributable to differing airfield elevations and Mach number differences outbound versus inbound.

Consequently, with the equations yielding slightly different results at average WC = 0, the cruise fuel portions of the models would appear to indicate an average wind component where the use of one model becomes preferable over the other. However, for this to be valid, the outbound routing needs to be considered from top of climb rather than the first waypoint, as now done for the return flight, i.e. to be corrected by the 0.09% determined in chapter 7.3. Thus

$$0.3379\, e^{-0.00200\, WC} = 0.3381\, e^{-0.00186\, WC} \tag{61}$$

The two models, appropriately corrected, intersect at an average tailwind component of 4.2 kts. A perusal of the flight plan data in Appendix 11 reveals this to be inconsequential. All average wind components are significantly higher, the closest being 7 kts (August 85%) and 8 kts (August 50%). Assuming normal distribution, at 99% probability levels, the lowest average tailwind component for the return flight calculates at 5.8 kts.

It is understood that the result of equation (61) is not indicative of a tailwind component above which Mach numbers should be reduced in tailwind conditions. As evidenced in Appendix 11 the Mach number varies continually throughout the flight in response to varying conditions, even for low average tailwind components. An average wind component cannot be a predictor here.

Finally, whilst equation (43) is applicable for the return flight modelling, a difference in the factor k_3 is noted, but not unexpected: For instance, a 10% increase in ground speed (tailwind) results in 9.1% reduction in flying time, whilst a 10% reduction in ground speed (headwind) increases flying time by 11.1%. A positive ΔTAS therefore has a lesser relative effect than the same but negative ΔTAS, reflected in the slightly lower exponential factor k_3 for tailwind conditions.

Ultimately, the same format modelling applies for the outbound and return flights, based on the same number of degrees of freedom. Using equation (43): $Trip\ Fuel_i = k_1 + k_{2_i}e^{k_3 WC}$, the commonality of constants across routes is illustrated in Table 11:

	Outbound			Return
Constant	Route 1	Route 2	Route 3	Route 4
K_1	2.63%			2.75%
k_{2_i}	33.70%	33.77%	34.15%	33.81%
K_3	0.00200			0.00186

Table 10 Commonality of Constants across the Routes

7.7 Correlation between Theory and the Results

Following on from a summary of the availability of performance prediction tools, chapter 3 continues with a discussion on optimising fuel consumption and achieving maximum range flight. Influencing factors on maximum range are highlighted in chapter 3.6 and more specifically the effects of flight altitude and wind are generically analysed in chapters 3.9 and 3.10. The approximate methods to determine range in chapter 3.5 culminate in a discussion in chapter 3.11 of the simplified range model first postulated by Randle, Hall and Vera-Morales [52]. An adaptation of their model ultimately formed the theoretical foundation for the initial part of this research, analysing fuel dependency on environmental conditions. Preceding the analysis of flight data in chapters 6 and 7, the influencing factors on range were modelled in chapters 3.12 to 3.16, specifically through application of the modified simplified range equation.

The discussions in chapter 3.6 have shown that, when flying in compressible air, maximum range is achieved by flying at an optimum altitude (Figure 1). Optimum altitude in turn is dependent on aircraft weight (Figure 4), increasing as weight decreases. Ideally, an aircraft should continuously cruise climb to keep altitude optimised. In practical flight operations, though, flight occurs along an air traffic control pre-determined flight level system, to separate air traffic from one another. To stay close to optimum altitude, flights step climb repeatedly throughout a long flight (Figure 5). Modern Flight Planning Systems plan flights to operate as close to optimum as possible. Consequently, the analyses in chapters 6 and 7 are based on flight at optimum altitude. Further, as discussed in chapter 6.6 and shown in

Table 8, flight altitudes are further optimised by the Flight Planning Systems, by taking the difference in wind intensity between different flight levels into account.

Chapter 3.6 showed that maximum range Mach number decreases with decreasing weight at a given altitude (Figure 2) and increases with altitude at a given weight (Figure 3). In chapter 6.7 Figure 27 and Figure 28 respectively expanded on this. The results of Figure 2 and Figure 3 remain true when flying purely for maximum range. If, however, one further optimises a flight by minimising the combined fuel and time related costs (cost index flying), Mach number becomes primarily dependent on the chosen cost index, and varies only marginally with weight and altitude. The flight plans analysed reflect this.

Chapter 3.10 specifically discusses the effects of wind on range. Figure 11 shows that the maximum range Mach number increases into headwind, decreases into tailwind. Figure 13 then further shows that, when flying cost index $\neq 0$, the required variation in Mach number in response to wind effects is minor. This was observed for the return flight with tailwind where Mach number reduced to M 0.82 from M 0.825 only when flying near jetstreams, with an average Mach number of approximately M 0.823 versus M 0.825 for the still air case. The outbound flight into headwind did not increase Mach number though and was operated consistently at M 0.825 (other than during step climbs). Chapter 6.7 demonstrates how the increase in drag with increasing Mach number for a transonic wing design negates the effectiveness of increasing Mach number into headwind.

From Figure 21 and Figure 35, the average wind component does not exceed ± 30 to 35 kts (approximately 15 to 18 m/s). Table 10, for outbound Route 1, shows the still air fuel to weight ratio to be 33.7%. With a 15 m/s headwind, applying the parameters of Table 10 to the empirical equation (40), the fuel ratio increases to 35.7%. Applying actual averaged conditions to the simplified range equation (24), as was done for Table 3 with no change in Mach number, the fuel ratio is calculated to be 35.4% for the 15 m/s headwind, a relative difference of 0.8%. This then validates the discussion in chapter 6.10 which reasons, for wind component to true airspeed ratios of less than 10%, for equation (40) to be an approximation of equation (24).

Chapter 3.14 quantifies the combined effects of wind and Mach number, again using the simplified range equation. For the return flight, Route 4, the fuel to weight ratio in still air is 33.81%, as per Table 10. A 15 m/s tailwind applied to equation (40) reduces the fuel ratio to 32.0%. Applying actual conditions to equation (24), a 15 m/s tailwind combined with a reduction of M 0.002 in average Mach number versus the still air case decreases the cruise fuel ratio to 32.3%, again a relative difference of about 0.8%. The results are therefore consistent with the theory.

Table 6 in chapter 3.15 reflects the effect of temperature on range, as predicted by the simplified range equation, to be approximately ± 0.9% change in range per ∓ 5 K temperature change. Figure 31 suggests that seasonal differences to be around 3 K at times, typically balanced between positive and negative variance along the route. Figure 34 then confirms that temperature effects, along the routes under study, predicted to be small by the theory anyway, are negligible.

Chapter 3.1 highlighted that the flight plans studied are optimised by the flight planning system through the step-by-step use of look-up tables of aircraft performance provided by the aircraft manufacturer. Such optimisation takes into account optimum altitudes, wind and temperature effects. With flights so optimised, correlation sufficiency between the findings of chapters 6 and 7 and the discussion on theory in chapter 3 exists.

8 DATA ANALYSIS - ACTUAL FLIGHT PLANS

To validate the necessity for an improved forecasting tool for route performance, a comparison is needed of the current forecasting methodology to actual flight plans. As before, such flight plans were obtained from the commercially available flight planning system by SITA, a company specializing in air transport communications and information technology.

Although the direct connection between the two city-pairs under study exists since 2011, such operations occurred seasonally: May to October the route was typically operated directly when the winds were less unfavourable, otherwise a technical stop was used roughly midway to uplift fuel and allow for higher payload capability. Since the northern hemisphere winter season 2015/16 the flights are being operated directly year round. Consequently, continuous flight plan data has only become available from mid-April 2015, with full month data since May 2015, yielding 28 months of data until August 2017.

Over the period 845 actual flights were conducted out of a possible 854. Nine flights (1%) did not operate due to either technical defects or extreme weather conditions. In times of extreme weather such as severe snow storms, conditions at destination and / or alternate airfields can be beyond aircraft landing capabilities. Alternatively, large enroute weather patterns such as tropical storms may preclude operations. In numerous instances, typically when payload demand (potentially) exceeded payload capability, more than one flight plan was assessed on a particular day of operation. Consequently, when sorted by the three routes utilized, 1105 data sets are available: 457 for route 1, 441 for route 2 and 207 for route 3.

With the previous chapters having illustrated the overwhelmingly predominant dependence of fuel requirements on the average wind component, it is instructive to plot actual average wind component on a day of operation versus the monthly average wind component at the 85% probability level (as used for forecasting) to visualise the daily versus the seasonal variations. Figure 40 and Figure 41 respectively provide a high level overview of two annual periods: September 2015 to August 2016 and September 2016 to August 2017. An annual view was chosen for ease of comparison between charts. As such, these figures do not distinguish between routes flown; rather they aim to provide the overall annual versus daily patterns of wind variations.

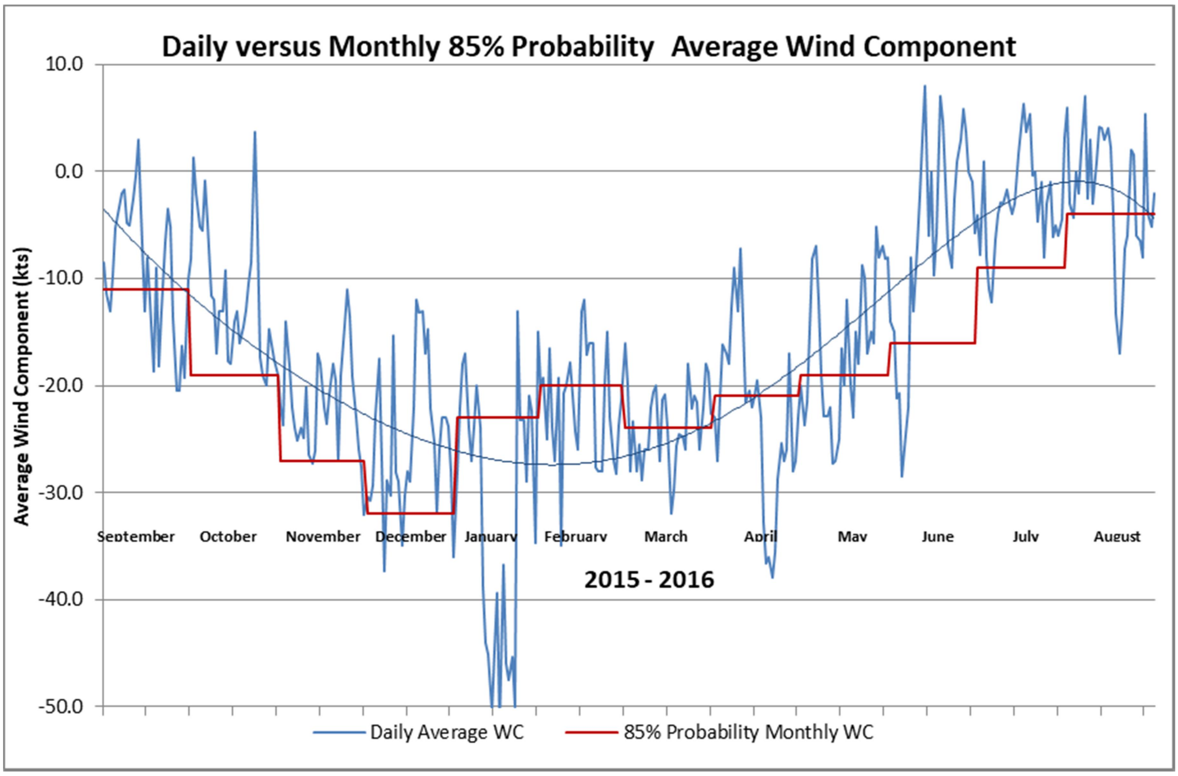

Figure 40 Daily versus Monthly 85% Probability Average Wind Component 2015 to 2016

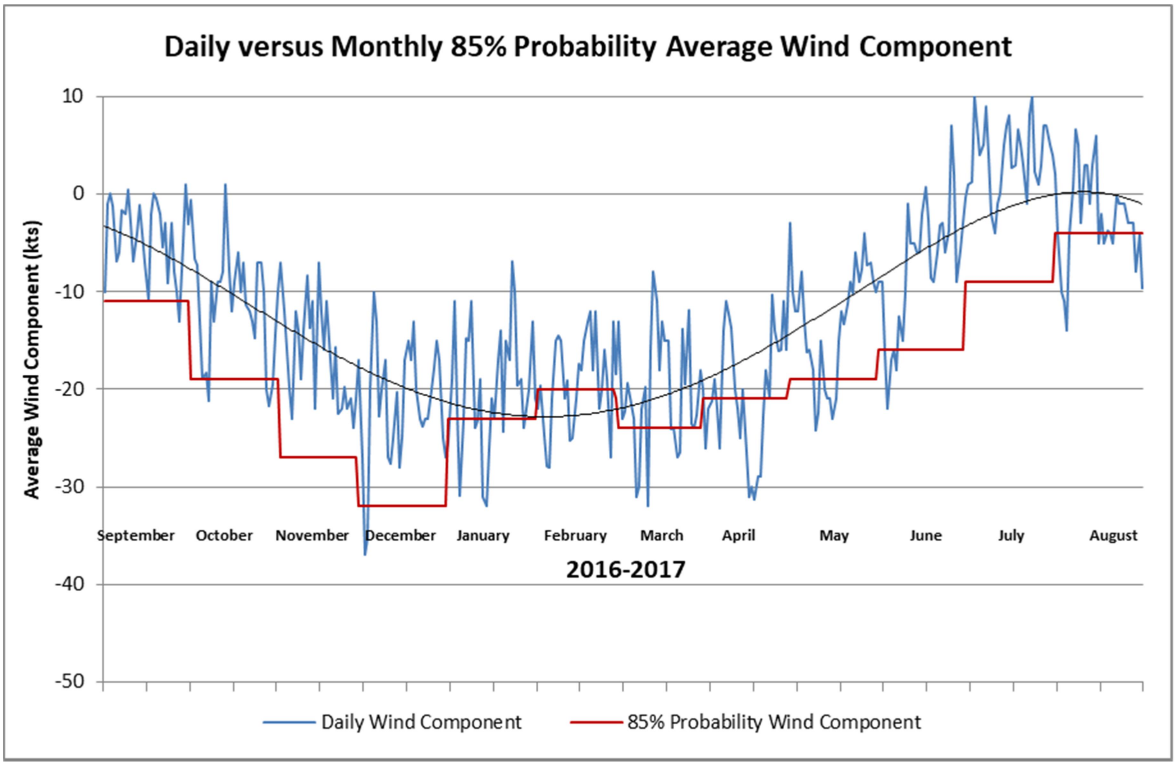

Figure 41 Daily versus Monthly 85% Probability Average Wind Component 2016 to 2017

The polynomial trend lines in Figure 40 and Figure 41 appear to indicate a slight variance in expected average wind components, the maximum and minimum trend line headwind components being circa 4 kts less in 2016 / 2017 versus 2015 / 2016. These trend lines correlate with the daily variations at an R-Squared of around 60%, random daily variances being evident. This is discussed further in the next chapter 8.1.

8.1 Changes in Annual Climate Patterns

Figure 42 combines two years of average wind components (Figure 40 and Figure 41), without showing the 85% probability monthly average wind component.

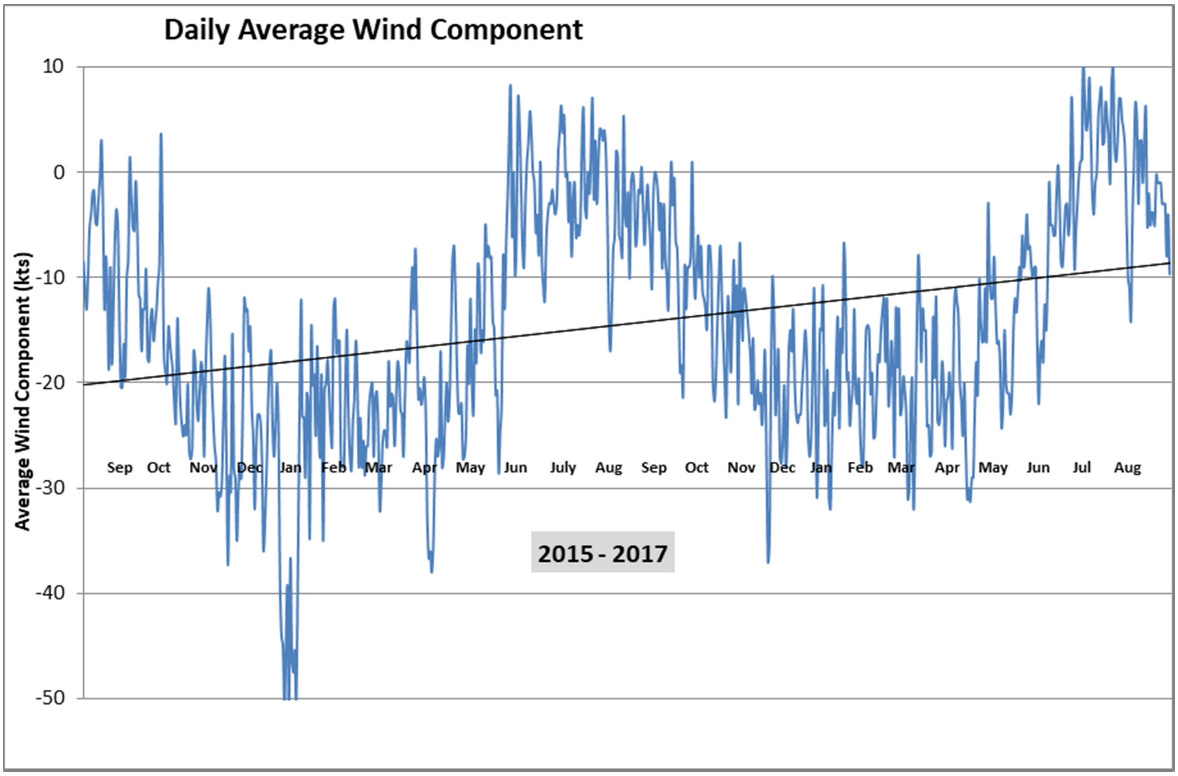

Figure 42 Daily Average Wind Component 2015 to 2017

At face value the linear trend line and the data itself appears to indicate a general reduction in headwind component, season to season, over the two year period. However, the R-Squared for the linear trend line is 9.5%. At such a low value further significance testing is required. Performing a t-test on the data using commercially available NCSS Statistical software [66] indicates that the null hypothesis, the default position that there is no relationship between the data and the regression line, i.e. the slope of the linear regression line being zero, must be rejected [62].

The implied reduction of headwind component of about 6 kts per annum seems excessive, and will require further analysis. The route under study, being more than 7000 nm long, stretches across close to one third of the earth circumference. Variations in wind patterns consequently cannot be the result of localised weather effects such as thunderstorms. Even the change in wind strength and direction when crossing frontal systems remains localized [67], especially since average wind components are considered.

Rather, large scale weather patterns may be fluctuating or transforming with time. Changes in large scale weather patterns arise primarily from climate change. The dominant view [68], historically, has been that climate change occurs over tens of millennia or more. Unequivocal geological evidence accumulated over the last few decades revealed, however, that climate change can occur more abruptly, over periods of decades and even years [68]. It therefore seems conceivable that the data contains an element of change in large scale weather patterns. Invariably, two years of continuous data does not suffice to establish a reliable trend, though.

Continuous full-month data exists only since May 2015, when non-stop operations outbound commenced year round. Beforehand, since 2011, non-stop flights were conducted seasonally, with technical stops when the wind patterns were most unfavourable.

Figure 43 displays the best fit polynomial trend lines for each year 2011 to 2017 for the period April to September, visually verified to be representative of an annual variation cycle. The actual daily average wind components are deliberately omitted to unclutter the graph. Moreover, trends rather than scatter are of interest in this discussion. R Squared values, varying between 60% and 75%, imply high representivity.

Whilst the spread between most and least favorable years in terms of average wind component stretches to as much as 8 to 9 kts, such variance certainly is not linear from year to year. Further, horizontal variance with calendar days is observable. However, patterns, other than the expected annual variation, are not readily discernible from Figure 43. An average annual seasonal trend line is also shown, together with upper and lower error bands.

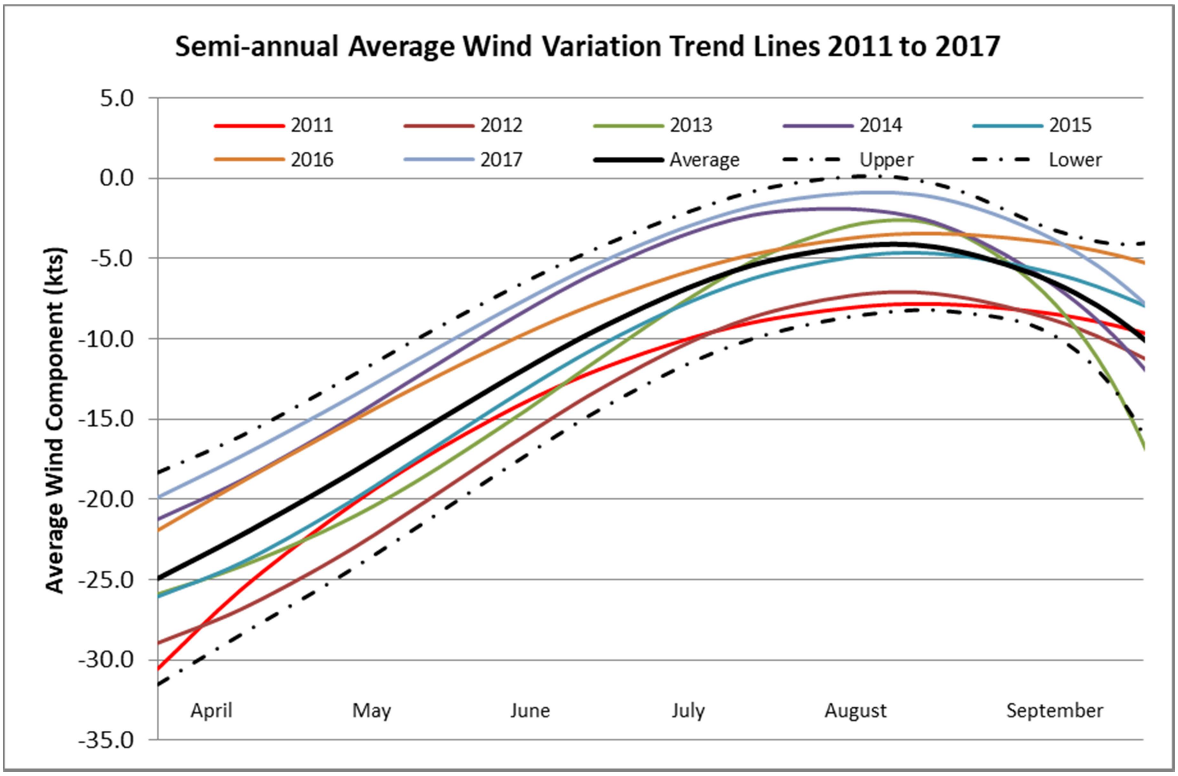

Figure 43 Semi-annual Average Wind Variation Trend Lines 2011 to 2017

As the sample size to determine each data point on the average trend line is small (seven years) the Student t-Distribution is applied [62], together with the standard error $\alpha_{\bar{x}}$ calculated from:

$$\alpha_{\bar{x}} = \frac{\alpha}{\sqrt{n}} \tag{62}$$

The error band E is then calculated as:

$$E = \bar{x} \pm t\frac{\alpha}{\sqrt{n}} \tag{63}$$

Where t is the value from the t-distribution reflecting the required confidence level.

For the individual years shown to remain within the error bands a two-tailed confidence level of 99.5% is required [62]. Consequently, the error bands are large at around ± 8.8 kts. Further, towards the end of September the error bands appear to start diverging, reflective of the seasonal cycle also being variant with time. The individual trend lines would indicate the date location of peaks (lowest average wind component) to vary by about a month.

Figure 43 does not lend itself to establish a trend though, as sequential years do not successively reduce the average wind component. For instance, for 2015 the average wind components increased relative to 2014. A more productive approach, accordingly, would therefore be to compare the average wind components on specific days each year. Conveniently, mid-month dates were chosen for Figure 44.

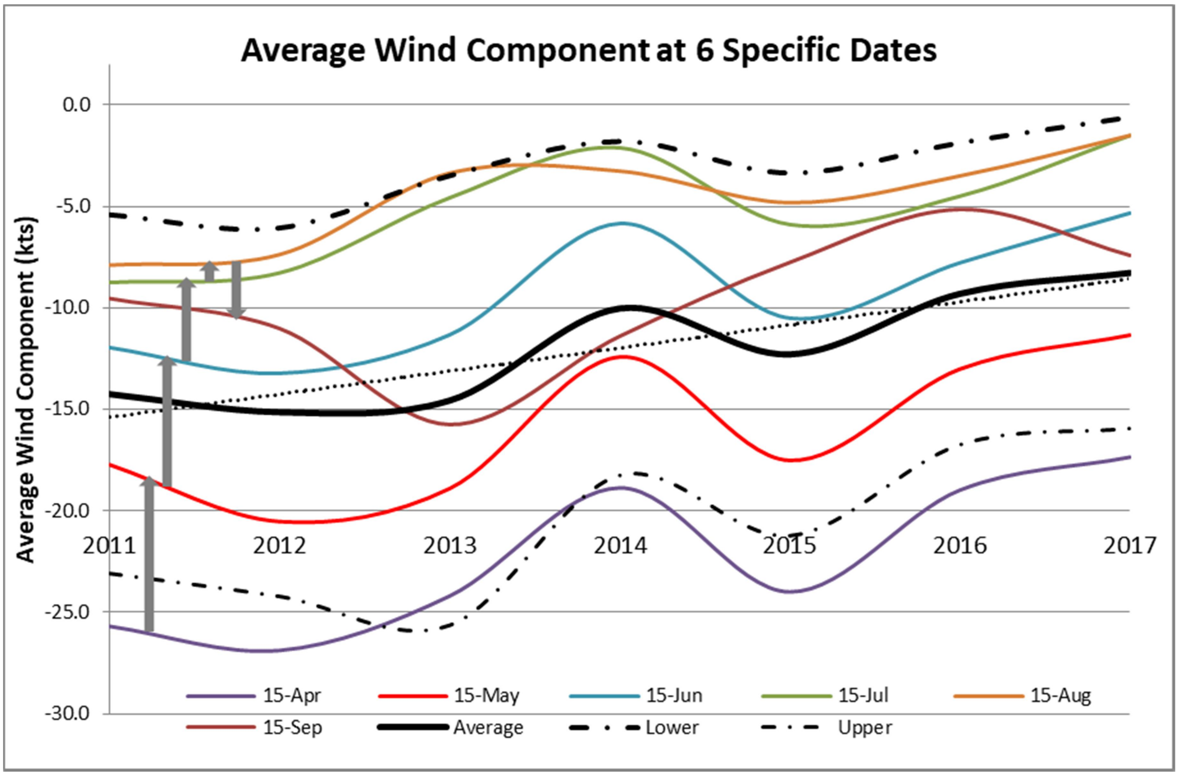

Figure 44 Average Wind Component Trend Lines at 6 Specific Dates 2011 to 2017

The specific date curves in Figure 44 are reflective of the seasonal variation observed in Figure 42 and Figure 43: From April the average headwind component decreases, at first rapidly, to reach minimum values around July / August. For September the headwind components start increasing again. The grey arrows indicate the calendar progression of the trend lines.

In the view presented in Figure 44 the specific date curves, although meandering, tend towards a reduction in average headwind component with calendar time. Linear trend lines, omitted here for clarity other than for the average trend line, all portray positive slopes. To obtain an average trend across the years in Figure 44 the underlying polynomial equations for the trend lines in Figure 43 were applied daily over 183 days spanning April to September each year, then averaged.

As for Figure 43 error bands are shown around the “average” polinomial in Figure 44, at the same 99.5% level. In this instance, though, the “15-Apr” trend line lies partially outside the lower error band. In Figure 44 the trend lines for “15-Apr” to “15-Jul” inclusive follow the same meadering pattern. The trend lines for “15-Aug” and “15-Sep” do not. If one re-calculates the figures for “15-Apr” to “15-Jul” only, these four trend lines then fall within the 99.5% error bands. Figure 45 reflect this.

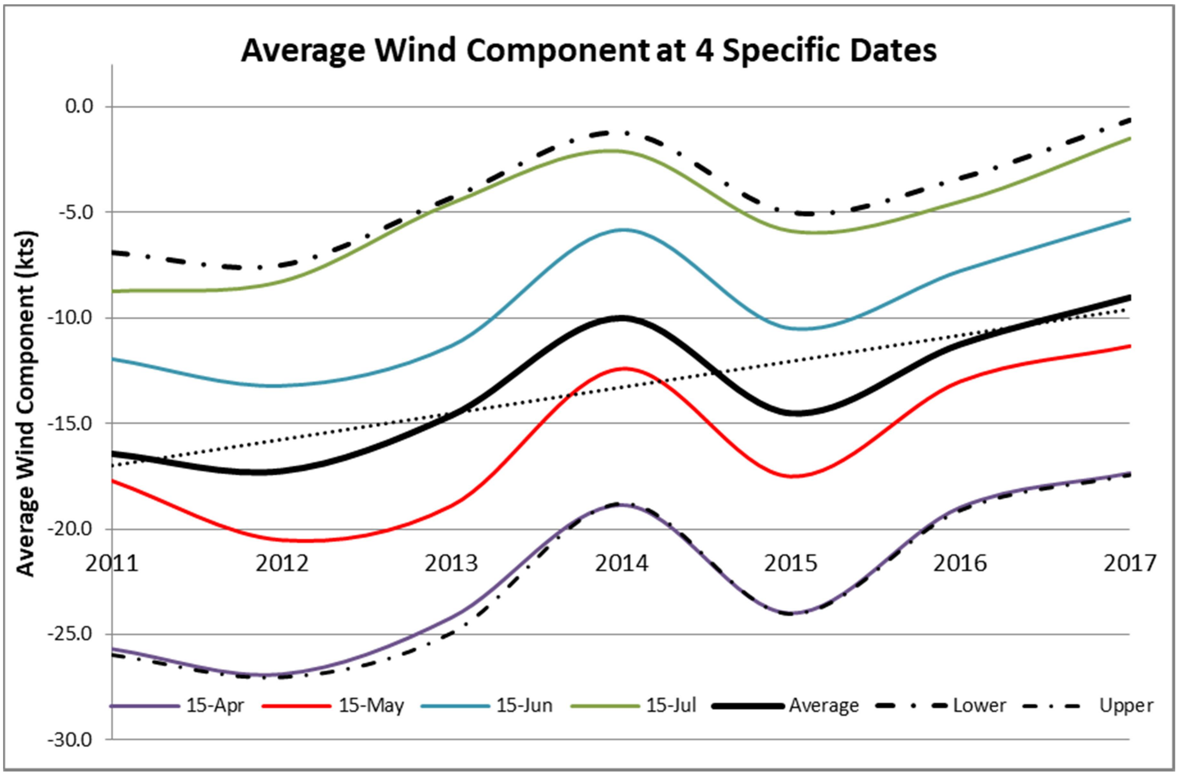

Figure 45 Average Wind Component Trend Lines at 4 Specific Dates 2011 to 2017

For the years 2011-2012 and again 2015 to 2017 particularly the “15-Sep” line in Figure 44 biases the average line and the error bands upwards thereby “exposing” the “15-Apr” trend line. August / September are the relatively calm months with average wind components around the 5 kts headwind range. As such, winds are not dominated by the jetstreams experienced during other months, with their predominantly easterly flow patterns. Rather, wind patterns are more random in August / September resulting in the trend lines observed.

One could apply trend lines to the “average” curve in Figure 44 and / or Figure 45. To do so would yield different results when using 4 dates versus 6 dates and in fact versus 12 dates. A cautionary aspect is that only half year data was utilized, due to data availability constraints. It cannot reasonably be assumed that the other half year periods mirror the assessed half year periods, expecially since the set of routes are more exposed to weather patterns in the northern than southern hemisphere.

Since the "average" curves in Figure 44 and Figure 45 derive from data in turn calculated from polynomial trend lines (rather than actual data points) it becomes possible to replicate the "average" curve with a polynomial trend line of sufficiently high order, achieving an R-Squared close to 100% in the process. However, it cannot be infered, in this instance, that correlation adequacy exists with the raw data.

Using polynomial trend lines to approximate the data requires fourth or higher order polynomials to achieve levels of correlation better than for a linear trend line. Whilst representative of the data centrally, typically near the edges of the data set the trendlines start displaying anomalous patterns no longer observed representative. Consequently, using higher order polynomials to project beyond the data set becomes questionable. Only regressions resulting in long term gradual but steady progressions (e.g. linear, logarithmic, exponential) or in repetive patterns (e.g. sinusoidal) or a combination there-of seem to serve here.

Within the available data set, then, and given the magnitude of the error bands, it ultimately can only be established that there is a not insignificant change in average wind component with time. To establish long term trends requires annual data over decades. Nevertheless, from the data used for Figure 42 it was already established that the null hypothesis, that the slope of the linear trend line is zero, is rejected. Variation with time exists.

It must be re-emphasized that the pupose of the discussion in this chapter was limited to establishing the legitimacy of the visually observed shifting of average wind patterns in Figure 40 and Figure 41. Depth of data availability prevents establishing reliable long term trend modelling. Further analysis, probably spanning decades, would be required to estblish trend patterns. Nevertheless, the presence of shifting patterns requires consideration in any modelling attempts of average wind component variation.

8.2 Accuracy of Current Forecasting Methodology

The current forecasting methodology considers the 85% probability average monthly wind distribution, by route, to predict the fuel requirements at maximum take-off weight (MTOW). From the fuel requirements the payload capability is calculated. Whenever a full passenger load cannot be carried the number of sellable seats is restricted in the airline's flight reservation system.

Cargo carrying capability does not get considered in this instance. As the outbound flight becomes restricted on passenger capability through parts of the year, the flight is consequently unable, passengers necessarily being prioritized, of carrying regular scheduled cargo year round. The conservatism in this approach aims to minimise the off-loading of passengers, consequently biasing towards flying with more empty seats than might have been necessary. Figure 46 reflects this: actual trip fuel requirements are more often less than predicted fuel requirements at MTOW.

To obtain the actual trip fuel requirements, equation (43) was applied using the average daily wind component along each route (as available), then selecting the most favourable solution (least trip fuel):

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 WC} \tag{43}$$

The difference between actual and predicted trip fuel requirements is presented in Figure 46, positive results indicating higher actual fuel requirements than predicted. The 85% probability level is presented in Figure 46 by the difference being 0%. Although Figure 46 shows 28 months of data, the analysis there-after restricts itself to the 24 months September 2015 to August 2017 inclusively. Given the evidently cyclical nature of wind variations this prevents bias towards more or less favourable months.

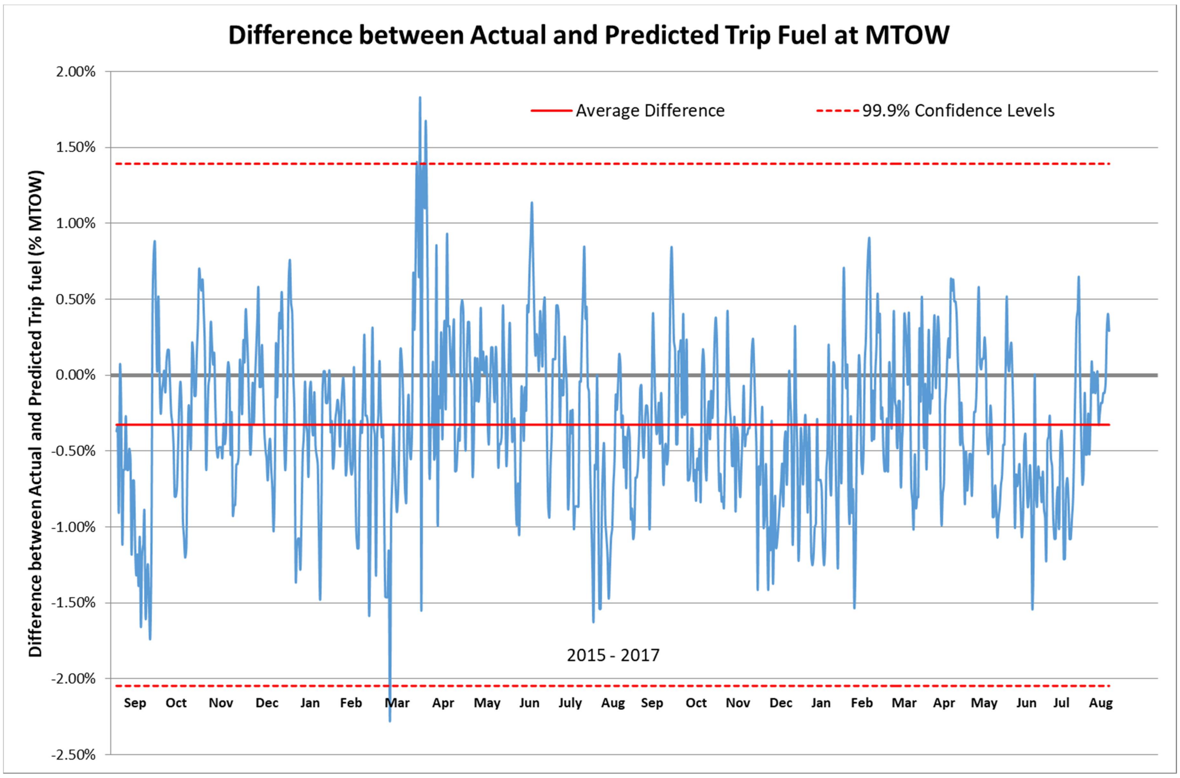

Figure 46 Difference between Actual and Predicted Trip Fuel at MTOW

The resulting 724 data points yielded an average difference of predicted versus actual trip fuel requirements of -0.327% with a standard deviation of 0.526%. On occasion some extreme outliers are observable (December 2015 and January 2016) attributable to the unusually low / high headwind components in December 2015 / January 2016 respectively, as observed in Figure 42.

The predicted values are those based on 85% probability wind component level whilst the observed values vary around the mean (50% probability level). Nonetheless, 26.0%, not 15%, of data points in Figure 46 are above 0%, indicating predicted conditions worse than actual, even though the underlying assumption is that 85% of average wind components are less favourable than predicted.

It is important to note that the 15% probability presents the cumulative effect of over estimation (total area under the standard distribution curve outside the 85% probability line), i.e. the combination of number of occurrences multiplied by the magnitude of over estimation. Since this methodology ultimately determines the number of denied boardings of passengers annually, rather than the number of flights where this occurs, commercially it constitutes the correct application.

Practically, therefore, although 26% of flights on the day of operation required more fuel than predicted, the amount of extra fuel is, on average, less than the average amount of overestimation on the other 74% of flights, in line with the -0.327% average deviation (mean). Specifically, the cumulative underestimation is 17.5% versus an overestimation of 82.5%. The slight deviation from a 15% / 85% distribution is likely attributable to the same average monthly wind component being utilized year for year, whilst Chapter 8.1 illustrated the presence of variation likely to result from climate change effects.

If the data is normally distributed in terms of number of flights over- / underestimated, a 74% probability would yield a z-value z = 0.6433 from tables [62]. In accordance with equation (48), multiplying the standard deviation by the z-value predicts an average difference of -0.338%. This compares to the observed value of -0.327%.

Starting from the assumption that the two mean values so determined are equal (the null hypothesis) at the same probability level of 85% (z = ±1.44 for a two sided distribution), one can apply the following equation to the sample distribution [62]:

$$\mathrm{z} = \frac{Observed\ Value - Assumed\ value}{Standard\ error\ of\ the\ sampling\ distribution} \tag{64}$$

With the standard error $\alpha_{\bar{x}}$ calculated from:

$$\alpha_{\bar{x}} = \frac{\alpha}{\sqrt{n}} \tag{62}$$

The calculated z value from equation (64) then is z = -0.563, less than the desired value. The null hypothesis is therefore not rejected and the data may be taken as approximately normally distributed.

A measure of the accuracy of the predictive methodology is required. Consistent with earlier discussions, R Squared is a useful measure of correlation between sets of data:

$$R\ Squared = 1 - \frac{Sum\ of\ Squares\ Error\ (SSE)}{Sum\ of\ Squares\ Total\ (SST)} \tag{34}$$

Where:

$$SSE = \sum_{i=1}^{n} (y_i - \hat{y})^2 \tag{35}$$

And:

$$SST = \sum_{i=1}^{n} (y_i - \bar{y})^2 \tag{36}$$

Comparing the 85% predictions to the actual fuel requirements at MTOW over the period September 2015 to August 2017 yields an **R Squared of 35.0%.**

65% of the variance remains unexplained by the current predictive methodology. Being approximately normally distributed, 99.9% of all data will lie within a ± 1.720% variance of fuel burn around the average difference of -0.327% between the predicted and actual wind component of -0.327% determined earlier. The average difference and the 99.9% confidence levels are shown in Figure 46.

8.3 Effect on Passenger Load Carrying Capabilities

With the predictive methodology focused on fuel requirements but the application thereof ultimately being on forecasting passenger load capability, it cannot be inferred that, in 85% of cases passenger load capability is understated. The number of passenger seats on an aircraft is finite and static. Consequently, where theoretical predicted passenger capacity exceeds 100% the over- respectively underestimation becomes diminished or even inconsequential. (Rather, the extra payload capacity above a full passenger load enables the carrying of ad hoc cargo. Ad hoc cargo demand typically arises at short notice rather than being booked months in advance.)

For a given average wind component the trip fuel requirements can be calculated from equation (43). With the trip fuel plus fuel reserve requirements and the operating empty weight (OEW) of the aircraft subtracted from the maximum take-off weight (MTOW), the payload capability can be determined from:

$$Payload = MTOW - Fuel\ on\ Board - OEW \tag{65}$$

Then, with average passenger weights known, the predicted versus actual passenger load factor capability is assessed on any given day, as depicted in Figure 47. Passenger Load Factor (LF) in this context is defined as

$$Load\ Factor\ (\%) = \frac{Passenger\ Carrying\ Capability}{Number\ of\ Passenger\ Seats} \tag{66}$$

Principally, if not restricted by fuel requirements, the aircraft is capable of carrying up to 126% of the number of available seats, but this only becomes of value (other than cargo) with a reconfiguration of the aircraft cabin layout. Any variance from predicted load factor becomes inconsequential during such periods. This effect turns out to be clearly evident in Figure 47. Similarly, while the effect of the unusually strong average headwind component experienced in January 2016 is evident in Figure 47, the relatively mild headwind components of December 2015 added no benefit.

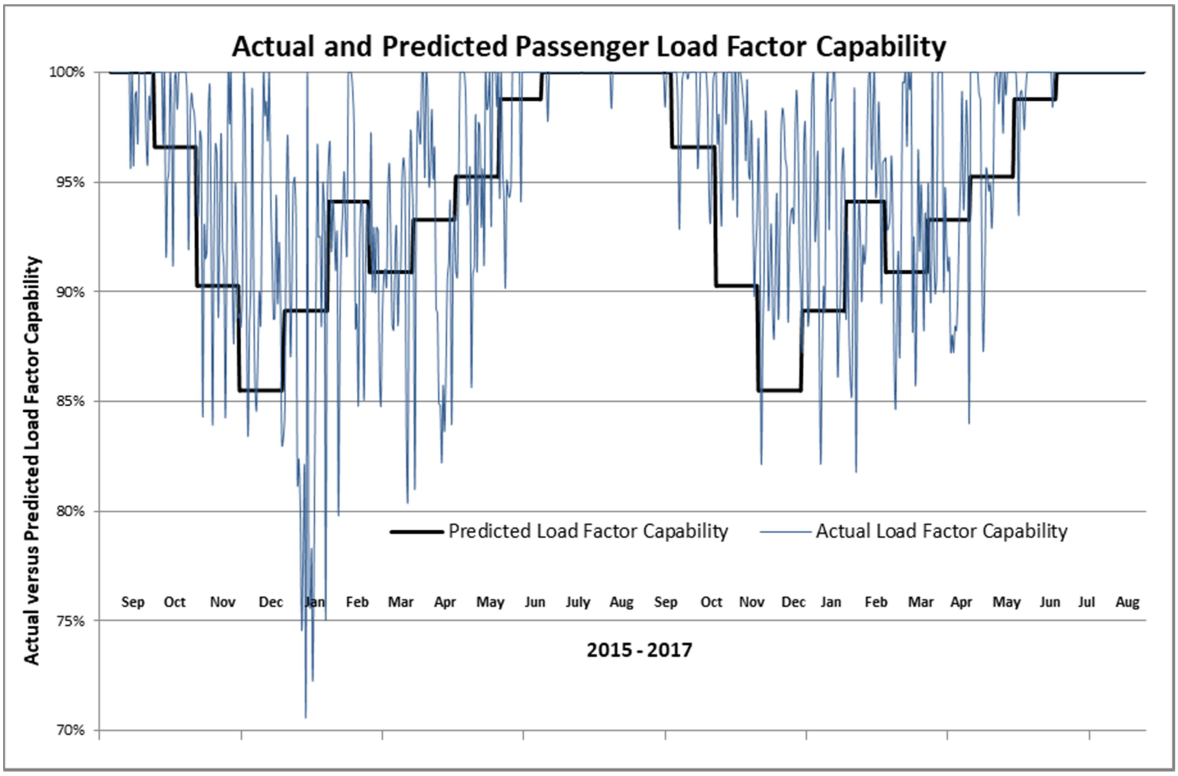

Figure 47 Actual and Predicted Passenger Load Factor Capability

For two months annually, July and August, a full passenger load is predicted possible (plus some cargo) at the 85% probability level (17% of flights), with September capable of 99%. Over the two year period 32% of flights were capable of accommodating a full passenger load, a combination of the average wind component having been predicted at the 85%

probability level together with average wind components not being payload limiting throughout parts of the annual seasonal cycle.

The 99.9% probability band from Chapter 8.2 of ± 1.720% on fuel burn around the predicted mean of -0.327% translates into a -21.2% to +14.4% load factor variability around predicted payload capability, as evident in Figure 48.

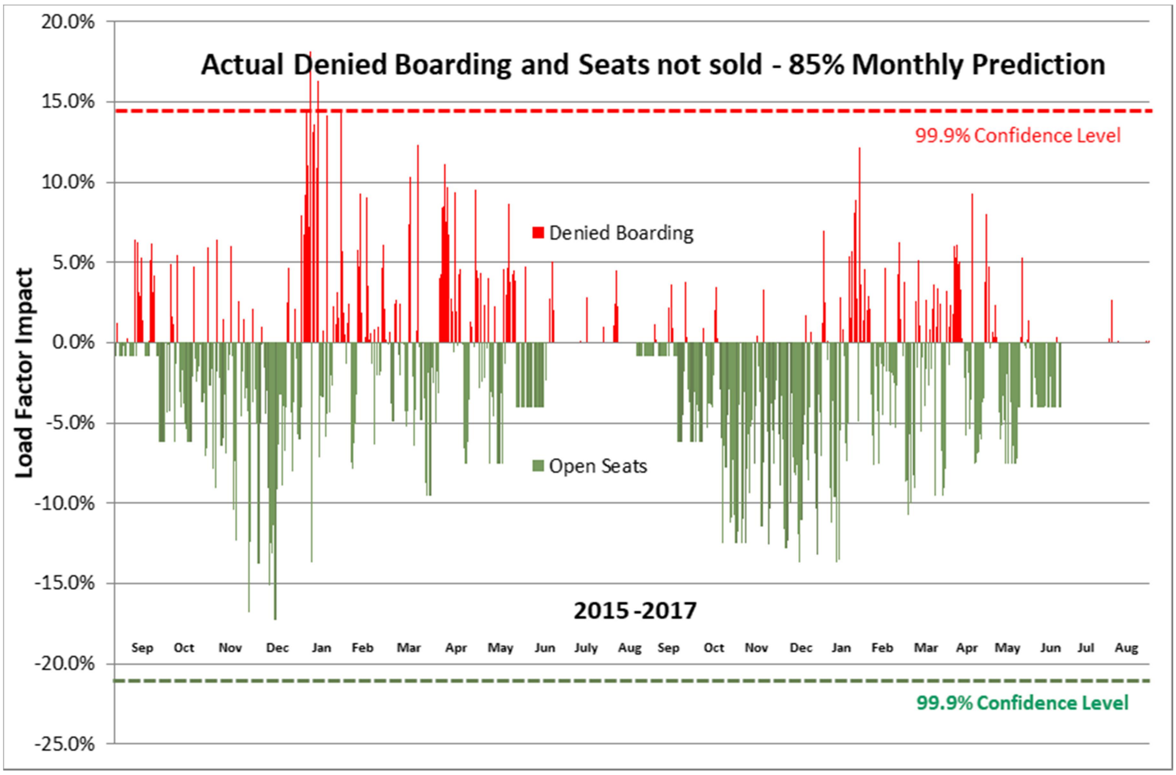

Figure 48 Potential for Denied Boarding and for Seats Available but not Sold as a Result of the 85% Probability Monthly Prediction

Figure 48 shows that, when predictions are under- or overstated, the magnitudes of such events are often significant, ranging from as much as potentially 18.1% of passengers denied boarding to possibly 17.3% seats remaining unsold. This is expected due to the variation levels around the predictions, as discussed in Chapter 8.2. A 1% difference in fuel burn magnifies into approximately a 10% difference in load factor capability.

In aggregate, over the 24 months September 2015 to August 2017, a potential for denied boarding equivalent to 7.8 full flights (full passenger loads) existed, and a possible 19.7 full passenger loads remained unsold. Both have significant impact, since denied boarding and seats not sold impair an airline financially: Denied boarding may incur penalty payments and / or hotel costs and / or may require re-routing of passengers possibly with other airlines with the resulting loss of revenue. Loss of goodwill may also be the result. Unsold seats, conversely, results in revenue not generated.

The average potential for some form of impairment is translated into a load factor impact potential of 3.8% per flight. Invariably, though, this is diluted by actual loads versus maximum potential loads. Actual annual average load factor over the two years was 77.5%. Since no record exists of how many passengers were turned away at the time of booking, the number of seats not sold was conservatively estimated as follows: Where actual load factor equals the predicted load factor potential, but actual load factor capability was higher on a given day, the seats not sold were taken as the difference between actual and predicted capability.

Figure 49 therefore presents the denied boardings / seats not sold based on actual loads, for the period September 2015 to August 2017. The impact of variation from prediction is significantly reduced. Only one flight experienced the need to deny some passengers boarding. Only the equivalent of 4.9 full aircraft of seats not sold was incurred. The average load factor impact experienced was 0.68%.

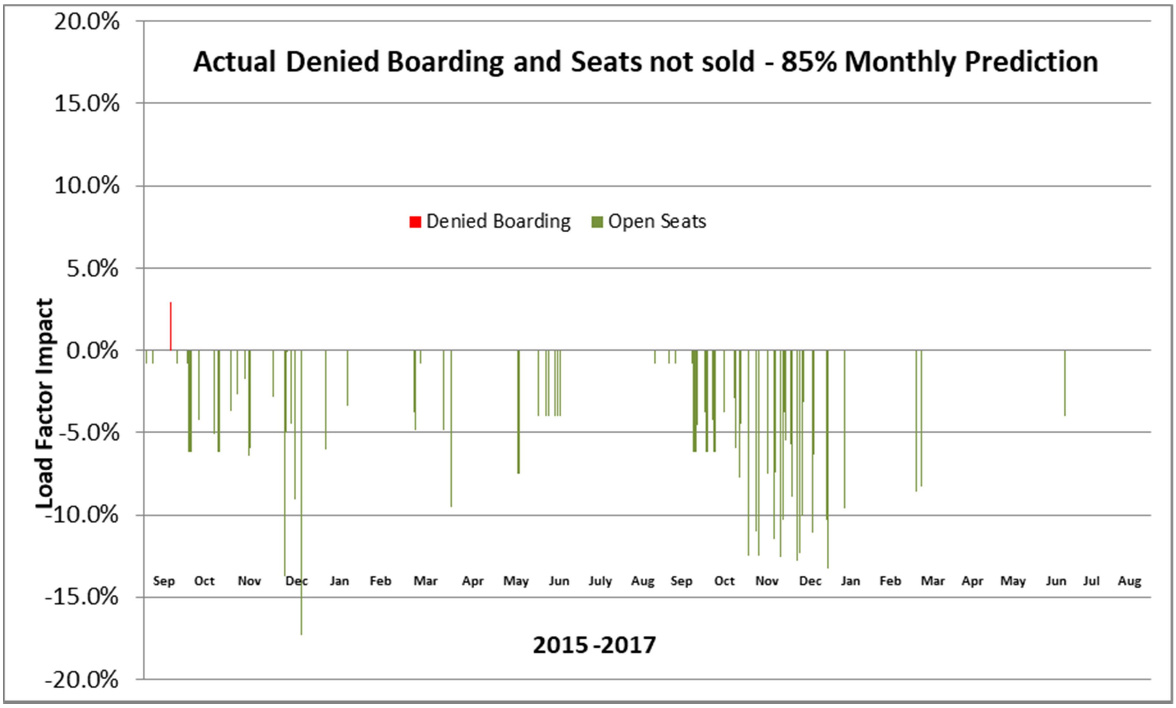

Figure 49 Actual Denied Boarding and Seats Not Sold as a Result of the 85% Probability Monthly Prediction

This would appear to imply that the strategy of preferably avoiding denied boarding using the 85% probability level is effective, without creating excessive amounts of seats unsold.

Rather, actual loads currently largely mitigate any inefficiency in the current modelling methodology. If / when actual load factors grow the current prediction methodology can become counterproductive.

For instance, a 15% increase in average annual load factor increases the load factor impact of denied boarding / seats not sold to 2.62%. Assuming normally distributed load factor dispersion, the probability density function can be applied to the load factor data using the observed mean and standard distribution:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\{(x-\mu)/\sigma\}^2} \tag{66}$$

The results are portrayed in Figure 50. As explained at the beginning of this chapter, predicted load factor is calculated based on the monthly 85% probability average wind component. Available load factor depicts the capability for the actual average wind component on the day of operation.

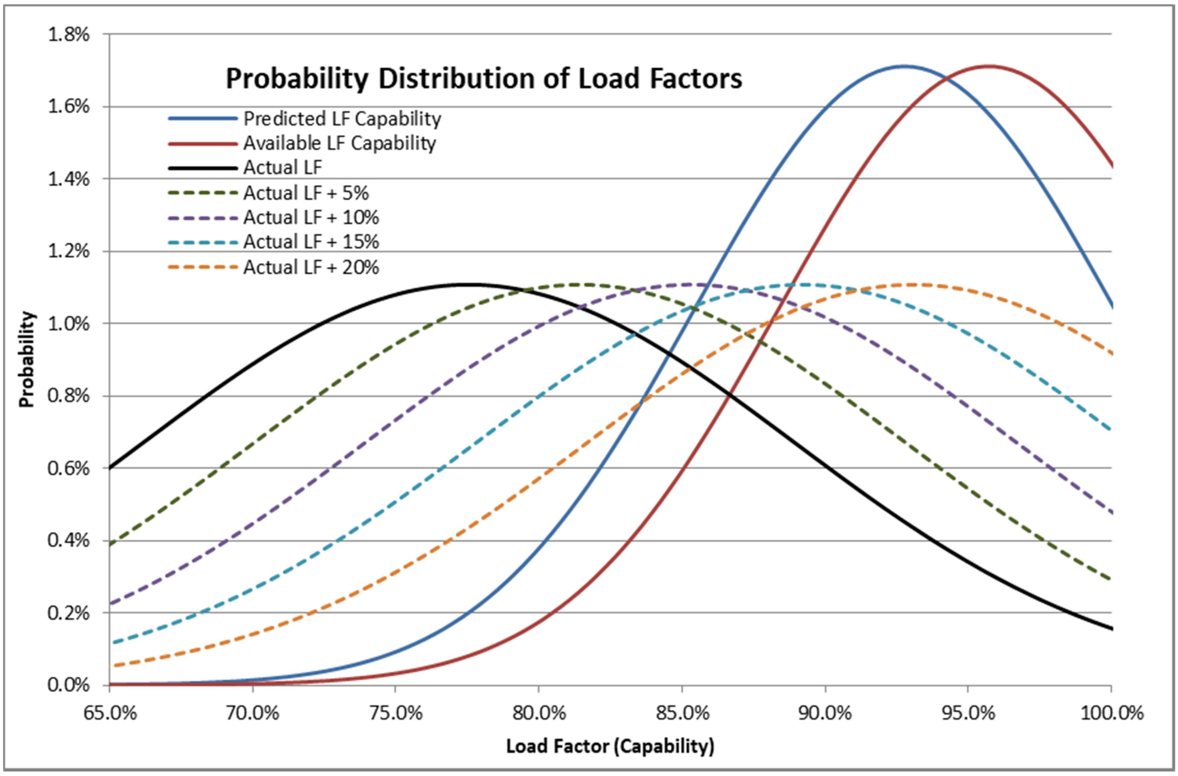

Figure 50 Probability Distribution of Actual, Possible and Predicted Load Factors

Since the available load factor results are inclusive of random variations around the annual weather pattern the standard deviation for this set of data is overstated. With Figure 50 being illustrative rather than deterministic, the standard deviation for the predicted load factor data set is applied instead. Actual load factors plus potential growth are shown. Figure 50 terminates at 100%, acknowledging that the physical constrain of seats on the aircraft.

The Gaussian (Normal) curves in each instance depict the probability of a given load factor (capability) occurring. Given the integral conservatism of the "Predicted Load Factor" curve this curve must naturally shift horizontally left relative to the "Available Load Factor" curve.

Correctly interpreted, the "Predicted Load Factor" curve forecasts, say, a 1.5% probability of realizing an 89.0% load factor capability versus a 91.9% available load factor capability. Cumulatively, the "Predicted Load Factor" curve forecasts that 17.3% of flights can provide a 100% load factor versus 29.4% for the "Available Load Factor" curve. For the twenty four month reviewed, "Available Load Factor" of 100% occurred for 31.8% of flights, the difference attributable to random variations.

As expected, the current forecasting methodology remains conservative. 99.3% and 99.8% of flights had, respectively, predicted and available capacity above the current average annual load factor of 77.5%. Only 2.6% of flights had a required a load factor capability of 100%, explaining the difference between Figure 48 and Figure 49, as further shown in Figure 51.

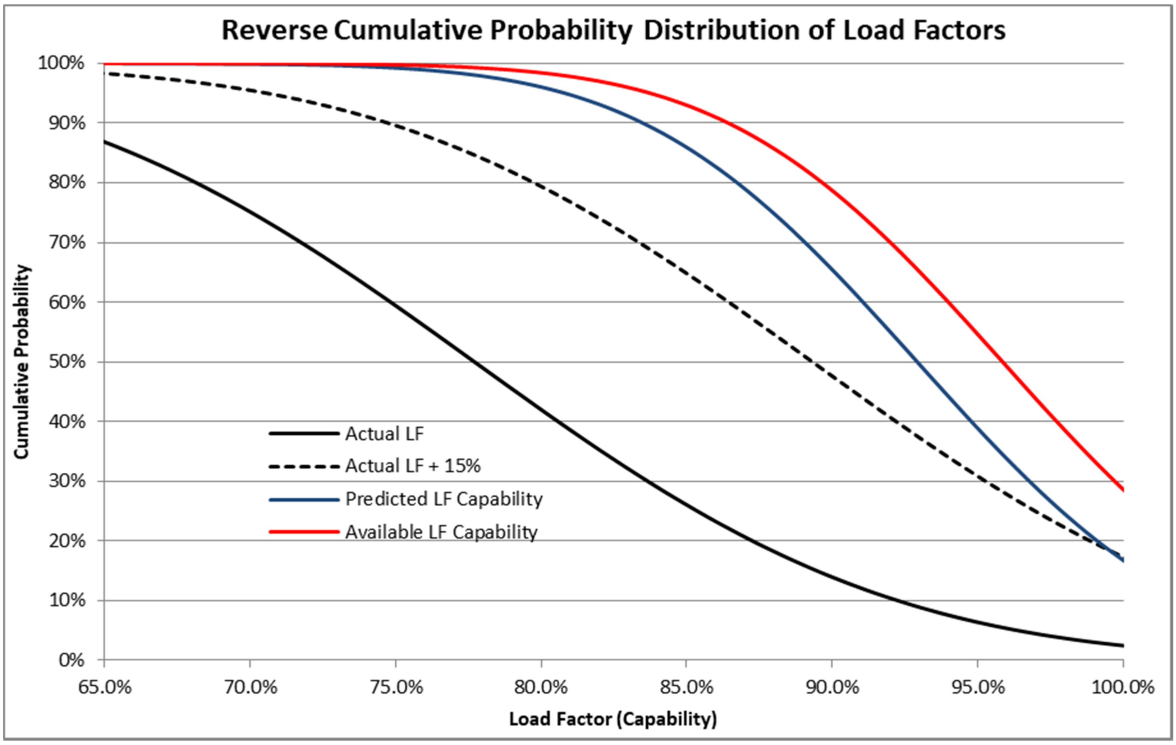

Figure 51 Reverse Cumulative Probability Distribution of Actual, Possible and Predicted Load Factors

The reverse cumulative probability distribution is the integral of Equation (67) from positive infinity to a given load factor. Practically, at a given load factor the curve depicts the cumulative probability between 100% and the load factor (capability).

For the two years analysed, supply exceeded demand noticeably, fortifying that the actual impact of predictive inaccuracy was marginal when compared to the impact potential. However, were the actual load factor to increase by, for example, 15%, as shown in Figure 51, the predicted respectively available load factor capabilities may no longer meet demand. Consequently, the need for improved modelling remains.

8.4 Modelling of Average Wind Component Annual Variations

Chapters 6, 7 and 8 so far all depict the cyclical, repetitive annual patterns in average wind component variation. Chapter 8.1 moderates this theme slightly by highlighting a longer term trend beyond such annual cycles.

Very coarsely, the current 85% probability monthly average wind component methodology is equally cyclical in nature, with a seeming anomaly around December / January / February (refer Figure 40 and Figure 41), although the actual daily average wind component plots does not appear to be fully supportive of this. Rather the variability in January / February 2016 (Figure 40), as well as December 2016 (Figure 41), might even suggest the forecast figures to be inconsistent. Regardless, any smooth form modelling is likely to be more representative than the stepped approach of the current forecasting methodology. For instance, sinusoidal modelling may better represent the seasonal variations, specifically since a full year appears representative of one full sinus wave.

With the long term climatic variation patterns not known, but expected to be relatively minor annually (as will be seen in this chapter), such climatic variation can nevertheless be pseudo-modelled by applying a linear trend with time, at least over the short term, to the annual variations. By re-assessing the recently experienced underlying parameters continually any non-linear impacts can be minimized. The intent is to use recent past history to predict the next full pattern. The proposed equation to predict the average wind component $\overline{WC}$ therefore takes the form:

$$\overline{WC} = k_a \sin\left(\pi\left(\frac{n_c+k_z}{180}\right)\right) + \frac{k_{av}\,(n_c - k_c)}{365} + k_0 \qquad (68)$$

With:

n_c = calendar day (1st January = 1)

k_a = amplitude of the sinusoidal function (kts)

k_z = zero point of the sinusoidal function (days)

k_c = starting point of the analysed data (days)

k_{av} = annual climatic drift in wind component (kts p.a.)

k_0 = average wind component without climatic drift

Calendar day, converted to radians, substitutes for degrees in the sinusoidal function. It is understood that there are 360 degrees in a full circle versus 365.25 days per annum. As the equation seeks to approximate a data set subject to instabilities from around the annual pattern, the difference is deemed not significant.

Equation (68) invariably has to be applied to individual routes. Each route is expected to have its unique set of constants for equation (68). The geographic shift of one routing versus another will have slightly differing exposure to seasonal wind variations. Once the predicted value from each route is determined, the most favorable result (route) becomes the predictor on any given day. In each instance, the various constants are adjusted to maximize the correlation, R-Squared, with the actual daily average wind component data, for a given route.

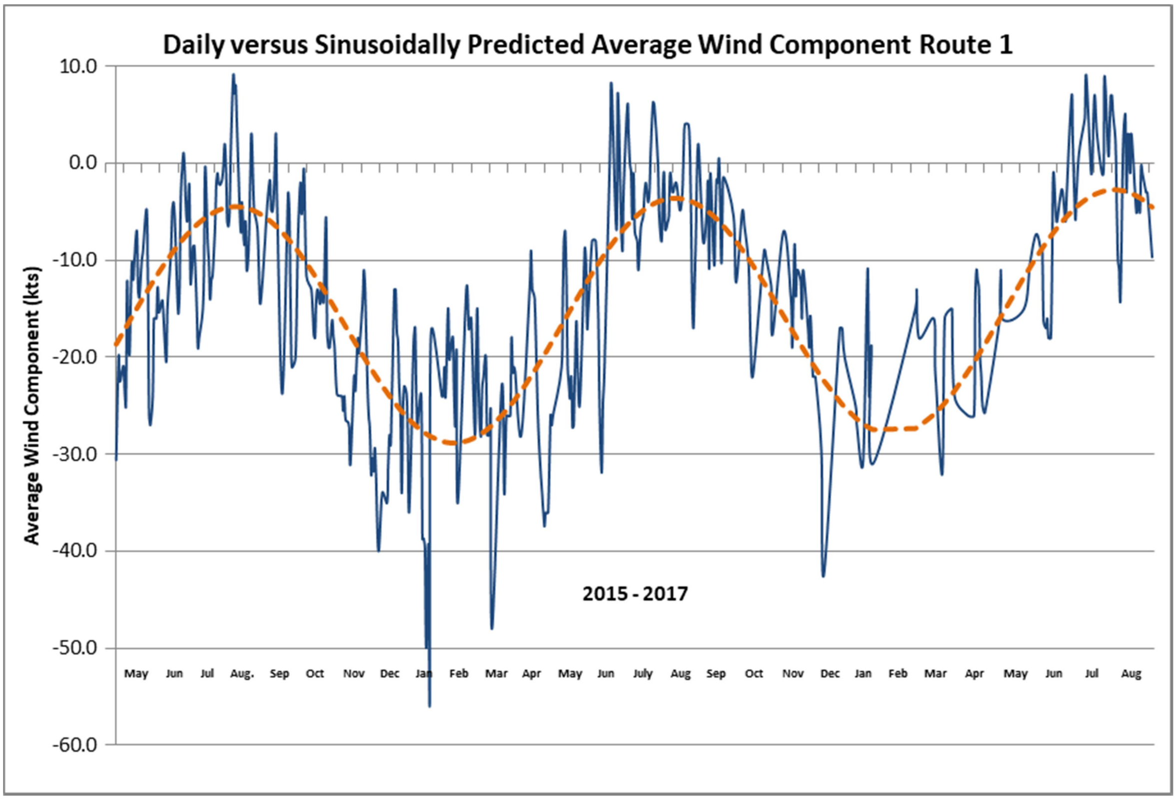

Figure 52 Daily versus Sinusoidally Predicted Average Wind Component Route 1

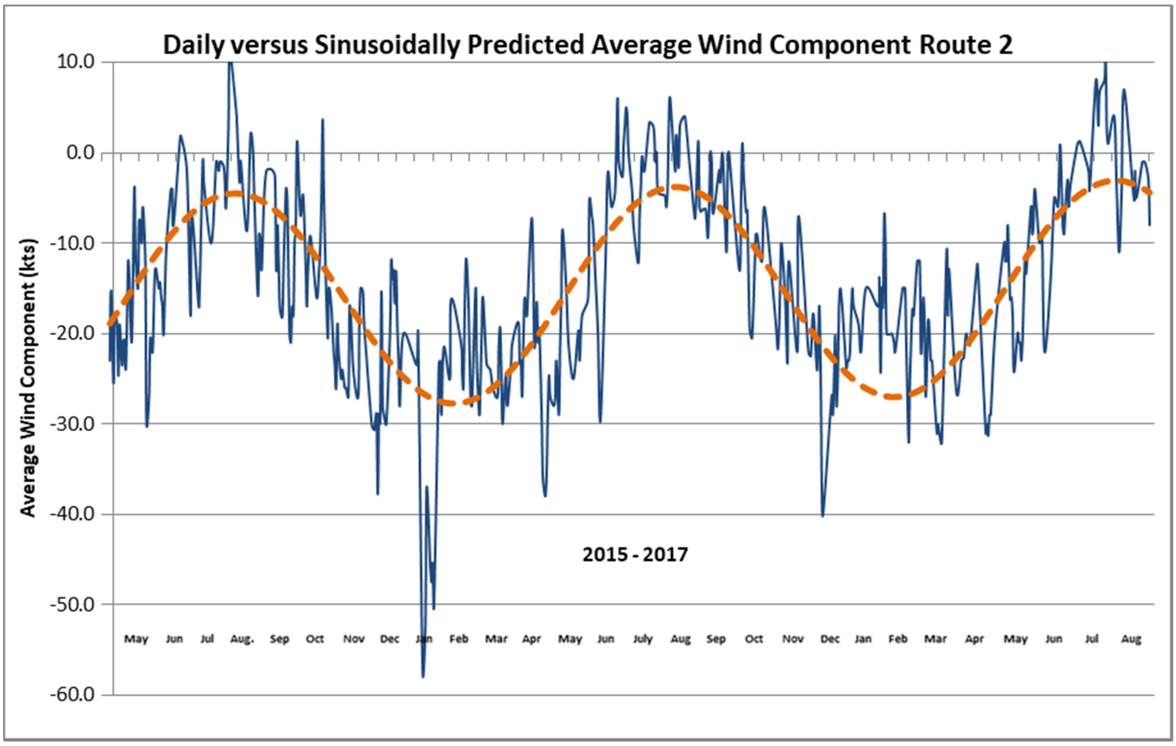

Figure 53 Daily versus Sinusoidally Predicted Average Wind Component Route 2

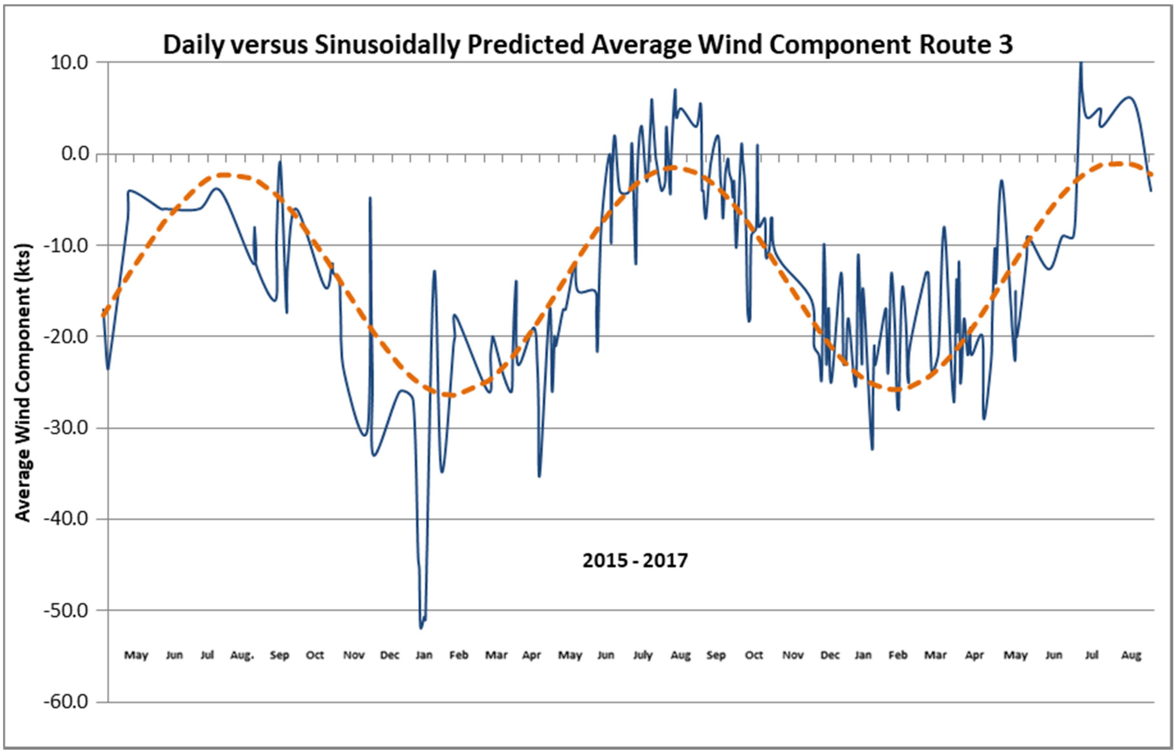

Figure 54 Daily versus Sinusoidally Predicted Average Wind Component Route 3

As shown in Figure 52 to Figure 54, the full twenty eight months of data, May 2015 to August 2017 for each specific route, as available, were utilized, with n_c = 1 representing 1 January 2016.

Specifically, for route 1 equation (68) over this period becomes:

$$\overline{WC}_{Route\ 1} = 12.4\sin\left(\pi(\frac{n_c + 233.8}{180})\right) + \frac{0.88\ (n_c + 241)}{365} - 17.1 \qquad (69)$$

The R-Squared in this instance is 58.9%, significantly higher than the 35% for the current methodology of using monthly average wind components.

For route 2, equation (68) for the period May 2015 to August 2017 becomes:

$$\overline{WC}_{Route\ 2} = 11.8\sin\left(\pi(\frac{n_c + 232.2}{180})\right) + \frac{0.72\ (n_c + 244)}{365} - 16.5 \qquad (70)$$

The R-Squared calculates as 55.0%.

For route 3, equation (68) for the period May 2015 to August 2017 becomes:

$$\overline{WC}_{Rou\quad 3} = 12.3\sin\left(\pi(\frac{n_c + 230.7}{180})\right) + \frac{0.64\ (n_c + 245)}{365} - 14.6 \qquad (71)$$

The R-Squared calculates as 61.7%.

Compared to the R-Squared of 35% presented in Chapter 8.3 for the monthly average wind component methodology, correlation between daily and predicted data appears markedly improved for all three routes, as expected. It could be noticed that Route 3, being the longest and the least used, yielded the best R-Squared. This particular route makes the most effort of avoiding Jetstream cores (Figure 19) and the associated closely spaced isotachs of intense headwind effects. Consequently, the aircraft flies within more moderate wind patterns likely to be subjected less to randomness.

Small variances in the constants for equation (68) are observable across the three routes. The average wind component k_0 decreases from Route 1 to 3. With Route 1 being the shortest route, this is expected as the purpose of alternate routes is to avoid high concentrations of headwind components (jetstreams). The routes become increasingly longer whilst the average headwind component reduces, the trade-off.

The starting point for the analysed data, k_c, depends on the availability of actual data and is non-consequential to the analysis. Small variances in the annual climatic drift, k_{av}, are observable decreasing away from the jetstreams. It might be that the mean intensity of jetstreams may be changing in the long term. The trend effect is observable in the predictive curves of Figure 52 to Figure 54. The k_{av} values are similar to the 0.85 kts per annum derived from Figure 44.

Slight variances (± 3 days) in where the sinusoidal curves are at 0° or 180°, k_z, are observable. Since weather patterns shift in annual cycles, this gain is attributable to the slight differences in geographic routing. The variances in amplitude of the sinusoidal function, k_a, are within 5% of each other. Accordingly, the three predictive equations (69) to (71) are consistent.

As initially anticipated, the annual climate change effect, modelled by a linear equation, is minor. Applying linear modelling to the climate change effect, even over a short term, remains an assumption. The error bands observed in Figure 43 to Figure 45 prevent reliably modelling the climate change shift, for limited the data available. Nevertheless, adding the linear component to equation (68) improves the predictability of the modelling, albeit slightly, as Table 11 illustrates. As expected, Route 1 benefits most from the added linear modelling, being most directly exposed to the prevailing jet streams.

R Squared	Sinusoidal and Linear Modelling	Sinusoidal Modelling only
Route 1	58.9%	56.7%
Route 2	55.0%	53.2%
Route 3	61.7%	60.0%

Table 11 Correlation of the Modelling with Actual Data

All three equations (69) to (71) predict the average wind component along their designated route. As such, a direct comparison to actual average wind components on the day of operation is not meaningful, particularly since the route flown on the day may not be the route predicted by the forecasting methodology.

Rather, the comparative base must necessarily be the actual versus predicted trip fuel requirements at MTOW. This is preferable to drawing and individually analysing three computerised flight plans each day for the 28 months under study, over 2500 in total. However, Chapters 6 and 7 have shown that the trip fuel can, for each route, reliably be calculated from:

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 \overline{WC}} \tag{43}$$

Calculating trip fuel requirements from predicted average wind components along each route on a daily basis, and then choosing the most favourable route, lowest trip fuel requirement, a comparison to actual daily trip fuel requirements at MTOW becomes possible. The results are presented in Figure 55. **The R-Squared calculates as 59.3%**, compared to 35% for the current monthly average wind component methodology. The improvement in correlation is evident. This compares to the R-Squared of 58.9% for correlation between the sinusoidal model and the average wind component data along Route 1.

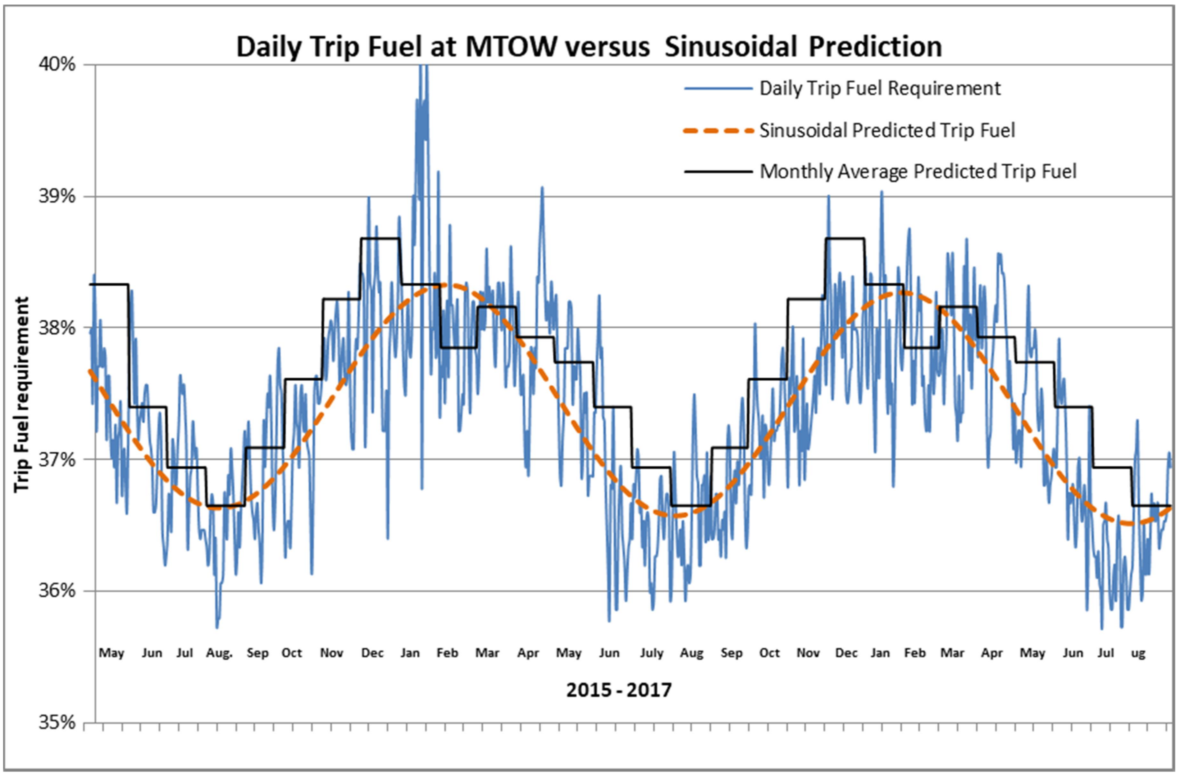

Figure 55 Daily versus Sinusoidal Prediction of Trip Fuel Requirement at MTOW

The peaks and troughs of the sinusoidal predictive curve show a slight decreasing trend with calendar time, as expected. As the climatic drift tends (currently) towards decreasing headwind conditions, trip fuel requirements necessarily decrease synchronously.

8.5 Choice of Route Using Sinusoidal Modelling

It is instructive to review the spread of utilization of the three routes available over the two years September 2015 to August 2017, as depicted in Table 12. Table 12 implies, when sinusoidal modelling is applied, that all flights would have been predicted to operate along Route 1 exclusively. The predicted average wind components from the sinusoidal modelling differed on average by -0.12 kts with a standard deviation of 0.16 kts between Route 1 and

2, and by on average -2.15 kts with a standard deviation of 0.32 kts between Route 1 and Route 3.

	Daily Actual at MTOW	Monthly Average Prediction	Sinusoidal Modelling
Route 1	48.2%	58.6%	100%
Route 2	31.8%	32.9%	0.0%
Route 3	15.5%	8.5%	0.0%

Table 12 Distribution of Flights across the Available Routes

As shown in Figure 21, for Route 2 to have less cruise fuel requirements than Route 1 the average headwind component must be at least 1.0 kts less. Similarly, for Route 3 to prevail, the headwind component must be 6.6 kts less than for Route 1. For the sinusoidal modelling, for Route 2 to prevail over Route 1 respectively Route 3 to prevail over Route 1 thus requires 5.5 and 13.9 standard deviations variance respectively.

Chebyshev's theorem [62] states that, regardless of how the data values are distributed, at least $(1-1/k^2)$ of the values lie within k standard deviations of the mean (for $k \geq 1$). Therefore, there is a 1.7% probability of sinusoidal predictions for Route 2 prevailing over those for Route 1, and a 0.26% probability of Route 3 prevailing over Route 1. If the data is normally distributed then the probability becomes less than 10^{-4}%.

The geographic shifting between the routes appears insufficient to achieve adequate reduction of the average headwind component to justify the extra track miles to be flown. A changeover to Routes 2 or 3 on any day of operation is more likely to be driven by variance around the seasonal patterns. **Therefore, the sinusoidal modelling in fact reduces to just equation (69)**, at least when the equation is used for direct daily predictions.

The monthly average wind component forecasting methodology utilizes the three routes in similar ratios to what would actually happen, but not in the same distribution. The monthly average methodology predicts that Route 3 predominates in January. Only three actual flights, had they operated at MTOW, would have had to revert to Route 3 in January 2016, the most volatile month observable in Figure 55.

The closeness of the plots for Route 1 and 2 in Figure 21 easily allows transferrals between these two routes when working with longer term (monthly) averages. The error bars resulting from rounding as discussed in Chapter 7.4 and shown in Figure 38 can on their own account for such transferrals between routes.

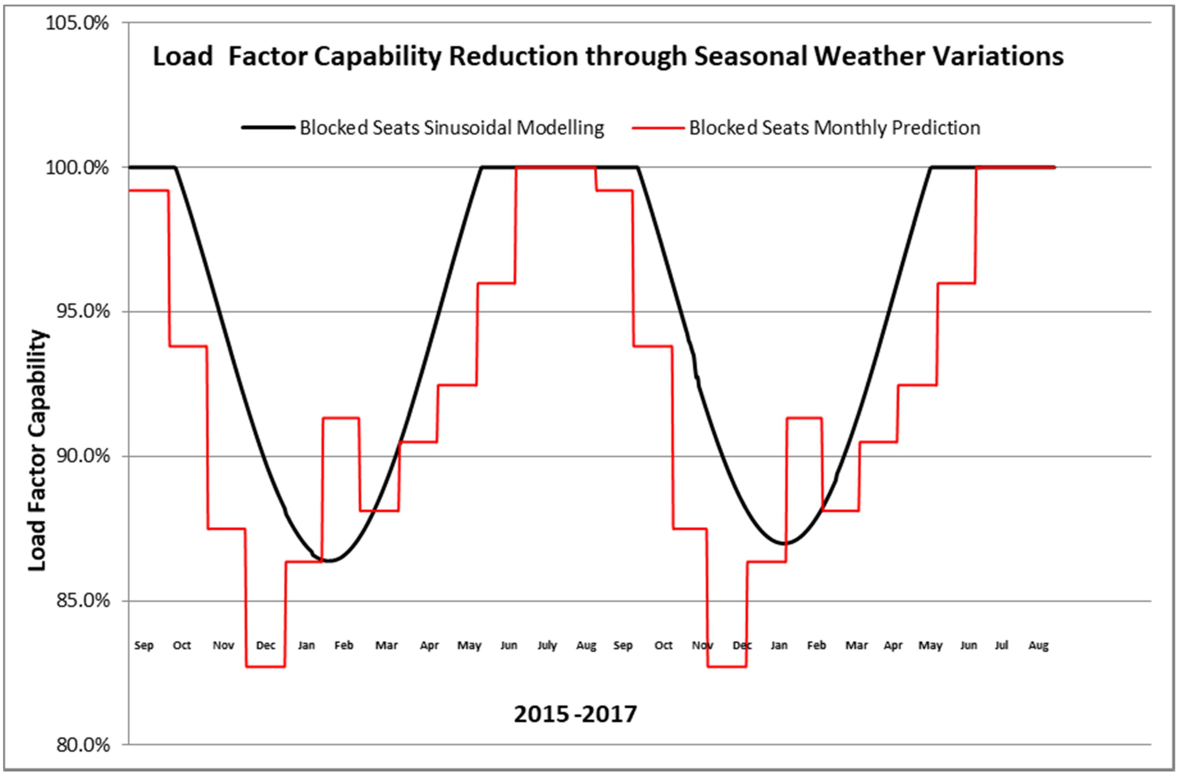

Figure 56 Seasonal Weather Variation Impact on Load Factor Capability

With the ultimate aim being to determine load factor capability, Figure 56 depicts the seasonal variation for the period September 2015 to August 2017. For the sinusoidal modelling the effect of climatic drift again is observable.

It must be noted that the monthly average wind component respectively load factor capability depicts the 85% probability level whilst the sinusoidal modelling represents the mean (50% probability). This does not distract from the discussions in this chapter, though, nor does it negate the significantly increased correlation of the sinusoidal modelling. The need to bias the predicted data against the risk of denied boardings will be discussed as part of the approach to the Monte Carlo simulation.

8.6 Comparison of Forecasting Methodologies

As done under Chapter 8.3, whilst the predictive methodology focuses on fuel requirements, the application thereof ultimately aims to forecast passenger load capability. As similarly observed in Figure 48, Figure 57 still reflects significant potential for denied bordering respectively for seats not sold. Given the observed variability of daily actual average wind component around the sinusoidal modelling of the average wind component in Figure 55 this is expected.

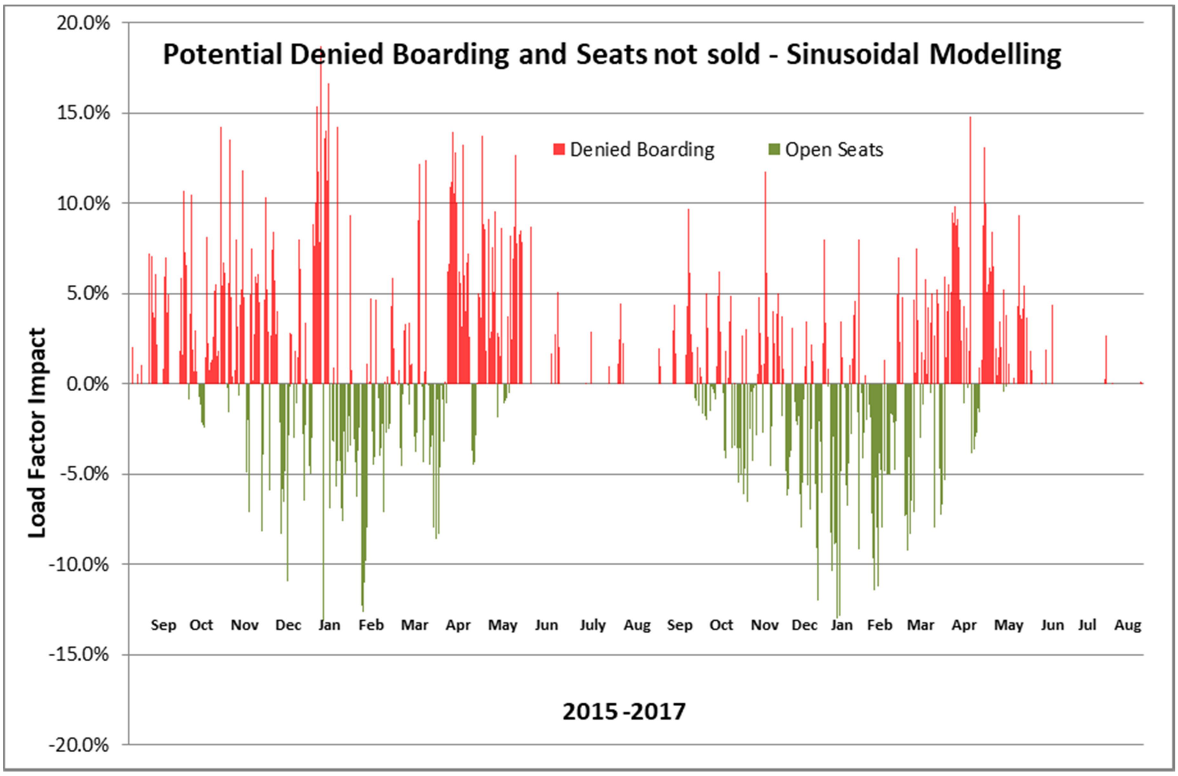

Figure 57 Potential for Denied Boarding and Seats Not Sold as a Result of the Sinusoidal Prediction

Figure 57 appears to imply a shift towards more denied boardings due to headwinds stronger than expected when compared to Figure 48. Figure 48 is predicated on 85% probability monthly average winds to protect against denied boardings whilst Figure 57 is based on a sinusoidal modelling of the daily average wind component, without protecting against denied boarding.

From the data in Appendix 5, the effect on headwind component of applying the 85% probability approach can be derived. Recalculating the data based on the revised winds yields Figure 58.

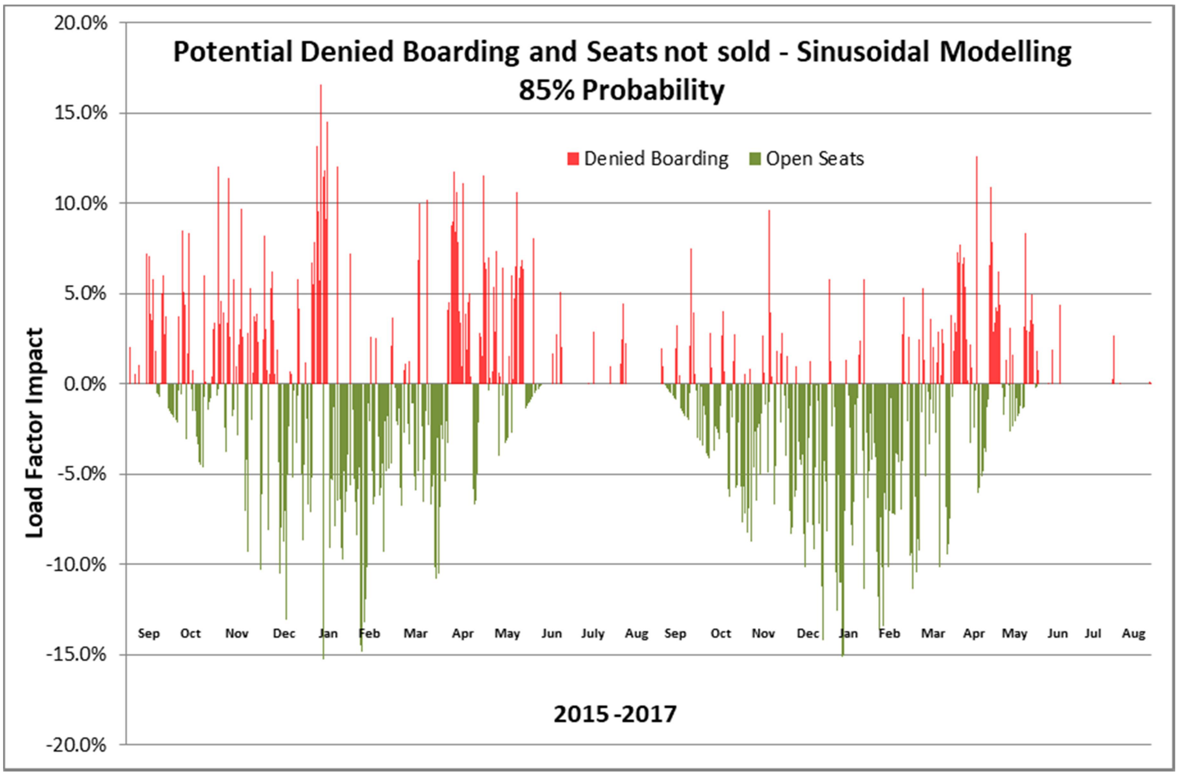

Figure 58 Potential for Denied Boarding and Seats Not Sold as a Result of the Sinusoidal Prediction at the 85% Probability Level

The resulting impact per annum, at 85% probability level, can now be tabulated:

85% Probability Level	Monthly Average Prediction	Sinusoidal Modelling
Denied Boarding	3.9 full aircraft loads	4.7 full aircraft loads
Unsold Seats	9.9 full aircraft loads	7.5 full aircraft loads
Total	13.8 full aircraft loads	12.2 full aircraft loads
Average Load Factor Impact	3.80%	3.38%

Table 13 Comparison of the Potential Impact of the Predictions

Although the sinusoidal modelling increases the potential for denied boarding, the overall impact is an improvement. If the denied boarding potential is not palatable to an airline, the probability level could be increased to reduce denied boarding with the concurrent increase in unsold seats remaining well below the potential of the current methodology of using 85% probability monthly average wind components. Such levels of denied boarding / unsold seats will only ever be incurred when the flight, on a daily basis, is filled to the predicted load factor capability.

As discussed in Chapter 8.3, demand is well below supply with an annual average load factor of 77.5%. As was done for Figure 49 for monthly average predictions, the actual denied boardings / unsold seats that would have resulted from the sinusoidal modelling are illustrated in Figure 59.

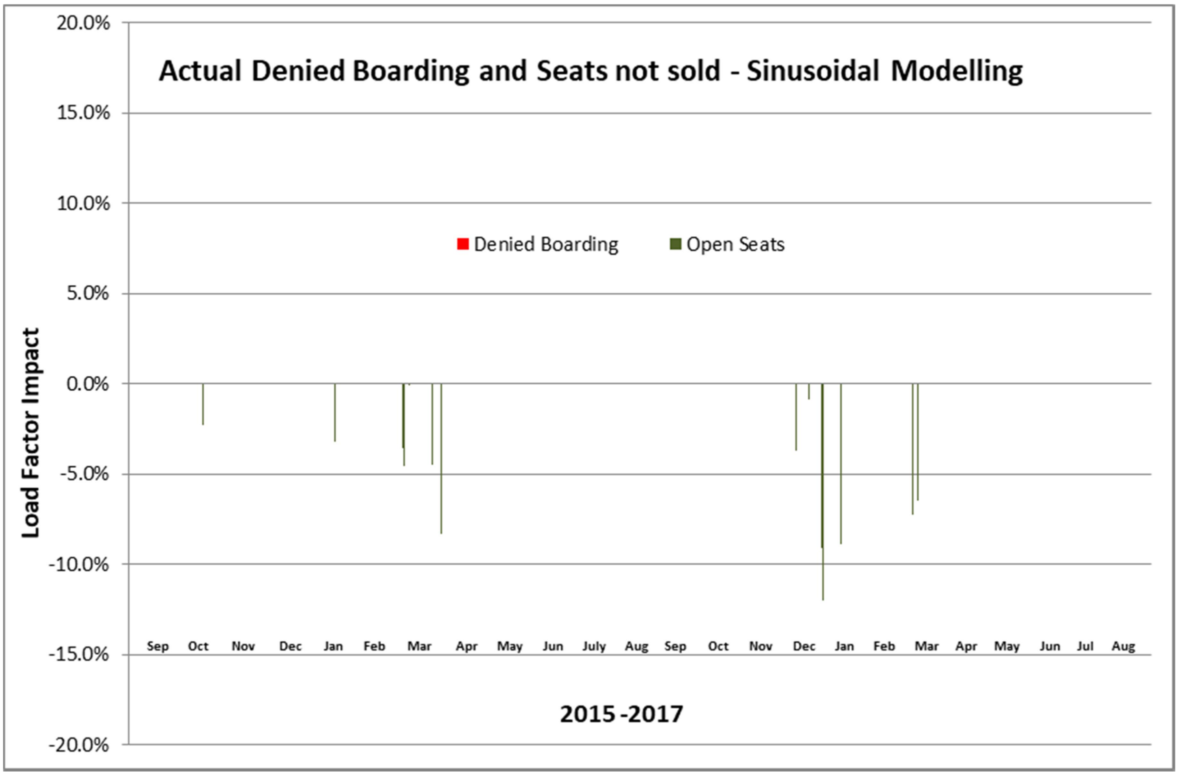

Figure 59 Actual Denied Boarding and Seats Not Sold as a Result of the Sinusoidal Prediction

Even at the 50% (average) level the results in Figure 59 compare very favourably against the results of Figure 49. There would have been no denied boardings and the equivalent of 0.37 aircraft loads per annum of unsold seats versus 2.5 per annum for the current 85% monthly average methodology. Only 13 flights out of 724 (1.8%) would have operated with seats unsold with an average load factor impact of 5.7%, had the sinusoidal modelling been applied. In contrast the current monthly average wind component methodology affected 80 flights (11%) with an average load factor impact of 6.2%.

With a 15% increase in load factors, the annual impact would be 5.25 aircraft loads versus 9.48 for the current methodology. The benefits of the sinusoidal modelling with climatic drift correction are evident when compared to the current methodology of utilizing monthly average wind components.

8.7 Sensitivity Analysis

Chapter 8.6 illustrates the improvement in forecasting capability through the use of sinusoidal modelling over the current methodology of monthly average wind components. This is attributable to the sinusoidal modelling explaining 59% of the variance in average wind component versus the current monthly average methodology only correlating with the actual daily variations in average wind component at 35%. Nevertheless, with 41% of the variance in average wind component remaining unexplained, it is instructive to assess the potential impact there-of.

Chapter 8.2 demonstrated that the difference between the actual daily data the sinusoidal prediction can be considered approximately normally distributed. The implication there-of is that the potential deviation from the sinusoidal prediction can be equally positive as negative. The data is not significantly skewed in either direction. The standard deviation for the deviation from the sinusoidal prediction of the average wind component is calculated to be 7.39 kts.

At the commonly used 85% probability level, from tables [62] the corresponding z-value is 1.44. From equation (64) one can then determine the upper and lower 85% probability estimates around the sinusoidal prediction, as depicted in Figure 60 for 2015 to 2017.

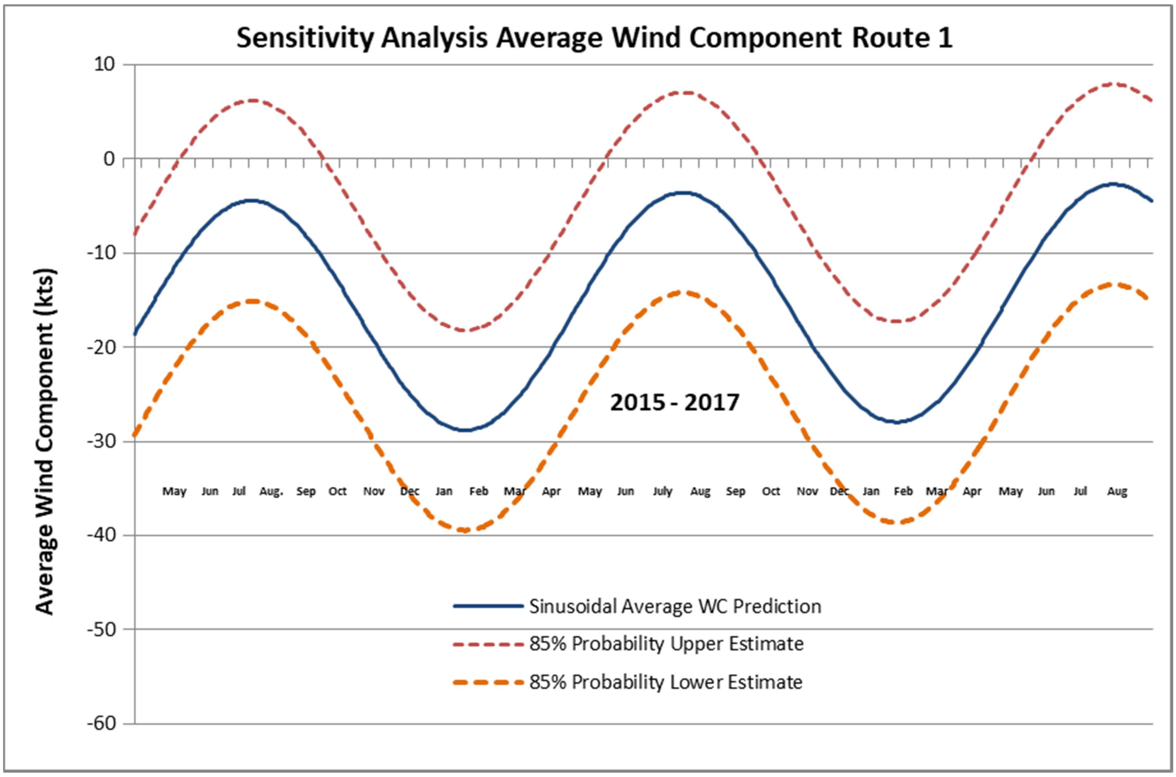

Figure 60 Sensitivity Analysis Average Wind Component Route 1

Chapter 8.5 determined the geographic shifting between the routes to be insufficient for the daily sinusoidal predictions from equations (70) (Route 2) or (71) (Route 3) to produce improved results (sufficiently reduced average headwind component) than those from equation (69) (Route 1). Consequently, only Route 1 finds consideration in Figure 60. Since Route 2 and 3 will only be flown when, on a day of operation, the payload capability improves, respectively when fuel consumption is less (even if the extra payload capability is not required), considering only the 85% probability estimations for Route 1 is conservative.

Within the 85% probability level the upper and lower estimations show that the sinusoidal prediction can vary by as much as ± 10.6 kts. Applying these variations in wind to equation (43) with the parameters from Table 10 for Route 1, the trip fuel requirements based on sinusoidal wind predictions and the upper and lower estimates can be calculated. The results are shown in Figure 61 for Route 1 for 2015 to 2017.

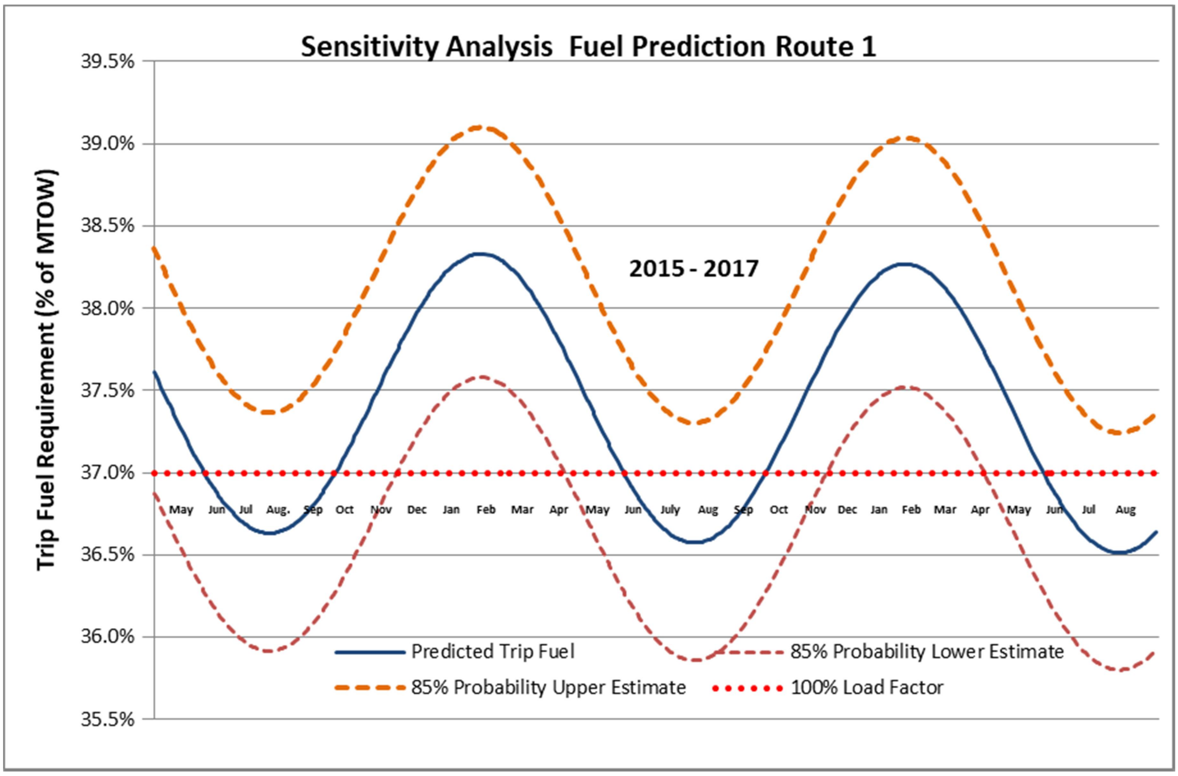

Figure 61 Sensitivity Analysis Trip Fuel Requirement Route 1

Here the 85% probability estimates represent ± 0.75% in trip fuel requirements. The potential impact equates to about ∓ 25 passengers, and thus remains potentially significant, depending on demand.

Figure 61 also shows the permissible trip fuel requirement to achieve 100% passenger load factor. An underestimation of the trip fuel requirement, from the sinusoidal wind prediction, potentially results in denied boarding, an overestimation in potentially flying with empty seats unnecessarily. Figure 61 implies that an underestimation of the fuel requirement always creates the potential for denied boarding. Conversely, an overestimation does not always create the potential of flying empty seats unnecessarily.

This needs to be considered in context, though. The sinusoidal average wind component prediction is just that, the average, or 50% probability level. Current practise, however, is to use winds at, typically, the 85% probability level. The equivalent is the upper estimate curve in Figure 61. On that basis, the prevailing likelihood is for overestimation of trip fuel requirements resulting in flying empty seats unnecessarily, rather than denying boarding. This then is consistent with the discussion in chapter 8.3.

Nonetheless, even though the sinusoidal modelling of the average wind component noticeably improves payload capability predictability over the current methodology, the margins remain high. The possibility of denied boarding respectively of flying empty seats unnecessary remains high. A more elaborate forecasting methodology is required.

9 VERIFICATION OF THE AVERAGE WIND COMPONENT MODELLING

Equations (69) to (71) were shown in Chapter 8.4 to improve the predictability of the average wind component along the three routes versus the current methodology of considering monthly average wind components, based on twenty-eight months of continuous data May 2015 to August 2017 inclusive. A further six months of subsequent data, September 2017 to February 2018 inclusive, are available to verify the sinusoidal modelling. The results for Route 1 are shown in Figure 62. With the predictive modelling being cyclical, thus repetitive, six months of data suffices.

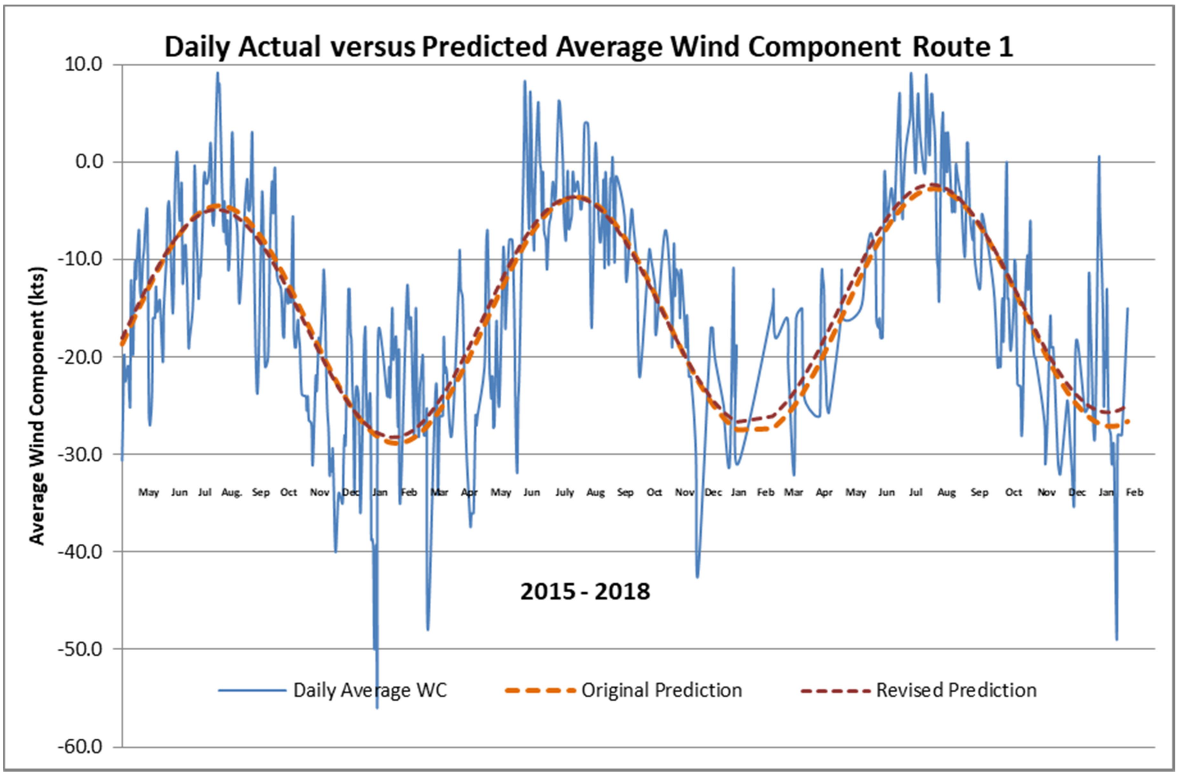

Figure 62 Daily Actual versus Predicted Average Wind Component for Route 1

Equation (69), developed from the data set May 2015 to August 2017 inclusive, yielded a correlation coefficient, R-Squared, of 58.9%. The new, added data set correlated with the actual average wind component at 63.5% despite three significant outliers in December 2017 and January 2018.

When equation (69) is applied to the full period of available data, May 2015 to February 2018, the correlation with the actual data stands at 56.6%, slightly reduced. This is attributed to the average of the headwind components reducing from -16.9 kts for 2015/6 to -13.0 kts for 2016/7 to -12.5 kts for 2017/8, resulting in two different average values for the 27 versus 33 months considered. The value of the average of the wind component is used to determine the correlation R-Squared as per equations (34) to (36).

$$\overline{WC}_{Route\ 1} = 12.4 \sin\left(\pi\left(\frac{n_c + 233.8}{180}\right)\right) + \frac{0.88\ (n_c + 241)}{365} - 17.1 \tag{69}$$

Equation (69) was then re-optimised to yield the revised predictions shown in Figure 62, expressed as

$$\overline{WC}_{Route\ 1} = 12.0 \sin\left(\pi\left(\frac{n_c + 237}{180}\right)\right) + \frac{1.30\ (n_c + 241)}{365} - 17.2 \tag{72}$$

The correlation for the revised prediction improved only marginally, though, to 57.0%. The most significant adjustment is to the climatic change correction, having increased from 0.88 kts per annum to 1.30 kts per annum. Over the 33 month period this contributes 1.15 kts of the 1.4 kts difference between the original and revised predictive curves (Equations (69) and (72)). The resulting difference in trip fuel requirements after 33 months is 0.28%.

Evidently, the modelling methodology presented by equations (69) / (72) is applicable to the underlying data, with the climate change effect, despite contributing only slightly, remaining the biggest variant. As discussed in Chapter 8.1, the uncertainty around the climate change variance can be minimised by using a rolling 24 to 36 month re-evaluation of the model to predict the forthcoming twelve months. A 24 to 36 month period is prudent to (a) not be overly influenced by short term perturbations and (b) not letting the assumption of linear climatic variation deviate noticeably from actual trends. By using 24 to 36 months of data to then predict the next 12 to 18 months the effects of any variances outside the predictions are minimised, as illustrated in Figure 62. Certainly, the sinusoidal modelling remains significantly more effective than utilizing monthly average wind components.

For consistency, the modelling for Route 2 and Route 3 are equally examined. The results for Route 2 are shown in Figure 63. Consistent with the observations for Route 1, the correlation with actual data reduced slightly from 55% to 52.8%. The reduction in correlation is similar to that observed for Route 1, for the same reason of changing average wind component.

For Route 3 (Figure 64) the correlation decreases from 61.7% to 57.6%. Only 41 data points are available for the 6 months, heavy affected by the outliers towards the end of February 2018. Without the furthest two outliers the correlation would be 59.6%, the slight reduction in correlation being in line with the observations for Routes 1 and 2.

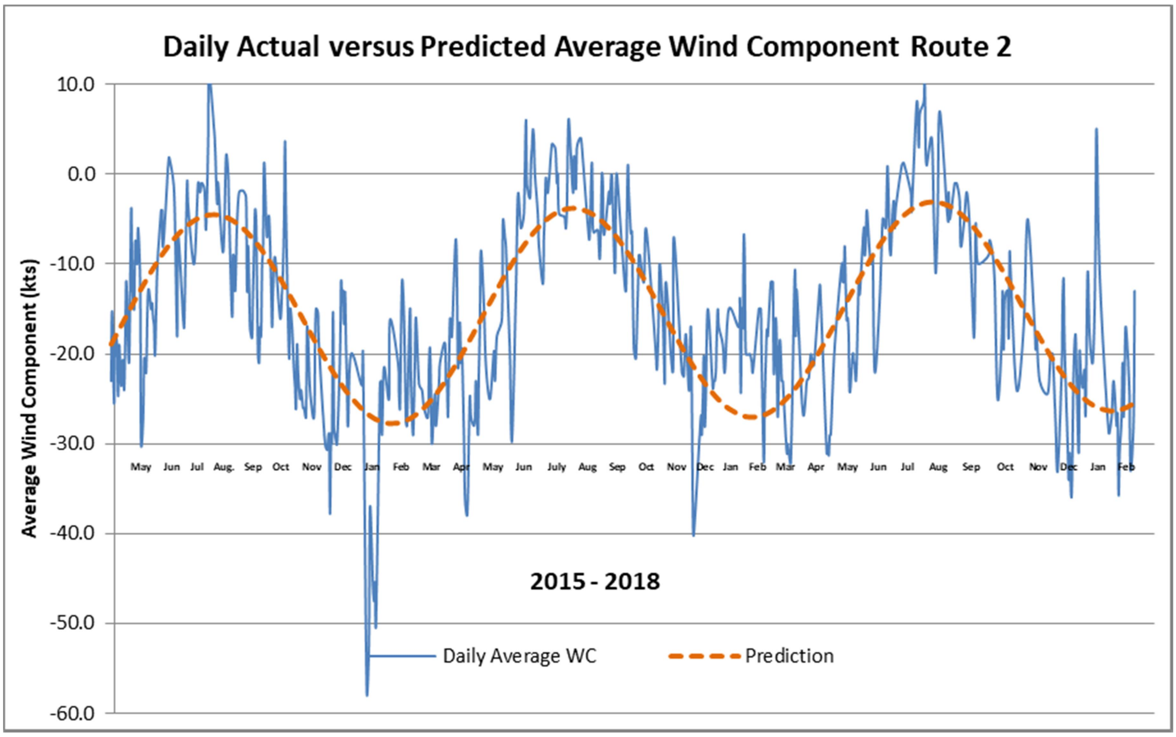

Figure 63 Daily Actual versus Predicted Average Wind Component for Route 2

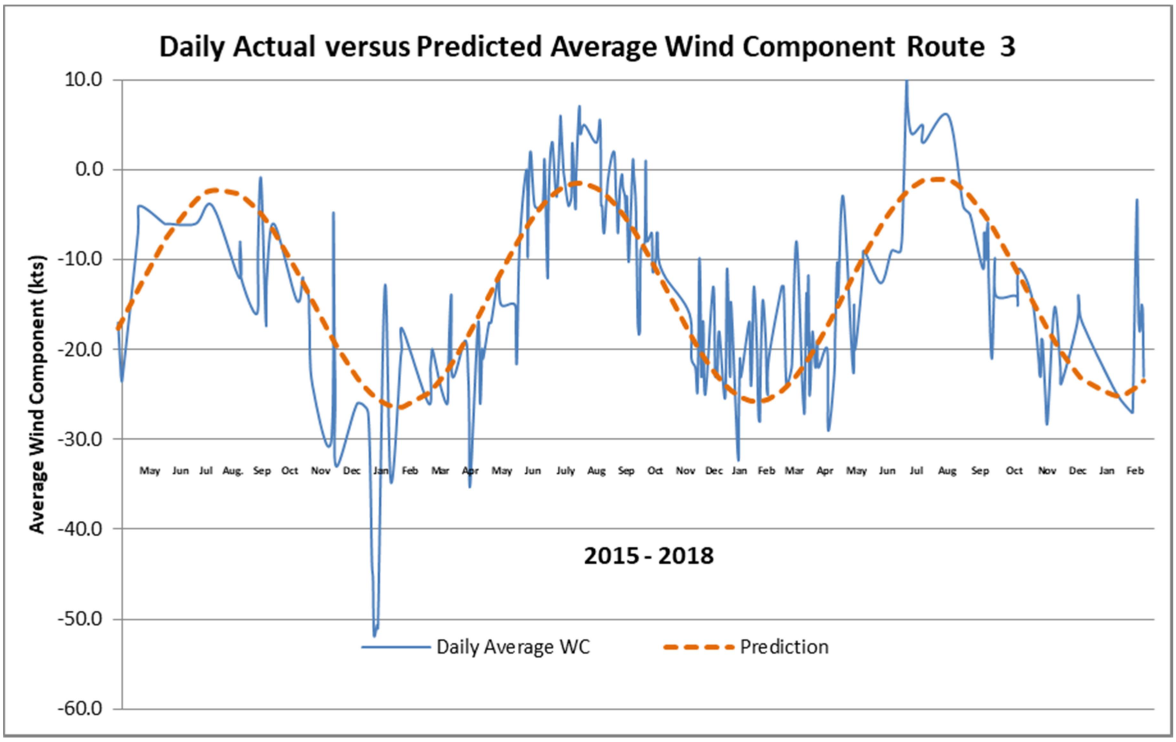

Figure 64 Daily Actual versus Predicted Average Wind Component for Route 3

10 MONTE CARLO SIMULATION BACKGROUND

Monte Carlo Simulation refers to a widely used approach for solving complex problems using computer algorithms to simulate the variables in the problem. Typically an algorithm is developed to "model" the problem, and then the algorithm is run many times (from a few hundred up to millions) in order to develop a statistical data set for how the model behaves. Monte Carlo methods are often used in simulating physical and mathematical systems. Because of their reliance on repeated computation of random or pseudo-random numbers, these methods are most suited to calculation by a computer and tend to be used when it is unfeasible or impossible to compute an exact result with a deterministic algorithm [69].

Tossing a coin has two possible outcomes (heads or tails), each with a 50% probability. In a million coin tosses, roughly half will be "heads" and half will be "tails". No complex math is required to know this. In its simplest form a Monte Carlo simulation would prove the same result: Using a random number generator to generate “0” for "heads" and “1” for "tails" a million times, each time recording the results in a database, would reveal that very close to 50% of the calculations resulted in “0” or "heads" and the other 50% in “1” or "tails".

Monte Carlo simulation methods are especially useful in studying systems with a large number of coupled degrees of freedom, such as fluids and cellular structures. They are equally useful for modelling phenomena with significant uncertainty in inputs, such as the calculation of risk in business. They are widely successful methods in risk analysis when compared with alternative methods or human intuition. For instance, when Monte Carlo simulations have been applied in space exploration and oil exploration, actual observations of failures, cost overruns and schedule overruns are routinely better predicted by the simulations than by human intuition (expert opinion) or alternative methods such as “what if” scenario planning or calibrated probability assessments [70].

Monte Carlo Simulations are often used in physical and mathematical problems and are most useful when it is difficult or impossible to use other approaches. Such methods are mainly used in three distinct problem classes [71]:

- Optimization,
- Numerical integration, and
- Generating draws from a probability distribution.

In principle, Monte Carlo methods can be used to solve any problem having a probabilistic interpretation. By the law of large numbers, integrals described by the expected value of some random variable can be approximated by taking the empirical or sample mean of independent samples of the variable. When the probability distribution of the variable is parametrized, mathematicians often use a Markov Chain Monte Carlo (MCMC) sampler [72] [73] [74] [75].

More complexly, a problem could be solved by generating draws from a sequence of probability distributions satisfying a nonlinear evolution equation. These flows of probability distributions can always be interpreted as the distributions of the random states of a Markov process whose transition probabilities depend on the distributions of the current random states [76] [77].

In probability theory and statistics, a Markov chain or Markoff chain, named after the Russian mathematician Andrey Markov, is a stochastic process that satisfies the Markov property. Loosely speaking, a process satisfies the Markov property if it can make predictions for the future of the process based solely on its present state just as well as it could knowing the process's full history, i.e., conditional on the present state of the system, its future and past are independent [78].

10.1 Introduction

Although Monte Carlo Simulation methods vary, they tend to follow a particular pattern:

1. Define a domain of possible inputs.
2. Generate inputs randomly from a probability distribution over the domain.
3. Perform a deterministic computation on the inputs.
4. Aggregate the results of the individual computations into the final result.

10.2 Evolution of Monte Carlo Simulations

Random methods of computation and experimentation (generally considered forms of stochastic simulation) can arguably be traced back to the earliest pioneers of probability theory, but are more specifically traced to the pre-electronic computing era. The general difference of a Monte Carlo simulation is that it systematically "inverts" the typical mode of simulation, treating deterministic problems by first finding a probabilistic analog. Previous methods of simulation and statistical sampling generally did the opposite: using simulation to test a previously understood deterministic problem. Though examples of an "inverted" approach do exist historically, they were not considered a general method until the popularity of the Monte Carlo method spread.

In the 1930s, Fermi first experimented with the Monte Carlo method while studying neutron diffusion, but did not publish anything on it [79].

In 1946, physicists at the Los Alamos Scientific Laboratory were investigating radiation shielding and the distance that neutrons would likely travel through various materials. Despite having most of the necessary data, such as the average distance a neutron would travel in a substance before it collided with an atomic nucleus, and how much energy the neutron was likely to give off following a collision, the Los Alamos physicists were unable to solve the problem using conventional, deterministic mathematical methods. Ulam had the idea of using random experiments, de facto thus inventing the modern version of the Markov Chain Monte Carlo method [80].

Immediately after Ulam's breakthrough, von Neumann understood its importance and programmed the ENIAC computer (Electronic Numerical Integrator and Computer, the first electronic general-purpose computer) to carry out Monte Carlo calculations. Using lists of "truly random" random numbers was extremely slow, however, so von Neumann developed a way to calculate pseudorandom numbers, using the middle-square method. Though this method had been criticized as crude, von Neumann justified this as being faster than any other method at his disposal, also noting that, when it went awry, it did so obviously, unlike methods that could be subtly incorrect [81].

Being secret, the work of von Neumann and Ulam required a code name. A colleague of von Neumann and Ulam, Metropolis, suggested using the name *Monte Carlo*, in reference to the Monte Carlo Casino [79].

Monte Carlo methods became central to the simulations required for the Manhattan Project, though severely limited by the computational tools at the time. The Rand Corporation and the U.S. Air Force were two of the major organizations responsible for funding and disseminating information on Monte Carlo methods during this time, and they began to find a wide application in many different fields.

In the 1950s the use of mean field genetic type Monte Carlo Simulations became wide spread. Harris and Kahn used mean field genetic-type Monte Carlo methods for estimating particle transmission energies [82]. Mean field genetic type Monte Carlo methodologies were also used as heuristic natural search algorithms in evolutionary computing [83] [84].

The use of even more sophisticated Monte Carlo methods had certainly started by the mid-1960s, with the work of McKean Jr. on Markov interpretations of a class of nonlinear parabolic partial differential equations arising in fluid mechanics [85] [86].

10.3 Use of Random Numbers in Monte Carlo Simulations

Generically, use of Monte Carlo methods requires large amounts of random numbers. This spurred the development of pseudorandom number generators. These are far quicker to use than the tables of random numbers previously used for statistical sampling [87].

Monte Carlo simulation methods do not necessarily always require truly random numbers except for some applications, such as primality testing, where unpredictability is vital [88]. Many of the most useful Monte Carlo simulations use deterministic, pseudorandom sequences, making it easy to test and re-run simulations. The only quality usually necessary to make good simulations is for the pseudo-random sequence to appear "random enough" in a certain sense.

Application dependent, pseudo-random sequences typically should pass a series of statistical tests. Testing that the numbers are uniformly distributed or follow another desired distribution, when a sufficiently large number of elements of the sequence are considered, is one of the simplest and most common ones [59].

Sawilowsky lists the characteristics of a high quality Monte Carlo simulation [89]:

- the (pseudo-random) number generator has certain characteristics (*e.g.*, a long "period" before the sequence repeats)
- the (pseudo-random) number generator produces values that pass tests for randomness
- there are enough samples to ensure accurate results
- the proper sampling technique is used
- the algorithm used is valid for what is being modeled
- it simulates the phenomenon in question.

10.4 Applications in Aerospace

Monte Carlo methods are especially useful for simulating phenomena with significant uncertainty in inputs and systems with a large number of coupled degrees of freedom. More specific to aerospace, Monte Carlo Simulations are applied in a wide range of sub-disciplines:

Accurate prediction of aircraft trajectories is an important part of decision support and automated tools in air traffic management. By combining information from multiple aircraft at different locations at different times, trajectory prediction accuracy can be improved. However, the high dimensionality of the problem and nonlinearities in aircraft dynamics and control prohibit the use of common filtering methods.

Lymperopoulous and Lygeros [90] developed a novel particle-filtering algorithm to address the structure of the problem and solve it in realistic scale situations. Aircraft are assumed to fly level (possibly at different altitudes) with known, constant, aircraft-dependent airspeeds. Wind forecast errors estimates were based only on ground radar measurements. Simulation results compared to actual data suggested this methodology is viable in realistic situations. Further, the algorithm is numerically robust with time or the number of aircraft involved in the flight scenario.

Hurter et al [91] analyzed wind effect further by extracting the wind magnitude and direction from the radar tracks of aircraft belonging to various speed categories. Using a simplified model to drastically reduce the number of unknown variables (neglecting the effects of lateral drift on the along-track speed for aircraft flying at high speeds) an ordinary least squares method was then be applied to a linearized problem. The extracted wind had been compared with the Météo-France wind grid, and with the wind computed from Mode-S data downlinked from the aircraft. The approximated wind is very close to the wind obtained from the other two sources, at least in airspace volumes with sufficient data availability. Limiting the model is the requirement of sufficient data, with several aircraft flying in various directions.

Yet further, Zheng and Zhao [92] presented a systematic procedure for the design and evaluation of probabilistic trajectory conformance monitoring algorithms, predicting whether an aircraft is likely to deviate significantly from its intended trajectory in the near future. Likely causes of non-conformances were categorized and stochastic kinematic trajectory predictions were used. The deviation metric is defined as the probability with which predicted trajectories exceed a containment region around the intended trajectory. The algorithm then estimates the non-conformance probability over time for uncertainties with arbitrary probabilistic distributions. When this non-conformance probability reaches a predefined threshold within the decision interval, a non-conformance is declared. Monte Carlo simulations were used to systematically study the effects of various algorithm parameters on conformance monitoring system performances.

Within the airport environment, Zou et all [93] used the commercially available discrete event simulation software Arena to estimate the capacity of airport runway systems, taking into account the effects of aircraft landing performance, wake vortex separation requirements, time and speed on final approach, touchdown point, runway occupancy time, location of runway exits and arrival-departure mix.

Analytical models employ mathematical formulas to directly calculate the capacity with the inputs representing the key variables on runway capacity. In these models, authors usually built an expression to figure out the average Runway Occupancy Time (ROT) within specific time duration and calculate its inverse as the estimated runway capacity. The advantage of analytical models is giving a direct way to calculate the capacity. However, the accuracy and practicability of the results is highly dependent on how many variables are considered in the model, and how many of them are treated as random variables. The simulation results were found to match actual data recorded [93].

Wake turbulence noticeably affect the sequencing of take-offs and landings. Pruis and Delisi [94] used a Monte Carlo analysis to compare Lidar observations of wake vortex circulation intensity and trajectories to the predictions of a new probabilistic fast-time wake vortex model. These model predictions, using a collective of deterministic numerical models, attempt to account for the two primary sources of uncertainty in fast-time wake vortex models: the errors introduced by sensitivity to the initial aircraft parameters and environmental conditions; and errors introduced because of imperfections in the model assumptions and simplifications.

Their model reproduced observed vortex behaviour and predicted approximately the same mean and spread as the observations. The study further showed that uncertainties in the lead aircraft parameters can be as important as uncertainties in the atmospheric conditions in generating the spread observed in the field observations of wake vortices.

Wake vortex separation standards were established in the 1970s, essentially time spacing aircraft arrivals / departures depending on the categories of the lead and following aircraft. With airport runway systems reaching capacity limits such conservative separation standards increasingly decrease take-off and landing efficiencies. Eurocontrol in 2004 estimated that, by 2025, 3.7 million flights annually cannot be accepted. Holzäpfel et al [95] similarly simulated aircraft wake vortices for take-off and landing using Monte Carlo methods, intending to establish a more dynamic approach to wake separation.

On the military side of aviation, Lefebvre et al [96] focused on a methodological approach for predicting simulated low-resolution infrared sensor dispersion of an aircraft. They applied such predictions to the classification of different aircraft on the resulting set of low-resolution infrared images, based on a quasi-Monte Carlo survey of the code output dispersion.

Existing computer simulations of aircraft infrared signature (IRS) do not account for dispersion induced by uncertainty on input parameters, such as aircraft aspect angles and meteorological conditions. Assuming a spatially white noise background model, classification performance so determined appears to be more accurate than more classical state of the art techniques.

Very topical currently, Vanek et al [97] investigated the feasibility of a purely vision based sense and avoid system, required for small unmanned aerial vehicles (UAV) to routinely access airspaces. The two distinct functions, sensing and avoidance, were integrated into a common framework. The sensitivity of the estimation performance and the resulting avoidance response with respect to different intruder motion was investigated in a Monte-Carlo simulation. Unlike the Traffic collision Avoidance Systems (TCAS) in use in commercial aviation, no information is exchanged between aircraft. Rather, only passive 2-D vision information is available to estimate the encountering traffic. Based on the predicted intruder motion the time of the encounter and the minimum distance are predicted. If then required, the autopilot initiates an avoidance manoeuvre. The viability of the system was demonstrated on several estimation approaches. Representative encounter scenarios are presented to provide performance measures, including detection time and achieved miss distance of distinctive approaches to assess the applicability of the results.

In the domain of space flight, a process was developed for estimating the uncertainty of weight prediction for future space transportation systems, using Monte Carlo simulations. Wilhite et al [98] modelled the impact of shortfalls in technology projections for future launch vehicles as simple dry weight percentage increases to determine dry weight and gross weight sensitivities both for single-stage and two-stage reusable launch concepts. For this, they used historical weight-estimating relationships, which are typically used during the concept definition phase of a system. They found the two-stage system is much less sensitive to the weight growth as compared to the single-stage system. The top four drivers of the weight uncertainty are propulsion, body structure, thermal protection system, and subsystems.

In the field of Aerodynamics, abrupt changes in flow around aircraft surfaces (e.g., flow separation / reattachment, boundary layer transition, unsteadiness, shocks, etc.), as measured in simulated environments like wind tunnels or as computationally simulated, are likely be predicted incorrectly as to the exact location of where (or when) the change happens.

Causality inter alia includes the error introduced by simulating a real system at a smaller scale and at non-ideal conditions, or the error due to turbulence models in a computational simulation. The uncertainty analysis principles that had been developed and are being applied currently do not fully account for uncertainty in the knowledge of the location of abrupt physics changes or sharp gradients. This leads to a potentially underestimated uncertainty in those areas.

To address this, Pinier [99] proposed a general mathematical model that results in an asymmetric uncertainty proportional to the gradient in the nominal data. Additionally, based on previous work, a method for dispersing aerodynamic data within asymmetric uncertainty bounds in a more realistic way was developed for use within Monte Carlo-type analyses.

With that, Pinier [99] illustrates that the combination provides for more realistic estimates of uncertainty in applications, where phenomena such as flow separation / reattachment, shockwave / boundary layer interactions, laminar-turbulent transition, or bi-modal dynamics play a key role in the aerodynamic characteristics of the vehicle.

Testing and evaluation of designs / systems remains an integral part of any developmental efforts. Directed pre-planning of any testing or evaluation enhances the effectiveness there-of. With this in mind Bjorkman, Sarkani and Mazzuchi [100] described a methodology that uses a Model Based Systems Engineering framework and Monte Carlo simulation to define uncertainty reduction goals. The use of Monte Carlo simulations makes the uncertainty predictions (means and probability distributions) easy to obtain and visualize. Test planners and program managers can use the uncertainty reduction goals to make test design decisions regarding instrumentation, number of test points, and so on to achieve the desired uncertainty reduction goals. As tests become completed, physical models can be updated with test data and additional analyses conducted to determine if the system meets user requirements. The methodology was demonstrated through a simple case study involving a series of tests to predict the landing performance of an aircraft.

More specifically, Nikbay and Acar [101] applied Monte Carlo Simulation methods to develop a flutter prediction methodology making use of Lagrange formulation for aero-elastic modelling and Theodorsen function for aerodynamic load calculation, for three dimensional wing and wing/store configurations. Flutter results in all cases were in excellent agreement with the reference data.

Operationally, as air traffic volumes continue to increase Performance Based Navigation (PBN) is featuring increasingly more in modern air traffic control systems. With global satellite systems dramatically reducing Navigation System Errors (NSE) the Lateral Flight Technical Error (FTE) becomes the main component of Total System Error (TSE). Turbulence is one of the most important factors affecting lateral FTE because it can arise throughout the flight. Lateral track control systems are required to compensate for turbulence through good damping and zero steady-state error. Zhao et al [102] [103] devised a statistical estimation model for control systems which yielded a smaller lateral FTE standard deviation than conventional systems.

Li, Jun and Rui [104] looked more holistically at estimating total system error (TSE) in Performance Based Navigation, also with a view to improving calculation times. With the true position unknown, TSE obeys a certain probability distribution in-flight. Currently, the existing TSE estimation methods include the root sum square method (RSSM) and the scalar quantity summation method (SQSM).

On the systems side, Kulkani et al [105] propose a combined energy-based model with an empirical physics of failure model for degradation analysis and prognosis of electrolytic capacitors in DC-DC power converters, using Monte Carlo simulation methods. A model based approach to studying degradation phenomena enables combining the energy based modelling of the DC-DC converter with physics of failure models of capacitor degradation, and allows predictions using stochastic simulation methods of how system performance deteriorates with time. The methodology provides a framework for developing efficient qualitative fault signature methods for fault detection and fault isolation.

On the maintenance side, aircraft structures are designed to be damage tolerant, capable of withstanding small amounts of damage. As such, regular inspections are imperative to detect and repair such small amounts of damage timeously, preventing structural failures affecting safety. Recently, structural health monitoring techniques have been developed that uses sensors and actuators to detect damages on structures paving the way for progressive inspection. Pattabhiraman et al [106] modelled fatigue crack propagation with repeated pressurisation cycles using the Paris Law with uncertainty parameters, with randomly distributing the damage sizes after a number of flights using Monte Carlo Simulation. Further the probability of detection during the inspection process was also modelled, resulting in a fleet Monte Carlo Simulation predicting average fleet behaviour.

As a Master of Science degree thesis Varela [107] used probabilistic methods to study the health assessment challenge of several critical components using probabilistic methods. The uncertainty in selected geometrical, material, and load variables was modelled and the Monte Carlo simulation method was used to calculate probabilities whether a specified life limit would be reached. Further, variables whose uncertainty influences the predicted life of the structural components the most were identified.

Large differences in maintenance costs were observed for operators of one type of engine, engine maintenance being a significant part of the direct operating costs of an aircraft. Such differences are attributable to in-service environmental and operating conditions. Müller et al [108] developed a probabilistic tool to predict shop visit requirements and the respective maintenance work scopes depending on these factors. The tool consists of an engine performance model combined with a number of physics-based damage mechanisms at component level. Variations of performance relevant parameters due to production scatter are also considered thus enabling the determination of the deterioration of the individual parts. The developed tool runs a Monte Carlo simulation in which a fleet of engines is modelled through their respective lifetime of maintenance and performance deterioration.

The decision to repair or replace of any single part is implemented through a sum of different logic rules in the model. It is represented via data-driven distribution functions, in which the probabilities of failure, repair and replacement for each part are specified depending on the number of reference flight cycles. The environmental and operational variations are considered through a physics-based cycle weighting. The model's ability to describe the effects of varying environmental and operating conditions on part damage, and therefore engine maintenance cost and reliability was verified against an actual example.

Lewis [109] discussed quantifying the measurement of technical performance as well technical risk analysis utilizing Bayesian methods and Monte Carlo simulation. Most importantly, no publications were found that uses Monte Carlo simulations to forecast aircraft range capabilities within given environmental conditions.

11 MONTE CARLO MODELLING

The analyses of chapters 6 and 7 were based on sample data from a commercially available flight planning tool, assuming Maximum Take-off Weight departures, based on representative average wind profiles, for pre-selected routes. From the data a predictive equation for trip fuel requirements (climb, cruise and descent fuel) was derived. In this equation the average wind component $\overline{WC}$ becomes the sole independent variable, yielding a correlation coefficient of over 99%. The aircraft type flown along a fixed route (distance) determines the value of the constants:

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 \overline{WC}} \tag{43}$$

Chapter 8 then examined the actual average wind components of 845 flights plans used operationally, over a period of 28 months. The data exhibited cyclical behaviour concurrent with seasonal variations, as expected, but also displayed a small long term variation trend. With calendar days n_c representing the independent variable, the cyclical and long term average wind component trends were modelled by:

$$\overline{WC} = k_a \sin\left(\pi\left(\frac{n_c + k_z}{180}\right)\right) + \frac{k_{av}\,(n_c - k_c)}{365} + k_0 \tag{67}$$

In this instance, the constants are dependent on the route flown. Route dependent, the correlation coefficient varied between 55% and 62%. Consequently, significant uncertainty regarding the actual route average wind component to be expected on any given day remains.

A necessary next step, therefore, is to establish the variability of average wind component around the predicted value from equation (68). The extent of any variability, measured through the standard deviation, as well as the distribution of the variation around the mean significantly impacts any modelling processes. A skewed distribution, left or right, can significantly alter the results of a simulation, if the distribution is inappropriately assumed normal. Similarly, a bi-or multi-modal distribution would be incorrectly represented by an assumed bell shaped distribution.

11.1 Distribution of the Random Average Wind Component Variation

Figure 65 presents the actual average wind component for any given day, less the calculated average wind component from equation (68), for Route 1. Some outliers are observable, more notably when the actual average wind component is less than the predicted value.

Since calculated average wind components are always headwinds, as seen in Figure 62, the most noticeable outliers present significantly reduced headwinds respectively tailwinds. Aircraft load capability is therefore better than predicted in these instances.

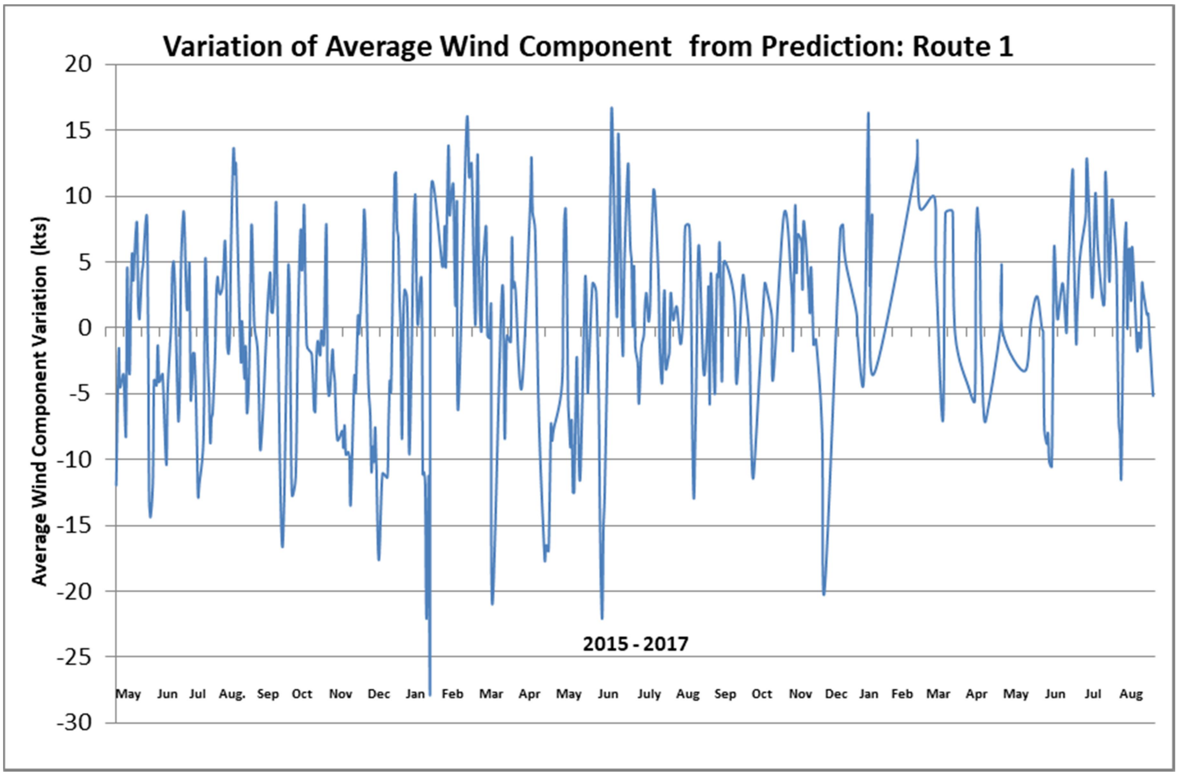

Figure 65 Variation of Average Wind Component from Cyclical Prediction: Route 1

The distribution in Figure 65 appears random. Pearson's product-moment correlation coefficient indicates the strength of the linear relationship between two quantitative variables [62]:

$$\mathrm{r} = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2}\sqrt{\sum(y-\bar{y})^2}} \tag{73}$$

The square of r from this formula can be interpreted as the variance in the variable y attributable to the variance in the variable x [62], providing a similar measure to R Squared defined in equation (34). Nevertheless, the R Squared calculation as defined in equation (34) differs in that it compares, as a function of the independent variable x, predicted values of $\hat{y}$ with actual values of y. As such, consideration of the Pearson correlation coefficient is appropriate in this instance. For the data presented in Figure 65, r^2 = 3.4%, confirming that the data is in fact random.

To assess the distribution of the 457 data points they are grouped into 0.5 Standard Deviation bins. Similarly, for the same standard deviation and same number of total observations, the normal distribution of the data points is established. The results are presented in Figure 66.

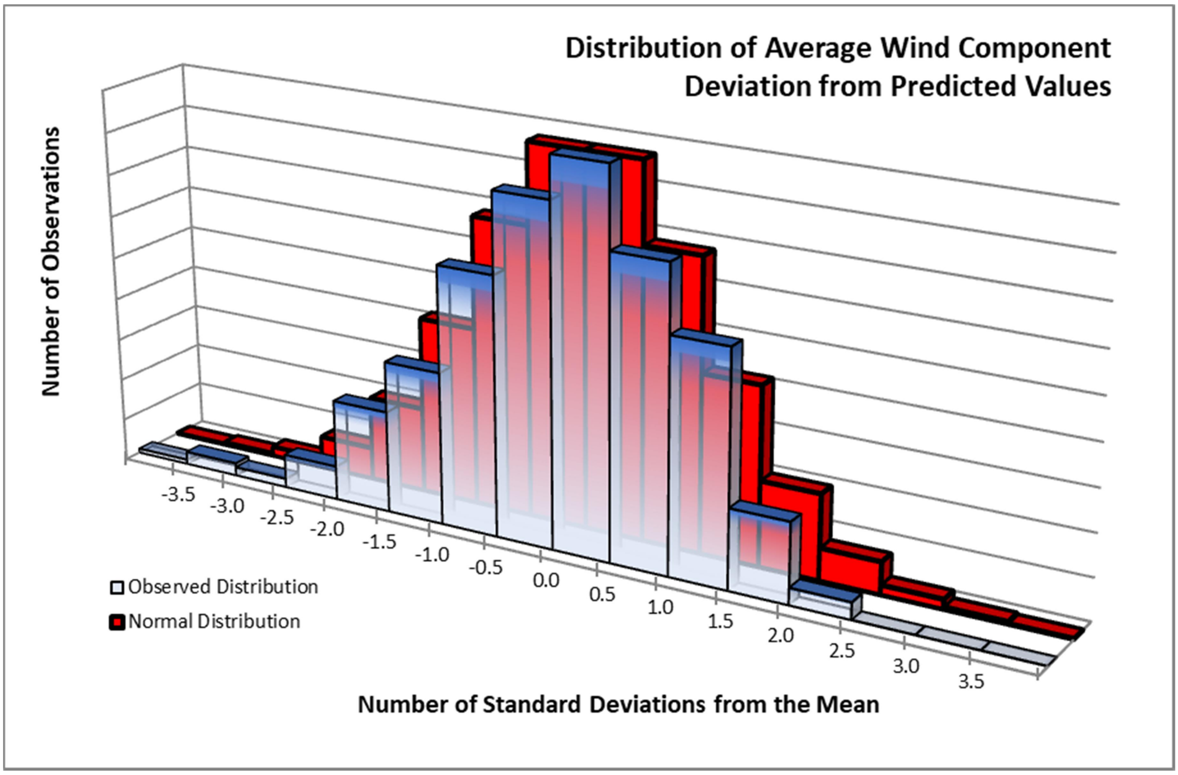

Figure 66 Distribution of Average Wind Component Deviation from Cyclical Prediction: Route 1

The actual distribution of data points approximately matches the normal distribution. The data points do not exhibit multimodality. Applying equation (37) in this instance, comparing actual observations versus predicted (normally distributed) per bin, yields an R-Squared of 98.6%.

A more appropriate methodology [62] is to compute the Chi-square statistic, χ^2, comparing observed and expected frequencies:

$$\chi^2 = \sum \frac{(f_O - f_C)^2}{f_C} \quad (74)$$

The null and alternate hypotheses in this instance are:

H_0: The observed data is normally distributed.

H_1: The observed data is not normally distributed.

For the test to be accurate each expected frequency considered should be five or greater [62], resulting in seven degrees of freedom, as the observed data was also utilized to determine the sample mean and sample standard deviation. With $\chi^2 = 9.33$ being less than the critical value of 12.02 (from tables [62]) the null hypothesis is not rejected. The observed data is normally distributed.

The median was calculated to be 0.084 standard deviations from the mean. It needs to be established whether this value is statistically significant. The null and alternate hypotheses are:

H_0: The observed difference between the median and mean is statistically not significant at the 90% probability level.

H_1: The observed difference between the median and mean is statistically significant at the 90% probability level.

For a z = 0.084 the median is 3.14% from the mean, thus within the required ± 5%. The null hypothesis is therefore not rejected.

Nevertheless, it remains prudent to assess whether the sample data is significantly skewed. Doane and Seward [110] discuss various options to measure skewness, advocating the use of the following equation, comparing the mean and median, to determine the Pearson 2 skewness coefficient (sk):

$$\mathrm{sk} = \frac{3(\bar{x} - m)}{\sigma} \tag{75}$$

The calculated median not being statistically different from the mean implies that the mean and median coincide in the underlying population. Consequently, the observed data is not skewed. The underlying population can therefore be assumed to be normally distributed in any simulations to be applied.

Accordingly, given the average wind component value on any given calendar day n_c as calculated from equation (68) together with the standard deviation, it now becomes possible to model the wind distribution. Therefore, the fuel requirements, and thus the payload capability can be calculated on a daily basis rather than the rudimentary monthly average wind component approach currently in use.

Further, by applying random number simulations, the principle of the Monte Carlo approach, it becomes possible to model the probability distribution on a daily basis. The accepted probability level can now be chosen retrospectively based on the results, rather than being fixed prior to any analysis.

11.2 Monte Carlo Simulation using Excel

As illustrated in Chapter 10, Monte Carlo simulations tend to follow the following pattern:

1. <u>Define a domain of possible inputs.</u>

   The preceding chapters have shown that the predominantly deterministic input variable is the average wind component along any given route. The mean average wind component on any given day is calculated from equation (68), whilst the variance around the daily mean is normally distributed variance.

2. <u>Generate inputs randomly from a probability distribution over the domain.</u>

   With the mean and standard deviation known each day, a random number generator, the essence of any Monte Carlo simulation, then provides a probability distribution from sufficient number of iterations.

3. <u>Perform a deterministic computation on the inputs.</u>

   For any / every chosen probability level the fuel requirements, and hence the payload capability can be calculated and / or displayed graphically.

4. <u>Aggregate the results of the individual computations into the final result.</u>

   The daily payload capabilities then aggregate at any desired probability level into payload memoranda for an airline to determine the number of sellable tickets for the next forecast period.

Numerous Monte Carlo Simulation packages are commercially available to be adapted to simulate the average wind components, respectively the fuel consumptions, respectively the payload capability on a daily basis. Such packages will provide for more “automation”, such as selection of the number of iterations and production of graphics, as required. However, for the purpose of this research, Microsoft Excel will suffice to illustrate the Monte Carlo modelling, thus building the necessary models from basics.

In fact, Monte Carlo modelling, as applied in Excel, applies the following function for any number of iterations to simulate normally distributed data:

$$\text{Simulated Value} = \text{NORM.INV (RAND (), average, standard deviation)} \tag{76}$$

The NORM.INV function in Excel returns the inverse of the normal cumulative distribution for the specified mean and standard deviation, for any given random number, RAND (). Such a random number is equally likely to assume any value between zero and one.

Appendix 14 illustrates how such a spreadsheet could be structured. By selecting the route number, the various constants automatically insert into the two equations for predicting average wind component and determining the fuel requirements.

This particular spreadsheet was designed to predict trip fuel requirements and payload capability for a twelve months period, from a selected starting date. The user is able to choose the required probability level of achieving the predicted performance, or better.

Ideally, the required probability level is a considered balance between the risks / costs of flying empty seats versus off-loading overbooked passengers. (Although a topic of discussion in Chapter 8.3, this in itself is worthy of some further optimization studies).

At the pre-determined probability level, the spreadsheet provides both the expected trip fuel value as a percentage of maximum take-off weight, and the predicted bookable number of passengers.

For illustrative purposes, for each day the spreadsheet generates 10,000 random numbers to predict average wind components, resulting in over 3.65 million calculations, which takes mere seconds.

A comparison of the average value for each of the 10,000 calculations per selected day against the average calculated from equation (68) yields a difference of less than 0.1%. The number of iterations can therefore be deemed sufficiently representative.

Further, the user can assess the prospect of the availability of a desired load factor, including the likelihood of being able to sell all seats on the aircraft (100% load factor). The Aircraft Operator needs to be able to achieve a minimum average load factor annually to operate any route profitably.

For instance, entering the break-even load factor on the spreadsheet determines the daily probability level of having the performance capability to carry the break-even load. There may well be days where it may not be guaranteed that a flight can be operated profitably. However, a tool of this nature allows one to assess the risk of the operation over the period of a financial year, when combined with expected load factors (passenger loads). Invariably, such a spreadsheet is highly and easily adaptive to specific needs.

Evidently, this illustration negates the need for extravagant software and demonstrates the ease of establishing improved predictive capabilities over current rudimentary forecasting methodologies. Any required spreadsheets can easily be custom developed in-house.

11.3 Verification of the Monte Carlo Simulation versus Actual Data

The Monte Carlo simulation uses the average daily wind component, derived from equation (68) and the standard deviation derived from actual deviations around the mean, such as depicted in Figure 65. Equation (68) in turn derived from actual wind data for the period May 2015 to August 2017. The equation was subsequently applied to the period September 2017 to February 2018, and compared to the independent actual data over the period.

Chapter 8.7 discusses this in detail, verifying that the correlation between predicted and actual data remained similar to that for the data used to develop equation (68). With the defining parameters verified, the Monte Carlo Simulation is representative.

11.4 Comparison of the Monte Carlo Simulation versus Current Forecasting Approaches

Current forecasting approaches use monthly average winds at a chosen probability level, to predict trip fuel requirements, or better (less), to derive payload capability. Typically, an 85% probability level is chosen, although this may be overly conservative, based on the discussion in Chapter 8.3. An immediately apparent shortcoming is that such an approach utilizes the same average wind component for the entire month, followed by a noticeable step change for the next month.

The use of probability as high as 85% partly disguises the reduction in the intended conservative view of this current methodology, but can also partly result in potentially unnecessarily onerous results. The actual probability of the average wind component being the monthly average figure applied (or less) can potentially vary between 65% and 95%.

Figure 67 reflects the Monte Carlo simulation of the 85% probability winds for 2018, based on equation (68) applied to Route 1. The constants for equation (68) applied for route 1 were determined from actual daily average wind components for the period May 2015 to August 2017 inclusively. Figure 67 further reflects the monthly average wind components, at 85% probability level, used to derive the original set of data to derive equation (43), the trip fuel dependency on average wind component along the route.

To recap, in the context of deriving equation (43) the data was only used to determine the relationship between trip fuel along a route and the average wind component. Whichever probability level the actual average wind component represented is inconsequential here.

Stated differently, independent of when average wind component $\overline{WC}$ occurs, it will result in the trip fuel requirement calculated from equation (43), for a specific route.

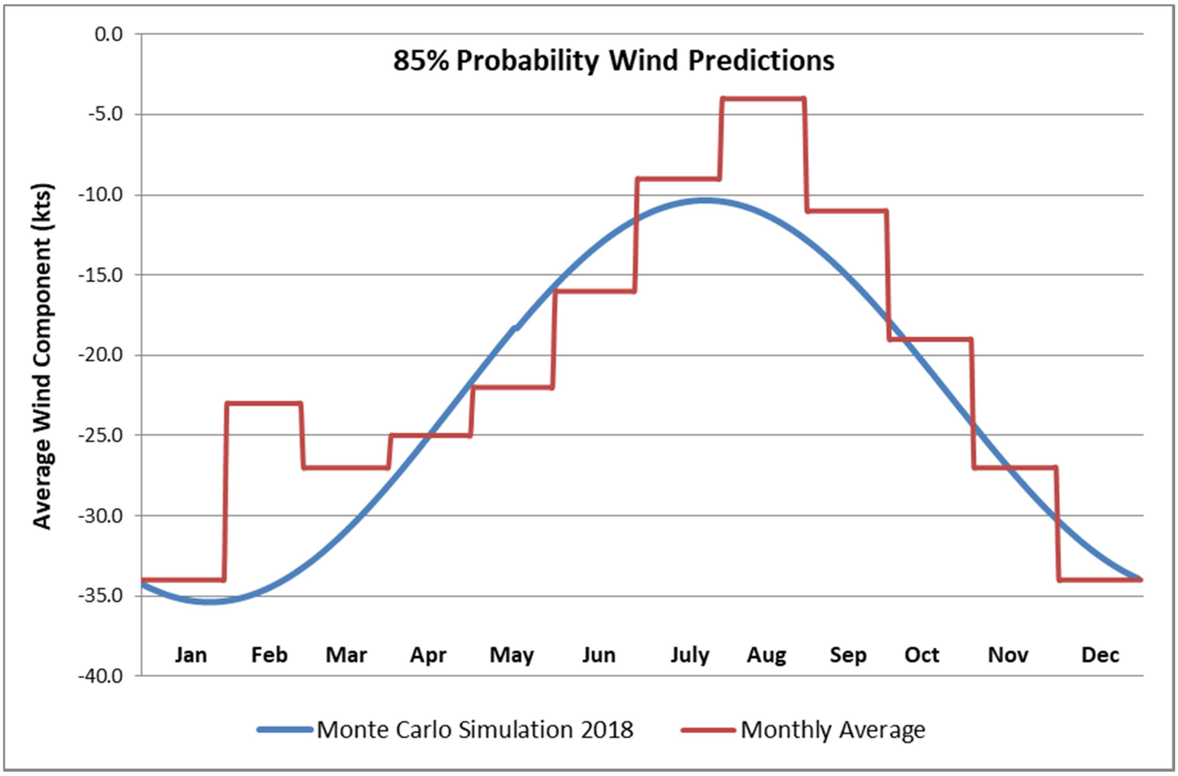

Figure 67 85% Probability Wind Predictions

The monthly average wind components are derived from actual wind data for the period 2015 to 2016. As such, they cannot be reflective of the changes in annual climatic patterns, discussed in chapter 8.1 and incorporated into equation (68) in chapter 8.4. Consequently, some trend variation between the two predictive methodologies is inevitable. Between 2016 and 2018, a linear reduction 1.8 kts is predicted by equation (68) for route 1.

Far more noticeable are the seeming "anomalies" in the wind patterns for February and August. This raises the question of whether the sinusoidal modelling, assuming annually repetitive wind variations (modified by a long-term trend), as derived in chapter 8.4, is sufficiently representative. Figure 68 reproduces Figure 42, with a 30-day moving average trend line added.

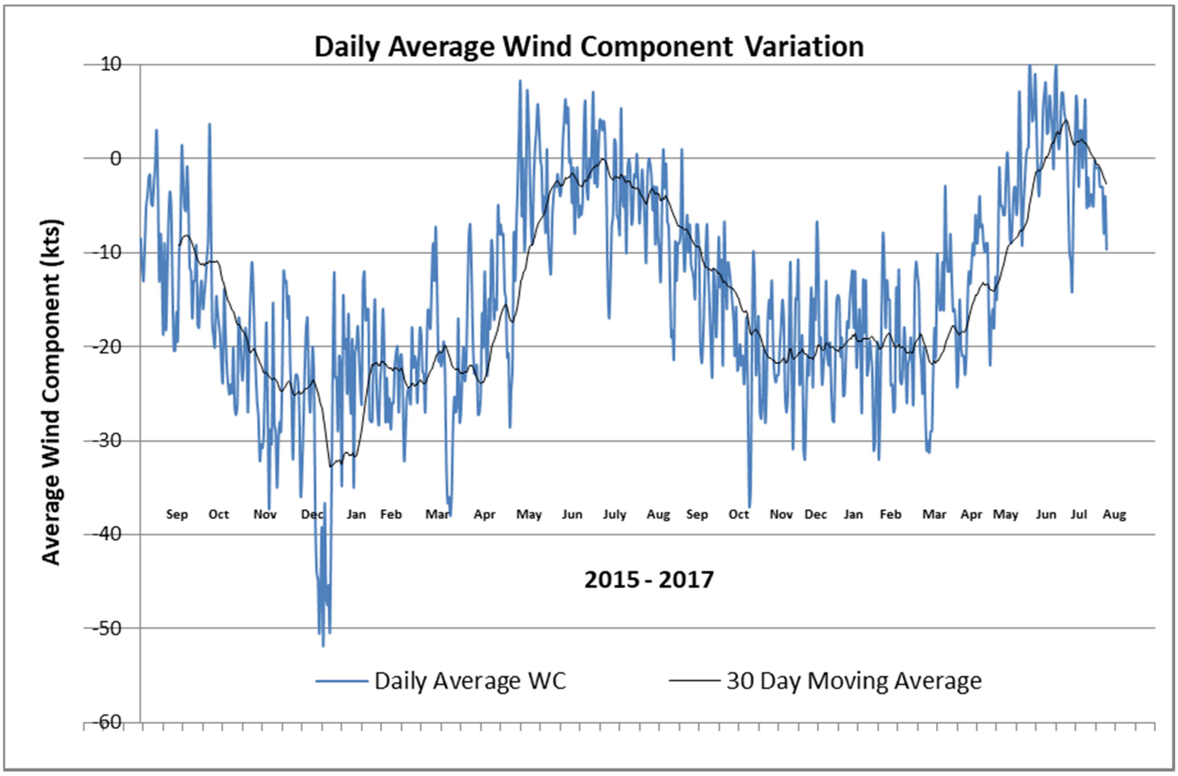

Figure 68 Daily Average Wind Component Variations

The 30-day moving average trend line suggests that February 2016 indeed experienced unusually weak average headwind components relative to the surrounding months. This effect is not repeated the following year, 2016, although it can be argued that the whole Northern Hemisphere winter period experienced milder headwind conditions for that season. The August "peak", seen in the monthly-average-wind-component curve in Figure 67, is not reflected in the moving average trend line in Figure 68 for 2016 or for 2017.

Clearly, the anomalies seen in Figure 67 are not recurring annual events. Rather, they appear to be short-term variations from the long-term trend respectively the annual cyclical nature of weather patterns. Consequently, a significant shortcoming in the current methodology exists: Using the monthly average wind component experienced during the preceding year can distort the predictions for the following year, when unusual short-term variations occur.

As a result booking levels might become more restricted than necessary resulting in excessive empty seats on the day of operation. Alternatively, the aircraft might end up overbooked requiring denied boardings.

11.5 Monte Carlo Simulation of the Load Factors

Chapter 8.3 compared predicted load factor capabilities against actual load factors and generated some cumulative probability distributions (Figure 50 and Figure 51). These comparisons were generic though, as they merely considered the relative probabilities of load factors and load factor capabilities, without any consideration for seasonality effects.

Passenger demand can vary by day of week and by month of year. The commercial departments of airlines make use of commercially available yield management systems to forecast passenger loads on a daily basis taking into account such variability. The purpose of this chapter, therefore, is not to duplicate or replace such yield management system functionality, although the Monte Carlo simulation methodology might well be of value to such underlying analyses. Rather, the purpose here is to assess the interactivity between capability and demand with due regard for variability in both.

Figure 69 plots actual load factors from December 2016 to January 2018, inclusive. Additionally, the Monte Carlo simulation predictions for 2017 of load factor capability are presented for 2017.

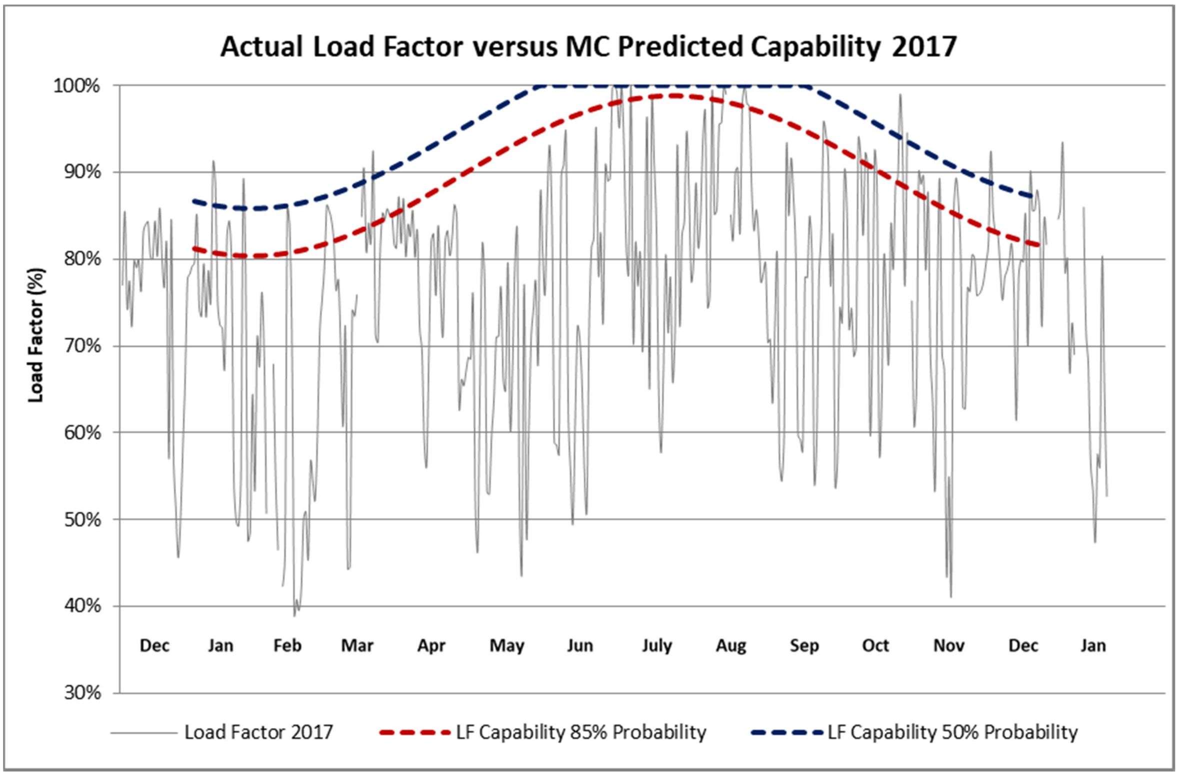

Figure 69 Actual Load Factors versus Monte Carlo Predicted Capability 2017, Outbound Flight

Interestingly, only 16% of flights had a load factor better than predicted at the 85% probability level. This compares favorably to the contemporary methodology of using monthly average wind components, as detailed in chapter 8.3, where 27% of flights achieved load factors better than predicted capability. Consequently, the risk of flying empty seats unnecessarily is reduced through the simulation depicted in Figure 69. In Figure 70 the 30-day moving average trend line is added to the actual load factor graph.

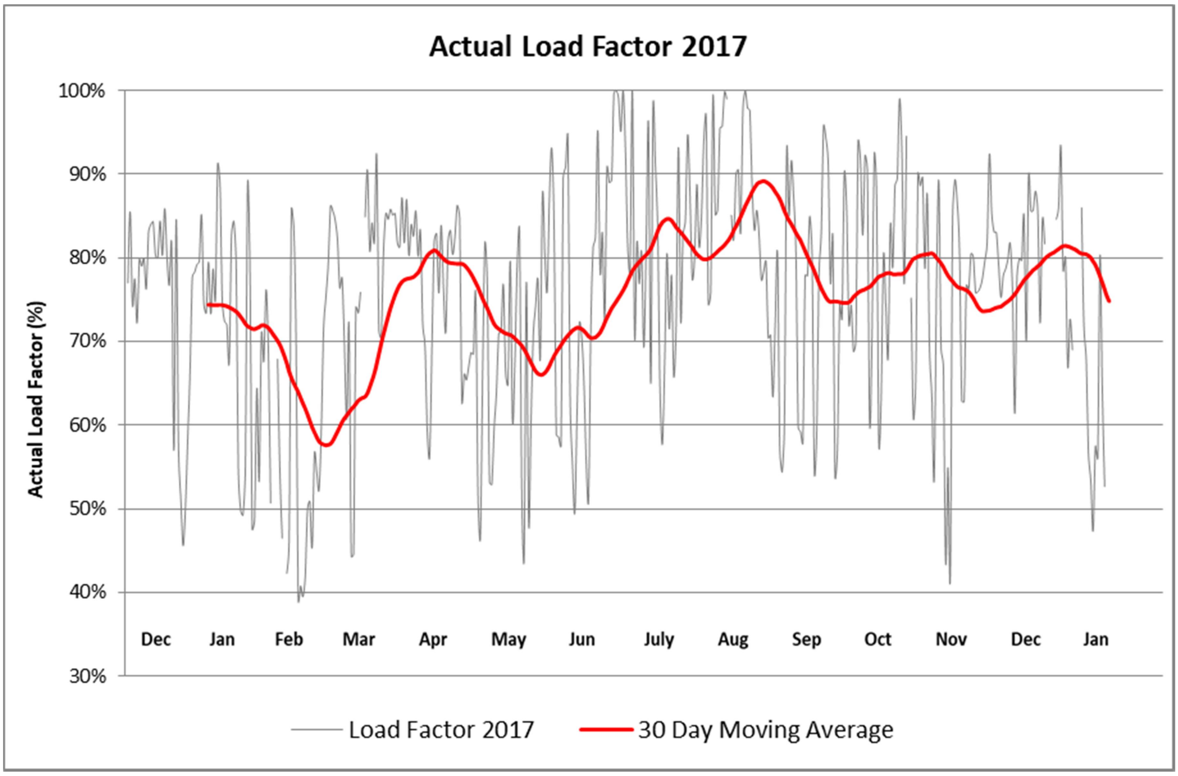

Figure 70 Actual Load Factors 2017 Outbound Flight

Seasonal effects are evident: Peaks in passenger loads are seen over the Easter and Christmas holiday periods. The Northern Hemisphere summer holiday period is reflected in the passenger load peaks of July and August.

With the variation around the seasonal pattern, the 30-day moving average curve, known from the actual load factors for the period, a Monte Carlo simulation again becomes possible. The resulting Excel spreadsheet is similar in design to the one depicted in Appendix 14. Figure 71 portrays, at the 50% and 85% probability levels, the required load factors and the load factor capabilities from the respective Monte Carlo simulations, for 2017.

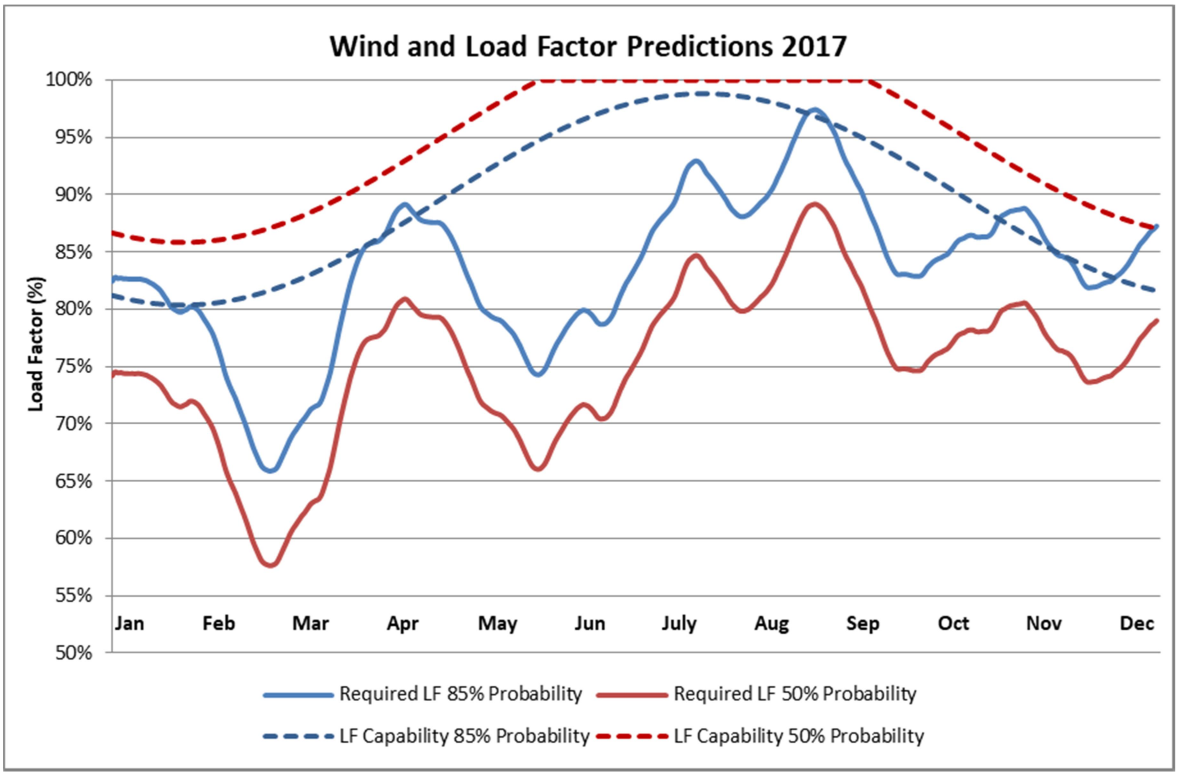

Figure 71 Monte Carlo Load Factor Predictions 2017, Outbound Flight

In this instance, up to 19% of flights are predicted to require a load factor greater than predicted available, at the 85% level both for the load demand and supply capability predictions. It must be emphasised that the requirement prediction is for 85% or less demand, whilst the capability is for 85% or more supply. As evident from Figure 71, the risk of demand exceeding supply is predominant only during the peak periods, most noticeably over December / January, when winds are the most adverse.

Up to this point, the approach, even with refined forecasting through the suggested modelling derived in this thesis, has been to assess the 85% probability wind levels. Figure 71 now suggests that a different approach to dealing with the demand versus supply problematic would be more prudent.

With Monte Carlo simulations established for both the supply and demand distributions, it becomes practical to assess the risk factor of demand exceeding supply on a daily basis. Payload restrictions based on risk appetite can then imposed individually per flight, rather than generically per month, as done historically.

11.6 The Risk of Demand exceeding Supply

Figure 72 reveals that the risk of demand exceeding supply only surpasses the 15% probability level over December.

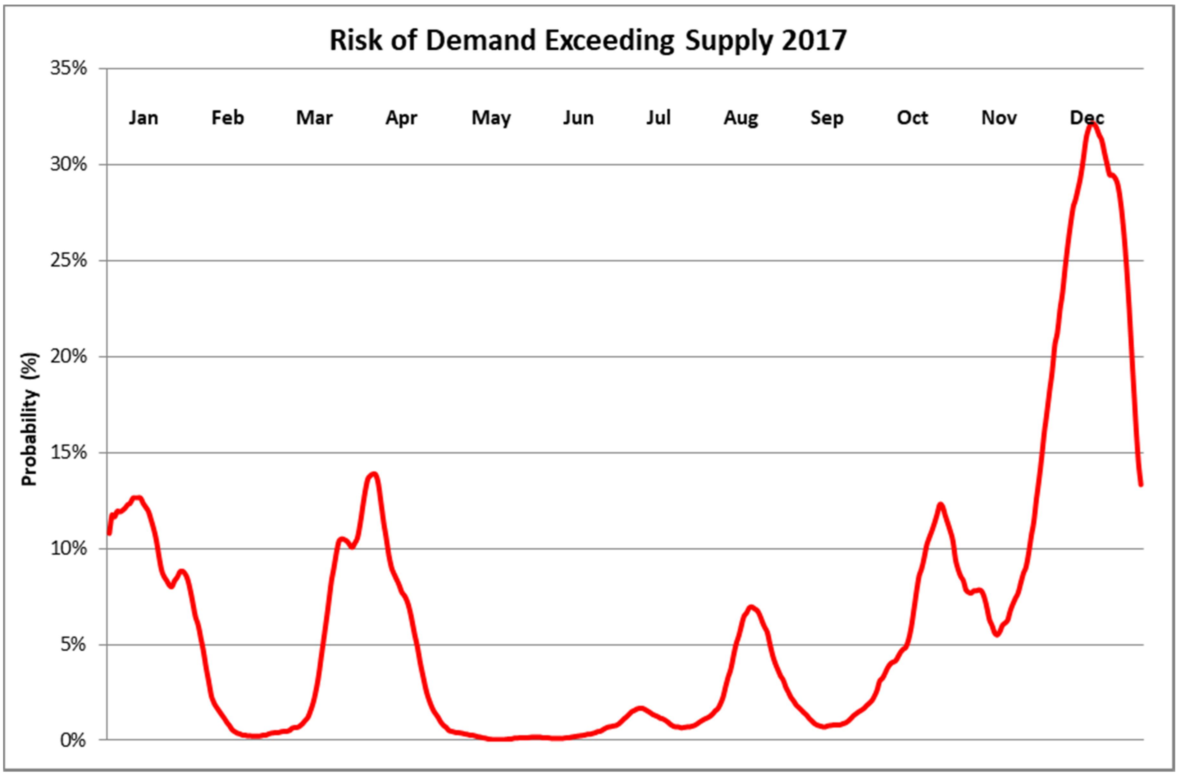

Figure 72 Risk of Denied Boarding, 2017, Outbound Flight

However, from Figure 71, the December period does not reflect the highest demand levels, but does fall within the period where winds are least favourable. Invariably, the pattern in Figure 72 differs from that of Figure 71, as Figure 72 combines load demand with load supply probability distributions, taking into account that the load factor cannot exceed 100%.

In combination, however, the December period presents the greatest risk by far of demand exceeding supply. For this period, imposing payload restrictions, reducing the number of sellable seats, is certainly warranted to contain the risk. Conversely, though, for the remainder of the period under review, the risk of demand exceeding supply remains well below the 15% risk level, prior to any payload restrictions having been imposed.

This verifies the discussion of chapter 8.3 respectively the graphics of Figure 49 that the current methodology of using monthly averages is onerously restrictive: denied boarding virtually never happens but numerous flights operate with open seats that were in fact sellable. With the sinusoidal modelling of the average wind component established in chapter 8.4 Figure 59 further demonstrates that the risk of flying with empty seats greatly reduces, prior to even matching load demand and supply. Depending on the risk appetite, therefore, restricting payload is only required in very confined instances.

11.7 Load Factor Restrictions based on Risk of Denied Boarding

Using Monte Carlo simulation of the payload demand and payload supply probability distributions it becomes possible to determine the required payload restriction to achieve a preferred risk profile. The preferred risk profile is presented by the associated load factor restriction, of not having to off load passengers. Figure 73 portrays such required payload restrictions (load factors) at four different risk levels. The lower the desired risk level is, the more likely it will be that a payload restriction will be required. The respective graphs are more angular since payload restrictions can only be done in discrete units (seats), even if expressed as a percentage of total seats on the aircraft.

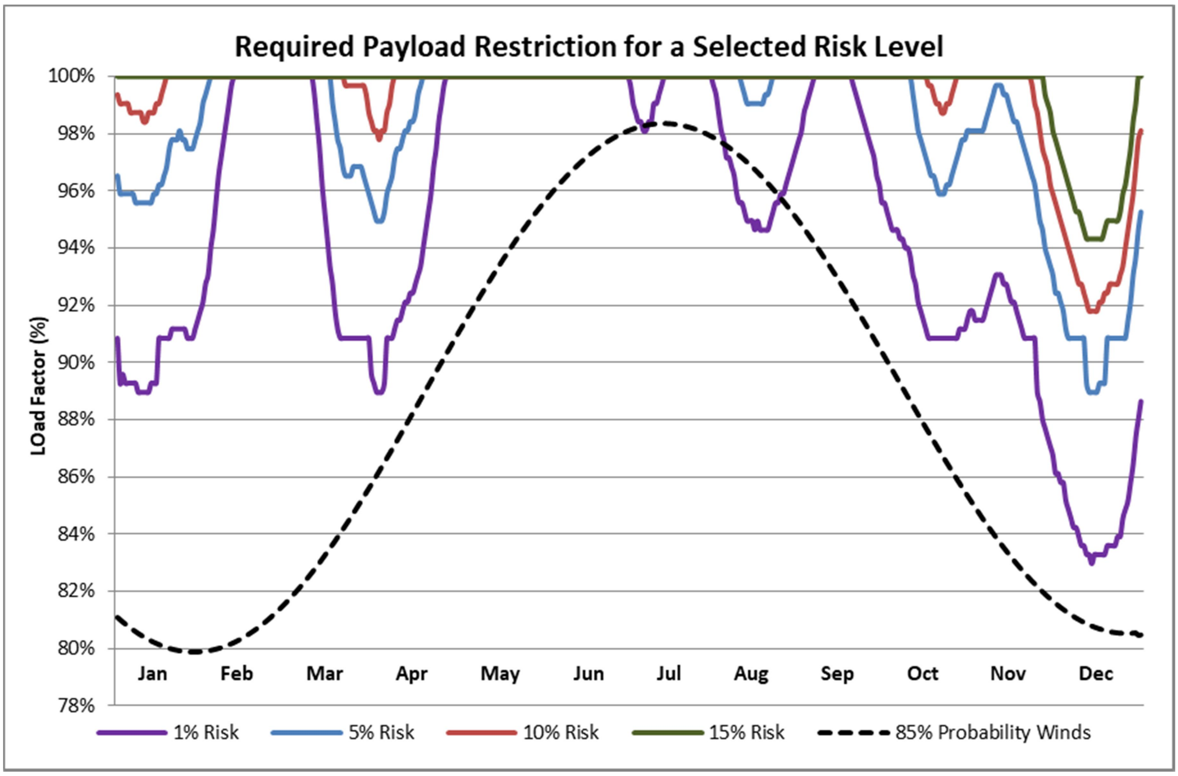

Figure 73 Required Payload Restriction at the Selected Risk Level

As already predicted by Figure 71, payload restrictions need only be considered during the various peak periods. Depending on risk appetite the required restrictions are minimal, with the notable exception over the December period. At the 15% risk level, only the December period requires some intervention. Further, the predicted payload capability for 85% probability winds (or better) is presented in Figure 73. Noticeably, using 85% probability winds to predict payload capability remains highly conservative in this instance. The probability of denied boarding (demand exceeding supply) is mostly far less than 1% except for the July / August period, where the probability touches 2% at peak demand.

Again, this correlates with the discussion of chapters 8.3 (Figure 49) and 8.4 (Figure 59) where it was shown that, for the expected demand, the risk of denied boarding is negligible, even with the current methodology of using monthly averages. Invariably, as payload demand increases with market growth over time, the risk of denied boarding will increase, with the sinusoidal modelling containing the increased risk with market growth somewhat longer, before it could become problematic.

Figure 74 repeats Figure 73 but includes a 5% increase in demand, approximating one to two year's market growth. To retain the selected risk levels of denied boarding requires more restrictive load factor limitations, as expected.

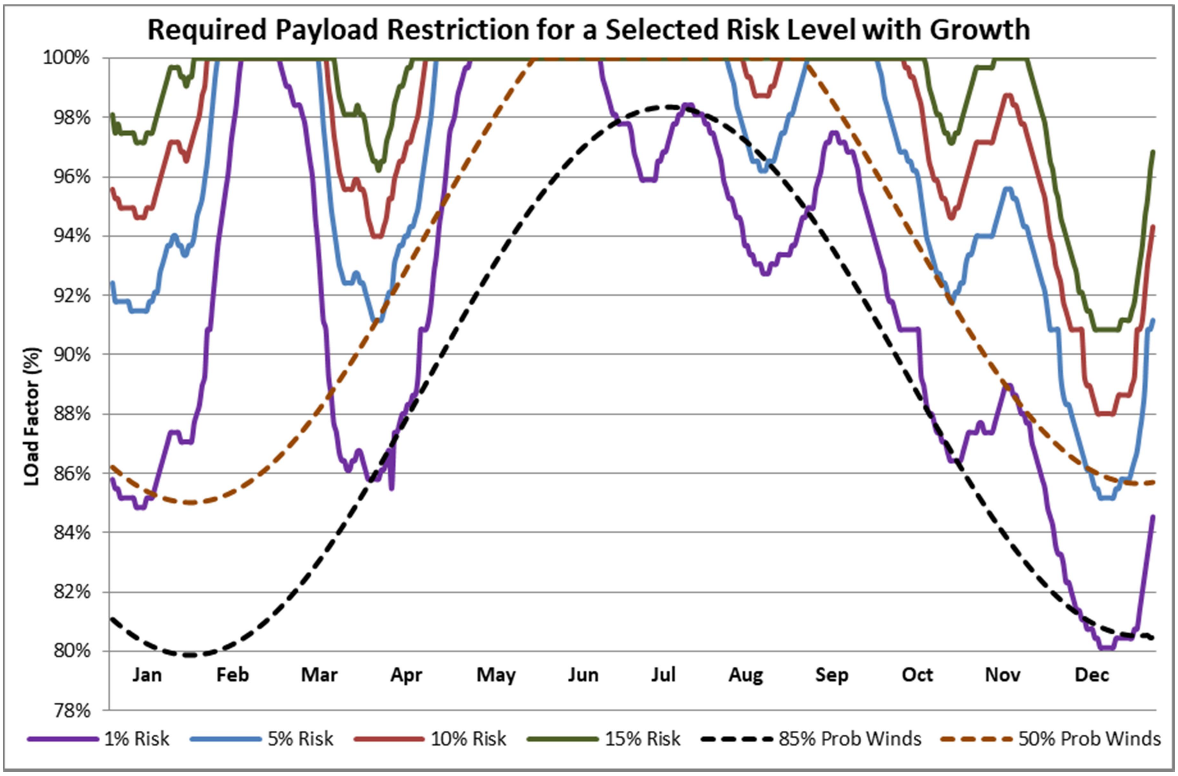

Figure 74 Required Payload Restriction at the Selected Risk Level, with Market Growth

Nonetheless, the load factor limitations based on 85% probability winds remains highly conservative with mostly around 1% risk of denied boarding, except for the period July / August. Here, the risk of denied boarding can be as high as 5% at peak time. Nevertheless, the winds for the July / August period are the most favourable, permitting full passenger capability more often than not.

Accordingly, in the absence of availability of payload demand predictions, restricting payload on the basis of only the predicted wind components at 85% probability level remains an overly conservative methodology for denied boarding risk management. Figure 71 would suggest that using the average wind component (50% probability) remains sufficiently conservative, even with near term growth above current load demand levels. Only the August peak period would then be exposed to a 10% (current load demand) to 15% (with growth) risk of denied boarding, only when the aircraft is not able to carry 100% passenger load.

In all these graphs depicting load factor on the vertical axis, a 100% load factor remains the maximum achievable. At a desired probability level, payload capability may well be higher than 100% passenger load during periods throughout the year, implying that additionally cargo could be carried. Since this is cargo capability is not available year round, such cargo would be ad hoc, typically at short notice, and thus does not distract from this study: The focus remains on passenger load capability, which cannot exceed 100%, as there are only a finite number of seats that can be filled on the aircraft. Therefore, the graphs are shown capped at 100% load factor.

11.8 The Probability of Flying Empty Seats Unnecessarily

Reducing the risk of denied boarding, becoming more restrictive in the number of seats made available, invariably increases the risk of flying empty seats that could have been filled. Potential revenue is not realized. Invariably, there is a balance depending on risk appetite.

As expected, Figure 75 shows the risk of sellable seats being blocked to be higher during the peak periods. Further, the risk of revenue not realized increases as the risk of denied boarding decreases, with the 85% probability winds based payload restrictions being most onerous. An approximate balance exists between the 5% off load risk profile, respectively the 50% probability wind profile with respect to the risk of flying empty seats unnecessarily. The risks of offload approximately match the risks of revenue not realized.

As before, Figure 76 in turn considers the effect of a 5% market growth. The 5% offload risk profile now moves closer to the 50% probability winds profile. Figure 73 to Figure 76 suggest that, in the absence of load demand predictions, the 50% probability winds should be used to restrict the load factors, largely containing the risks of offloads to within 5% and the risk of revenue not realized to within 10%.

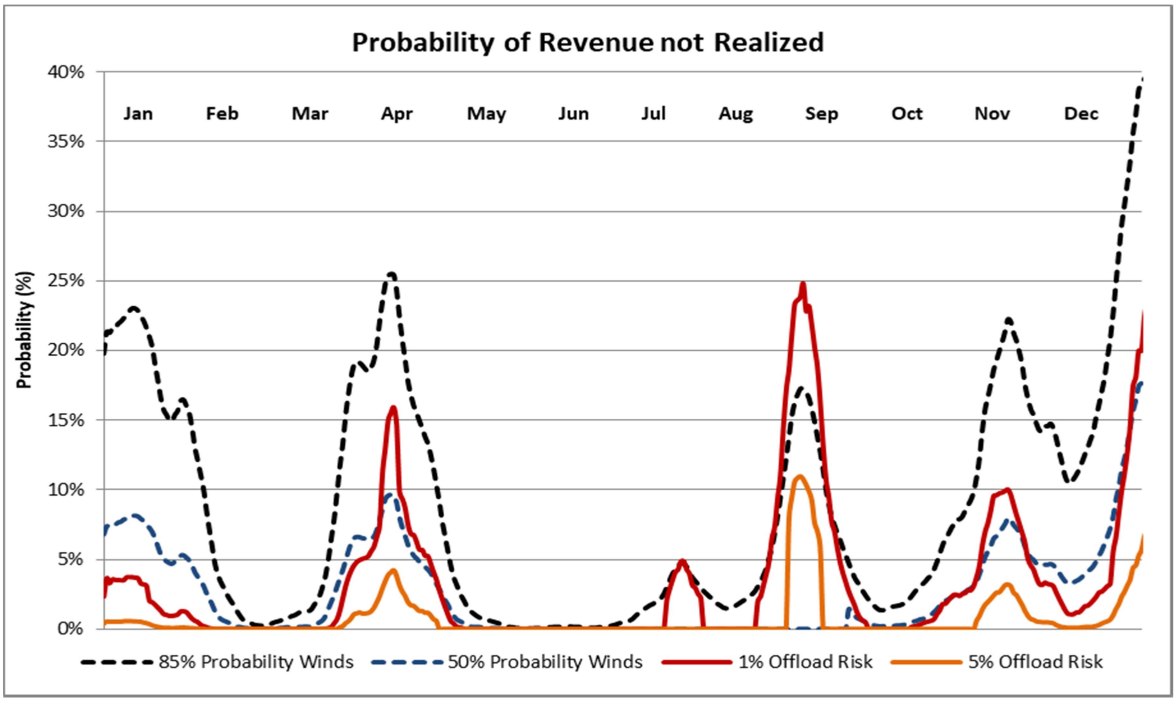

Figure 75 Risk of Revenue not Realized

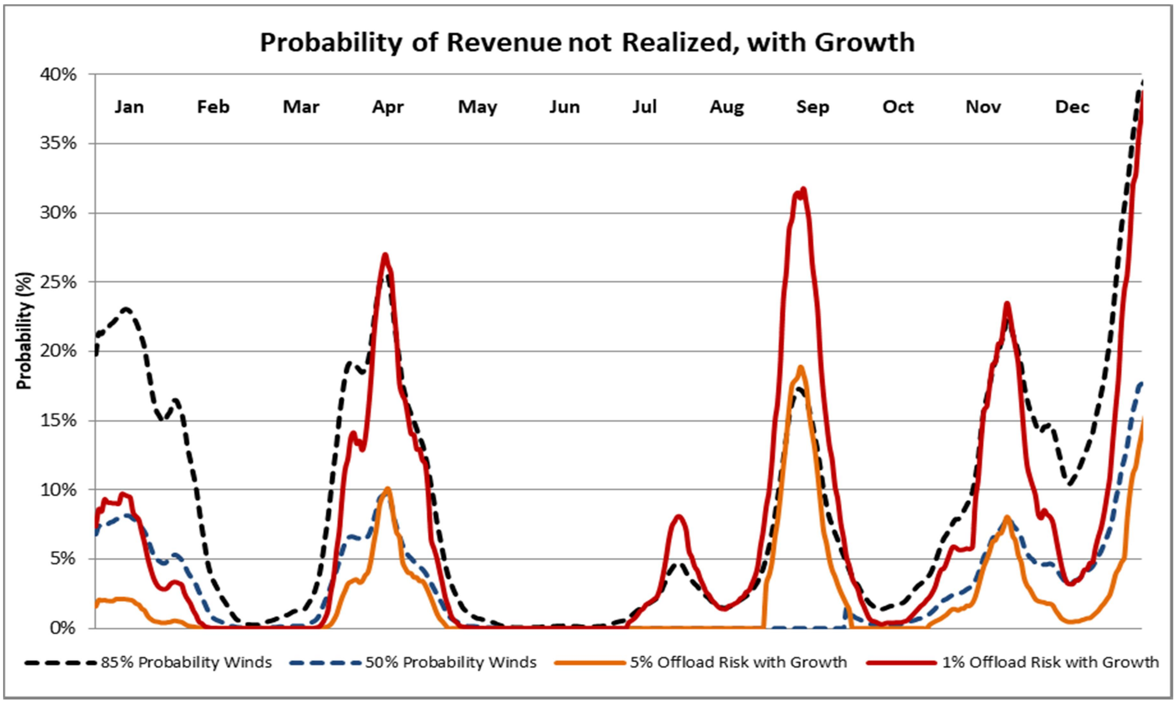

Figure 76 Risk of Revenue not Realized, with Market Growth

12 SUMMARY: FROM RUDIMENTARY FORECASTING TO SCENARIO PLANNING

Current forecasting approaches use monthly average winds at a chosen probability level, to predict trip fuel requirements, or better (less), to derive payload capability. An immediately apparent shortcoming is that such an approach utilizes the same average wind component for the entire month, followed by a noticeable step change for the next month. The required probability level is predetermined and thus becomes fixed. Typically, an 85% probability level is chosen.

Chapter 8.3 compares historic predicted payload capability to actual loads carried, to assess the likelihood of denied boarding respectively of sellable seats not actually sold. Both have significant impact, since denied boarding and seats not sold impair an airline financially: Denied boarding may incur penalty payments and / or hotel costs and / or may require re-routing of passengers possibly with other airlines with the resulting loss of revenue. Loss of goodwill may also be the result. Unsold seats, conversely, results in revenue not generated.

The discussion of chapter 8.3 respectively the graphics of Figure 49 reveal that the current methodology of using monthly averages is onerously restrictive: denied boarding virtually never happens but numerous flights operate with open seats that were in fact sellable. Significant revenue potential remains unrealized.

Chapters 8.4 and 8.6 then replace the monthly average wind component with sinusoidal modelling of the annual cyclical variation of the average wind component, modified slightly to allow for climate change drift. Although the sinusoidal modelling increases the potential for denied boarding, the overall impact is an improvement, bearing in mind that the cyclical modelling of the average wind component here represents the 50% (average) probability level. Certainly, the sinusoidal modelling nearly doubles the correlation with the underlying data set, explaining far more of the variability observed.

The 85% probability cyclical winds could equally be modelled to reduce the number of denied boarding, but at the cost of increased amounts of revenue not realized. Thus, different probability levels, depending on risk appetite, can be considered, albeit only be restarting the analysis for the desired level. This remains cumbersome.

Even with the improved sinusoidal modelling of the average wind component, the methodology nevertheless restricts itself to forecasting supply only, with no consideration for demand. The impact of variations around the mean is partially circumvented by predetermining probability levels, but does not find direct consideration.

Having established normality around the sinusoidal modelling of the independent variable, the average wind component, Chapter 11 then models the daily variability of the average wind component using random number generation, the Monte Carlo simulation. A predetermined probability level reflecting risk appetite is no longer required. Rather, the desired probability levels can now be applied as a variable. Further, along the same principles, historic demand can be modelled simultaneously with predicted average wind components, determining supply, using Monte Carlo simulation. Seasonal variations in average wind component with the annual cyclical weather patterns and climate changes can now be compared to the unrelated daily, weekly and seasonal variations in passenger travel patterns. Supply and demand can now be compared and, where necessary, matched, as depicted in Figure 69.

With Monte Carlo simulations established for both the supply and demand distributions, it becomes practical to assess the actual risk factor of demand exceeding supply on a daily basis, rather than predetermining probability levels. Payload restrictions based on risk appetite can then be imposed individually per flight, rather than generically per month, as done historically. By managing supply versus demand on a daily basis, the risk of flying empty seats unnecessarily, respectively the risk of denied boarding can be minimized. Further, predicted growth in demand can easily be incorporated into the forecasting process.

Seasonal effects are evident for the origin-destination city pair under consideration in this research. As is apparent from Figure 71, the risk of demand exceeding supply is predominant only during these peak periods, most noticeably over December / January, when winds concurrently are the most adverse. Figure 72 further reveals that the risk of demand exceeding supply only surpasses the 15% probability level (if that is the desired level) over December.

However, from Figure 71, the December period does not reflect the highest demand levels, but does fall within the period where winds are least favourable. In combination, nevertheless, the December period presents the greatest risk by far of demand exceeding supply. For this period, imposing payload restrictions, reducing the number of sellable seats, is certainly warranted to contain the risk. Conversely, though, for the remainder of the year under review, the risk of demand exceeding supply remains well below the 15% risk level, prior to any payload restrictions having been imposed.

The current approach, even with the refined forecasting through the suggested sinusoidal modelling derived in this research, to assess the 85% probability wind levels for supply determination is therefore overly restrictive and onerous on revenue generation capabilities. The discussions of Chapter 8.6 are further corroborated by the analysis of Chapter 11.

Using Monte Carlo simulation of the payload demand and payload supply probability distributions enables determining the required payload restriction to achieve any preferred risk profile. The risk profile can flexibly be chosen post analysis, rather than needing to be predetermined. Payload restrictions, if any, can be determined daily rather than monthly. Further, and more importantly, as projected demand is updated closer to time of flight, the analyses can easily be recalculated to achieve the optimum balance between available supply and required demand.

Invariably, as payload demand increases with market growth over time, the risk of denied boarding will increase, with the sinusoidal modelling containing the increased risk with market growth somewhat longer, before it could become problematic. Monte Carlo simulation contains the risk even longer. Fundamentally, through the Monte Carlo simulation capabilities, the forecasting has progressed from rudimentary and conservative supply prediction towards daily scenario planning of matching supply and demand.

13 POSSIBLE ENHANCEMENTS TO THE FORECASTING MODEL

Provided one has knowledge of the deterministic statistical parameters of any set of data (mean, standard deviation, skewness, and modality) Monte Carlo simulation can be applied to model any such data set.

13.1 Take-off Performance

For the analysis in this thesis, it was assumed that the aircraft is always capable of departing off the origin runway at maximum take-off weight. For a given field elevation, take-off performance is predicated by available engine thrust. Engine thrust, in turn, is dependent primarily on outside air temperature [36]. A typical thrust availability profile is depicted in Figure 77.

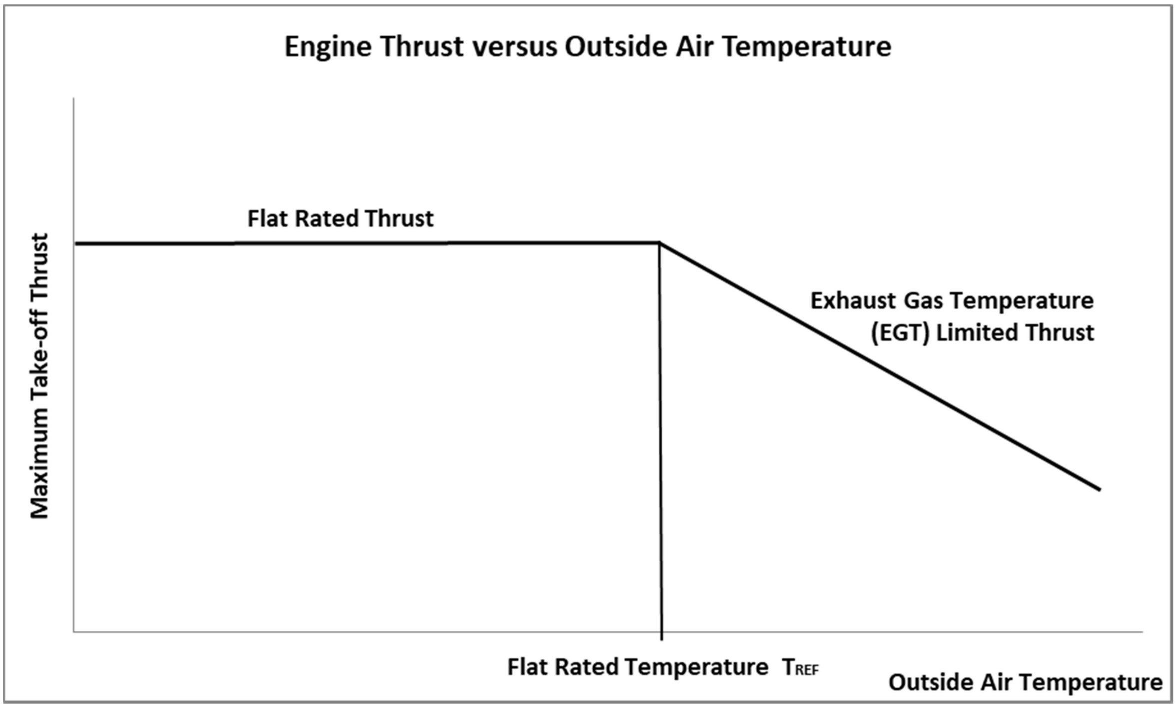

Figure 77 Engine Thrust versus Outside Air Temperature

Provided the flat rated thrust up to the flat rated temperature (T_{REF}) allows for a departure at maximum take-off weight (or more), the assumption of Maximum Take-off Weight (MTOW) capability underlying this research is not unreasonable. For the aircraft type considered in this research, Figure 78 shows the performance restricted take-off weight (RTOW) as a function of outside air temperature [111].

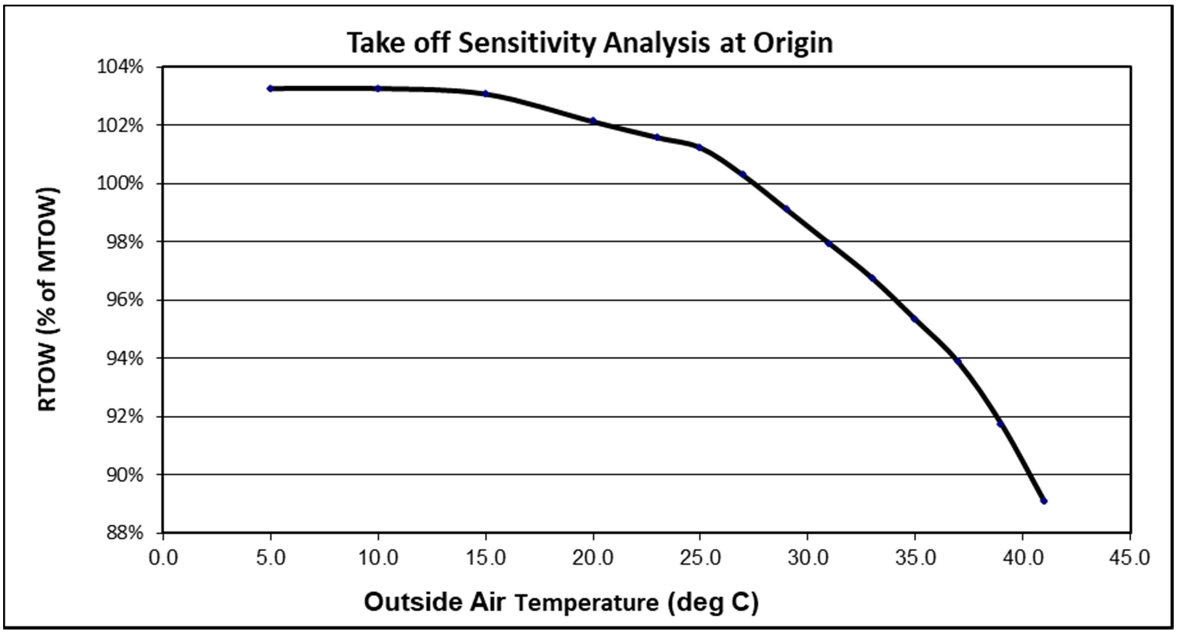

Figure 78 Take-off Sensitivity to Outside Air Temperature at Airport of Origin

Although the T_{REF} for the engine type is relatively low, the flat rated thrust available is more than needed to achieve MTOW. MTOW is therefore achievable up to about 27 °C for this aircraft type, on the predominant runway in use for take-off. It then becomes instructive to compare temperatures variations at the origin airport [112].

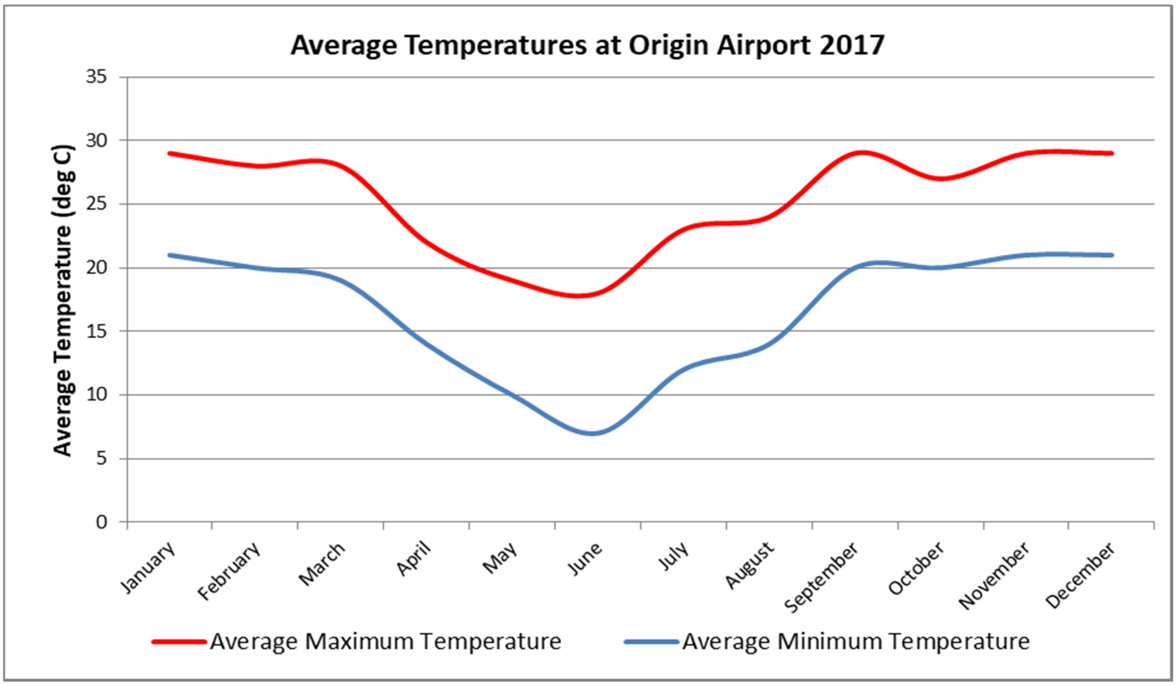

Figure 79 Average Outside Air Temperatures at Airport of Origin, 2017

Provided the flight is not scheduled to depart when daily maximum temperatures are reached, maximum take-off weight performance remains typically available throughout the year, except possibly for the occasional heat wave. Then, only an occasional delayed take-off to ensure that the outside air temperature is sufficiently cool may be necessary at times.

Alternatively, departures could be scheduled to ensure outside air temperatures remain well below the 27 °C throughout the year, allowing for the occasional above average temperature weather patterns. Operationally, therefore, temperature effects on take-off performance are circumventable in this particular instance.

Commercially, though, this may not be desirable if it prevents optimized scheduling to maximize connectivity, respectively if delays cause passengers to miss their connecting flights too frequently. Clearly, though, there is a potential trade-off between optimized scheduling and loss of payload capability. As shown in Chapter 11, December combines seasonal peak demands with most adverse wind patterns. December is also one of the hottest months at the airport of origin.

In the country of origin a heat wave is deemed to exist when the temperature is 5 °C or more above the average maximum temperature of the hottest month [113]. At 34 °C, the performance Restricted Take-off Weight (RTOW) is 96.0% of structural Maximum Take-off Weight (MTOW). Whilst significant in number of passengers potentially affected, in terms relative to the MTOW the impact is small (4.0%), allowing for an approximation to be applied. Also, the lower take-off weight results in a reduced trip fuel requirement, partially negating the impact on payload capability.

Effectively, modelling the impact of high temperature effects during the take-off requires modelling the trip fuel requirements at lower take-off weights. Equation (16) can be rearranged as:

$$W_{fuel} = W_i(1 - exp^{\left(SFC\frac{-R}{TAS}\frac{D}{L}\right)}) \tag{77}$$

Assuming that True Airspeed (TAS), Lift to Drag Ration (L/D) and Specific Fuel Consumption (SFC) remain approximately constant:

$$dW_{fuel} \approx dW_i * exp^{\left(SFC\frac{-R}{TAS}\frac{D}{L}\right)}) \tag{78}$$

The actual weight impact affecting payload is then

$$\Delta Weight = (RTOW - MTOW) - \Delta W_{fuel} \tag{79}$$

With the Restricted Take-off Weight (RTOW) being the result of temperature effects. Then:

$$\Delta Weight \approx (RTOW - MTOW) - k_{fuel}\,(RTOW - MTOW) \tag{80}$$

So that, for purposes of the simulation of reduced take-off weights:

$$\Delta Payload\ Capability \approx (1 - k_{fuel})(RTOW - MTOW) \tag{81}$$

Once again it becomes possible to incorporate the risk and impact of outside air temperatures seasonally, again using Monte Carlo simulation. However, this would require data on the likelihood and extent of temperature variations above maximum average temperatures. Alternatively, daily average temperatures at the intended departure time can be analysed for variance, for subsequent modelling.

13.2 Take-off Runway

Each runway (normally) has two take-off directions diametrically opposite. Choice of runway direction for take-off is normally predicated by the surface wind conditions, a take-off into wind generally resulting in better take-off performance capability [36]. Nevertheless, for the same headwind component, take-off performance capability may differ between runway ends: The runway may be sloped, with an uphill slope being adverse to take-off performance. Different obstacles or terrain profiles in the departure zone require different initial climb capabilities.

Based on seasonal surface wind variations, the likelihood of different take-off directions can be modelled through a Monte Carlo simulation, should this affects take-off performance capability. Naturally, any headwind component will partially counter the take-off performance degradation of using the opposite runway direction.

13.3 Enroute and Destination Weather

Although there are exceptions, a fundamental concept in commercial aviation is to have at least two airports available for landing at or near the destination airport. Typically, this would consist of the destination airport plus one alternate airport. Sufficient fuel needs to be available to fly to the destination airport, perform a go-around and missed approach, then proceed to the alternative airport. Upon landing at the alternative airport the aircraft should then still have 30 minutes of fuel in tanks [36].

On rare occasions, the weather at destination may be such that a landing may potentially (according to aviation weather forecasts) not be possible. The aircraft then has to operate with two designated alternate airports, to retain the concept of having at least two opportunities to land. Fuel must be carried to be able to reach the further alternate airport, following a diversion from the destination airport, and land with 30 minutes in tanks [36].Consequently, a further alternate airport necessitates carrying additional operational fuel at the expense (when payload range limited) of payload capability.

Similarly, large-scale enroute weather patterns such as tropical depressions (cyclones, hurricanes) can spread out up to 2000 km, potentially necessitating some circumnavigation by the flight. Although each flight carries some legally prescribed level of contingency fuel [36] for unplanned events, such may not be sufficient for extensive re-routings. Additional fuel may be required again, possibly, at the expense of payload capability.

Based on historic experience it is possible to, seasonally dependent, model the risk of needing to carry additional fuel. Since such weather effects do not affect the take-off capability, the correction for additional fuel translated directly into a reduction of the supply capability.

13.4 Cargo

The research has been focussed on the aircraft passenger payload capability between a payload range limited cities pair, with the ability to always carry a full load of passengers not guaranteed throughout an annual cycle. Consequently, passengers being prioritized over cargo normally, the aircraft is not capable of carrying cargo year round. Conversely, though, during other periods of the annual cycle, the aircraft is quite capable of carrying more than a full passenger load, of carrying cargo. To illustrate, the sinusoidal modelling of Figure 56 is reproduced in Figure 80. Figure 80 shows load factor capability as a percentage of the maximum number of passenger seats, without capping the graph at 100%.

Up to 5% above the payload equivalent to a full passenger load can at times be carried additionally as cargo. Expressed as a percentage of Maximum Take-Weight this equates to a relatively minor 0.5% during the most favourable winds. However, where passenger demand is lower, more cargo may well be added instead. There may well be seasonal demand for cargo carrying capability, such as perishables.

Determining the cargo capability as part of the Monte Carlo simulation is straightforward, being the difference between the predicted total payload capability (at the preferred probability level) and the predicted demand for the day. Since passengers remain prioritized over cargo, the cargo capability necessarily needs to be treated on a “standby” basis. Nevertheless, a prior knowledge of cargo potential is of value for planning purposes.

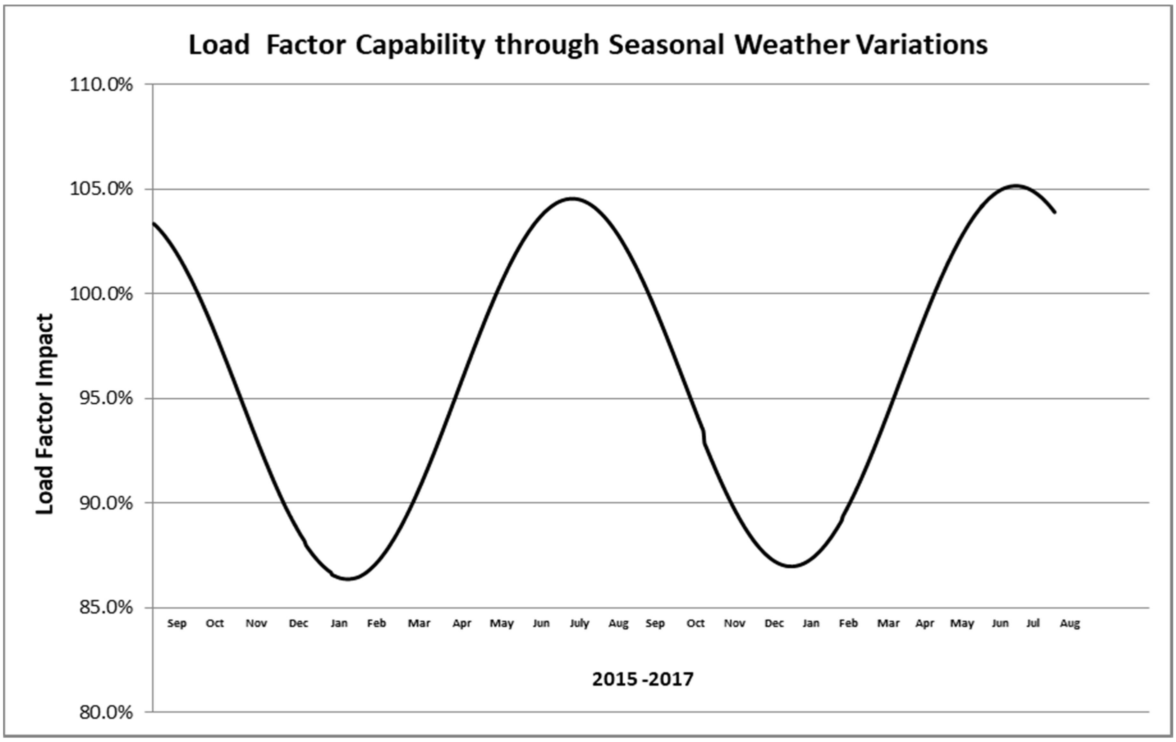

Figure 80 Seasonal Weather Variation Impact on Load Factor Capability

14 SUMMARY: BUILDING AND APPLYING THE FORECASTING MODEL

14.1 Payload Range Capability

The fundamental aim of this forecasting model is to predict the payload capability of the aircraft to operate on a chosen city pair, with due consideration to weather effects influencing performance. Where the aircraft is capable of transporting a full payload (passengers or passengers plus cargo) throughout the annual cycle without payload restrictions, no forecasting requirements exist. Supply remains at 100%. An understanding of whether the aircraft intended to be operated on a chosen city pair can become payload range limited, payload needing to be traded for fuel to be able to complete the mission, is prerequisite.

14.2 Fuel Requirements

A necessary first step is to determine the fuel requirements to operate the aircraft between the intended city pair, along the route or routes suitable for the flight, exposed to varying environmental conditions. This research has shown that, for very long routes, where the effects of localized weather phenomena are not significantly influential versus the more global weather patterns to which the flight is exposed, the average wind component for the flight predicts fuel requirements essentially exclusively:

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 \overline{WC}} \tag{43}$$

The aircraft type flown along a fixed route (distance) determines the value of the constants. It must be noted that, absent of further research, equation (43) can only be applied to long-range aircraft operating at the limits of their payload range capability. For a medium range (single-aisle) aircraft having a payload range limit of, say, four to five hours flying time, it cannot be assumed that the average wind component along the route remains sufficiently descriptive to be used as the singular predictor for trip fuel requirements.

Since the intent is to predict maximum payload capability for given circumstances, equation (43) is necessarily based on a departure at maximum take-off weight capability of the aircraft. To derive the various constants for equation (43), commercially available flight planning systems can be used to extract sufficient numbers of operational flight plans, per route, with varying average wind components. From these operational flight plans, the required climb fuel, trip (cruise) fuel, descent fuel can be determined, to apply to equation (43). One now has a predictor for trip fuel requirement with the average wind component as the only independent variable.

Since take-off is assumed at maximum take-off weight in each instance, the various required reserve / contingency / alternate fuel amounts remain sufficiently constant. From the total fuel requirements at any given average wind component, payload capability can then be calculated.

It must be noted that establishing the parameters for equation (43) remains a once-off exercise, as long as the same aircraft type is operated along the same route. Once the constants in equation (43) have been established, the equation can be applied going forward. This in itself constitutes a noticeable improvement over the current approach of calculating numerous operational flight plans every half year.

It must further be noted that, since flying for maximum range, the fuel requirements are those applicable to a cost index close to or at zero. A significant change in cost index flown (should fuel prices decrease substantially) requires the constants for equation (43) to be re-established.

14.3 Average Wind Components

To apply equation (43) requires knowledge of the average wind components on a daily basis. Invariably, the most recent historic data is required to predict the next six to twelve months. The research has shown that the average wind component is cyclical annually, and can be modelled as such using a sinusoidal profile. However, the data also exhibited a relatively minor longer term trend, attributable to changes in climatic patterns. With climate change occurring over extended periods, the available data was insufficient to model the long term trend.

Instead, a proxy linear variation was established over a two year period, to project to the third year. For the predominant route outbound, the effect was a 0.88 kts change per annum over the period 2015 to 2017. It cannot be assumed that this annual change continues linearly into the future. A continuous re-evaluation is required. The research indicated that the cyclical plus long term trend of the average wind component can be modelled by:

$$\overline{WC} = k_a \sin\left(\pi\left(\frac{n_c+k_z}{180}\right)\right) + \frac{k_{av}\,(n_c - k_c)}{365} + k_0 \qquad (67)$$

In this instance, the constants are dependent on the route flown. The independent variable is calendar day n_c. To establish the constants and the annual long term trend requires at least two years of daily average wind component data, preferably more. This should minimise the randomness in the long term trend that may misrepresent the trend for a smaller data set of just one year. To optimise equation (67) the constants are adjusted so as to maximise the correlation, R-Squared, with the underlying data.

An alternative, simpler approach could be to utilize the last twelve months of data, the minimum required to determine a complete cycle, to predict the next twelve months, without any consideration for the relatively minor long term trend. Equation (67) then reduces to:

$$\overline{WC} = k_a \sin\left(\pi(\frac{n_c + k_z}{180})\right) + k_0 \tag{82}$$

Equation (81) unquestionably becomes easier to optimise especially if the intent is to review the payload capabilities more frequently (e.g. monthly versus half-yearly). In this case the data should be continuously restricted to the last twelve months to minimise the impact of long term variations.

Nonetheless, this simplified approach can result in a potential loss of accuracy: Using the 0.88 kts change in average wind component as an example, and applying this value to equation (43), would result in 0.06% of MTOW decrease in trip fuel requirements, from one year to the next, about the equivalent of two passengers.

14.4 Monte Carlo Modelling

So far it has been established how to model:

- The fuel requirements as a function of average wind component
- The daily mean value of the average wind component as a function of calendar days

Erratically, the actual daily average wind component varies around the mean sinusoidal pattern. Here-in lies the uncertainty of the actual conditions experienced on any given day. The variances around the mean require modelling, to be able to assess the likelihood / risk associated with such variances.

Here, Monte Carlo simulation using random numbers becomes a powerful tool to model the distribution of average wind component around the mean determined from equations (68) or (81). From the average wind component distribution the fuel requirement distribution and thereafter the payload capability distribution can be determined on a daily basis.

Independently and concurrently, the expected daily passenger loads (average and variance) can similarly be modelled through a Monte Carlo simulation. Ideally, the projections from the airline’s yield management system should be utilized. Alternatively, the previous 12 months actual passenger loads, adjusted for expected growth, can be utilized to project for the next twelve months.

Having modelled supply (payload capability) and demand (expected number of passengers), the actual risk of supply being unable to meet demand can be determined on a daily basis. Such risk may be acceptably low enough to not need to restrict booking levels at all, as was seen during this research. Alternatively, based on a level of risk deemed acceptable of denied boarding, respectively of not selling seats, booking levels could be restricted if necessary.

The Monte Carlo simulation provides full flexibility for the planners to choose the acceptable risk levels and to intervene accordingly, rather than restricting supply (payload) based on a predetermined probability level, with no consideration of expected demand. Further, rather than supply (payload) being restricted at a fixed level for a full month, as currently happens, the airline's commercial department can entice passengers away from peak demand flights, knowing that the flight before / after the peak demand flight have capacity available. Demand varies seasonally but also by day of the week.

14.5 Continuous Forecasting

Currently, payload memoranda are established on a half-yearly basis, for the next twelve months. Once the model is build, from the supply side, only the average wind component requires updating, followed by re-optimization of either equation (68) or equation (82). Consequently, the model lends itself to usage that is far more frequent (e.g. monthly).

The yield management systems used by airlines continuously update their projections up to the date of departure, based on actual booking patterns leading up the day of operation. Accordingly, there is merit in re-calculating the forecasting model frequently, to re-assess the risk of denied boarding, respectively of unsold seats, to intervene as necessary / appropriate.

Applied consistently and repetitively, the number of denied boardings / unsold seats can thus be minimized. Only the residual risk of an excessive outlier of average wind component on any given day remains.

15 CONCLUSION

The aim of this research was to establish an improved dynamic forecasting methodology that minimises the risk of unfilled seats, respectively of denied boardings. This has been achieved. More than that, rudimentary forecasting using monthly average environmental conditions to restrict payload, whether necessary or not, is replaced by Monte Carlo simulation of both supply (payload capability) and demand. Specifically:

- Rather than pre-imposing a probability level to the payload capability predictions it is now possible to assess the risk of demand exceeding supply on a daily basis.
- Rather than imposing payload restrictions for a full month at a time, payload restrictions are now only necessary where the risk of demand exceeding supply surpasses any risk level specifically chosen post analysis.
- Rather than risking blocking seats unnecessarily, the process can now be managed on a daily basis, including enticing passengers to fly before or after any payload critical flights.
- Rather than determining payload restrictions every half year, the circumstances can be repeatedly re-assessed as any day of flight approaches.

The risk of flying empty seats respectively of denied boarding has been reduced to the risk of having an occasional outlier in environmental conditions. Fundamentally, the forecasting model developed here allows for scenario planning.

During the analysis of operational flight plans it was discovered that trip fuel requirements are exclusively predictable by the average wind component for a given route, at a correlation of over 98%. For this to hold, the route must be primarily influenced by global weather patterns rather than localised weather phenomena.

Rather than continuously evaluating operational flight plans, trip fuel requirements are now determined from a formula, simplifying the forecasting processes substantially. Such a formula needs to only be established once for a given aircraft type flying a particular route.

16 FURTHER RESEARCH

An unexpected but welcome finding from this research was the discovery that average wind component becomes the singular predominant predictor of trip fuel requirements for a given ultra-long range route and aircraft type. Having a representative equation with only one independent variable to predict fuel requirements for forecasting significantly simplifies any modelling processes. Such an equation, once established, eliminates having to continuously calculate full operational flight plans in each instance.

This unique predictability of fuel requirements is partly driven by the operational flight plans produced by commercially available flight planning systems, which seek to optimise each flight according to the expected enroute environmental conditions. Such is achieved by planning each flight at optimum flight levels and optimum speed schedules for a given cost index, respectively when flying for maximum range (Cost Index = 0).

16.1 Different Aircraft Type

To confirm the veracity of the principle established here the analysis should be repeated for a different aircraft type capable of operating along the same route. This was not done as part of this study purely due to the lack of alternative aircraft types (and the corresponding data) capable of flying the route available to the airline.

To achieve this comparison, the analysis presented in chapter 6.4 needs to be repeated, specifically Figure 21, except this can be restricted to the primary route, Route 1. Route 2 and 3 yielded identical results, other than the factor k_{2_i}in equation (40) changing due to the difference in distance flown, as had been demonstrated in chapter 6.4. A different aircraft type will therefore have a different k_{2_i}as the still air fuel requirement. The factor k_3, which remains identical for all three routes, will change for a different aircraft type. Consequently, only 24 flight plans are required to establish the parameters for the cruise phase of flight:

$$Cruise\ Fuel_i = k_{2_i} e^{k_3 WC} \tag{40}$$

In chapter 6.4, 24 data points sufficed to achieve a correlation coefficient of around 99%.

16.2 Different Routing

The particular routing under study in this research extend over 7000 nm and is thus transcontinental / transoceanic, covering around a third of the earth's circumference. As such, the three outbound routes are dominated by global weather patterns of both hemispheres rather than by localised weather phenomena. Further, the outbound routes have both a northerly and westerly component, with fuel performance thus influenced by several jet streams along the way. A predominantly north- / southbound routing, on the other hand, would not be significantly influenced by jetstreams, as evidenced by flying times northbound versus southbound differing only by minutes rather than hours. Despite jetstreams meandering, their general direction is mostly near perpendicular to a north – south trajectory. This does not imply that the same dependence on average wind component does not exist, merely that the variations in average wind component are minimal in comparison.

Conversely, the effect of jetstreams on flying times amplifies as trajectories become more east-west orientated. Therefore, a different routing of similar length in a predominantly easterly / westerly direction should be analysed along the same principles as done in chapter 6. Such a route would still be exposed to the effects of jet streams, which still meander and seasonally shift geographically.

Such an analysis would, however, eliminate any potential averaging effect of being exposed to differing seasons during one flight, from summer to winter, from spring to autumn and vice versa. Rather, an analysis of a predominantly westerly routing would show up whether seasonal temperature variations and varying tropopause levels would change the level of near-unique dependence on average wind component observed in this study.

Whilst the high dependence on average wind component is expected to remain, given that this was already demonstrated when flying north-westerly trajectories, it may become necessary to add dependent variables. The ultimate purpose here would be to establish whether seasonal temperature variations are sufficiently influential to have to be considered additionally to the average wind component.

A predominantly pure westerly flight into prevailing headwind conditions exposed to the seasonality of only one hemisphere may well affect the same aircraft type differently. Further, westerly routes should be studied at different latitudes. The variation in seasonal temperatures and tropopause levels are far more marked closer to the poles than to the equator.

16.3 Different Distances

This particular study focused on an ultra-long range routing covering a distance of approximately one third of the earth circumference. The resultant near exclusive dependence on the average wind component for fuel requirements in cruise is attributable to the flight being predominantly influenced by global weather patterns rather than localized weather effects. Consequently, it is expected that, as routes become shorter, such a unique dependence could diminish. Localized weather effects become more influential relative to global weather patterns and may well affect the unique dependence on average wind component.

However, attempting to consider localized weather phenomenon creates its own unique challenges. Whilst the forecasting of global enroute winds and temperatures is well established and reliable, as discussed in chapter 3.18, the forecasting of localized weather phenomena, such as thunderstorm activities, requiring deviation from the planned route is not sufficiently detailed to even find consideration for day to day operational flight plans. Precisely for this reason aircraft are still required to carry contingency fuel as explained in chapter 3.18. Rather, forecasting of localized weather phenomena is area focused rather than route or location (airport) focused, providing estimated coverage, horizontally and vertically, for the given area. Prior to flight on the day of operation, neither the flight planer nor the flight crew will know the exact location of any thunderstorm activities that may affect the flight.

As a starting point, to assess the impact of average wind component with distance, the same routing as for this study could be utilized. More specifically, route 1 could be split into ever shortening cruise segments, with each segment assessed separately, as done in chapter 6.3 and 6.4, for the dependence on average wind component. To further enhance the veracity of the results this could be done in two ways: keeping the first cruise waypoint fixed and reducing the distance flown from the last cruise waypoint backwards, or vice versa. Appendix 8 provides the necessary data.

Such an analysis will alter both factors $k_{2_i}$and k_3 from equation (40), due to the change in distance flown and different fuel consumption resulting in different weight ratios respectively, as expected from the discussions in chapters 3.11 and 6.10. Keeping the last cruise waypoint fixed and shortening the distances from the start will further enhance the analysis as different initial weights are considered, even if the ratios of initial to final weights in cruise remain similar to the first case. Nevertheless, it remains possible to assess the correlation coefficient of the exponential trend line fitted to the data set, to establish whether there is a decrease in correlation.

16.4 Effect of Weight

The analysis in this research assumed take-off at maximum take-off weight in each instance. To enhance the forecasting capability the analysis of chapters 6.3 and 6.4 could be repeated at different weights. The aim of such research would be to establish whether cruise fuel could be determines from a combined empirical function of average wind component (WC) and take-off weight (TOW):

$$Cruise\ Fuel_i = F(WC, TOW) \tag{83}$$

16.5 Different Operating Spectrum

This study focused on an aircraft type specifically designed for long to ultra-long operations. The wing design of such an aircraft is optimised for transonic flight as discussed in chapter 6.7. The take-off / climb and approach / landing phases of flight typically only constitute less than 10% of total flight time. Efficiency requirements for cruise override to achieve the maximum range capability.

Single aisle transport aircraft, on the other hand, are designed to cater for closely located city pairs, with the cruise phase of flight at times being measured in minutes rather than hours. Consequently, this category of aircraft has a different focus on wing design. This is evident in that single aisle aircraft typically cruise at speeds of M 0.74 to M 0.78, versus the M 0.82 to 0.86 for long range aircraft. Here one would, for example, expect more of an adjustment of Mach number with wind effects, as discussed in chapters 3.10 and 6.7.

Nevertheless, despite being designed for frequent take-offs and landings, derivatives from these single aisle families of aircraft are infringing on transcontinental capability with, for example, the A321LR with new generation engines having a 4000 nm range capability. It is therefore instructive to similarly analyse such aircraft on payload range limited routes, such as, for example, between Europe and Eastern North America.

16.6 Changing Weather Patterns

History does not necessarily repeat itself. Yet historical data constitutes the essence of forecast modelling. Albeit relatively small, the data available for this research indicated the presence of a shift in wind patterns, seemingly decreasing in magnitude with time. Such shifts in wind patterns are likely attributable to long to very long climate change effects.

In chapter 3.18 the accuracy of short term forecasting, eighteen to twenty-four hours prior to the planned time of arrival at destination, was demonstrated to be more than adequate, given that flights are operated with a 3% to 5% contingency fuel allowance. It cannot be inferred though, that longer term forecasting, a year in advance, yields similar levels of accuracy. Short term wind and temperature forecasting relies predominantly on the most recent data preceding a flight.

As discussed in chapter 8.1, changes in large scale weather patterns arise primarily from climate change. The dominant view, historically, has been that climate change occurs over tens of millennia or more. More recently though, unequivocal geological evidence accumulated over the last few decades revealed that climate change can occur more abruptly, over periods of decades and even years. Nonetheless, the available data for this research, seven half years April to September, proved inconclusive. The depth of wind data available did not suffice to establish any long term pattern. Rather than ignoring the change entirely, though, a proxy linear modelling of the trend was applied during the research.

Such approximations may well suffice when applied to two to three years' worth of wind data, but this then invariably restricts the amount of data that can be used, which has other implications: the standard deviation calculated from the variance around the mean may not be as refined, impacting the Monte Carlo simulated probability distribution of wind patterns around the mean.

An analysis of the long term trends then requires, at a minimum, ten full years of data. More likely though, several decades of data are required to differentiate between the long term trend and short term variations, in climatic terms, around the mean.

Further complicating such an analysis is that it cannot be assumed that long term trends are uniform for all regions of the world. Analysing routes individually becomes cumbersome, however. Rather it seems that here a encompassing long term modelling of the global weather pattern trends is needed, from which the impact for individual routes can then be derived. Such an approach would likely require substantive computing power.

17 POTENTIAL OF THIS RESEARCH

This research was aimed at exploring and demonstrating a more effective approach to forecasting payload capability along payload limited routes than the current methodology in use. In the process the research yielded an important finding: Cruise fuel requirements, at least for very long range flights, can be predicted virtually exclusively by the average wind component experienced along the route. This simplifies the forecasting process significantly.

Further, when combined with expected loads the improved forecasting was advanced into scenario planning using Monte Carlo simulations. Compared to the current rudimentary capability forecasting methodology based on monthly average winds at a pre-determined probability level, the scenario planning allows for a daily assessment of the probability of supply exceeding demand, at any chosen probability level during the analysis, not before.

A further refinement potential here is to initially allow for a high risk approach, thus minimising blocking off of seats half a year before flight, then refining this continuously up to the date of flight, as both supply and demand projections become more accurate. Leading up to the actual date of flight, the combined data of expected demand from the airline's yield management system and the expected improved accuracy of wind data translated into capability (supply) allows for a continuous refinement and reassessment. In fact, risk based decision making replaces the once-off fixed risk coarse predictions half a year or more in advance. Such an approach requires repeated application of the model described in chapter 14, through updating the basic parameters, expected passenger load and average wind component.

Further, such a scenario planning approach has further potential for any airline. When incorporating equation (82) suggested in chapter 16.4 to be derived from further research, the expected demand combined with the expected fuel requirement (from the average wind component and required take-off weight) allows for the matching of revenue and associated fuel cost during budgeting processes. The airline would have a better forecast of its profit potential. This too can be continuously refined leading up to a date of flight, which further assists with cash flow planning.

Still further, such scenario planning is not limited to existing routes. New routes can be assessed as to their viability based on expected demand and the associated matched cost of operation. Here, the scenario planning would be focused slightly differently. The sensitivity to varying passenger demand would be the primary focus to establish the potential of any route so analysed.

18 REFERENCES

[1] Filippone, A. Comprehensive analysis of transport aircraft flight performance. (2008) Progress in Aerospace Sciences, 44 (3), pp. 192-236.

[2] McIntyre, Ron Adverse impact of flight management systems on long range international airline operations. (1996) AIAA/IEEE Digital Avionics Systems Conference - Proceedings, pp. 359-363.

[3] Airbus Flight Operations Support & Line Assistance, Getting to Grips with Cost Index (1998) Issue II

[4] Nangia, R.K., Blake, W., Zeune, C. Relating & comparing operating efficiencies of civil aircraft & military transports (jets & turbo-props). (2010) 27th Congress of the International Council of the Aeronautical Sciences 2010, ICAS 2010, 1, pp. 244-263.

[5] Flouris, T., Rationalizing Aircraft Performance Dynamic Modelling in Airline Fleet Planning Decisions. (2010) Macrothink Institute, Journal Enterprise Risk Management ISSN 1937-7916 2010, Vol. 1, No. 1: E3.

[6] Justin, C.Y., Mavris, D.N. Aircraft and engine economic evaluation for fleet renewal decision-making and maintenance contract valuation. (2015) Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 229 (11), pp. 2051-2055.

[7] Filippone, A. Theoretical framework for the simulation of transport aircraft flight. (2010) Journal of Aircraft, 47 (5), pp. 1679-1696.

[8] Xiao, Y., Zhao, Q., Kaku, I., Xu, Y. Development of a fuel consumption optimization model for the capacitated vehicle routing problem. (2012) Computers and Operations Research, 39 (7), pp. 1419-1431.

[9] Schultz, R.L. Fuel optimality of cruise. (1974) Journal of Aircraft, 11 (9), pp. 586-587.

[10] Speyer, J.L. On the fuel optimality of cruise (1973) Journal of Aircraft, 10 (12), pp. 763-765.

[11] Vankan, W.J., Kesseler E. and Laban M., Multi-objective Optimisation of Aircraft Range and Fuel Consumption. (2007) National Aerospace Laboratory NLR, NLR-TP-2007-522.

[12] Park, Y. O'Kelly, M.E. Fuel burn rates of commercial passenger aircraft: Variations by seat configuration and stage distance. (2014) Journal of Transport Geography, 41, pp. 137-147.

[13] Swan, W.M., Adler, N. Aircraft trip cost parameters: A function of stage length and seat capacity. (2006) Transportation Research Part E: Logistics and Transportation Review, 42 (2), pp. 105-115.

[14] Givoni, M., Rietveld, P. Airline's choice of aircraft size - Explanations and implications. (2009) Transportation Research Part A: Policy and Practice, 43 (5), pp. 500-510.

[15] Chang, R.C., Lan, C.E., Su, S.-J. The fuel conservation study for a transport aircraft from performance prediction. (2007) Hangkong Taikong ji Minhang Xuekan/Journal of Aeronautics, Astronautics and Aviation, 39 A (4), pp. 275-282.

[16] Chang, R.C. Examination of excessive fuel consumption for transport jet aircraft based on fuzzy-logic models of flight data. (2015) Fuzzy Sets and Systems, 269, pp. 115-134.

[17] Chang, R.C., Tan, S. Post flight analysis based on QAR in FOQA program for jet transport aircraft part I: angular position monitoring of flight control surface. (2012) Journal of Aeronautics, Astronautics and Aviation, Series A, 44 (1), pp. 9-16.

[18] Klein, V. Estimation of aircraft aerodynamic parameters from flight data. (1989) Progress in Aerospace Sciences, 26 (1), pp. 1-77.

[19] Franco, A., Rivas, D. Analysis of optimal aircraft cruise with fixed arrival time including wind effects. (2014) Aerospace Science and Technology, 32 (1), pp. 212-222.

[20] Collins, Bela P. Estimation of aircraft fuel consumption. (1982) J AIRCR, V 19 (N 11), pp. 969-975.

[21] Martinez-Val, R., Perez, E., Cuerno, C., Palacin, J.F. Cost-range trade-off of intermediate stop operations of long-range transport airplanes. (2013) Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 227 (2), pp. 394-404.

[22] Poll, D.I.A. On the effect of stage length on the efficiency of air transport. (2011) Aeronautical Journal, 115 (1167), pp. 273-283.

[23] Singh, V., Sharma, S.K. Fuel consumption optimization in air transport: a review, classification, critique, simple meta-analysis, and future research implications. (2015) European Transport Research Review, 7 (2), 24 p.

[24] Torenbeek, E. Cruise performance and range prediction reconsidered. (1997) Progress in Aerospace Sciences, 33 (5-6), pp. 285-321.

[25] Torenbeek, Egbert, Wittenberg, Hans Generalized maximum specific range performance. (1983) Journal of Aircraft, 20 (7), pp. 617-622.

[26] Menon, P.K.A. Study of aircraft cruise. (1989) Journal of Guidance, Control, and Dynamics, 12 (5), pp. 631-639.

[27] Rivas, D., Lopez-Garcia, O., Esteban, S., Gallo, E. An analysis of maximum range cruise including wind effects. (2010) Aerospace Science and Technology, 14 (1), pp. 38-48.

[28] Cavcar, M. Bréguet range equation. (2006) Journal of Aircraft, 43 (5), pp. 1542-1544

[29] Cavcar, A. Constant altitude-constant Mach number cruise range of transport aircraft with compressibility effects. (2006) Journal of Aircraft, 43 (1), pp. 125-131.

[30] Aircraft Motion Group of EDSU. Approximate methods for estimation of cruise range and endurance: aeroplanes with turbo-jet and turbo-fan engines. (1982) Engineering Sciences Data Unit, Data Items.

[31] Cavcar, M., Cavcar, A. Comparison of generalized approximate cruise range solutions for turbojet/fan aircraft. (2003) Journal of Aircraft, 40 (5), pp. 891-895.

[32] Cavcar, A., Cavcar, M. Approximate solutions of range for constant altitude - Constant high subsonic speed flight of transport aircraft. (2004) Aerospace Science and Technology, 8 (6), pp. 557-567.

[33] Bert, Charles W. Prediction of range and endurance of jet aircraft at constant altitude. (1981) Journal of Aircraft, 18 (10), pp. 890-892.

[34] Rivas, D., Valenzuela, A. Compressibility effects on maximum range cruise at constant altitude. (2009) Journal of Guidance, Control, and Dynamics, 32 (5), pp. 1654-1658.

[35] Torenbeek, E. Unified cruise performance. (2013) Aerospace Series, pp. 363-391.

[36] Airbus Flight Operations Support & Line Assistance, Getting to Grips with Performance (2002)

[37] Padilla, C.E. (Book) Optimizing Jet Transport Efficiency: Performance. (1996) Optimizing Jet Transport Efficiency.

[38] Valenzuela, A., Rivas, D., Francoz, A. Cruise optimization using trajectory patterns. (2010) 10th AIAA Aviation Technology, Integration and Operations Conference 2010, ATIO 2010, 2.

[39] Valenzuela, A., Rivas, D. Optimization of aircraft cruise procedures using discrete trajectory patterns. (2014) Journal of Aircraft, 51 (5), pp. 1632-1640.

[40] Ackert, Shannon, Aircraft Payload Range Analysis for Financiers. (2013) Aircraft Monitor

[41] Martinez-Val, Rodrigo, Perez, Emilio, Munoz, Tomas, Cuerno, Cristina Design constraints in the payload-range diagram of ultrahigh capacity transport airplanes. (1994) Journal of Aircraft, 31 (6), pp. 1268-1272.

[42] Martinez-Val, R., Palacin, J.F., Perez, E. The evolution of jet airliners explained through the range equation. (2008) Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 222 (6), pp. 915-919.

[43] Martinez-Val, R., Roa, J., Perez, E., Cuerno, C. Effects of the mismatch between design capabilities and actual aircraft utilization. (2011) Journal of Aircraft, 48 (6), pp. 1921-1927.

[44] Martinez-Val, R., Perez, E., Cuerno, C., Palacin, J.F. Cost-range trade-off in the design and operation of long range transport airplanes. (2010) 27th Congress of the International Council of the Aeronautical Sciences 2010, ICAS 2010, 1, pp. 264-271.

[45] Martínez-Val, R., Pérez, E., Palacín, J.F. Historical evolution of air transport productivity and efficiency. (2005) 43rd AIAA Aerospace Sciences Meeting and Exhibit - Meeting Papers, pp. 4665-4673.

[46] Nangia, R.K. Efficiency parameters for modern commercial aircraft. (2006) Aeronautical Journal, 110 (1110), pp. 495-510.

[47] Nangia, R.K., Zeune, C., Blake, W. Operating efficiency of military jet transports. (2009) 47th AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition, art. no. 2009-0044.

[48] Nangia, R.K., Zeune, C., Blake, W. Operating efficiency of military transports (Jets & Turbo-Props) & Comparisons with civil aircraft. (2010) 48th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition, art. no. 2010-0848.

[49] Filippone, A. Cruise altitude flexibility of jet transport aircraft. (2010) Aerospace Science and Technology, 14 (4), pp. 283-294.

[50] Hale, F.J., Steiger, A.R. Effects of wind on aircraft cruise performance. (1981) Journal of Aircraft, 18 (4), pp. 320-321.

[51] Hale, Francis J., Steiger, Arthur R. Effects of wind on aircraft cruise performance. (1979) Journal of Aircraft, 16 (6), pp. 382-387.

[52] Randle, W.E., Hall, C.A., Vera-Morales, M. Improved range equation based on aircraft flight data. (2011) Journal of Aircraft, 48 (4), pp. 1291-1298.

[53] Filippone, A. On the benefits of lower Mach number aircraft cruise. (2007) Aeronautical Journal, 111 (1122), pp. 531-542.

[54] John, J. E. A. Gas Dynamics. (1984) Library of Congress in Publication Data, 2nd edition

[55] Daudel, S. Vialle, G. Yield management: Application to air transport and other service industries. (1994) Institut du Transport Aérien, Paris

[56] IATA; International Air Transport Association Annual Review 2016 72nd Annual General Meeting Dublin, June 2016.

[57] http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cyc/upa/jet.rxml

[58] http://www.classzone.com/books/earth_science/terc/content/investigations/es1908/es1908page04.cfm

[59] Kroese, D. P.; Taimre, T.; Botev, Z.I. (2011). Handbook of Monte Carlo Methods. New York: John Wiley & Sons. ISBN 0-470-17793-4.

[60] Chinesta, F., Leygue, A., Ammar, A., Cueto, E. and Huerta, A. PGD Based Advanced Numerical Modelling of Materials and Processes. (2012) EPU.

[61] Chinesta, F., Leygue, A., Poitou, A., Advanced Simulation of Composite Manufacturing Processes (2011) World Scientific Review Volume - 9in x 6in

[62] Hanke, J.E. and Reitsch, A.G. Understanding Business Statistics (1994), Library of Congress in Publication Data, 2nd edition

[63] https://www.aviationweather.ws/076_The_Tropopause.php

[64] Chalia S. (June 2016), "Offset of Shock Location in Supercritical Airfoils", International Research Journal of Engineering and Technology 3 (6): pg. 24-29,

[65] Harris C. D. (1990), "NASA Supercritical Airfoil, A Matrix of Family Related Airfoils", NASA Technical Paper 2969

[66] NCSS Statistical Software (2018), available at *https://www.ncss.com*

[67] *David Roth (2013).* "Unified Surface Analysis Manual", Hydrometeorological Prediction Center, http://www.wpc.ncap.noaa.gov

[68] Alley R. B. et al, Committee On Abrupt Climate Change (2002), "Abrupt Climate Change: Inevitable Surprises", National Academy Press

[69] Douglas Hubbard "How to Measure Anything: Finding the Value of Intangibles in Business" pg. 46

[70] Hubbard D. and Samuelson D.A. (October 2009) "Modelling without Measurement", *OR/MS Today: 28–33.*

[71] *Kroese, D. P.; Brereton, T.; Taimre, T.; Botev, Z. I. (2014). "Why the Monte Carlo method is so important today". WIREs Comput Stat.* ***6****: 386–392. doi:10.1002/wics.1314.*

[72] Metropolis, Nicholas; Rosenbluth, Arianna W.; Rosenbluth, Marshall N.; Teller, Augusta H.; Teller, Edward (1953-06-01). "Equation of State Calculations by Fast Computing Machines". The Journal of Chemical Physics. 21 (6): 1087–1092. Bibcode:1953JChPh..21.1087M. doi:10.1063/1.1699114. ISSN 0021-9606.

[73] Hastings, W. K. (1970-04-01). "Monte Carlo sampling methods using Markov chains and their applications". Biometrika. 57 (1): 97–109. doi:10.1093/biomet/57.1.97. ISSN 0006-3444.

[74] Liu, Jun S.; Liang, Faming; Wong, Wing Hung (2000-03-01). "The Multiple-Try Method and Local Optimization in Metropolis Sampling". Journal of the American Statistical Association. 95 (449): 121–134. doi:10.1080/01621459.2000.10473908. ISSN 0162-1459.

[75] Martino, Luca; Read, Jesse (2013-07-11). "On the flexibility of the design of multiple try Metropolis schemes". Computational Statistics. 28 (6): 2797–2823. doi:10.1007/s00180-013-0429-2. ISSN 0943-4062.

[76] Kolokoltsov, Vassili (2010). Nonlinear Markov processes. Cambridge Univ. Press. p. 375.

[77] Del Moral, Pierre (2013). Mean field simulation for Monte Carlo integration. Chapman & Hall/CRC Press. p. 626. "Monographs on Statistics & Applied Probability"

[78] Markov process (mathematics) - Britannica Online Encyclopedia

[79] Metropolis, N. (1987). "The beginning of the Monte Carlo method". Los Alamos Science (1987 Special Issue dedicated to Stanislaw Ulam): 125–130.

[80] Eckhardt, Roger (1987). "Stan Ulam, John von Neumann, and the Monte Carlo method". Los Alamos Science, Special Issue (15): 131–137.

[81] Macrae, Norman (1992). John von Neumann: The Scientific Genius Who Pioneered the Modern Computer, Game Theory, Nuclear Deterrence, and Much More. Pantheon Press. ISBN 0-679-41308-1.

[82] Herman, Kahn; Harris, Theodore, E. (1951). "Estimation of particle transmission by random sampling". Natl. Bur. Stand. Appl. Math. Ser. 12: 27–30.

[83] Turing, Alan M. "Computing machinery and intelligence". Mind. LIX (238): 433–460.

[84] Barricelli, Nils Aall (1957). "Symbiogenetic evolution processes realized by artificial methods". Methodos: 143–182.

[85] McKean, Henry, P. (1967). "Propagation of chaos for a class of non-linear parabolic equations". Lecture Series in Differential Equations, Catholic Univ. 7: 41–57.

[86] McKean, Henry, P. (1966). "A class of Markov processes associated with nonlinear parabolic equations". Proc. Natl. Acad. Sci. USA. 56 (6): 1907–1911.

[87] Von Neumann, John (1951). "Various techniques used in connection with random digits". National Bureau of Standards Applied Mathematics Series. 12: 36–38

[88] Davenport, J. H. "Primality testing revisited". Proceeding ISSAC '92 Papers from the international symposium on Symbolic and algebraic computation: 123 129

[89] Sawilowsky, Shlomo S. (2003). "You think you've got trivials?". Journal of Modern Applied Statistical Methods. 2 (1): 218–225.

[90] Lymperopoulos, I., Lygeros, J. Sequential Monte Carlo methods for multi-aircraft trajectory prediction in air traffic management. (2010) International Journal of Adaptive Control and Signal Processing, 24 (10), pp. 830-849.

[91] Hurter, C., Alligier, R., Gianazza, D., Puechmorel, S., Andrienko, G., Andrienko, N. Wind parameters extraction from aircraft trajectories. (2014) Computers, Environment and Urban Systems, 47, pp. 28-43.

[92] Zheng, Q.M., Zhao, Y.J. Probabilistic approach to trajectory conformance monitoring. (2012) Journal of Guidance, Control, and Dynamics, 35 (6), pp. 1888-1898.

[93] Zou, X., Cheng, P., Cheng, N. A simulation model for airport runway capacity estimation. (2014) 17th IEEE International Conference on Intelligent Transportation Systems, ITSC 2014, art. no. 6958117, pp. 2669-2674.

[94] Pruis, M.J., Delisi, D.P. Comparison of ensemble predictions of a new probabilistic fast -time wake vortex model and lidar observed vortex circulation intensities and trajectories. (2011) 3rd AIAA Atmospheric Space Environments Conference,

[95] Holzäpfel, F., Kladetzke, J., Amelsberg, S., Lenz, H., Schwarz, C., De Visscher, I. Aircraft wake vortex scenarios simulation package for take-off and departure. (2009) American Institute of Aeronautics and Astronautics Journal of Aircraft Issue 46 (2) pp 713-717.

[96] Lefebvre, S., Allassonnière, S., Jakubowicz, J., Lasne, T., Moulines, E. Aircraft classification with a low resolution infrared sensor. (2013) Machine Vision and Applications, 24 (1), pp. 175-186.

[97] Vanek, B., Péni, T., Zarándy, Á., Bokor, J., Zsedrovitsk, T., Roska, T. Performance characteristics of a complete vision only sense and avoid system. (2012) AIAA Guidance, Navigation, and Control Conference 2012,

[98] Wilhite, A.W., Gholston, S.E., Parrington, P.A., Swain, J.J. Evaluating technology projections and weight prediction method uncertainty of future launch vehicles.(2008) American Institute of Aeronautics and Astronautics Journal of Spacecraft and Rockets Issue 45 (3) pp 587-591.

[99] Pinier, J.T. Asymmetric uncertainty expression for high gradient aerodynamics. (2012) 50th AIAA Aerospace Sciences Meeting Including the New Horizons Forum and Aerospace Exposition, art. no. AIAA 2012-0081,

[100] Bjorkman, E.A., Sarkani, S., Mazzuchi, T.A. Using model-based systems engineering as a framework for improving test and evaluation activities. (2013) Systems Engineering, 16 (3), pp. 346-362.

[101] Nikbay, M., Acar, P. Flutter based aeroelastic optimization of an aircraft wing with analytical approach. (2012) Collection of Technical Papers - AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, art. no. AIAA 2012-1796,

[102] Zhao, H., Xu, X., Zhang, J., Zhu, Y., Yang, C., Hong, S. Lateral flight technical error estimation model for performance based navigation. (2011) Chinese Journal of Aeronautics, 24 (3), pp. 329-336.

[103] Zhao, H.-S., Xu, X.-H., Zhang, J., Zhu, Y. Comparison study of lateral flight technical error due to turbulence in performance based navigation. (2012) CICTP 2012: Multimodal Transportation Systems - Convenient, Safe, Cost-Effective, Efficient - Proceedings of the 12th COTA International Conference of Transportation Professionals, pp. 1915-1923.

[104] Li, F., Jun, Z., Rui, L. Real-time total system error estimation: Modelling and application in required navigation performance. (2014) Chinese Journal of Aeronautics, 27 (6), pp. 1544-1553.

[105] Kulkarni, C., Biswas, G., Kim, K., Bharadwaj, R.M. Model-based avionics systems fault simulation and detection. (2010) Technical Program for the MFPT 2010 Conference - Transition: From R and D to Product, 37 p.

[106] Pattabhiraman, S., Kim, N.H., Haftka, R.T., Ross, R. Modelling average maintenance behaviour of fleet of airplanes using fleet-MCS. (2010) AIAA Infotech at Aerospace 2010, art. no. 2010-3400,

[107] Varela, J.A.G., Study of probabilistic approach for structural health assessment of aerospace structures. (2011) Master Thesis, The University of Texas at El Paso.

[108] Müller, M., Staudacher, S., Friedl, W.-H., Köhler, R., Weißschuh, M. Probabilistic engine maintenance modelling for varying environmental and operating conditions. (2010) Proceedings of the ASME Turbo Expo, 6 (PARTS A AND B), pp. 629-638.

[109] Lewis, T.L., Quantitative approach to technical performance measurement and technical risk analysis utilizing Bayesian methods and Monte Carlo simulation. (2010) Doctoral Thesis, George Washington University.

[110] Doane, D.P. and Seward L.E., Measuring Skewness: A Forgotten Statistic? (2011) Journal of Statistical Education 19 (2).

[111] Flysmart with Airbus: Take-off Application

[112] http://www.worldweatheronline.com/

[113] http://www.weathersa.co.za/

19 ADDITIONAL READING

[114] Fermi, Enrique; Richtmyer, Robert, D. (1948). "Note on census-taking in Monte Carlo calculations". LAM. 805 (A). "Declassified report Los Alamos Archive"

[115] Hetherington, Jack, H. (1984). "Observations on the statistical iteration of matrices". Phys. Rev. A. 30 (2713): 2713–2719.

[116] *Rosenbluth, Marshall, N.; Rosenbluth, Arianna, W. (1955). "Monte-Carlo calculations of the average extension of macromolecular chains". J. Chem. Phys. 23: 356–359.*

[117] *Del Moral, Pierre (1996). "Non Linear Filtering: Interacting Particle Solution." (PDF). Markov Processes and Related Fields.* ***2*** *(4): 555–580.*

[118] Gordon, N.J.; Salmond, D.J.; Smith, A.F.M. (April 1993). "Novel approach to nonlinear/non-Gaussian Bayesian state estimation". Radar and Signal Processing, IEE Proceedings F. 140 (2): 107–113.

[119] Kitagawa, G. (1996). "Monte carlo filter and smoother for non-Gaussian nonlinear state space models". Journal of Computational and Graphical Statistics. 5 (1): 1–25.

[120] Del Moral, Pierre (1996). "Non Linear Filtering: Interacting Particle Solution." Markov Processes and Related Fields. 2 (4): 555–580.

[121] Del Moral, Pierre (1998). "Measure Valued Processes and Interacting Particle Systems. Application to Non Linear Filtering Problems". Annals of Applied Probability (Publications du Laboratoire de Statistique et Probabilités, 96-15 (1996) ed.). 8 (2): 438–495.

[122] Carvalho, Himilcon; Del Moral, Pierre; Monin, André; Salut, Gérard (July 1997). "Optimal Non-linear Filtering in GPS/INS Integration." (PDF). IEEE-Trans. on Aerospace and electronic systems. 33 (3).

[123] Crisan, Dan; Gaines, Jessica; Lyons, Terry (1998). "Convergence of a branching particle method to the solution of the Zakai". SIAM Journal on Applied Mathematics. 58 (5): 1568–1590.

[124] Crisan, Dan; Lyons, Terry (1997). "Nonlinear filtering and measure-valued processes". Probability Theory and Related Fields. 109 (2): 217–244.

[125] Crisan, Dan; Lyons, Terry (1999). "A particle approximation of the solution of the Kushner–Stratonovitch equation". Probability Theory and Related Fields. 115 (4): 549–578.

[126] Crisan, Dan; Del Moral, Pierre; Lyons, Terry (1999). "Discrete filtering using branching and interacting particle systems". Markov Processes and Related Fields. 5 (3): 293–318.

[127] Del Moral, Pierre; Miclo, Laurent (2000). Branching and Interacting Particle Systems Approximations of Feynman-Kac Formulae with Applications to Non-Linear Filtering. Lecture Notes in Mathematics. 1729. pp. 1–145.

[128] Del Moral, Pierre; Guionnet, Alice (1999). "On the stability of Measure Valued Processes with Applications to filtering". C.R. Acad. Sci. Paris. 39 (1): 429–434.

[129] Del Moral, Pierre; Guionnet, Alice (2001). "On the stability of interacting processes with applications to filtering and genetic algorithms". Annales de l'Institut Henri Poincaré. 37 (2): 155–194.

[130] Tracey, B., Wolpert, D., Alonso, J.J. Using supervised learning to improve Monte Carlo integral estimation (2013) AIAA Journal, 51 (8), pp. 2015-2023.

[131] Tracy, B., Using Supervised Learning to Improve Monte Carlo Integral Estimation. (2013) American Institute of Aeronautics and Astronautics Journal Vol 51, No. 8

[132] Akram, F., Prior, M.A. and Mavris, D.N. A comparison between Monte Carlo and Evidence Theory Approaches for Technology Portfolio Planning. (2011) American Institute of Aeronautics and Astronautics 2011-1412.

[133] Anderson, J. D., Fundamentals of Aerodynamics (1985).

[134] Biegler, L.T., Grossmann, I.E. Retrospective on optimization. (2004) Computers and Chemical Engineering, 28 (8), pp. 1169-1192.

[135] Black, A.W.R., Crossley, W.A., van Seeters, P. Investigations of perspectives for re-engining commercial transport aircraft. (2012) 12th AIAA Aviation Technology, Integration and Operations (ATIO) Conference and 14th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference.

[136] Ding, D., Zhang, Y. Improved fuel capacity estimation method. (2010) Journal of Aircraft, 47 (5), pp. 1798-1803.

[137] Kundu, Ajoy Kumar, Airplanes – Design and Construction. (2011) Cambridge University Press

[138] McDonald, R.A. Establishing mission requirements based on consideration of aircraft operations. (2013) Journal of Aircraft, 50 (3), pp. 741-751.

[139] Ohme, P., Raaby, C. A model-based approach to aircraft performance assessment. (2008) AIAA Atmospheric Flight Mechanics Conference and Exhibit, art. no. 2008-6873.

[140] Scheafer, M. Development of a Forecast Model for Global Air Traffic Emissions. (2012) Deutsches Zentrum fuer Luft und Raumfahrt Institut fuer Antriebstechnik, Forschungsbericht 2012-08

[141] Schittkowski, K. NLPQL: A Fortran subroutine solving constrained nonlinear programming problems. (1986) Annals of Operations Research, 5 (1-4), pp. 485-500.

[142] Schricker, B.C., Biglari, D., Luchner, T., Trotter, S.R., Cagle, J.P., Cole, J.M., Thomas, T. An overview of the Extended Range Multi-Purpose (ERMP) end-to-end simulation. (2010) Fall Simulation Interoperability Workshop 2010, 2010 Fall SIW, pp. 127-134.

[143] Schricker, B.C., Biglari, D., Luchner, T., Trotter, S.R., Cagle, J.P., Cole, J.M., Thomas, T. The current status and future vision of the Extended Range Multi-Purpose (ERMP) end-to-end simulation. (2010) Fall Simulation Interoperability Workshop 2010, 2010 Fall SIW, pp. 135-140.

[144] *Liu, J.S.; Chen, R. (1995). "Blind deconvolution via sequential imputations" (PDF). Journal of the American Statistical Association. Taylor & Francis Group. 90 (430): 567–576.*

APPENDIX 1. CLIMB FUEL AND DESCENT / APPROACH FUEL REQUIREMENTS FOR FLIGHT FROM HOME BASE

Period	Trip Fuel (excluding reserves) (% of MTOW	Climb Fuel (% of MTOW)	Descent Fuel (% of MTOW)	Cruise Fuel (% of MTOW)
JAN 50%	38.13%	2.14%	0.48%	35.51%
FEB 50%	37.55%	2.15%	0.48%	34.93%
MAR 50%	37.97%	2.13%	0.48%	35.36%
APR 50%	37.71%	2.14%	0.45%	35.12%
MAY 50%	37.52%	2.13%	0.47%	34.92%
JUN 50%	37.30%	2.15%	0.50%	34.65%
JUL 50%	36.87%	2.17%	0.48%	34.22%
AUG 50%	36.55%	2.17%	0.48%	33.91%
SEP 50%	37.01%	2.15%	0.49%	34.37%
OCT 50%	37.39%	2.14%	0.48%	34.76%
NOV 50%	38.10%	2.15%	0.48%	35.47%
DEC 50%	38.53%	2.17%	0.51%	35.85%
JAN 85%	38.32%	2.15%	0.47%	35.70%
FEB 85%	37.86%	2.15%	0.49%	35.22%
MAR 85%	38.13%	2.15%	0.45%	35.53%
APR 85%	37.91%	2.15%	0.46%	35.30%
MAY 85%	37.72%	2.14%	0.46%	35.11%
JUN 85%	37.43%	2.16%	0.50%	34.77%
JUL 85%	36.94%	2.15%	0.48%	34.31%
AUG 85%	36.68%	2.17%	0.48%	34.03%
SEP 85%	37.10%	2.15%	0.48%	34.46%
OCT 85%	37.63%	2.17%	0.48%	34.98%
NOV 85%	38.25%	2.17%	0.49%	35.59%
DEC 85%	38.69%	2.17%	0.48%	36.05%
Average		2.15%	0.48%	
Standard Deviation		0.01%	0.01%	

APPENDIX 2. WIND COMPONENT VARIATION ROUTE 1

Waypoint	June	July	August	September	October	November	December
EA	-50	-58	-59	-40	-41	-28	-32
EB	-47	-56	-56	-39	-39	-27	-31
EC	-51	-59	-60	-41	-42	-28	-32
ED	-37	-43	-39	-31	-29	-24	-26
EE	-32	-38	-33	-28	-25	-22	-23
EF	-29	-35	-28	-26	-21	-19	-21
EG	-27	-33	-26	-25	-20	-19	-19
EH	-26	-32	-24	-24	-19	-18	-18
EI	-23	-30	-21	-23	-18	-18	-16
EJ	-21	-28	-18	-21	-16	-17	-13
EK	-15	-22	-10	-17	-13	-14	-8
EL	-16	-19	-1	-11	-8	-13	-4
EM	-9	-16	4	-7	-5	-9	1
EN	-7	-13	6	-4	-3	-7	2
EO	-6	-11	2	-2	-2	-6	3
EP	-5	-9	3	0	-1	-5	4
EQ	-3	-5	9	4	3	-3	8
ER	1	6	13	9	6	0	10
ES	4	13	23	14	9	2	5
ET	8	14	23	14	9	1	2
EU	8	14	23	14	9	1	2
EV	11	17	24	16	8	-1	-1
EW	11	18	23	15	7	-3	-3
EX	8	14	16	9	6	-7	-4
EY	8	13	14	8	4	-11	-9
EZ	8	13	14	6	2	-15	-13
FA	6	13	13	4	-1	-19	-18
FB	5	12	13	2	-5	-24	-23
FC	2	13	14	2	-9	-31	-31
FD	0	12	14	0	-12	-35	-35
FE	-4	11	14	-3	-16	-39	-39
FF	-4	11	14	-3	-16	-39	-39
FG	-8	0	13	-6	-19	-41	-42
FH	-13	0	11	-8	-22	-42	-42
FI	-19	0	9	-11	-24	-42	-42
FJ	-27	2	5	-17	-27	-38	-41
FK	-28	-8	-3	-18	-26	-31	-38
FL	-21	-12	-12	-11	-24	-26	-39
FM	-12	-5	-10	-3	-23	-26	-47
FN	-12	-5	-10	-3	-23	-26	-47
FO	-12	-1	-5	-5	-24	-32	-58
FP	-18	-4	-2	-13	-26	-40	-68
FQ	-26	-11	-5	-24	-33	-47	-74
FR	-32	-26	-15	-36	-47	-64	-84
FS	-32	-26	-15	-36	-47	-64	-84
FT	-32	-26	-15	-36	-47	-64	-84
FU	-30	-36	-19	-34	-51	-67	-81
FV	-27	-27	-12	-23	-38	-51	-63
FX	-28	-27	-13	-23	-39	-51	-62

APPENDIX 3. WIND COMPONENT VARIATION ROUTE 2

Waypoint	December	January	February	March	April	May
AB	-35	-16	-13	-17	-27	-34
AC	-34	-15	-13	-16	-25	-32
AD	-36	-17	-13	-17	-28	-35
AE	-33	-15	-11	-14	-23	-30
AF	-30	-13	-9	-14	-22	-29
AG	-29	-12	-7	-13	-21	-29
AH	-28	-12	-7	-13	-21	-29
AI	-27	-11	-6	-13	-20	-29
AJ	-26	-10	-5	-12	-18	-27
AK	-24	-9	-4	-10	-16	-25
AL	-22	-8	-2	-9	-15	-25
AM	-23	-8	-2	-10	-15	-23
CN	-21	-8	2	-9	-16	-21
CO	-14	-6	5	-4	-11	-13
CP	-9	-4	7	1	-8	-11
CQ	-10	0	14	10	-4	-13
CR	5	6	14	9	5	0
CS	4	8	19	12	12	10
CT	-11	8	15	12	12	17
CU	-24	8	-5	-11	-1	17
CV	-24	8	-5	-11	-1	17
CW	-32	7	-17	-20	-9	12
CX	-34	3	-22	-24	-12	8
CY	-37	-7	-27	-29	-16	1
CZ	-38	-17	-33	-33	-19	-6
DA	-32	-17	-30	-28	-17	-13
DB	-39	-19	-47	-34	-30	-32
DC	-37	-21	-45	-34	-39	-42
DD	-40	-21	-44	-42	-49	-38
DE	-40	-24	-44	-42	-45	-38
DF	-47	-25	-41	-50	-42	-30
DG	-63	-25	-47	-60	-49	-29
DH	-73	-24	-54	-70	-49	-34
DI	-89	-24	-69	-81	-57	-52
DJ	-89	-24	-69	-81	-57	-52
DK	-85	-25	-70	-69	-56	-56
DL	-65	-26	-54	-49	-45	-45
DM	-65	-26	-54	-50	-44	-46

APPENDIX 4. STEP CLIMB SEASONAL VARIATION

OUTBOUND	MAR 50%	JUN 50%	SEP 50%	DEC 50%
Flight Level ('100 ft)	Weight (% of MTOW)	Weight (% of MTOW)	Weight (% of MTOW)	Weight (% of MTOW)
300	97.9%	97.8%		97.8%
320	93.8%	91.7%	97.8%	91.8%
340	86.0%	84.4%	84.5%	83.9%
360	79.7%	82.8%	83.8%	78.2%
380	67.1%	71.1%	72.9%	68.3%
400	65.6%	66.0%	66.3%	64.6%
400	62.5%	64.1%	63.0%	61.4%

RETURN	MAR 50%	JUN 50%	SEP 50%	DEC 50%
Flight Level ('100 ft)	Weight (% of MTOW)	Weight (% of MTOW)	Weight (% of MTOW)	Weight (% of MTOW)
310		96.7%	96.7%	
330	96.8%	94.5%	94.5%	96.9%
350	87.4%	86.5%	86.5%	87.4%
370	79.9%	76.9%	75.5%	80.5%
390	69.6%	70.9%	70.7%	70.0%
390	65.2%	65.0%	64.8%	65.8%

APPENDIX 5. CRUISE FUEL REQUIREMENTS ALONG OUTBOUND ROUTES

Season	Route 1		Route 2		Route 3	
	Wind Component (kts)	Cruise Fuel (%)	Wind Component (kts)	Cruise Fuel (%)	Wind Component (kts)	Cruise Fuel (%)
JAN 50%	-30	35.83%	-27	35.65%	-20	35.50%
JAN 85%	-34	36.11%	-30	35.82%	-23	35.68%
FEB 50%	-20	35.18%	-18	35.08%	-19	35.40%
FEB 85%	-23	35.39%	-20	35.25%	-20	35.55%
MAR 50%	-24	35.42%	-22	35.33%	-18	35.42%
MAR 85%	-27	35.61%	-24	35.52%	-21	35.53%
APR 50%	-22	35.23%	-18	35.11%	-17	35.38%
APR 85%	-25	35.46%	-21	35.30%	-20	35.48%
MAY 50%	-19	34.99%	-17	34.94%		
MAY 85%	-22	35.22%	-19	35.11%		
JUN 50%	-14	34.67%	-15	34.79%		
JUN 85%	-16	34.77%	-17	34.88%		
JUL 50%	-8	34.21%	-10	34.42%		
JUL 85%	-9	34.33%	-10	34.49%		
AUG 50%	-2	33.92%	-5	34.18%		
AUG 85%	-4	33.99%	-8	34.27%		
SEP 50%	-10	34.38%	-10	34.47%		
SEP 85%	-11	34.44%	-12	34.52%		
OCT 50%	-17	34.85%	-17	34.94%	-15	35.13%
OCT 85%	-19	34.96%	-19	35.05%	-16	35.27%
NOV 50%	-25	35.49%	-27	35.65%	-27	36.01%
NOV 85%	-27	35.59%	-28	35.80%	-28	36.11%
DEC 50%	-31	35.86%	-30	35.86%	-26	35.95%
DEC 85%	-34	36.10%	-32	36.05%	-28	36.07%

APPENDIX 6. VARIATION IN ISA DEVIATION

	January 50%			January 85%			
Waypoint	Flight Level ('100 ft)	Outside Air Temp (°C)	ISA DEV (°C)	Flight Level ('100 ft)	Outside Air Temp (°C)	ISA DEV (°C)	Difference in ISA DEV
AA	300	-32	12.4	300	-32	12.4	0.0
AB	300	-32	12.4	300	-31	13.4	1.0
AC	300	-32	12.4	300	-31	13.4	1.0
AD	300	-32	12.4	300	-31	13.4	1.0
AE	300	-32	12.4	300	-31	13.4	1.0
AF	300	-31	13.4	300	-31	13.4	0.0
AG	300	-31	13.4	300	-31	13.4	0.0
AH	300	-31	13.4	300	-31	13.4	0.0
AI	300	-31	13.4	300	-31	13.4	0.0
AJ	300	-31	13.4	300	-31	13.4	0.0
AK	300	-31	13.4	300	-31	13.4	0.0
AL	320	-36	12.4	320	-36	12.36	0.0
AM	320	-36	12.4	320	-36	12.36	0.0
AN	320	-36	12.4	320	-36	12.36	0.0
AO	320	-36	12.4	320	-36	12.36	0.0
AP	320	-36	12.4	320	-36	12.36	0.0
AQ	320	-36	12.4	320	-36	12.36	0.0
AR	320	-36	12.4	320	-36	12.36	0.0
AS	340	-42	10.3	340	-42	10.32	0.0
AT	340	-42	10.3	340	-42	10.32	0.0
AU	340	-42	10.3	340	-42	10.32	0.0
AV	340	-42	10.3	340	-42	10.32	0.0
AW	360	-48	8.3	360	-47	9.28	1.0
AX	360	-48	8.3	360	-47	9.28	1.0
AY	360	-48	8.3	360	-48	8.28	0.0
AZ	360	-48	8.3	360	-48	8.28	0.0
BA	360	-48	8.3	360	-48	8.28	0.0
BB	360	-48	8.3	360	-48	8.28	0.0
BC	360	-48	8.3	360	-48	8.28	0.0
BD	360	-48	8.3	360	-48	8.28	0.0
BE	360	-48	8.3	360	-48	8.28	0.0
BF	360	-48	8.3	360	-48	8.28	0.0
BG	360	-48	8.3	360	-48	8.28	0.0
BH	360	-48	8.3	380	-52	8.24	0.0
BI	360	-48	8.3	380	-52	8.24	0.0
BJ	380	-53	7.2	380	-52	8.24	1.0
BK	380	-53	7.2	380	-52	8.24	1.0
BL	380	-53	7.2	380	-52	8.24	1.0
BM	380	-53	7.2	380	-52	8.24	1.0
BN	400	-58	6.2	400	-57	7.2	1.0
BO	400	-58	6.2	400	-57	7.2	1.0
BP	400	-58	6.2	400	-57	7.2	1.0
BQ	400	-58	6.2	400	-57	7.2	1.0
BR	400	-58	6.2	400	-57	7.2	1.0
BS	400	-57	7.2	400	-56	8.2	1.0
BT	400	-57	7.2	400	-56	8.2	1.0
BU	400	-57	7.2	400	-56	8.2	1.0
BV	400	-56	8.2	400	-55	9.2	1.0
BW	400	-56	8.2	400	-55	9.2	1.0
BX	400	-56	8.2	400	-55	9.2	1.0
BY	400	-56	8.2	400	-55	9.2	1.0
BZ	400	-56	8.2	400	-55	9.2	1.0

Waypoint De-identified	Flight Level ('100 ft)	April 50% Outside Air Temp (°C)	ISA DEV (°C)	Flight Level ('100 ft)	April 85% Outside Air Temp (°C)	ISA DEV (°C)	Difference in ISA DEV
CA	300	-36	8.4	300	-36	8.4	0.0
CB	300	-36	8.4	300	-35	9.4	1.0
CC	300	-36	8.4	300	-35	9.4	1.0
CD	300	-35	9.4	300	-35	9.4	0.0
CE	300	-34	10.4	300	-34	10.4	0.0
CF	300	-34	10.4	300	-33	11.4	1.0
CG	300	-33	11.4	300	-33	11.4	0.0
CH	300	-33	11.4	300	-32	12.4	1.0
CI	300	-33	11.4	300	-32	12.4	1.0
CJ	300	-32	12.4	300	-32	12.4	0.0
CK	300	-32	12.4	300	-32	12.4	0.0
CL	300	-32	12.4	320	-37	11.36	-1.0
CM	300	-32	12.4	320	-37	11.36	-1.0
CN	300	-31	13.4	320	-36	12.36	-1.0
CO	300	-31	13.4	320	-36	12.36	-1.0
CP	320	-36	12.4	320	-35	13.36	1.0
CQ	340	-41	11.3	340	-41	11.32	0.0
CR	340	-41	11.3	340	-41	11.32	0.0
CS	360	-47	9.3	360	-46	10.28	1.0
CT	360	-47	9.3	360	-46	10.28	1.0
CU	360	-47	9.3	360	-46	10.28	1.0
CV	360	-47	9.3	360	-46	10.28	1.0
CW	360	-47	9.3	360	-47	9.28	0.0
CX	360	-47	9.3	360	-47	9.28	0.0
CY	360	-47	9.3	360	-47	9.28	0.0
CZ	360	-47	9.3	360	-47	9.28	0.0
DA	360	-48	8.3	360	-48	8.28	0.0
DB	360	-49	7.3	360	-49	7.28	0.0
DC	360	-51	5.3	360	-50	6.28	1.0
DD	360	-51	5.3	360	-50	6.28	1.0
DE	360	-53	3.3	360	-53	3.28	0.0
DF	380	-58	2.2	380	-58	2.24	0.0
DG	400	-61	3.2	400	-59	5.2	2.0
DH	400	-59	5.2	400	-58	6.2	1.0
DI	400	-59	5.2	400	-58	6.2	1.0
DJ	400	-58	6.2	400	-56	8.2	2.0
DK	400	-57	7.2	400	-56	8.2	1.0
DL	400	-57	7.2	400	-56	8.2	1.0

Waypoint De-identified	Flight Level ('100 ft)	July 50% Outside Air Temp (°C)	ISA DEV (°C)	Flight Level ('100 ft)	July 85% Outside Air Temp (°C)	ISA DEV (°C)	Difference in ISA DEV
EA	300	-38	6.4	280	-34	6.44	0.0
EB	300	-38	6.4	280	-34	6.44	0.0
EC	300	-38	6.4	280	-33	7.44	1.0
ED	300	-38	6.4	300	-37	7.4	1.0
EE	300	-36	8.4	300	-36	8.4	0.0
EF	300	-35	9.4	300	-35	9.4	0.0
EG	300	-35	9.4	300	-35	9.4	0.0
EH	300	-35	9.4	300	-35	9.4	0.0
EI	300	-34	10.4	300	-34	10.4	0.0
EJ	300	-34	10.4	320	-38	10.36	0.0
EK	300	-33	11.4	320	-38	10.36	-1.0
EL	320	-38	10.4	320	-38	10.36	0.0
EM	320	-38	10.4	320	-37	11.36	1.0
EN	320	-37	11.4	320	-37	11.36	0.0
EO	320	-37	11.4	320	-37	11.36	0.0
EP	320	-37	11.4	320	-37	11.36	0.0
EQ	340	-43	9.3	340	-43	9.32	0.0
ER	340	-43	9.3	340	-43	9.32	0.0
ES	360	-48	8.3	360	-48	8.28	0.0
ET	360	-48	8.3	360	-48	8.28	0.0
EU	360	-48	8.3	360	-48	8.28	0.0
EV	360	-48	8.3	360	-48	8.28	0.0
EW	360	-48	8.3	360	-48	8.28	0.0
EX	360	-48	8.3	360	-48	8.28	0.0
EY	360	-48	8.3	360	-47	9.28	1.0
EZ	360	-48	8.3	360	-47	9.28	1.0
FA	360	-47	9.3	360	-47	9.28	0.0
FB	360	-47	9.3	360	-47	9.28	0.0
FC	360	-47	9.3	360	-47	9.28	0.0
FD	360	-47	9.3	360	-47	9.28	0.0
FE	360	-47	9.3	360	-47	9.28	0.0
FF	360	-47	9.3	360	-47	9.28	0.0
FG	360	-47	9.3	360	-47	9.28	0.0
FH	360	-48	8.3	360	-47	9.28	1.0
FI	360	-48	8.3	360	-48	8.28	0.0
FJ	380	-53	7.2	380	-52	8.24	1.0
FK	380	-53	7.2	380	-53	7.24	0.0
FL	380	-54	6.2	380	-53	7.24	1.0
FM	380	-54	6.2	380	-53	7.24	1.0
FN	380	-54	6.2	380	-53	7.24	1.0
FO	380	-54	6.2	380	-53	7.24	1.0
FP	400	-58	6.2	400	-57	7.2	1.0
FQ	400	-58	6.2	400	-58	6.2	0.0
FR	400	-57	7.2	400	-57	7.2	0.0
FS	400	-57	7.2	400	-57	7.2	0.0
FT	400	-57	7.2	400	-57	7.2	0.0
FU	400	-56	8.2	400	-55	9.2	1.0
FV	400	-56	8.2	400	-55	9.2	1.0
FX	400	-56	8.2	400	-55	9.2	1.0

	October 50%			October 85%			
Waypoint De-identified	Flight Level ('100 ft)	Outside Air Temp (°C)	ISA DEV (°C)	Flight Level ('100 ft)	Outside Air Temp (°C)	ISA DEV (°C)	Difference in ISA DEV
EA	320	-41	7.4	300	-36	8.4	1.0
EB	320	-41	7.4	300	-36	8.4	1.0
EC	320	-41	7.4	300	-36	8.4	1.0
ED	320	-40	8.4	300	-36	8.4	0.0
EE	320	-40	8.4	300	-35	9.4	1.0
EF	320	-39	9.4	300	-34	10.4	1.0
EG	320	-39	9.4	300	-34	10.4	1.0
EH	320	-39	9.4	300	-34	10.4	1.0
EI	320	-38	10.4	300	-33	11.4	1.0
EJ	320	-38	10.4	300	-33	11.4	1.0
EK	320	-38	10.4	300	-33	11.4	1.0
EL	320	-37	11.4	320	-37	11.36	0.0
EM	320	-37	11.4	320	-37	11.36	0.0
EN	320	-37	11.4	320	-37	11.36	0.0
EO	320	-37	11.4	320	-37	11.36	0.0
EP	320	-37	11.4	320	-37	11.36	0.0
EQ	320	-37	11.4	320	-36	12.36	1.0
ER	340	-42	10.3	340	-42	10.32	0.0
ES	340	-42	10.3	340	-42	10.32	0.0
ET	360	-47	9.3	360	-47	9.28	0.0
EU	360	-47	9.3	360	-47	9.28	0.0
EV	360	-47	9.3	360	-47	9.28	0.0
EW	360	-47	9.3	360	-47	9.28	0.0
EX	360	-47	9.3	360	-47	9.28	0.0
EY	360	-48	8.3	360	-47	9.28	1.0
EZ	360	-48	8.3	360	-48	8.28	0.0
FA	360	-48	8.3	360	-48	8.28	0.0
FB	360	-48	8.3	360	-48	8.28	0.0
FC	360	-48	8.3	360	-48	8.28	0.0
FD	360	-48	8.3	360	-48	8.28	0.0
FE	360	-48	8.3	360	-48	8.28	0.0
FF	360	-48	8.3	360	-48	8.28	0.0
FG	360	-48	8.3	360	-48	8.28	0.0
FH	360	-49	7.3	360	-49	7.28	0.0
FI	360	-49	7.3	360	-49	7.28	0.0
FJ	360	-49	7.3	360	-49	7.28	0.0
FK	360	-50	6.3	360	-50	6.28	0.0
FL	380	-55	5.2	380	-55	5.24	0.0
FM	380	-55	5.2	380	-54	6.24	1.0
FN	380	-55	5.2	380	-54	6.24	1.0
FO	380	-55	5.2	380	-54	6.24	1.0
FP	380	-55	5.2	380	-54	6.24	1.0
FQ	400	-58	6.2	400	-57	7.2	1.0
FR	400	-57	7.2	400	-57	7.2	0.0
FS	400	-57	7.2	400	-57	7.2	0.0
FT	400	-57	7.2	400	-57	7.2	0.0
FU	400	-57	7.2	400	-57	7.2	0.0
FV	400	-56	8.2	400	-56	8.2	0.0
FX	400	-56	8.2	400	-55	9.2	1.0

APPENDIX 7. CLIMB FUEL AND DESCENT / APPROACH FUEL REQUIREMENTS FOR THE RETURN FLIGHT TO HOME BASE

Period	Trip Fuel (excluding reserves) (% of MTOW	Climb Fuel (% of MTOW)	Descent Fuel (% of MTOW)	Cruise Fuel (% of MTOW)	Cruise Fuel (% of MTOW) (fixed Climb Fuel)
JAN 50%	35.11%	3.13%	0.50%	31.48%	32.37%
FEB 50%	35.53%	3.15%	0.55%	31.83%	32.74%
MAR 50%	35.27%	3.18%	0.52%	31.57%	32.51%
APR 50%	35.22%	3.19%	0.53%	31.50%	32.46%
MAY 50%	35.29%	3.21%	0.52%	31.57%	32.53%
JUN 50%	35.47%	3.32%	0.50%	31.66%	32.74%
JUL 50%	35.82%	3.29%	0.50%	32.03%	33.08%
AUG 50%	36.04%	3.33%	0.50%	32.21%	33.30%
SEP 50%	35.68%	3.27%	0.51%	31.89%	32.93%
OCT 50%	35.31%	3.22%	0.50%	31.59%	32.57%
NOV 50%	34.92%	3.18%	0.50%	31.24%	32.18%
DEC 50%	34.75%	3.13%	0.52%	31.11%	31.99%
JAN 85%	35.27%	3.17%	0.52%	31.58%	32.51%
FEB 85%	35.68%	3.19%	0.50%	31.98%	32.93%
MAR 85%	35.45%	3.17%	0.50%	31.78%	32.71%
APR 85%	35.42%	3.22%	0.51%	31.69%	32.67%
MAY 85%	35.48%	3.23%	0.51%	31.74%	32.74%
JUN 85%	35.57%	3.32%	0.51%	31.74%	32.82%
JUL 85%	35.85%	3.29%	0.48%	32.08%	33.12%
AUG 85%	36.11%	3.37%	0.47%	32.28%	33.40%
SEP 85%	35.76%	3.32%	0.51%	31.93%	33.01%
OCT 85%	35.45%	3.26%	0.51%	31.67%	32.69%
NOV 85%	35.08%	3.21%	0.51%	31.37%	32.33%
DEC 85%	34.90%	3.15%	0.53%	31.22%	32.14%

Average	3.26%	0.51%	
Standard Deviation	0.08%	0.02%	

APPENDIX 8. SEASONAL FLIGHT PLAN DATA OUTBOUND ROUTE 1

January 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-30					
EA	2.7%	2.7%	2.2%	2.2%	300	486	500	0.825	-14	280	14	-32	12.4	94.7%
EB	0.2%	2.9%	0.2%	2.4%	300	486	500	0.825	-14	280	14	-32	12.4	94.5%
EC	0.8%	3.8%	0.9%	3.3%	300	486	500	0.825	-14	290	14	-32	12.4	93.5%
ED	0.6%	4.4%	0.7%	4.0%	300	488	500	0.825	-12	290	13	-32	12.4	92.7%
EE	2.4%	6.8%	2.7%	6.7%	300	490	500	0.825	-10	300	11	-31	13.4	89.9%
EF	0.4%	7.3%	0.4%	7.1%	300	491	500	0.825	-9	320	9	-31	13.4	89.4%
EG	0.5%	7.8%	0.6%	7.7%	300	492	500	0.825	-8	320	8	-31	13.4	88.8%
EH	0.2%	8.0%	0.2%	7.9%	300	492	500	0.825	-8	320	8	-31	13.4	88.5%
EI	1.7%	9.7%	1.9%	9.8%	300	493	500	0.824	-7	320	7	-31	13.4	86.6%
EJ	0.5%	10.2%	0.5%	10.4%	300	494	500	0.824	-6	330	6	-31	13.4	86.0%
EK	2.6%	12.8%	3.0%	13.3%	300	495	500	0.823	-5	330	6	-31	13.4	82.9%
EL	2.5%	15.4%	2.8%	16.1%	320	492	495	0.824	-3	20	6	-36	12.4	80.1%
EM	1.2%	16.5%	1.2%	17.4%	320	494	495	0.825	-1	40	7	-36	12.4	78.8%
EN	0.5%	17.0%	0.6%	17.9%	320	495	495	0.825	0	50	8	-36	12.4	78.3%
EO	0.7%	17.8%	0.8%	18.8%	320	496	495	0.825	1	50	9	-36	12.4	77.5%
EP	0.8%	18.6%	0.9%	19.7%	320	496	495	0.825	1	60	9	-36	12.4	76.5%
EQ	4.6%	23.2%	5.2%	24.9%	320	498	494	0.825	4	60	9	-37	11.4	71.5%
ER	9.1%	32.4%	10.0%	35.0%	340	494	487	0.823	7	80	9	-42	10.3	62.1%
ES	1.7%	34.1%	1.9%	36.9%	340	493	488	0.824	5	110	5	-42	10.3	60.4%
ET	2.3%	36.4%	2.5%	39.4%	360	483	480	0.821	3	160	4	-48	8.3	58.1%
EU	0.1%	36.5%	0.1%	39.5%	360	483	480	0.821	3	160	4	-48	8.3	58.0%
EV	1.6%	38.1%	1.8%	41.2%	360	480	480	0.821	0	210	5	-48	8.3	56.5%
EW	1.5%	39.5%	1.5%	42.8%	360	478	480	0.821	-2	220	6	-48	8.3	55.1%
EX	2.8%	42.4%	3.1%	45.8%	360	477	481	0.822	-4	240	11	-48	8.3	52.4%
EY	1.3%	43.6%	1.3%	47.2%	360	474	481	0.823	-7	250	18	-48	8.3	51.2%
EZ	1.1%	44.7%	1.1%	48.3%	360	471	481	0.823	-10	250	22	-48	8.3	50.2%
FA	2.1%	46.8%	2.2%	50.5%	360	469	481	0.823	-12	250	26	-48	8.3	48.3%
FB	0.7%	47.5%	0.8%	51.3%	360	469	481	0.824	-12	250	27	-49	7.3	47.6%
FC	0.5%	48.1%	0.5%	51.8%	360	466	481	0.824	-15	250	27	-49	7.3	47.1%
FD	1.8%	49.8%	1.9%	53.6%	360	466	481	0.824	-15	250	25	-49	7.3	45.5%
FE	0.2%	50.1%	0.2%	53.9%	360	466	481	0.825	-15	260	22	-49	7.3	45.3%
FF	1.4%	51.4%	1.5%	55.4%	360	466	481	0.825	-15	260	22	-49	7.3	44.0%
FG	1.1%	52.5%	1.1%	56.5%	360	465	481	0.825	-16	260	21	-49	7.3	43.1%
FH	1.4%	53.8%	1.4%	57.9%	360	464	481	0.825	-17	270	21	-50	6.3	41.8%
FI	1.7%	55.5%	1.8%	59.6%	360	461	480	0.825	-19	270	23	-50	6.3	40.3%
FJ	3.6%	59.1%	3.7%	63.3%	360	456	480	0.825	-24	270	28	-50	6.3	37.2%
FK	5.0%	64.1%	5.0%	68.3%	360	447	480	0.826	-33	270	39	-51	5.3	32.8%
FL	4.7%	68.9%	4.6%	72.9%	360	435	479	0.826	-44	270	51	-51	5.3	28.6%
FM	1.9%	70.8%	1.0%	74.0%	380	418	475	0.825	-57	280	63	-55	1.5	27.1%
FN	2.8%	73.6%	3.4%	77.4%	380	418	475	0.825	-57	280	63	-55	1.5	24.7%
FO	4.2%	77.8%	3.8%	81.2%	380	404	475	0.826	-71	280	72	-55	1.5	21.3%
FP	4.3%	82.1%	3.8%	85.0%	380	396	475	0.827	-79	280	79	-55	1.5	17.8%
FQ	4.4%	86.5%	3.9%	88.9%	400	386	472	0.825	-86	280	90	-58	-1.5	14.4%
FR	6.6%	93.2%	5.3%	94.2%	400	377	473	0.826	-96	270	99	-57	-0.5	9.4%
FS	1.8%	95.0%	1.7%	96.0%	400	377	473	0.826	-96	270	99	-57	-0.5	8.0%
FT	0.0%	95.0%	0.1%	96.0%	400	377	473	0.826	-96	270	99	-57	-0.5	8.0%
FU	1.8%	96.7%	1.5%	97.5%	400	386	474	0.826	-88	260	101	-56	0.5	6.7%
FV	0.1%	96.8%	0.1%	97.6%	400	410	474	0.826	-64	260	100	-56	0.5	6.6%
FX	0.3%	97.2%	0.3%	97.9%	400	411	474	0.826	-63	260	99	-56	0.5	6.4%
LDG	2.8%	100.0%	2.1%	100.0%										5.2%

January 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-34					
EA	2.7%	2.7%	2.2%	2.2%	300	484	500	0.825	-16	270	18	-32	12.4	94.7%
EB	0.2%	2.9%	0.2%	2.4%	300	485	500	0.825	-15	270	17	-31	13.4	94.5%
EC	0.8%	3.8%	0.9%	3.3%	300	483	500	0.825	-17	270	17	-31	13.4	93.5%
ED	0.6%	4.4%	0.7%	4.0%	300	488	500	0.825	-12	280	16	-31	13.4	92.8%
EE	2.4%	6.8%	2.7%	6.7%	300	489	500	0.825	-11	280	13	-31	13.4	90.0%
EF	0.4%	7.2%	0.4%	7.1%	300	491	500	0.825	-9	290	11	-31	13.4	89.5%
EG	0.5%	7.7%	0.6%	7.7%	300	491	500	0.825	-9	290	10	-31	13.4	88.9%
EH	0.2%	7.9%	0.2%	7.9%	300	492	500	0.825	-8	290	10	-31	13.4	88.6%
EI	1.7%	9.6%	1.9%	9.8%	300	493	500	0.824	-7	290	9	-31	13.4	86.7%
EJ	0.5%	10.1%	0.5%	10.4%	300	493	500	0.824	-7	290	7	-30	14.4	86.1%
EK	2.6%	12.7%	3.0%	13.3%	300	494	500	0.823	-6	300	6	-30	14.4	83.0%
EL	2.5%	15.3%	2.8%	16.1%	320	495	495	0.824	0	50	6	-36	12.4	80.2%
EM	1.1%	16.4%	1.2%	17.4%	320	498	495	0.825	3	60	9	-36	12.4	79.0%
EN	0.5%	16.9%	0.6%	17.9%	320	499	495	0.825	4	70	10	-36	12.4	78.4%
EO	0.7%	17.7%	0.8%	18.8%	320	499	495	0.825	4	70	11	-36	12.4	77.6%
EP	0.8%	18.5%	0.9%	19.7%	320	500	495	0.825	5	70	11	-36	12.4	76.7%
EQ	4.6%	23.1%	5.2%	24.9%	320	501	495	0.825	6	70	11	-36	12.4	71.7%
ER	8.9%	32.0%	10.0%	35.0%	320	501	493	0.824	8	90	10	-36	12.4	62.5%
ES	1.7%	33.6%	1.9%	36.9%	320	500	493	0.822	7	90	8	-37	11.4	60.6%
ET	2.3%	35.9%	2.5%	39.4%	360	482	481	0.821	1	140	2	-47	9.3	58.4%
EU	0.1%	36.1%	0.1%	39.5%	360	482	481	0.821	1	140	2	-47	9.3	58.3%
EV	1.6%	37.6%	1.8%	41.2%	360	476	481	0.821	-5	250	6	-47	9.3	56.7%
EW	1.5%	39.1%	1.5%	42.8%	360	474	481	0.822	-7	260	9	-47	9.3	55.3%
EX	2.9%	42.0%	3.1%	45.8%	360	472	481	0.822	-9	260	15	-48	8.3	52.6%
EY	1.3%	43.3%	1.3%	47.2%	360	469	481	0.823	-12	260	22	-48	8.3	51.4%
EZ	1.0%	44.3%	1.1%	48.3%	360	466	482	0.823	-16	260	27	-48	8.3	50.4%
FA	2.1%	46.4%	2.2%	50.5%	360	464	481	0.824	-17	260	31	-48	8.3	48.5%
FB	0.8%	47.2%	0.8%	51.3%	360	463	481	0.824	-18	260	32	-48	8.3	47.7%
FC	0.4%	47.6%	0.5%	51.8%	360	459	482	0.824	-23	260	32	-48	8.3	47.3%
FD	1.8%	49.4%	1.9%	53.6%	360	459	481	0.824	-22	260	31	-48	8.3	45.7%
FE	0.3%	49.7%	0.2%	53.9%	360	458	481	0.825	-23	270	30	-49	7.3	45.4%
FF	1.4%	51.1%	1.5%	55.4%	360	458	481	0.825	-23	270	30	-49	7.3	44.2%
FG	1.0%	52.1%	1.1%	56.5%	360	457	481	0.825	-24	270	29	-49	7.3	43.2%
FH	1.4%	53.5%	1.4%	57.9%	360	457	481	0.825	-24	270	30	-49	7.3	42.0%
FI	1.7%	55.2%	1.8%	59.6%	360	456	481	0.825	-25	260	33	-49	7.3	40.5%
FJ	3.7%	58.8%	3.7%	63.3%	360	452	481	0.825	-29	260	38	-50	6.3	37.2%
FK	5.0%	63.8%	5.0%	68.3%	360	444	481	0.826	-37	270	46	-50	6.3	32.8%
FL	4.8%	68.7%	4.6%	72.9%	380	427	475	0.824	-48	270	59	-54	2.5	28.8%
FM	2.0%	70.6%	1.0%	74.0%	380	417	476	0.825	-59	270	69	-54	2.5	27.1%
FN	2.7%	73.4%	3.4%	77.4%	380	417	476	0.825	-59	270	69	-54	2.5	24.9%
FO	4.3%	77.6%	3.8%	81.2%	380	400	476	0.826	-76	270	78	-54	2.5	21.3%
FP	4.3%	81.9%	3.8%	85.0%	400	390	473	0.824	-83	280	85	-57	-0.5	17.9%
FQ	4.5%	86.4%	3.9%	88.9%	400	384	473	0.825	-89	270	96	-57	-0.5	14.5%
FR	6.6%	93.0%	5.3%	94.2%	400	371	474	0.826	-103	270	106	-56	0.5	9.5%
FS	1.8%	94.8%	1.7%	96.0%	400	371	474	0.826	-103	270	106	-56	0.5	8.1%
FT	0.1%	94.9%	0.1%	96.0%	400	371	474	0.826	-103	270	106	-56	0.5	8.1%
FU	1.8%	96.7%	1.5%	97.5%	400	379	475	0.827	-96	270	108	-55	1.5	6.8%
FV	0.1%	96.8%	0.1%	97.6%	400	402	476	0.827	-74	270	106	-55	1.5	6.7%
FX	0.3%	97.1%	0.3%	97.9%	400	403	476	0.827	-73	270	106	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

February 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-20					
EA	2.8%	2.8%	2.2%	2.2%	300	489	501	0.825	-12	290	12	-31	13.4	93.1%
EB	0.2%	3.0%	0.2%	2.4%	300	490	501	0.825	-11	290	12	-30	14.4	92.9%
EC	0.9%	3.9%	0.9%	3.3%	300	490	501	0.825	-11	290	11	-30	14.4	91.9%
ED	0.6%	4.5%	0.7%	4.0%	300	492	501	0.825	-9	290	11	-30	14.4	91.1%
EE	2.5%	7.0%	2.7%	6.7%	300	495	501	0.825	-6	280	7	-30	14.4	88.3%
EF	0.3%	7.3%	0.4%	7.1%	300	498	501	0.825	-3	280	5	-30	14.4	87.9%
EG	0.5%	7.9%	0.6%	7.7%	300	499	501	0.824	-2	280	4	-30	14.4	87.3%
EH	0.2%	8.1%	0.2%	7.9%	300	499	501	0.824	-2	280	3	-29	15.4	87.0%
EI	1.7%	9.8%	1.9%	9.8%	300	501	501	0.824	0	320	1	-29	15.4	85.1%
EJ	0.5%	10.3%	0.5%	10.4%	300	502	501	0.823	1	80	2	-29	15.4	84.5%
EK	2.7%	13.0%	3.0%	13.3%	300	504	500	0.822	4	90	6	-30	14.4	81.4%
EL	2.5%	15.5%	2.8%	16.1%	320	503	495	0.824	8	80	14	-35	13.4	78.7%
EM	1.2%	16.7%	1.2%	17.4%	320	506	495	0.824	11	90	17	-35	13.4	77.4%
EN	0.5%	17.2%	0.6%	17.9%	320	507	495	0.825	12	90	19	-35	13.4	76.9%
EO	0.8%	18.0%	0.8%	18.8%	320	507	495	0.825	12	80	19	-36	12.4	76.1%
EP	0.9%	18.9%	0.9%	19.7%	320	507	495	0.825	12	80	19	-36	12.4	75.1%
EQ	4.6%	23.5%	5.2%	24.9%	320	508	495	0.825	13	80	19	-36	12.4	70.3%
ER	9.1%	32.5%	10.0%	35.0%	320	506	493	0.825	13	80	17	-36	12.4	61.0%
ES	1.7%	34.3%	1.9%	36.9%	320	506	493	0.822	13	90	16	-37	11.4	59.1%
ET	2.4%	36.6%	2.5%	39.4%	360	492	480	0.82	12	90	14	-47	9.3	56.9%
EU	0.0%	36.6%	0.1%	39.5%	360	492	480	0.82	12	90	14	-47	9.3	56.9%
EV	1.7%	38.4%	1.8%	41.2%	360	492	481	0.821	11	90	13	-47	9.3	55.3%
EW	1.4%	39.8%	1.5%	42.8%	360	493	481	0.821	12	110	12	-47	9.3	53.9%
EX	2.8%	42.6%	3.1%	45.8%	360	491	481	0.821	10	140	10	-47	9.3	51.3%
EY	1.3%	43.9%	1.3%	47.2%	360	489	481	0.822	8	180	11	-47	9.3	50.2%
EZ	1.1%	44.9%	1.1%	48.3%	360	486	481	0.822	5	210	14	-47	9.3	49.2%
FA	2.0%	47.0%	2.2%	50.5%	360	482	482	0.822	0	230	22	-47	9.3	47.3%
FB	0.8%	47.7%	0.8%	51.3%	360	478	482	0.823	-4	230	32	-47	9.3	46.6%
FC	0.4%	48.2%	0.5%	51.8%	360	470	482	0.824	-12	240	36	-47	9.3	46.2%
FD	1.8%	50.0%	1.9%	53.6%	360	463	482	0.824	-19	240	45	-47	9.3	44.6%
FE	0.3%	50.3%	0.2%	53.9%	360	453	483	0.825	-30	250	57	-48	8.3	44.3%
FF	1.4%	51.7%	1.5%	55.4%	360	453	483	0.825	-30	250	57	-48	8.3	43.0%
FG	1.2%	52.9%	1.1%	56.5%	360	445	482	0.825	-37	250	66	-48	8.3	42.0%
FH	1.4%	54.3%	1.4%	57.9%	360	439	482	0.825	-43	250	72	-48	8.3	40.7%
FI	1.9%	56.3%	1.8%	59.6%	360	434	482	0.826	-48	250	76	-49	7.3	39.0%
FJ	3.9%	60.1%	3.7%	63.3%	360	431	482	0.826	-51	260	74	-49	7.3	35.7%
FK	5.3%	65.4%	5.0%	68.3%	360	434	480	0.826	-46	270	56	-50	6.3	31.1%
FL	4.7%	70.2%	4.6%	72.9%	360	438	478	0.825	-40	290	41	-52	4.3	27.2%
FM	1.5%	71.7%	1.0%	74.0%	360	444	476	0.824	-32	290	33	-54	2.3	25.9%
FN	3.1%	74.8%	3.4%	77.4%	360	444	476	0.824	-32	290	33	-54	2.3	23.3%
FO	4.1%	78.9%	3.8%	81.2%	380	435	472	0.825	-37	270	39	-57	-0.5	20.1%
FP	4.0%	82.9%	3.8%	85.0%	380	428	472	0.826	-44	270	48	-58	-1.5	16.9%
FQ	4.2%	87.1%	3.9%	88.9%	400	421	472	0.824	-51	260	58	-59	-2.5	13.8%
FR	6.0%	93.1%	5.3%	94.2%	400	411	473	0.825	-62	260	68	-57	-0.5	9.3%
FS	1.8%	94.9%	1.7%	96.0%	400	411	473	0.825	-62	260	68	-57	-0.5	7.9%
FT	0.0%	94.9%	0.1%	96.0%	400	411	473	0.825	-62	260	68	-57	-0.5	7.9%
FU	1.7%	96.7%	1.5%	97.5%	400	415	475	0.826	-60	260	71	-55	1.5	6.7%
FV	0.1%	96.8%	0.1%	97.6%	400	431	476	0.826	-45	260	71	-54	2.5	6.6%
FX	0.3%	97.1%	0.3%	97.9%	400	432	476	0.826	-44	260	71	-54	2.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

February 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-23					
EA	2.8%	2.8%	2.2%	2.2%	300	488	501	0.825	-13	270	14	-30	14.4	93.0%
EB	0.2%	3.0%	0.2%	2.4%	300	488	501	0.825	-13	280	14	-30	14.4	92.7%
EC	0.9%	3.9%	0.9%	3.3%	300	488	501	0.825	-13	280	14	-30	14.4	91.8%
ED	0.6%	4.5%	0.7%	4.0%	300	492	501	0.825	-9	270	14	-30	14.4	91.0%
EE	2.5%	7.0%	2.7%	6.7%	300	495	502	0.825	-7	270	10	-30	14.4	88.2%
EF	0.3%	7.3%	0.4%	7.1%	300	497	502	0.825	-5	270	8	-29	15.4	87.8%
EG	0.6%	7.9%	0.6%	7.7%	300	498	502	0.825	-4	260	7	-29	15.4	87.1%
EH	0.1%	8.0%	0.2%	7.9%	300	499	502	0.825	-3	260	6	-29	15.4	87.0%
EI	1.7%	9.8%	1.9%	9.8%	300	502	501	0.823	1	210	1	-29	15.4	85.0%
EJ	0.5%	10.3%	0.5%	10.4%	300	505	501	0.823	4	100	5	-29	15.4	84.4%
EK	2.7%	13.0%	3.0%	13.3%	300	506	500	0.822	6	100	8	-29	15.4	81.4%
EL	2.5%	15.5%	2.8%	16.1%	320	505	495	0.824	10	90	15	-35	13.4	78.7%
EM	1.1%	16.5%	1.2%	17.4%	320	508	496	0.824	12	90	19	-35	13.4	77.5%
EN	0.5%	17.1%	0.6%	17.9%	320	509	496	0.825	13	90	20	-35	13.4	77.0%
EO	0.8%	17.8%	0.8%	18.8%	320	509	496	0.825	13	90	20	-35	13.4	76.2%
EP	0.9%	18.7%	0.9%	19.7%	320	509	496	0.825	13	90	20	-35	13.4	75.3%
EQ	4.6%	23.3%	5.2%	24.9%	320	511	495	0.825	16	90	20	-36	12.4	70.4%
ER	9.0%	32.3%	10.0%	35.0%	320	510	494	0.823	16	90	20	-36	12.4	61.2%
ES	1.7%	34.0%	1.9%	36.9%	320	511	493	0.822	18	90	21	-36	12.4	59.4%
ET	2.3%	36.3%	2.5%	39.4%	360	498	481	0.82	17	90	20	-47	9.3	57.2%
EU	0.1%	36.4%	0.1%	39.5%	360	498	481	0.82	17	90	20	-47	9.3	57.1%
EV	1.6%	38.0%	1.8%	41.2%	360	497	481	0.821	16	90	18	-47	9.3	55.6%
EW	1.4%	39.4%	1.5%	42.8%	360	497	481	0.821	16	90	17	-47	9.3	54.3%
EX	2.8%	42.2%	3.1%	45.8%	360	493	481	0.821	12	110	12	-47	9.3	51.7%
EY	1.3%	43.5%	1.3%	47.2%	360	487	482	0.822	5	180	8	-47	9.3	50.5%
EZ	1.1%	44.5%	1.1%	48.3%	360	482	482	0.822	0	230	13	-47	9.3	49.5%
FA	2.1%	46.7%	2.2%	50.5%	360	477	482	0.823	-5	240	24	-47	9.3	47.6%
FB	0.8%	47.4%	0.8%	51.3%	360	472	483	0.824	-11	240	33	-47	9.3	46.9%
FC	0.4%	47.9%	0.5%	51.8%	360	465	483	0.824	-18	240	38	-47	9.3	46.5%
FD	1.8%	49.7%	1.9%	53.6%	360	458	483	0.824	-25	250	46	-47	9.3	44.9%
FE	0.3%	50.0%	0.2%	53.9%	360	448	483	0.825	-35	250	59	-47	9.3	44.6%
FF	1.4%	51.4%	1.5%	55.4%	360	448	483	0.825	-35	250	59	-47	9.3	43.3%
FG	1.2%	52.6%	1.1%	56.5%	360	440	483	0.825	-43	250	69	-48	8.3	42.3%
FH	1.5%	54.1%	1.4%	57.9%	360	434	483	0.826	-49	250	75	-48	8.3	41.0%
FI	1.8%	55.9%	1.8%	59.6%	360	428	483	0.826	-55	260	80	-48	8.3	39.4%
FJ	4.0%	59.9%	3.7%	63.3%	360	424	482	0.826	-58	260	78	-49	7.3	35.9%
FK	5.4%	65.2%	5.0%	68.3%	360	430	481	0.826	-51	270	62	-50	6.3	31.3%
FL	4.7%	70.0%	4.6%	72.9%	360	435	479	0.826	-44	280	48	-51	5.3	27.4%
FM	1.6%	71.6%	1.0%	74.0%	360	441	477	0.825	-36	280	40	-53	3.3	26.1%
FN	3.0%	74.6%	3.4%	77.4%	360	441	477	0.825	-36	280	40	-53	3.3	23.6%
FO	4.1%	78.6%	3.8%	81.2%	380	430	474	0.825	-44	270	46	-56	0.5	20.4%
FP	4.1%	82.7%	3.8%	85.0%	380	422	474	0.826	-52	270	55	-57	-0.5	17.1%
FQ	4.3%	87.0%	3.9%	88.9%	400	414	472	0.824	-58	270	64	-58	-1.5	13.9%
FR	6.1%	93.1%	5.3%	94.2%	400	405	474	0.825	-69	270	74	-56	0.5	9.4%
FS	1.8%	95.0%	1.7%	96.0%	400	405	474	0.825	-69	270	74	-56	0.5	8.0%
FT	0.0%	95.0%	0.1%	96.0%	400	405	474	0.825	-69	270	74	-56	0.5	8.0%
FU	1.7%	96.7%	1.5%	97.5%	400	407	477	0.826	-70	270	78	-54	2.5	6.8%
FV	0.1%	96.8%	0.1%	97.6%	400	423	477	0.826	-54	270	78	-53	3.5	6.7%
FX	0.3%	97.1%	0.3%	97.9%	400	423	477	0.826	-54	270	78	-53	3.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

March 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-24					
EA	2.8%	2.8%	2.2%	2.2%	300	487	499	0.825	-12	250	17	-33	11.4	93.7%
EB	0.2%	3.0%	0.2%	2.4%	300	488	499	0.825	-11	250	17	-33	11.4	93.4%
EC	0.9%	3.8%	0.9%	3.3%	300	486	499	0.825	-13	250	16	-32	12.4	92.4%
ED	0.6%	4.5%	0.7%	4.0%	300	493	499	0.825	-6	250	16	-32	12.4	91.7%
EE	2.5%	6.9%	2.7%	6.7%	300	495	500	0.825	-5	250	15	-31	13.4	88.9%
EF	0.3%	7.3%	0.4%	7.1%	300	496	500	0.825	-4	250	13	-31	13.4	88.5%
EG	0.5%	7.8%	0.6%	7.7%	300	496	500	0.825	-4	250	13	-31	13.4	87.9%
EH	0.2%	8.0%	0.2%	7.9%	300	496	500	0.824	-4	250	12	-31	13.4	87.6%
EI	1.7%	9.7%	1.9%	9.8%	300	497	500	0.824	-3	250	9	-30	14.4	85.7%
EJ	0.5%	10.3%	0.5%	10.4%	300	498	500	0.824	-2	250	6	-30	14.4	85.1%
EK	2.7%	12.9%	3.0%	13.3%	300	500	500	0.823	0	0	0	-30	14.4	82.0%
EL	2.6%	15.5%	2.8%	16.1%	320	499	495	0.824	4	70	8	-35	13.4	79.2%
EM	1.1%	16.6%	1.2%	17.4%	320	502	496	0.825	6	80	13	-35	13.4	78.0%
EN	0.5%	17.1%	0.6%	17.9%	320	504	496	0.825	8	80	15	-35	13.4	77.5%
EO	0.7%	17.8%	0.8%	18.8%	320	504	496	0.825	8	80	17	-35	13.4	76.7%
EP	0.9%	18.7%	0.9%	19.7%	320	505	496	0.825	9	80	18	-35	13.4	75.7%
EQ	4.7%	23.4%	5.2%	24.9%	320	507	496	0.825	11	80	19	-36	12.4	70.7%
ER	9.0%	32.4%	10.0%	35.0%	320	505	494	0.823	11	80	15	-36	12.4	61.5%
ES	1.7%	34.1%	1.9%	36.9%	320	505	493	0.822	12	110	11	-36	12.4	59.6%
ET	2.2%	36.3%	2.5%	39.4%	360	494	481	0.82	13	120	13	-47	9.3	57.4%
EU	0.1%	36.4%	0.1%	39.5%	360	494	481	0.82	13	120	13	-47	9.3	57.3%
EV	1.6%	38.0%	1.8%	41.2%	360	495	481	0.821	14	130	14	-47	9.3	55.8%
EW	1.4%	39.4%	1.5%	42.8%	360	495	481	0.821	14	140	15	-47	9.3	54.5%
EX	2.9%	42.3%	3.1%	45.8%	360	494	482	0.821	12	160	14	-47	9.3	51.8%
EY	1.2%	43.5%	1.3%	47.2%	360	490	482	0.822	8	200	16	-47	9.3	50.7%
EZ	1.1%	44.6%	1.1%	48.3%	360	486	482	0.822	4	220	19	-47	9.3	49.7%
FA	2.1%	46.7%	2.2%	50.5%	360	481	482	0.823	-1	230	26	-47	9.3	47.8%
FB	0.7%	47.4%	0.8%	51.3%	360	476	483	0.823	-7	240	34	-47	9.3	47.1%
FC	0.4%	47.9%	0.5%	51.8%	360	468	483	0.824	-15	240	37	-47	9.3	46.7%
FD	1.8%	49.7%	1.9%	53.6%	360	464	483	0.824	-19	240	43	-47	9.3	45.0%
FE	0.3%	50.0%	0.2%	53.9%	360	458	483	0.825	-25	250	50	-47	9.3	44.7%
FF	1.4%	51.4%	1.5%	55.4%	360	458	483	0.825	-25	250	50	-47	9.3	43.5%
FG	1.1%	52.5%	1.1%	56.5%	360	454	483	0.825	-29	250	53	-48	8.3	42.5%
FH	1.4%	53.8%	1.4%	57.9%	360	452	482	0.825	-30	250	53	-48	8.3	41.3%
FI	1.8%	55.7%	1.8%	59.6%	360	450	482	0.825	-32	250	51	-48	8.3	39.7%
FJ	3.7%	59.4%	3.7%	63.3%	360	448	481	0.825	-33	260	44	-49	7.3	36.4%
FK	5.1%	64.5%	5.0%	68.3%	360	442	480	0.826	-38	280	42	-50	6.3	32.0%
FL	4.8%	69.3%	4.6%	72.9%	360	434	479	0.826	-45	290	47	-51	5.3	27.8%
FM	1.8%	71.2%	1.0%	74.0%	380	421	474	0.825	-53	290	55	-55	1.5	26.4%
FN	3.0%	74.1%	3.4%	77.4%	380	421	474	0.825	-53	290	55	-55	1.5	23.9%
FO	4.2%	78.3%	3.8%	81.2%	380	413	474	0.826	-61	280	61	-56	0.5	20.6%
FP	4.3%	82.6%	3.8%	85.0%	380	407	473	0.826	-66	280	68	-57	-0.5	17.2%
FQ	4.4%	87.0%	3.9%	88.9%	400	401	471	0.825	-70	270	77	-59	-2.5	13.9%
FR	6.2%	93.2%	5.3%	94.2%	400	398	472	0.826	-74	260	81	-59	-2.5	9.2%
FS	1.8%	95.0%	1.7%	96.0%	400	398	472	0.826	-74	260	81	-59	-2.5	7.9%
FT	0.0%	95.0%	0.1%	96.0%	400	398	472	0.826	-74	260	81	-59	-2.5	7.9%
FU	1.7%	96.7%	1.5%	97.5%	400	412	474	0.826	-62	260	77	-56	0.5	6.6%
FV	0.1%	96.8%	0.1%	97.6%	400	434	474	0.826	-40	260	74	-56	0.5	6.6%
FX	0.3%	97.1%	0.3%	97.9%	400	434	474	0.826	-40	260	73	-56	0.5	6.3%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

March 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-27					
EA	2.8%	2.8%	2.2%	2.2%	300	482	499	0.825	-17	260	20	-33	11.4	93.6%
EB	0.2%	3.0%	0.2%	2.4%	300	483	499	0.825	-16	260	20	-32	12.4	93.3%
EC	0.9%	3.8%	0.9%	3.3%	300	482	499	0.825	-17	260	19	-32	12.4	92.3%
ED	0.6%	4.5%	0.7%	4.0%	300	489	499	0.825	-10	260	19	-32	12.4	91.6%
EE	2.4%	6.9%	2.7%	6.7%	300	490	500	0.825	-10	260	17	-31	13.4	88.8%
EF	0.4%	7.3%	0.4%	7.1%	300	492	500	0.825	-8	260	16	-31	13.4	88.3%
EG	0.5%	7.9%	0.6%	7.7%	300	493	500	0.825	-7	260	15	-31	13.4	87.7%
EH	0.2%	8.1%	0.2%	7.9%	300	493	500	0.825	-7	260	14	-30	14.4	87.4%
EI	1.7%	9.8%	1.9%	9.8%	300	494	500	0.824	-6	260	11	-30	14.4	85.5%
EJ	0.5%	10.3%	0.5%	10.4%	300	495	500	0.824	-5	270	8	-30	14.4	84.9%
EK	2.7%	13.0%	3.0%	13.3%	300	500	500	0.823	0	0	0	-30	14.4	81.8%
EL	2.6%	15.5%	2.8%	16.1%	320	501	496	0.824	5	80	10	-35	13.4	79.1%
EM	1.1%	16.6%	1.2%	17.4%	320	505	496	0.825	9	80	15	-35	13.4	77.9%
EN	0.5%	17.1%	0.6%	17.9%	320	506	496	0.825	10	80	17	-35	13.4	77.3%
EO	0.7%	17.9%	0.8%	18.8%	320	507	496	0.825	11	80	18	-35	13.4	76.5%
EP	0.9%	18.7%	0.9%	19.7%	320	507	496	0.825	11	80	19	-35	13.4	75.6%
EQ	4.6%	23.3%	5.2%	24.9%	320	510	495	0.825	15	80	21	-35	13.4	70.8%
ER	8.9%	32.2%	10.0%	35.0%	320	508	494	0.823	14	90	19	-36	12.4	61.6%
ES	1.7%	33.9%	1.9%	36.9%	320	507	494	0.822	13	100	14	-36	12.4	59.7%
ET	2.2%	36.1%	2.5%	39.4%	360	497	481	0.82	16	100	16	-47	9.3	57.6%
EU	0.1%	36.2%	0.1%	39.5%	360	497	481	0.82	16	100	16	-47	9.3	57.5%
EV	1.6%	37.8%	1.8%	41.2%	360	498	481	0.821	17	110	17	-47	9.3	55.9%
EW	1.4%	39.2%	1.5%	42.8%	360	499	481	0.821	18	120	18	-47	9.3	54.6%
EX	2.8%	42.0%	3.1%	45.8%	360	494	482	0.821	12	150	13	-46	10.3	52.1%
EY	1.3%	43.3%	1.3%	47.2%	360	486	482	0.822	4	210	14	-46	10.3	50.9%
EZ	1.1%	44.3%	1.1%	48.3%	360	479	483	0.823	-4	230	21	-46	10.3	49.9%
FA	2.1%	46.4%	2.2%	50.5%	360	474	483	0.823	-9	240	29	-47	9.3	47.9%
FB	0.7%	47.2%	0.8%	51.3%	360	469	483	0.824	-14	250	38	-47	9.3	47.3%
FC	0.4%	47.6%	0.5%	51.8%	360	461	483	0.824	-22	250	41	-47	9.3	46.9%
FD	1.8%	49.4%	1.9%	53.6%	360	457	483	0.824	-26	250	47	-47	9.3	45.2%
FE	0.3%	49.7%	0.2%	53.9%	360	450	483	0.825	-33	250	54	-47	9.3	44.9%
FF	1.5%	51.2%	1.5%	55.4%	360	450	483	0.825	-33	250	54	-47	9.3	43.6%
FG	1.1%	52.3%	1.1%	56.5%	360	446	483	0.825	-37	250	57	-47	9.3	42.6%
FH	1.4%	53.7%	1.4%	57.9%	360	444	483	0.825	-39	260	58	-48	8.3	41.4%
FI	1.8%	55.5%	1.8%	59.6%	360	442	483	0.826	-41	260	56	-48	8.3	39.8%
FJ	3.8%	59.3%	3.7%	63.3%	360	441	482	0.826	-41	270	51	-49	7.3	36.5%
FK	5.1%	64.4%	5.0%	68.3%	360	440	481	0.826	-41	270	47	-50	6.3	32.1%
FL	4.8%	69.2%	4.6%	72.9%	360	432	480	0.826	-48	280	51	-51	5.3	28.0%
FM	1.9%	71.1%	1.0%	74.0%	380	420	475	0.825	-55	280	60	-55	1.5	26.4%
FN	2.9%	74.0%	3.4%	77.4%	380	420	475	0.825	-55	280	60	-55	1.5	24.1%
FO	4.3%	78.2%	3.8%	81.2%	380	410	475	0.826	-65	280	66	-55	1.5	20.7%
FP	4.1%	82.4%	3.8%	85.0%	380	404	474	0.826	-70	270	73	-56	0.5	17.4%
FQ	4.5%	86.8%	3.9%	88.9%	400	395	472	0.825	-77	270	82	-58	-1.5	14.0%
FR	6.3%	93.1%	5.3%	94.2%	400	392	473	0.825	-81	270	86	-57	-0.5	9.3%
FS	1.8%	94.9%	1.7%	96.0%	400	392	473	0.825	-81	270	86	-57	-0.5	8.0%
FT	0.1%	95.0%	0.1%	96.0%	400	392	473	0.825	-81	270	86	-57	-0.5	7.9%
FU	1.7%	96.7%	1.5%	97.5%	400	406	475	0.826	-69	260	81	-55	1.5	6.7%
FV	0.0%	96.7%	0.1%	97.6%	400	426	475	0.826	-49	260	78	-55	1.5	6.7%
FX	0.4%	97.1%	0.3%	97.9%	400	427	476	0.826	-49	260	78	-55	1.5	6.3%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

April 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-22					
EA	2.9%	2.9%	2.2%	2.2%	300	475	495	0.826	-20	240	29	-36	8.4	93.2%
EB	0.2%	3.1%	0.2%	2.4%	300	477	496	0.826	-19	250	30	-36	8.4	93.0%
EC	0.9%	4.0%	0.9%	3.3%	300	474	496	0.825	-22	250	31	-36	8.4	92.0%
ED	0.6%	4.6%	0.7%	4.0%	300	487	496	0.825	-9	240	32	-35	9.4	91.3%
EE	2.5%	7.1%	2.7%	6.7%	300	489	497	0.825	-8	240	31	-34	10.4	88.4%
EF	0.4%	7.5%	0.4%	7.1%	300	491	498	0.825	-7	240	29	-33	11.4	87.9%
EG	0.5%	8.0%	0.6%	7.7%	300	491	498	0.825	-7	240	28	-33	11.4	87.3%
EH	0.2%	8.3%	0.2%	7.9%	300	492	498	0.825	-6	240	27	-33	11.4	87.1%
EI	1.7%	10.0%	1.9%	9.8%	300	492	498	0.824	-6	240	23	-32	12.4	85.1%
EJ	0.5%	10.5%	0.5%	10.4%	300	493	498	0.824	-5	240	19	-32	12.4	84.5%
EK	2.7%	13.2%	3.0%	13.3%	300	495	499	0.824	-4	250	13	-32	12.4	81.5%
EL	2.6%	15.8%	2.8%	16.1%	320	490	495	0.824	-5	270	8	-36	12.4	78.7%
EM	1.2%	16.9%	1.2%	17.4%	320	492	495	0.825	-3	280	4	-36	12.4	77.4%
EN	0.5%	17.5%	0.6%	17.9%	320	493	495	0.825	-2	290	2	-36	12.4	76.8%
EO	0.8%	18.2%	0.8%	18.8%	320	495	496	0.825	-1	310	1	-36	12.4	76.0%
EP	0.9%	19.1%	0.9%	19.7%	320	496	496	0.825	0	50	1	-35	13.4	75.1%
EQ	4.8%	23.9%	5.2%	24.9%	320	499	496	0.825	3	80	5	-35	13.4	70.0%
ER	9.0%	32.9%	10.0%	35.0%	320	503	495	0.823	8	90	11	-35	13.4	60.7%
ES	1.7%	34.6%	1.9%	36.9%	320	506	494	0.822	12	100	13	-35	13.4	58.8%
ET	2.4%	37.0%	2.5%	39.4%	360	493	482	0.821	11	110	12	-46	10.3	56.6%
EU	0.0%	37.0%	0.1%	39.5%	360	493	482	0.821	11	110	12	-46	10.3	56.6%
EV	1.7%	38.7%	1.8%	41.2%	360	494	482	0.821	12	120	12	-46	10.3	55.0%
EW	1.4%	40.1%	1.5%	42.8%	360	494	482	0.821	12	130	12	-46	10.3	53.7%
EX	2.8%	42.9%	3.1%	45.8%	360	491	482	0.821	9	140	9	-46	10.3	51.1%
EY	1.3%	44.2%	1.3%	47.2%	360	487	482	0.822	5	180	7	-47	9.3	49.9%
EZ	1.1%	45.2%	1.1%	48.3%	360	484	482	0.823	2	210	8	-47	9.3	48.9%
FA	2.0%	47.3%	2.2%	50.5%	360	480	482	0.823	-2	240	13	-47	9.3	47.0%
FB	0.8%	48.0%	0.8%	51.3%	360	476	482	0.823	-6	250	19	-47	9.3	46.3%
FC	0.4%	48.4%	0.5%	51.8%	360	471	483	0.824	-12	250	22	-47	9.3	45.9%
FD	1.8%	50.3%	1.9%	53.6%	360	468	483	0.824	-15	250	27	-47	9.3	44.3%
FE	0.3%	50.6%	0.2%	53.9%	360	462	483	0.825	-21	250	34	-47	9.3	44.0%
FF	1.4%	52.0%	1.5%	55.4%	360	462	483	0.825	-21	250	34	-47	9.3	42.8%
FG	1.1%	53.1%	1.1%	56.5%	360	458	483	0.825	-25	250	39	-48	8.3	41.8%
FH	1.4%	54.4%	1.4%	57.9%	360	455	483	0.825	-28	250	44	-48	8.3	40.6%
FI	1.8%	56.3%	1.8%	59.6%	360	451	482	0.825	-31	250	48	-48	8.3	38.9%
FJ	3.8%	60.0%	3.7%	63.3%	360	446	482	0.826	-36	260	52	-49	7.3	35.7%
FK	5.1%	65.2%	5.0%	68.3%	360	440	480	0.826	-40	260	56	-50	6.3	31.3%
FL	4.8%	70.0%	4.6%	72.9%	360	436	478	0.826	-42	260	55	-52	4.3	27.1%
FM	1.8%	71.8%	1.0%	74.0%	380	425	472	0.825	-47	270	56	-57	-0.5	25.7%
FN	3.0%	74.8%	3.4%	77.4%	380	425	472	0.825	-47	270	56	-57	-0.5	23.2%
FO	4.2%	79.0%	3.8%	81.2%	380	418	472	0.826	-54	280	55	-58	-1.5	19.9%
FP	4.1%	83.1%	3.8%	85.0%	400	414	468	0.823	-54	280	54	-61	-4.5	16.7%
FQ	4.3%	87.4%	3.9%	88.9%	400	417	468	0.824	-51	280	53	-61	-4.5	13.5%
FR	5.9%	93.2%	5.3%	94.2%	400	418	470	0.825	-52	270	54	-59	-2.5	9.1%
FS	1.7%	95.0%	1.7%	96.0%	400	418	470	0.825	-52	270	54	-59	-2.5	7.9%
FT	0.1%	95.1%	0.1%	96.0%	400	418	470	0.825	-52	270	54	-59	-2.5	7.8%
FU	1.6%	96.7%	1.5%	97.5%	400	423	472	0.825	-49	270	55	-58	-1.5	6.6%
FV	0.1%	96.8%	0.1%	97.6%	400	436	472	0.825	-36	270	55	-57	-0.5	6.5%
FX	0.3%	97.1%	0.3%	97.9%	400	436	473	0.825	-37	270	55	-57	-0.5	6.3%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

April 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-25					
EA	2.9%	2.9%	2.2%	2.2%	300	469	496	0.826	-27	250	33	-36	8.4	93.1%
EB	0.2%	3.1%	0.2%	2.4%	300	471	496	0.826	-25	260	34	-35	9.4	92.9%
EC	0.9%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	260	34	-35	9.4	91.9%
ED	0.6%	4.6%	0.7%	4.0%	300	480	496	0.825	-16	250	35	-35	9.4	91.2%
EE	2.6%	7.1%	2.7%	6.7%	300	483	497	0.825	-14	250	34	-34	10.4	88.3%
EF	0.4%	7.6%	0.4%	7.1%	300	485	498	0.825	-13	250	32	-33	11.4	87.8%
EG	0.5%	8.1%	0.6%	7.7%	300	486	498	0.825	-12	250	31	-33	11.4	87.2%
EH	0.2%	8.3%	0.2%	7.9%	300	486	498	0.825	-12	250	30	-32	12.4	86.9%
EI	1.7%	10.0%	1.9%	9.8%	300	488	499	0.824	-11	250	26	-32	12.4	85.0%
EJ	0.5%	10.5%	0.5%	10.4%	300	489	499	0.824	-10	250	21	-32	12.4	84.4%
EK	2.8%	13.3%	3.0%	13.3%	300	491	499	0.823	-8	260	15	-31	13.4	81.2%
EL	2.6%	15.9%	2.8%	16.1%	320	489	495	0.824	-6	270	10	-36	12.4	78.4%
EM	1.1%	16.9%	1.2%	17.4%	320	492	495	0.825	-3	270	6	-35	13.4	77.3%
EN	0.5%	17.5%	0.6%	17.9%	320	493	496	0.825	-3	280	3	-35	13.4	76.7%
EO	0.9%	18.3%	0.8%	18.8%	320	495	496	0.825	-1	300	1	-35	13.4	75.8%
EP	0.9%	19.2%	0.9%	19.7%	320	496	496	0.825	0	50	1	-35	13.4	74.9%
EQ	4.7%	23.9%	5.2%	24.9%	320	501	496	0.825	5	80	7	-35	13.4	69.9%
ER	9.1%	32.9%	10.0%	35.0%	340	501	491	0.823	10	90	14	-39	13.3	60.7%
ES	1.7%	34.6%	1.9%	36.9%	340	503	490	0.824	13	90	15	-40	12.3	59.0%
ET	2.2%	36.8%	2.5%	39.4%	340	503	490	0.824	13	100	14	-40	12.3	56.8%
EU	0.1%	37.0%	0.1%	39.5%	340	503	490	0.824	13	100	14	-40	12.3	56.7%
EV	1.6%	38.6%	1.8%	41.2%	360	496	482	0.821	14	110	14	-46	10.3	55.2%
EW	1.4%	39.9%	1.5%	42.8%	360	496	482	0.821	14	110	13	-46	10.3	53.9%
EX	2.8%	42.7%	3.1%	45.8%	360	492	482	0.821	10	120	10	-46	10.3	51.3%
EY	1.3%	44.0%	1.3%	47.2%	360	486	483	0.822	3	160	4	-46	10.3	50.1%
EZ	1.1%	45.0%	1.1%	48.3%	360	481	483	0.823	-2	240	8	-46	10.3	49.1%
FA	2.1%	47.2%	2.2%	50.5%	360	475	483	0.823	-8	260	16	-47	9.3	47.2%
FB	0.7%	47.9%	0.8%	51.3%	360	471	483	0.824	-12	260	22	-47	9.3	46.5%
FC	0.4%	48.3%	0.5%	51.8%	360	466	483	0.824	-17	260	25	-47	9.3	46.1%
FD	1.8%	50.2%	1.9%	53.6%	360	462	483	0.824	-21	260	30	-47	9.3	44.4%
FE	0.3%	50.5%	0.2%	53.9%	360	457	483	0.825	-26	260	37	-47	9.3	44.2%
FF	1.4%	51.9%	1.5%	55.4%	360	457	483	0.825	-26	260	37	-47	9.3	42.9%
FG	1.1%	52.9%	1.1%	56.5%	360	453	483	0.825	-30	260	43	-47	9.3	42.0%
FH	1.4%	54.3%	1.4%	57.9%	360	449	483	0.825	-34	260	47	-47	9.3	40.7%
FI	1.8%	56.1%	1.8%	59.6%	360	445	483	0.826	-38	260	51	-48	8.3	39.1%
FJ	3.8%	60.0%	3.7%	63.3%	360	440	482	0.826	-42	260	56	-48	8.3	35.8%
FK	5.2%	65.2%	5.0%	68.3%	360	433	481	0.826	-48	260	62	-50	6.3	31.3%
FL	4.8%	70.0%	4.6%	72.9%	360	428	479	0.826	-51	270	61	-51	5.3	27.2%
FM	1.9%	71.9%	1.0%	74.0%	380	421	473	0.825	-52	270	61	-57	-0.5	25.7%
FN	3.0%	74.9%	3.4%	77.4%	380	421	473	0.825	-52	270	61	-57	-0.5	23.3%
FO	4.2%	79.0%	3.8%	81.2%	380	415	473	0.826	-58	270	60	-57	-0.5	19.9%
FP	4.2%	83.2%	3.8%	85.0%	400	412	469	0.824	-57	270	59	-59	-2.5	16.7%
FQ	4.2%	87.3%	3.9%	88.9%	400	416	470	0.825	-54	270	59	-59	-2.5	13.6%
FR	6.0%	93.3%	5.3%	94.2%	400	415	472	0.825	-57	270	59	-58	-1.5	9.2%
FS	1.7%	95.0%	1.7%	96.0%	400	415	472	0.825	-57	270	59	-58	-1.5	7.9%
FT	0.1%	95.1%	0.1%	96.0%	400	415	472	0.825	-57	270	59	-58	-1.5	7.8%
FU	1.6%	96.7%	1.5%	97.5%	400	418	474	0.826	-56	270	60	-56	0.5	6.7%
FV	0.1%	96.8%	0.1%	97.6%	400	429	474	0.826	-45	270	60	-56	0.5	6.6%
FX	0.3%	97.1%	0.3%	97.9%	400	430	474	0.826	-44	270	60	-56	0.5	6.3%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

May 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-19					
EA	2.8%	2.8%	2.2%	2.2%	320	459	488	0.823	-29	250	37	-42	6.36	92.6%
EB	0.2%	3.0%	0.2%	2.4%	320	460	488	0.823	-28	260	37	-42	6.4	92.3%
EC	1.0%	4.0%	0.9%	3.3%	320	457	488	0.823	-31	250	38	-41	7.4	91.2%
ED	0.6%	4.6%	0.7%	4.0%	320	471	488	0.823	-17	250	40	-41	7.4	90.5%
EE	2.6%	7.2%	2.7%	6.7%	320	473	489	0.823	-16	250	42	-40	8.4	87.7%
EF	0.4%	7.6%	0.4%	7.1%	320	475	490	0.823	-15	250	43	-39	9.4	87.2%
EG	0.5%	8.2%	0.6%	7.7%	320	475	491	0.824	-16	250	43	-39	9.4	86.6%
EH	0.2%	8.4%	0.2%	7.9%	320	476	491	0.824	-15	250	43	-39	9.4	86.3%
EI	1.8%	10.2%	1.9%	9.8%	320	477	492	0.824	-15	250	41	-39	9.4	84.3%
EJ	0.5%	10.8%	0.5%	10.4%	320	477	492	0.824	-15	250	39	-38	10.4	83.7%
EK	2.8%	13.6%	3.0%	13.3%	320	481	493	0.824	-12	250	34	-38	10.4	80.7%
EL	2.6%	16.1%	2.8%	16.1%	320	486	494	0.825	-8	250	26	-37	11.4	77.9%
EM	1.2%	17.3%	1.2%	17.4%	320	488	495	0.825	-7	250	20	-36	12.4	76.6%
EN	0.5%	17.9%	0.6%	17.9%	320	490	495	0.825	-5	240	17	-36	12.4	76.1%
EO	0.8%	18.6%	0.8%	18.8%	320	491	495	0.825	-4	240	14	-36	12.4	75.3%
EP	1.0%	19.6%	0.9%	19.7%	320	492	495	0.825	-3	240	12	-36	12.4	74.2%
EQ	4.7%	24.3%	5.2%	24.9%	320	495	495	0.825	0	230	4	-36	12.4	69.2%
ER	9.3%	33.6%	10.0%	35.0%	340	495	490	0.823	5	70	9	-40	12.3	59.9%
ES	1.7%	35.3%	1.9%	36.9%	340	499	489	0.824	10	80	12	-41	11.3	58.2%
ET	2.3%	37.6%	2.5%	39.4%	340	501	490	0.824	11	90	13	-41	11.3	55.9%
EU	0.1%	37.7%	0.1%	39.5%	340	501	490	0.824	11	90	13	-41	11.3	55.8%
EV	1.6%	39.3%	1.8%	41.2%	360	495	482	0.821	13	90	15	-46	10.3	54.3%
EW	1.4%	40.7%	1.5%	42.8%	360	497	482	0.821	15	100	16	-46	10.3	53.0%
EX	2.9%	43.6%	3.1%	45.8%	360	494	482	0.821	12	100	14	-47	9.3	50.3%
EY	1.2%	44.8%	1.3%	47.2%	360	492	482	0.822	10	110	11	-47	9.3	49.2%
EZ	1.1%	45.9%	1.1%	48.3%	360	490	482	0.822	8	120	9	-47	9.3	48.2%
FA	2.0%	47.9%	2.2%	50.5%	360	487	482	0.823	5	160	5	-47	9.3	46.3%
FB	0.8%	48.7%	0.8%	51.3%	360	484	482	0.823	2	220	8	-47	9.3	45.6%
FC	0.4%	49.1%	0.5%	51.8%	360	481	483	0.823	-2	230	10	-47	9.3	45.2%
FD	1.8%	50.9%	1.9%	53.6%	360	477	483	0.824	-6	240	15	-47	9.3	43.6%
FE	0.2%	51.1%	0.2%	53.9%	360	471	483	0.824	-12	250	24	-47	9.3	43.4%
FF	1.4%	52.5%	1.5%	55.4%	360	471	483	0.824	-12	250	24	-47	9.3	42.2%
FG	1.1%	53.6%	1.1%	56.5%	360	464	483	0.825	-19	250	32	-47	9.3	41.2%
FH	1.4%	55.0%	1.4%	57.9%	360	458	483	0.825	-25	260	39	-47	9.3	40.0%
FI	1.8%	56.8%	1.8%	59.6%	360	449	483	0.825	-34	260	48	-48	8.3	38.3%
FJ	3.9%	60.7%	3.7%	63.3%	360	437	482	0.826	-45	260	61	-49	7.3	35.0%
FK	5.3%	66.0%	5.0%	68.3%	360	434	481	0.826	-47	260	65	-50	6.3	30.5%
FL	4.6%	70.6%	4.6%	72.9%	360	446	478	0.825	-32	260	42	-52	4.3	26.5%
FM	1.4%	72.0%	1.0%	74.0%	380	448	472	0.824	-24	270	29	-57	-0.5	25.4%
FN	3.2%	75.2%	3.4%	77.4%	380	448	472	0.824	-24	270	29	-57	-0.5	22.8%
FO	3.9%	79.1%	3.8%	81.2%	380	445	471	0.825	-26	290	26	-58	-1.5	19.8%
FP	4.0%	83.1%	3.8%	85.0%	380	440	471	0.826	-31	290	31	-59	-2.5	16.6%
FQ	4.1%	87.2%	3.9%	88.9%	400	430	467	0.823	-37	280	38	-62	-5.5	13.5%
FR	5.9%	93.1%	5.3%	94.2%	400	419	468	0.825	-49	280	50	-61	-4.5	9.2%
FS	1.7%	94.8%	1.7%	96.0%	400	419	468	0.825	-49	280	50	-61	-4.5	7.9%
FT	0.1%	94.9%	0.1%	96.0%	400	419	468	0.825	-49	280	50	-61	-4.5	7.8%
FU	1.6%	96.6%	1.5%	97.5%	400	417	470	0.826	-53	280	56	-60	-3.5	6.7%
FV	0.1%	96.7%	0.1%	97.6%	400	425	470	0.826	-45	280	57	-59	-2.5	6.6%
FX	0.3%	97.0%	0.3%	97.9%	400	425	471	0.826	-46	280	58	-59	-2.5	6.3%
LDG	3.0%	100.0%	2.1%	100.0%										5.2%

May 85% Route 1

Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-22					
EA	2.9%	2.9%	2.2%	2.2%	300	460	494	0.826	-34	260	39	-37	7.4	92.5%
EB	0.2%	3.1%	0.2%	2.4%	300	462	494	0.826	-32	260	39	-37	7.4	92.2%
EC	1.0%	4.1%	0.9%	3.3%	300	459	494	0.826	-35	260	40	-37	7.4	91.1%
ED	0.6%	4.7%	0.7%	4.0%	300	472	495	0.826	-23	260	41	-36	8.4	90.4%
EE	2.6%	7.3%	2.7%	6.7%	300	475	496	0.825	-21	260	42	-35	9.4	87.5%
EF	0.4%	7.7%	0.4%	7.1%	300	477	497	0.825	-20	260	43	-34	10.4	87.0%
EG	0.5%	8.3%	0.6%	7.7%	300	478	497	0.825	-19	250	43	-34	10.4	86.4%
EH	0.2%	8.5%	0.2%	7.9%	300	478	497	0.825	-19	250	43	-34	10.4	86.2%
EI	1.8%	10.3%	1.9%	9.8%	300	480	497	0.825	-17	250	41	-34	10.4	84.1%
EJ	0.4%	10.7%	0.5%	10.4%	300	481	498	0.824	-17	250	38	-33	11.4	83.6%
EK	2.8%	13.5%	3.0%	13.3%	300	484	498	0.823	-14	250	34	-32	12.4	80.5%
EL	2.7%	16.2%	2.8%	16.1%	300	489	498	0.823	-9	250	27	-32	12.4	77.6%
EM	1.1%	17.3%	1.2%	17.4%	300	491	499	0.823	-8	240	23	-31	13.4	76.4%
EN	0.5%	17.8%	0.6%	17.9%	300	493	499	0.822	-6	240	21	-31	13.4	75.8%
EO	0.9%	18.7%	0.8%	18.8%	320	496	496	0.825	0	260	18	-36	12.4	74.9%
EP	0.9%	19.5%	0.9%	19.7%	320	489	496	0.825	-7	250	15	-36	12.4	73.9%
EQ	4.7%	24.2%	5.2%	24.9%	320	493	496	0.825	-3	240	6	-36	12.4	68.9%
ER	9.2%	33.5%	10.0%	35.0%	340	495	489	0.823	6	70	11	-41	11.3	59.7%
ES	1.7%	35.2%	1.9%	36.9%	340	502	490	0.824	12	90	14	-41	11.3	58.1%
ET	2.4%	37.6%	2.5%	39.4%	340	503	490	0.824	13	90	15	-40	12.3	55.7%
EU	0.0%	37.6%	0.1%	39.5%	340	503	490	0.824	13	90	15	-40	12.3	55.7%
EV	1.6%	39.2%	1.8%	41.2%	360	497	482	0.821	15	90	17	-46	10.3	54.2%
EW	1.4%	40.6%	1.5%	42.8%	360	499	482	0.821	17	90	18	-46	10.3	52.9%
EX	2.8%	43.3%	3.1%	45.8%	360	496	482	0.821	14	90	17	-46	10.3	50.3%
EY	1.3%	44.6%	1.3%	47.2%	360	493	482	0.822	11	100	15	-46	10.3	49.1%
EZ	1.1%	45.7%	1.1%	48.3%	360	492	482	0.822	10	100	12	-46	10.3	48.2%
FA	2.0%	47.7%	2.2%	50.5%	360	486	483	0.822	3	140	4	-47	9.3	46.3%
FB	0.8%	48.5%	0.8%	51.3%	360	480	483	0.823	-3	240	9	-47	9.3	45.6%
FC	0.4%	48.9%	0.5%	51.8%	360	477	483	0.824	-6	250	12	-47	9.3	45.2%
FD	1.8%	50.8%	1.9%	53.6%	360	473	483	0.824	-10	250	17	-47	9.3	43.6%
FE	0.2%	51.0%	0.2%	53.9%	360	467	483	0.824	-16	260	26	-47	9.3	43.4%
FF	1.5%	52.5%	1.5%	55.4%	360	467	483	0.824	-16	260	26	-47	9.3	42.1%
FG	1.1%	53.5%	1.1%	56.5%	360	460	483	0.825	-23	260	34	-47	9.3	41.1%
FH	1.4%	54.9%	1.4%	57.9%	360	453	483	0.825	-30	260	42	-47	9.3	39.9%
FI	1.8%	56.8%	1.8%	59.6%	360	444	483	0.826	-39	260	52	-47	9.3	38.3%
FJ	3.9%	60.6%	3.7%	63.3%	360	432	483	0.826	-51	260	65	-48	8.3	34.9%
FK	5.4%	66.0%	5.0%	68.3%	360	427	481	0.826	-54	260	70	-50	6.3	30.4%
FL	4.7%	70.7%	4.6%	72.9%	360	440	479	0.825	-39	270	47	-52	4.3	26.4%
FM	1.4%	72.1%	1.0%	74.0%	380	444	473	0.825	-29	270	35	-57	-0.5	25.3%
FN	3.2%	75.3%	3.4%	77.4%	380	444	473	0.825	-29	270	35	-57	-0.5	22.7%
FO	3.9%	79.2%	3.8%	81.2%	380	442	472	0.825	-30	270	31	-58	-1.5	19.7%
FP	4.0%	83.2%	3.8%	85.0%	380	438	472	0.826	-34	280	34	-58	-1.5	16.5%
FQ	4.1%	87.2%	3.9%	88.9%	400	429	468	0.824	-39	270	41	-61	-4.5	13.5%
FR	6.0%	93.2%	5.3%	94.2%	400	417	469	0.825	-52	270	54	-60	-3.5	9.1%
FS	1.7%	95.0%	1.7%	96.0%	400	417	469	0.825	-52	270	54	-60	-3.5	7.8%
FT	0.1%	95.1%	0.1%	96.0%	400	417	469	0.825	-52	270	54	-60	-3.5	7.7%
FU	1.6%	96.7%	1.5%	97.5%	400	415	471	0.826	-56	270	62	-59	-2.5	6.6%
FV	0.1%	96.8%	0.1%	97.6%	400	427	471	0.826	-44	270	63	-58	-1.5	6.5%
FX	0.3%	97.1%	0.3%	97.9%	400	426	472	0.826	-46	270	63	-58	-1.5	6.3%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

June 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-14					
EA	3.0%	3.0%	2.2%	2.2%	300	445	495	0.826	-50	260	57	-36	8.4	94.5%
EB	0.2%	3.2%	0.2%	2.4%	300	448	495	0.826	-47	270	56	-36	8.4	94.3%
EC	0.9%	4.1%	0.9%	3.3%	300	444	495	0.826	-51	270	55	-36	8.4	93.3%
ED	0.8%	4.9%	0.7%	4.0%	300	459	496	0.826	-37	270	54	-36	8.4	92.4%
EE	2.6%	7.5%	2.7%	6.7%	300	464	496	0.825	-32	270	48	-35	9.4	89.4%
EF	0.4%	7.9%	0.4%	7.1%	300	468	497	0.825	-29	270	42	-34	10.4	88.9%
EG	0.5%	8.4%	0.6%	7.7%	300	470	497	0.825	-27	270	40	-34	10.4	88.2%
EH	0.2%	8.6%	0.2%	7.9%	300	471	497	0.825	-26	270	39	-34	10.4	88.0%
EI	1.8%	10.5%	1.9%	9.8%	300	474	497	0.825	-23	270	35	-34	10.4	85.9%
EJ	0.5%	11.0%	0.5%	10.4%	300	477	498	0.824	-21	270	30	-33	11.4	85.2%
EK	2.8%	13.8%	3.0%	13.3%	300	483	498	0.823	-15	270	24	-33	11.4	82.0%
EL	2.7%	16.5%	2.8%	16.1%	320	482	498	0.825	-16	270	18	-37	11.4	79.0%
EM	1.1%	17.6%	1.2%	17.4%	320	485	494	0.825	-9	270	12	-37	11.4	77.8%
EN	0.6%	18.3%	0.6%	17.9%	320	487	494	0.825	-7	270	10	-37	11.4	77.1%
EO	0.8%	19.0%	0.8%	18.8%	320	488	494	0.825	-6	280	9	-37	11.4	76.2%
EP	0.9%	19.9%	0.9%	19.7%	320	489	494	0.825	-5	280	7	-37	11.4	75.3%
EQ	4.9%	24.7%	5.2%	24.9%	320	491	494	0.825	-3	300	3	-37	11.4	70.0%
ER	9.4%	34.1%	10.0%	35.0%	340	489	488	0.823	1	40	9	-42	10.3	60.4%
ES	1.7%	35.9%	1.9%	36.9%	340	493	489	0.824	4	60	9	-41	11.3	58.6%
ET	2.4%	38.3%	2.5%	39.4%	360	489	481	0.824	8	80	12	-47	9.3	56.3%
EU	0.1%	38.4%	0.1%	39.5%	360	489	481	0.824	8	80	12	-47	9.3	56.2%
EV	1.6%	40.0%	1.8%	41.2%	360	492	481	0.824	11	90	12	-47	9.3	54.6%
EW	1.4%	41.4%	1.5%	42.8%	360	492	481	0.824	11	100	11	-47	9.3	53.3%
EX	2.9%	44.3%	3.1%	45.8%	360	490	482	0.824	8	100	10	-47	9.3	50.5%
EY	1.3%	45.6%	1.3%	47.2%	360	490	482	0.824	8	110	8	-47	9.3	49.3%
EZ	1.0%	46.6%	1.1%	48.3%	360	490	482	0.824	8	110	7	-47	9.3	48.4%
FA	2.2%	48.7%	2.2%	50.5%	360	488	482	0.824	6	120	6	-47	9.3	46.3%
FB	0.8%	49.5%	0.8%	51.3%	360	487	482	0.823	5	150	4	-47	9.3	45.6%
FC	0.3%	49.8%	0.5%	51.8%	360	485	483	0.823	2	160	4	-47	9.3	45.3%
FD	1.8%	51.7%	1.9%	53.6%	360	483	483	0.823	0	210	4	-47	9.3	43.7%
FE	0.2%	51.9%	0.2%	53.9%	360	479	483	0.824	-4	240	8	-47	9.3	43.5%
FF	1.4%	53.3%	1.5%	55.4%	360	479	483	0.824	-4	240	8	-47	9.3	42.2%
FG	1.1%	54.4%	1.1%	56.5%	360	475	483	0.824	-8	250	13	-47	9.3	41.2%
FH	1.3%	55.7%	1.4%	57.9%	360	470	483	0.825	-13	260	19	-48	8.3	40.0%
FI	1.8%	57.5%	1.8%	59.6%	360	464	483	0.825	-19	260	26	-48	8.3	38.4%
FJ	3.7%	61.2%	3.7%	63.3%	360	455	482	0.825	-27	260	35	-48	8.3	35.1%
FK	5.1%	66.2%	5.0%	68.3%	360	453	481	0.826	-28	270	36	-50	6.3	30.6%
FL	4.6%	70.9%	4.6%	72.9%	380	453	474	0.824	-21	270	24	-55	1.5	26.7%
FM	1.0%	71.9%	1.0%	74.0%	380	461	473	0.824	-12	290	12	-56	0.5	25.9%
FN	3.5%	75.3%	3.4%	77.4%	380	461	473	0.824	-12	290	12	-56	0.5	23.0%
FO	3.8%	79.1%	3.8%	81.2%	380	461	473	0.825	-12	310	13	-57	-0.5	19.9%
FP	3.9%	83.0%	3.8%	85.0%	380	455	473	0.825	-18	310	19	-57	-0.5	16.8%
FQ	4.0%	87.0%	3.9%	88.9%	400	442	468	0.823	-26	290	26	-60	-3.5	13.7%
FR	5.5%	92.5%	5.3%	94.2%	400	438	470	0.824	-32	280	32	-59	-2.5	9.5%
FS	1.8%	94.3%	1.7%	96.0%	400	438	470	0.824	-32	280	32	-59	-2.5	8.1%
FT	0.1%	94.4%	0.1%	96.0%	400	438	470	0.824	-32	280	32	-59	-2.5	8.0%
FU	1.5%	96.0%	1.5%	97.5%	400	441	471	0.825	-30	290	30	-59	-2.5	6.9%
FV	0.2%	96.1%	0.1%	97.6%	400	444	471	0.825	-27	290	30	-59	-2.5	6.8%
FX	0.2%	96.3%	0.3%	97.9%	400	443	471	0.825	-28	290	31	-59	-2.5	6.6%
LDG	3.7%	100.0%	2.1%	100.0%										5.3%

June 85% Route 1

Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-16					
EA	3.0%	3.0%	2.2%	2.2%	300	440	496	0.826	-56	270	61	-36	8.4	94.5%
EB	0.2%	3.2%	0.2%	2.4%	300	442	496	0.826	-54	270	61	-36	8.4	94.3%
EC	1.0%	4.2%	0.9%	3.3%	300	439	496	0.826	-57	270	59	-36	8.4	93.2%
ED	0.6%	4.8%	0.7%	4.0%	300	455	496	0.826	-41	270	59	-35	9.4	92.4%
EE	2.7%	7.5%	2.7%	6.7%	300	462	497	0.825	-35	270	53	-35	9.4	89.3%
EF	0.3%	7.8%	0.4%	7.1%	300	468	497	0.825	-29	270	47	-34	10.4	88.9%
EG	0.6%	8.5%	0.6%	7.7%	300	470	498	0.825	-28	270	45	-34	10.4	88.1%
EH	0.2%	8.7%	0.2%	7.9%	300	471	498	0.825	-27	270	43	-34	10.4	87.9%
EI	1.8%	10.5%	1.9%	9.8%	300	473	498	0.825	-25	270	39	-33	11.4	85.8%
EJ	0.5%	11.1%	0.5%	10.4%	300	474	498	0.825	-24	270	35	-33	11.4	85.2%
EK	2.8%	13.9%	3.0%	13.3%	300	478	498	0.824	-20	270	29	-33	11.4	81.9%
EL	2.7%	16.6%	2.8%	16.1%	320	478	494	0.825	-16	270	23	-37	11.4	78.9%
EM	1.2%	17.7%	1.2%	17.4%	320	482	494	0.825	-12	270	17	-37	11.4	77.6%
EN	0.5%	18.3%	0.6%	17.9%	320	484	495	0.825	-11	270	15	-37	11.4	77.0%
EO	0.8%	19.0%	0.8%	18.8%	320	485	495	0.825	-10	270	13	-37	11.4	76.2%
EP	0.9%	19.9%	0.9%	19.7%	320	486	495	0.825	-9	270	11	-36	12.4	75.2%
EQ	4.9%	24.8%	5.2%	24.9%	340	481	487	0.822	-6	310	6	-42	10.3	70.0%
ER	9.3%	34.2%	10.0%	35.0%	340	492	488	0.823	4	60	10	-42	10.3	60.4%
ES	1.7%	35.9%	1.9%	36.9%	340	496	489	0.824	7	70	10	-41	11.3	58.6%
ET	2.4%	38.3%	2.5%	39.4%	360	491	481	0.821	10	80	13	-47	9.3	56.3%
EU	0.0%	38.3%	0.1%	39.5%	360	491	481	0.821	10	80	13	-47	9.3	56.3%
EV	1.7%	40.0%	1.8%	41.2%	360	493	481	0.821	12	90	14	-47	9.3	54.6%
EW	1.4%	41.4%	1.5%	42.8%	360	493	481	0.821	12	90	13	-47	9.3	53.3%
EX	2.8%	44.2%	3.1%	45.8%	360	491	482	0.822	9	100	11	-47	9.3	50.6%
EY	1.3%	45.5%	1.3%	47.2%	360	490	482	0.822	8	100	10	-47	9.3	49.4%
EZ	1.1%	46.6%	1.1%	48.3%	360	489	482	0.823	7	100	9	-47	9.3	48.4%
FA	2.0%	48.6%	2.2%	50.5%	360	488	482	0.823	6	100	7	-47	9.3	46.5%
FB	0.8%	49.4%	0.8%	51.3%	360	487	483	0.823	4	120	4	-47	9.3	45.8%
FC	0.4%	49.8%	0.5%	51.8%	360	485	483	0.823	2	150	2	-47	9.3	45.4%
FD	1.7%	51.5%	1.9%	53.6%	360	481	483	0.824	-2	240	4	-47	9.3	43.8%
FE	0.2%	51.7%	0.2%	53.9%	360	476	483	0.824	-7	260	10	-47	9.3	43.6%
FF	1.5%	53.2%	1.5%	55.4%	360	476	483	0.824	-7	260	10	-47	9.3	42.2%
FG	1.1%	54.3%	1.1%	56.5%	360	471	483	0.825	-12	260	16	-47	9.3	41.2%
FH	1.3%	55.6%	1.4%	57.9%	360	467	483	0.825	-16	260	21	-47	9.3	40.1%
FI	1.7%	57.3%	1.8%	59.6%	360	460	483	0.825	-23	270	29	-48	8.3	38.5%
FJ	3.8%	61.1%	3.7%	63.3%	360	451	482	0.826	-31	270	39	-48	8.3	35.2%
FK	5.2%	66.2%	5.0%	68.3%	360	448	481	0.826	-33	270	41	-49	7.3	30.6%
FL	4.6%	70.9%	4.6%	72.9%	380	451	475	0.824	-24	270	29	-55	1.5	26.7%
FM	1.1%	71.9%	1.0%	74.0%	380	460	474	0.824	-14	270	16	-56	0.5	25.8%
FN	3.3%	75.3%	3.4%	77.4%	380	460	474	0.824	-14	270	16	-56	0.5	23.0%
FO	3.9%	79.1%	3.8%	81.2%	380	458	473	0.825	-15	290	15	-57	-0.5	19.9%
FP	3.8%	82.9%	3.8%	85.0%	380	452	473	0.825	-21	290	21	-56	0.5	16.8%
FQ	4.0%	86.9%	3.9%	88.9%	400	441	469	0.823	-28	270	30	-60	-3.5	13.7%
FR	5.6%	92.5%	5.3%	94.2%	400	435	471	0.824	-36	270	37	-59	-2.5	9.5%
FS	1.8%	94.3%	1.7%	96.0%	400	435	471	0.824	-36	270	37	-59	-2.5	8.1%
FT	0.0%	94.3%	0.1%	96.0%	400	435	471	0.824	-36	270	37	-59	-2.5	8.1%
FU	1.6%	95.9%	1.5%	97.5%	400	440	472	0.825	-32	280	34	-58	-1.5	6.9%
FV	0.1%	96.0%	0.1%	97.6%	400	446	472	0.825	-26	280	34	-58	-1.5	6.8%
FX	0.2%	96.2%	0.3%	97.9%	400	446	472	0.825	-26	280	35	-58	-1.5	6.6%
LDG	3.8%	100.0%	2.1%	100.0%										5.4%

July 50% Route 1															
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-8					
EA	3.1%	3.1%	2.2%	2.2%	300	435	493	0.826	-58	270	64	-38	6.4	94.5%
EB	0.2%	3.3%	0.2%	2.4%	300	437	493	0.826	-56	270	64	-38	6.4	94.2%
EC	1.0%	4.3%	0.9%	3.3%	300	434	493	0.826	-59	270	64	-38	6.4	93.1%
ED	0.7%	4.9%	0.7%	4.0%	300	451	494	0.826	-43	270	64	-38	6.4	92.3%
EE	2.7%	7.6%	2.7%	6.7%	300	457	495	0.826	-38	270	61	-36	8.4	89.1%
EF	0.4%	8.1%	0.4%	7.1%	300	461	496	0.826	-35	260	59	-35	9.4	88.6%
EG	0.7%	8.7%	0.6%	7.7%	300	463	496	0.825	-33	260	57	-35	9.4	87.9%
EH	0.1%	8.8%	0.2%	7.9%	300	464	496	0.825	-32	260	56	-35	9.4	87.8%
EI	2.0%	10.8%	1.9%	9.8%	300	467	497	0.825	-30	260	53	-34	10.4	85.5%
EJ	0.5%	11.4%	0.5%	10.4%	300	469	497	0.825	-28	260	49	-34	10.4	84.9%
EK	2.8%	14.2%	3.0%	13.3%	300	475	497	0.824	-22	260	42	-33	11.4	81.6%
EL	2.7%	16.9%	2.8%	16.1%	320	474	493	0.825	-19	270	23	-38	10.4	78.6%
EM	1.2%	18.1%	1.2%	17.4%	320	478	494	0.825	-16	270	19	-38	10.4	77.3%
EN	0.5%	18.7%	0.6%	17.9%	320	481	494	0.825	-13	270	16	-37	11.4	76.7%
EO	0.9%	19.5%	0.8%	18.8%	320	483	494	0.825	-11	270	12	-37	11.4	75.7%
EP	0.9%	20.4%	0.9%	19.7%	320	485	494	0.825	-9	340	6	-37	11.4	74.7%
EQ	5.0%	25.4%	5.2%	24.9%	340	481	486	0.822	-5	60	16	-43	9.3	69.5%
ER	9.4%	34.8%	10.0%	35.0%	340	493	487	0.823	6	70	25	-43	9.3	59.9%
ES	1.7%	36.6%	1.9%	36.9%	360	493	480	0.82	13	70	24	-48	8.3	58.2%
ET	2.4%	39.0%	2.5%	39.4%	360	494	480	0.821	14	70	24	-48	8.3	55.8%
EU	0.1%	39.1%	0.1%	39.5%	360	494	480	0.821	14	70	23	-48	8.3	55.7%
EV	1.6%	40.7%	1.8%	41.2%	360	497	480	0.821	17	80	23	-48	8.3	54.2%
EW	1.4%	42.1%	1.5%	42.8%	360	498	480	0.821	18	80	22	-48	8.3	52.8%
EX	2.8%	45.0%	3.1%	45.8%	360	494	480	0.822	14	90	21	-48	8.3	50.1%
EY	1.2%	46.2%	1.3%	47.2%	360	494	481	0.822	13	90	20	-48	8.3	49.0%
EZ	1.1%	47.3%	1.1%	48.3%	360	494	481	0.822	13	90	19	-48	8.3	48.0%
FA	2.1%	49.3%	2.2%	50.5%	360	494	481	0.823	13	100	17	-47	9.3	46.1%
FB	0.8%	50.1%	0.8%	51.3%	360	494	482	0.823	12	100	16	-47	9.3	45.4%
FC	0.4%	50.5%	0.5%	51.8%	360	495	482	0.823	13	100	15	-47	9.3	45.0%
FD	1.7%	52.3%	1.9%	53.6%	360	494	482	0.823	12	100	14	-47	9.3	43.4%
FE	0.2%	52.5%	0.2%	53.9%	360	493	482	0.823	11	110	12	-47	9.3	43.2%
FF	1.4%	53.9%	1.5%	55.4%	360	493	482	0.823	11	110	12	-47	9.3	41.9%
FG	1.0%	54.9%	1.1%	56.5%	360	482	482	0.824	0	120	10	-47	9.3	41.0%
FH	1.3%	56.2%	1.4%	57.9%	360	482	482	0.824	0	120	8	-48	8.3	39.8%
FI	1.7%	58.0%	1.8%	59.6%	360	482	482	0.824	0	140	5	-48	8.3	38.1%
FJ	3.5%	61.5%	3.7%	63.3%	380	477	475	0.821	2	200	6	-53	3.5	35.1%
FK	5.0%	66.5%	5.0%	68.3%	380	467	475	0.822	-8	240	16	-53	3.5	30.8%
FL	4.6%	71.1%	4.6%	72.9%	380	463	475	0.823	-12	240	24	-54	2.5	26.9%
FM	0.9%	71.9%	1.0%	74.0%	380	470	475	0.824	-5	250	8	-54	2.5	26.2%
FN	3.5%	75.4%	3.4%	77.4%	380	470	475	0.824	-5	250	8	-54	2.5	23.3%
FO	3.8%	79.3%	3.8%	81.2%	380	475	476	0.824	-1	20	12	-54	2.5	20.1%
FP	3.7%	83.0%	3.8%	85.0%	400	466	470	0.821	-4	10	21	-58	-1.5	17.2%
FQ	3.9%	86.9%	3.9%	88.9%	400	459	470	0.822	-11	330	14	-58	-1.5	14.1%
FR	5.5%	92.4%	5.3%	94.2%	400	446	472	0.824	-26	260	28	-57	-0.5	9.9%
FS	1.9%	94.2%	1.7%	96.0%	400	446	472	0.824	-26	260	28	-57	-0.5	8.5%
FT	0.0%	94.2%	0.1%	96.0%	400	446	472	0.824	-26	260	28	-57	-0.5	8.5%
FU	1.6%	95.9%	1.5%	97.5%	400	438	474	0.825	-36	260	42	-56	0.5	7.3%
FV	0.1%	96.0%	0.1%	97.6%	400	447	474	0.825	-27	260	45	-56	0.5	7.2%
FX	0.2%	96.2%	0.3%	97.9%	400	447	474	0.825	-27	260	46	-56	0.5	7.1%
LDG	3.8%	100.0%	2.1%	100.0%										5.8%

July 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-9					
EA	2.9%	2.9%	2.2%	2.2%	280	436	494	0.820	-58	270	64	-34	6.44	94.6%
EB	0.2%	3.2%	0.2%	2.4%	280	438	494	0.820	-56	270	64	-34	6.4	94.4%
EC	1.0%	4.1%	0.9%	3.3%	280	434	495	0.820	-61	270	63	-33	7.4	93.1%
ED	0.8%	4.9%	0.7%	4.0%	300	444	495	0.826	-51	270	70	-37	7.4	92.3%
EE	2.7%	7.6%	2.7%	6.7%	300	450	495	0.826	-45	270	67	-36	8.4	89.1%
EF	0.4%	8.1%	0.4%	7.1%	300	455	496	0.826	-41	270	63	-35	9.4	88.6%
EG	0.7%	8.7%	0.6%	7.7%	300	457	497	0.826	-40	270	62	-35	9.4	87.8%
EH	0.2%	8.9%	0.2%	7.9%	300	458	497	0.826	-39	270	61	-35	9.4	87.5%
EI	1.9%	10.8%	1.9%	9.8%	300	461	497	0.825	-36	270	57	-34	10.4	85.3%
EJ	0.5%	11.3%	0.5%	10.4%	320	455	492	0.825	-38	270	55	-38	10.4	84.7%
EK	3.1%	14.4%	3.0%	13.3%	320	463	493	0.825	-30	270	47	-38	10.4	81.3%
EL	2.7%	17.1%	2.8%	16.1%	320	472	493	0.825	-21	270	35	-38	10.4	78.3%
EM	1.1%	18.2%	1.2%	17.4%	320	476	494	0.825	-18	270	26	-37	11.4	77.1%
EN	0.7%	18.9%	0.6%	17.9%	320	478	494	0.826	-16	270	22	-37	11.4	76.4%
EO	0.8%	19.6%	0.8%	18.8%	320	480	494	0.825	-14	270	19	-37	11.4	75.6%
EP	0.9%	20.5%	0.9%	19.7%	320	483	494	0.825	-11	270	16	-37	11.4	74.5%
EQ	5.0%	25.5%	5.2%	24.9%	340	481	486	0.822	-5	310	5	-43	9.3	69.3%
ER	9.4%	34.9%	10.0%	35.0%	340	496	487	0.823	9	70	17	-43	9.3	59.7%
ES	1.7%	36.6%	1.9%	36.9%	360	496	480	0.82	16	70	27	-48	8.3	58.0%
ET	2.4%	39.0%	2.5%	39.4%	360	497	480	0.821	17	80	26	-48	8.3	55.6%
EU	0.0%	39.0%	0.1%	39.5%	360	497	480	0.821	17	80	26	-48	8.3	55.6%
EV	1.6%	40.7%	1.8%	41.2%	360	501	480	0.821	21	80	25	-48	8.3	54.1%
EW	1.4%	42.1%	1.5%	42.8%	360	501	480	0.821	21	90	25	-48	8.3	52.7%
EX	2.8%	44.9%	3.1%	45.8%	360	496	481	0.821	15	90	23	-48	8.3	50.0%
EY	1.3%	46.2%	1.3%	47.2%	360	495	481	0.822	14	90	22	-47	9.3	48.8%
EZ	1.1%	47.3%	1.1%	48.3%	360	495	481	0.822	14	90	21	-47	9.3	47.8%
FA	2.1%	49.4%	2.2%	50.5%	360	494	482	0.823	12	90	19	-47	9.3	45.9%
FB	0.7%	50.1%	0.8%	51.3%	360	494	482	0.823	12	90	17	-47	9.3	45.3%
FC	0.4%	50.5%	0.5%	51.8%	360	495	482	0.823	13	90	17	-47	9.3	44.9%
FD	1.7%	52.2%	1.9%	53.6%	360	495	482	0.823	13	100	15	-47	9.3	43.3%
FE	0.2%	52.5%	0.2%	53.9%	360	494	482	0.823	12	100	13	-47	9.3	43.1%
FF	1.4%	53.9%	1.5%	55.4%	360	494	482	0.823	12	100	13	-47	9.3	41.8%
FG	1.1%	55.0%	1.1%	56.5%	360	494	482	0.824	12	100	11	-47	9.3	40.8%
FH	1.3%	56.3%	1.4%	57.9%	360	491	482	0.824	9	100	9	-47	9.3	39.6%
FI	1.6%	57.9%	1.8%	59.6%	360	488	482	0.824	6	100	6	-48	8.3	38.0%
FJ	3.6%	61.5%	3.7%	63.3%	380	474	475	0.821	-1	230	5	-52	4.5	34.9%
FK	5.0%	66.5%	5.0%	68.3%	380	463	476	0.822	-13	260	19	-53	3.5	30.6%
FL	4.6%	71.1%	4.6%	72.9%	380	459	476	0.823	-17	250	26	-53	3.5	26.7%
FM	0.9%	72.0%	1.0%	74.0%	380	468	476	0.824	-8	260	10	-53	3.5	26.0%
FN	3.6%	75.6%	3.4%	77.4%	380	468	476	0.824	-8	260	10	-53	3.5	23.0%
FO	3.7%	79.3%	3.8%	81.2%	380	481	476	0.824	5	50	10	-53	3.5	19.9%
FP	3.7%	83.0%	3.8%	85.0%	400	471	470	0.824	1	20	18	-57	-0.5	16.9%
FQ	3.9%	86.9%	3.9%	88.9%	400	458	470	0.822	-12	320	13	-58	-1.5	13.9%
FR	5.6%	92.5%	5.3%	94.2%	400	442	472	0.824	-30	270	32	-57	-0.5	9.6%
FS	1.7%	94.2%	1.7%	96.0%	400	442	472	0.824	-30	270	32	-57	-0.5	8.2%
FT	0.1%	94.3%	0.1%	96.0%	400	442	472	0.824	-30	270	32	-57	-0.5	8.2%
FU	1.5%	95.9%	1.5%	97.5%	400	432	474	0.825	-42	270	47	-55	1.5	7.0%
FV	0.1%	96.0%	0.1%	97.6%	400	440	475	0.825	-35	270	50	-55	1.5	6.9%
FX	0.3%	96.3%	0.3%	97.9%	400	440	475	0.825	-35	270	51	-55	1.5	6.7%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

August 50% Route 1														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Component (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-2					
EA	3.1%	3.1%	2.2%	2.2%	300	436	495	0.826	-59	260	67	-37	7.4	94.4%
EB	0.2%	3.3%	0.2%	2.4%	300	439	495	0.826	-56	260	67	-36	8.4	94.1%
EC	1.0%	4.3%	0.9%	3.3%	300	435	495	0.826	-60	260	67	-36	8.4	93.0%
ED	0.7%	5.0%	0.7%	4.0%	300	456	495	0.826	-39	260	66	-36	8.4	92.2%
EE	2.8%	7.8%	2.7%	6.7%	300	463	496	0.825	-33	260	59	-35	9.4	89.0%
EF	0.4%	8.2%	0.4%	7.1%	300	469	497	0.825	-28	260	53	-35	9.4	88.5%
EG	0.6%	8.8%	0.6%	7.7%	300	471	497	0.825	-26	260	50	-35	9.4	87.8%
EH	0.2%	9.0%	0.2%	7.9%	300	473	497	0.825	-24	260	49	-34	10.4	87.6%
EI	1.9%	10.9%	1.9%	9.8%	300	476	497	0.825	-21	260	43	-34	10.4	85.4%
EJ	0.4%	11.3%	0.5%	10.4%	300	479	497	0.824	-18	250	38	-34	10.4	84.9%
EK	3.0%	14.3%	3.0%	13.3%	300	486	496	0.823	-10	250	29	-34	10.4	81.6%
EL	2.5%	16.9%	2.8%	16.1%	300	495	496	0.822	-1	250	15	-33	11.4	78.7%
EM	1.2%	18.1%	1.2%	17.4%	300	500	496	0.822	4	190	7	-33	11.4	77.4%
EN	0.6%	18.6%	0.6%	17.9%	300	502	496	0.822	6	160	6	-33	11.4	76.7%
EO	0.8%	19.4%	0.8%	18.8%	320	495	493	0.825	2	130	2	-38	10.4	75.8%
EP	0.9%	20.3%	0.9%	19.7%	320	496	493	0.825	3	100	4	-38	10.4	74.9%
EQ	4.9%	25.2%	5.2%	24.9%	320	502	493	0.825	9	90	12	-38	10.4	69.6%
ER	9.4%	34.6%	10.0%	35.0%	340	500	487	0.823	13	70	27	-43	9.3	60.0%
ES	1.8%	36.4%	1.9%	36.9%	360	502	479	0.82	23	70	35	-48	8.3	58.2%
ET	2.3%	38.7%	2.5%	39.4%	360	502	479	0.82	23	70	34	-48	8.3	56.0%
EU	0.1%	38.8%	0.1%	39.5%	360	502	479	0.82	23	70	34	-48	8.3	55.9%
EV	1.7%	40.5%	1.8%	41.2%	360	504	480	0.821	24	80	32	-48	8.3	54.3%
EW	1.4%	41.9%	1.5%	42.8%	360	503	480	0.821	23	80	29	-48	8.3	52.9%
EX	2.9%	44.8%	3.1%	45.8%	360	496	480	0.821	16	80	26	-48	8.3	50.2%
EY	1.2%	46.0%	1.3%	47.2%	360	495	481	0.822	14	90	23	-48	8.3	49.0%
EZ	1.1%	47.1%	1.1%	48.3%	360	495	481	0.822	14	90	21	-47	9.3	48.0%
FA	2.1%	49.2%	2.2%	50.5%	360	495	482	0.822	13	90	19	-47	9.3	46.1%
FB	0.8%	50.0%	0.8%	51.3%	360	495	482	0.823	13	100	18	-47	9.3	45.3%
FC	0.4%	50.4%	0.5%	51.8%	360	496	482	0.823	14	100	17	-47	9.3	44.9%
FD	1.8%	52.2%	1.9%	53.6%	360	496	482	0.823	14	100	16	-47	9.3	43.3%
FE	0.2%	52.4%	0.2%	53.9%	360	496	482	0.823	14	100	15	-47	9.3	43.1%
FF	1.3%	53.8%	1.5%	55.4%	360	496	482	0.823	14	100	15	-47	9.3	41.9%
FG	1.1%	54.9%	1.1%	56.5%	360	495	482	0.823	13	100	14	-47	9.3	40.9%
FH	1.3%	56.2%	1.4%	57.9%	360	494	483	0.824	11	110	12	-47	9.3	39.7%
FI	1.7%	57.9%	1.8%	59.6%	360	492	483	0.824	9	120	10	-47	9.3	38.2%
FJ	3.5%	61.4%	3.7%	63.3%	360	488	483	0.824	5	160	6	-47	9.3	35.0%
FK	5.0%	66.4%	5.0%	68.3%	380	473	476	0.822	-3	230	10	-52	4.5	30.7%
FL	4.7%	71.1%	4.6%	72.9%	380	464	476	0.823	-12	260	17	-53	3.5	26.7%
FM	0.8%	71.8%	1.0%	74.0%	380	466	476	0.824	-10	270	12	-53	3.5	26.1%
FN	3.8%	75.6%	3.4%	77.4%	380	466	476	0.824	-10	270	12	-53	3.5	23.0%
FO	3.8%	79.4%	3.8%	81.2%	380	471	476	0.824	-5	290	5	-54	2.5	19.9%
FP	3.8%	83.1%	3.8%	85.0%	380	474	476	0.825	-2	250	2	-54	2.5	16.8%
FQ	3.9%	87.0%	3.9%	88.9%	400	466	471	0.822	-5	260	6	-57	-0.5	13.8%
FR	5.4%	92.5%	5.3%	94.2%	400	456	471	0.823	-15	240	21	-57	-0.5	9.6%
FS	1.9%	94.3%	1.7%	96.0%	400	456	471	0.823	-15	240	21	-57	-0.5	8.2%
FT	0.0%	94.3%	0.1%	96.0%	400	456	471	0.823	-15	240	21	-57	-0.5	8.2%
FU	1.6%	95.9%	1.5%	97.5%	400	454	473	0.824	-19	250	28	-56	0.5	7.0%
FV	0.1%	96.0%	0.1%	97.6%	400	461	473	0.824	-12	250	28	-56	0.5	6.9%
FX	0.3%	96.3%	0.3%	97.9%	400	460	473	0.824	-13	260	28	-56	0.5	6.7%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

August 85% Route 1														
Way-point De-identified	Time (% of Total)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-4					
EA	3.1%	3.1%	2.2%	2.2%	320	421	490	0.824	-69	260	76	-41	7.36	94.2%
EB	0.2%	3.3%	0.2%	2.4%	320	424	490	0.824	-66	270	76	-40	8.4	94.0%
EC	1.0%	4.3%	0.9%	3.3%	320	419	490	0.824	-71	270	76	-40	8.4	92.8%
ED	0.8%	5.1%	0.7%	4.0%	320	440	490	0.824	-50	270	74	-40	8.4	92.0%
EE	2.9%	7.9%	2.7%	6.7%	320	448	491	0.824	-43	270	66	-40	8.4	88.7%
EF	0.3%	8.3%	0.4%	7.1%	320	455	491	0.824	-36	270	58	-39	9.4	88.3%
EG	0.7%	8.9%	0.6%	7.7%	320	457	491	0.824	-34	270	56	-39	9.4	87.6%
EH	0.2%	9.1%	0.2%	7.9%	320	459	491	0.824	-32	270	53	-39	9.4	87.3%
EI	1.9%	11.0%	1.9%	9.8%	320	463	492	0.824	-29	260	48	-39	9.4	85.2%
EJ	0.6%	11.6%	0.5%	10.4%	320	466	492	0.825	-26	260	42	-39	9.4	84.6%
EK	3.0%	14.5%	3.0%	13.3%	320	473	492	0.825	-19	260	32	-39	9.4	81.3%
EL	2.6%	17.2%	2.8%	16.1%	320	484	492	0.825	-8	260	17	-38	10.4	78.4%
EM	1.2%	18.4%	1.2%	17.4%	320	490	493	0.825	-3	250	7	-38	10.4	77.1%
EN	0.6%	18.9%	0.6%	17.9%	320	494	493	0.825	1	200	2	-38	10.4	76.5%
EO	0.8%	19.7%	0.8%	18.8%	320	496	493	0.825	3	110	3	-38	10.4	75.6%
EP	0.9%	20.6%	0.9%	19.7%	320	498	493	0.825	5	110	7	-38	10.4	74.7%
EQ	4.8%	25.4%	5.2%	24.9%	320	504	493	0.825	11	90	15	-38	10.4	69.4%
ER	9.4%	34.8%	10.0%	35.0%	340	503	487	0.823	16	70	28	-43	9.3	59.8%
ES	1.7%	36.5%	1.9%	36.9%	360	504	479	0.82	25	80	36	-48	8.3	58.2%
ET	2.4%	38.9%	2.5%	39.4%	360	504	480	0.82	24	80	35	-48	8.3	55.9%
EU	0.0%	38.9%	0.1%	39.5%	360	504	480	0.82	24	80	35	-48	8.3	55.9%
EV	1.7%	40.5%	1.8%	41.2%	360	506	480	0.821	26	80	35	-48	8.3	54.3%
EW	1.4%	42.0%	1.5%	42.8%	360	506	480	0.821	26	80	31	-48	8.3	52.9%
EX	2.9%	44.8%	3.1%	45.8%	360	499	481	0.821	18	90	28	-48	8.3	50.2%
EY	1.2%	46.0%	1.3%	47.2%	360	497	481	0.822	16	90	25	-47	9.3	49.1%
EZ	1.1%	47.1%	1.1%	48.3%	360	496	481	0.822	15	90	23	-47	9.3	48.1%
FA	2.1%	49.2%	2.2%	50.5%	360	495	482	0.822	13	90	21	-47	9.3	46.1%
FB	0.8%	50.0%	0.8%	51.3%	360	495	482	0.823	13	90	19	-47	9.3	45.4%
FC	0.4%	50.4%	0.5%	51.8%	360	497	482	0.823	15	90	18	-47	9.3	45.0%
FD	1.8%	52.2%	1.9%	53.6%	360	497	482	0.823	15	90	18	-47	9.3	43.4%
FE	0.1%	52.3%	0.2%	53.9%	360	496	482	0.823	14	100	16	-47	9.3	43.3%
FF	1.4%	53.7%	1.5%	55.4%	360	496	482	0.823	14	100	16	-47	9.3	42.0%
FG	1.1%	54.8%	1.1%	56.5%	360	496	483	0.823	13	100	15	-47	9.3	41.0%
FH	1.3%	56.2%	1.4%	57.9%	360	495	483	0.824	12	100	13	-47	9.3	39.8%
FI	1.7%	57.8%	1.8%	59.6%	360	493	483	0.824	10	100	11	-47	9.3	38.3%
FJ	3.5%	61.3%	3.7%	63.3%	360	487	483	0.824	4	140	4	-47	9.3	35.0%
FK	5.0%	66.3%	5.0%	68.3%	380	469	476	0.822	-7	250	11	-52	4.5	30.8%
FL	4.6%	70.9%	4.6%	72.9%	380	461	476	0.823	-15	270	19	-52	4.5	26.9%
FM	0.9%	71.8%	1.0%	74.0%	380	462	477	0.824	-15	280	17	-53	3.5	26.1%
FN	3.7%	75.6%	3.4%	77.4%	380	462	477	0.824	-15	280	17	-53	3.5	23.0%
FO	3.7%	79.3%	3.8%	81.2%	380	469	476	0.824	-7	260	9	-53	3.5	19.9%
FP	3.7%	83.0%	3.8%	85.0%	380	471	476	0.825	-5	290	5	-54	2.5	16.8%
FQ	4.0%	87.0%	3.9%	88.9%	400	462	471	0.822	-9	280	10	-57	-0.5	13.7%
FR	5.4%	92.4%	5.3%	94.2%	400	452	472	0.824	-20	260	23	-57	-0.5	9.6%
FS	1.9%	94.3%	1.7%	96.0%	400	452	472	0.824	-20	260	23	-57	-0.5	8.2%
FT	0.1%	94.4%	0.1%	96.0%	400	452	472	0.824	-20	260	23	-57	-0.5	8.1%
FU	1.5%	95.9%	1.5%	97.5%	400	448	474	0.825	-26	260	31	-56	0.5	6.9%
FV	0.1%	96.0%	0.1%	97.6%	400	454	474	0.825	-20	270	32	-55	1.5	6.8%
FX	0.2%	96.3%	0.3%	97.9%	400	453	474	0.825	-21	270	32	-55	1.5	6.7%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

September 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-10					
EA	2.9%	2.9%	2.2%	2.2%	320	449	489	0.823	-40	270	42	-41	7.36	94.3%
EB	0.2%	3.2%	0.2%	2.4%	320	450	489	0.823	-39	280	42	-41	7.4	94.1%
EC	1.0%	4.1%	0.9%	3.3%	320	448	489	0.823	-41	280	42	-41	7.4	93.0%
ED	0.7%	4.8%	0.7%	4.0%	320	458	489	0.823	-31	280	42	-40	8.4	92.2%
EE	2.7%	7.5%	2.7%	6.7%	320	462	490	0.823	-28	270	39	-40	8.4	89.1%
EF	0.3%	7.8%	0.4%	7.1%	320	465	491	0.824	-26	270	37	-39	9.4	88.7%
EG	0.7%	8.5%	0.6%	7.7%	320	466	491	0.824	-25	270	36	-39	9.4	88.0%
EH	0.2%	8.7%	0.2%	7.9%	320	467	491	0.824	-24	270	35	-39	9.4	87.8%
EI	1.9%	10.6%	1.9%	9.8%	320	469	492	0.824	-23	270	33	-38	10.4	85.7%
EJ	0.5%	11.1%	0.5%	10.4%	320	471	492	0.825	-21	270	31	-38	10.4	85.1%
EK	2.8%	13.9%	3.0%	13.3%	320	476	493	0.825	-17	270	27	-38	10.4	81.9%
EL	2.7%	16.7%	2.8%	16.1%	320	483	494	0.825	-11	260	19	-37	11.4	78.9%
EM	1.1%	17.8%	1.2%	17.4%	320	487	494	0.825	-7	260	12	-37	11.4	77.7%
EN	0.7%	18.4%	0.6%	17.9%	320	490	494	0.825	-4	260	8	-37	11.4	77.0%
EO	0.8%	19.2%	0.8%	18.8%	320	492	494	0.825	-2	250	6	-37	11.4	76.1%
EP	0.9%	20.0%	0.9%	19.7%	320	494	494	0.825	0	240	3	-37	11.4	75.2%
EQ	4.8%	24.8%	5.2%	24.9%	320	498	494	0.825	4	110	5	-37	11.4	70.0%
ER	9.4%	34.2%	10.0%	35.0%	340	496	487	0.823	9	70	17	-42	10.3	60.3%
ES	1.7%	35.9%	1.9%	36.9%	360	494	480	0.823	14	70	22	-48	8.3	58.6%
ET	2.4%	38.3%	2.5%	39.4%	360	494	480	0.821	14	70	22	-48	8.3	56.3%
EU	0.1%	38.5%	0.1%	39.5%	360	494	480	0.821	14	70	22	-48	8.3	56.2%
EV	1.6%	40.1%	1.8%	41.2%	360	496	480	0.821	16	80	20	-48	8.3	54.6%
EW	1.4%	41.5%	1.5%	42.8%	360	495	480	0.821	15	80	18	-48	8.3	53.3%
EX	2.8%	44.3%	3.1%	45.8%	360	490	481	0.822	9	80	15	-48	8.3	50.6%
EY	1.3%	45.6%	1.3%	47.2%	360	489	481	0.822	8	90	12	-47	9.3	49.3%
EZ	1.1%	46.7%	1.1%	48.3%	360	488	482	0.822	6	90	10	-47	9.3	48.3%
FA	2.1%	48.8%	2.2%	50.5%	360	486	482	0.823	4	90	7	-47	9.3	46.4%
FB	0.8%	49.6%	0.8%	51.3%	360	484	482	0.823	2	80	4	-47	9.3	45.7%
FC	0.4%	50.0%	0.5%	51.8%	360	484	482	0.823	2	70	3	-47	9.3	45.3%
FD	1.7%	51.7%	1.9%	53.6%	360	482	482	0.823	0	30	2	-47	9.3	43.7%
FE	0.2%	52.0%	0.2%	53.9%	360	480	483	0.824	-3	330	3	-47	9.3	43.5%
FF	1.5%	53.5%	1.5%	55.4%	360	480	483	0.824	-3	330	3	-47	9.3	42.1%
FG	1.0%	54.5%	1.1%	56.5%	360	477	483	0.824	-6	290	6	-47	9.3	41.2%
FH	1.4%	55.9%	1.4%	57.9%	360	475	483	0.825	-8	280	9	-47	9.3	39.9%
FI	1.7%	57.6%	1.8%	59.6%	360	472	483	0.825	-11	270	14	-47	9.3	38.3%
FJ	3.6%	61.2%	3.7%	63.3%	360	466	483	0.825	-17	260	22	-48	8.3	35.0%
FK	5.1%	66.3%	5.0%	68.3%	380	457	475	0.822	-18	260	26	-54	2.5	30.6%
FL	4.6%	70.9%	4.6%	72.9%	380	463	474	0.823	-11	250	20	-54	2.5	26.8%
FM	1.0%	71.9%	1.0%	74.0%	380	471	474	0.824	-3	240	7	-55	1.5	26.0%
FN	3.4%	75.3%	3.4%	77.4%	380	471	474	0.824	-3	240	7	-55	1.5	23.2%
FO	3.8%	79.1%	3.8%	81.2%	380	469	474	0.824	-5	310	6	-55	1.5	20.1%
FP	3.8%	82.9%	3.8%	85.0%	380	462	475	0.825	-13	320	14	-55	1.5	16.9%
FQ	3.9%	86.8%	3.9%	88.9%	400	445	469	0.823	-24	300	24	-59	-2.5	13.9%
FR	5.7%	92.5%	5.3%	94.2%	400	436	472	0.824	-36	270	37	-57	-0.5	9.5%
FS	1.9%	94.3%	1.7%	96.0%	400	436	472	0.824	-36	270	37	-57	-0.5	8.1%
FT	0.1%	94.4%	0.1%	96.0%	400	436	472	0.824	-36	270	37	-57	-0.5	8.0%
FU	1.5%	96.0%	1.5%	97.5%	400	439	473	0.825	-34	260	44	-56	0.5	6.9%
FV	0.1%	96.1%	0.1%	97.6%	400	451	474	0.825	-23	260	46	-56	0.5	6.8%
FX	0.2%	96.3%	0.3%	97.9%	400	451	474	0.825	-23	260	47	-56	0.5	6.6%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

September 85% Route 1

Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-11					
EA	3.0%	3.0%	2.2%	2.2%	300	456	495	0.826	-39	270	43	-36	8.4	94.5%
EB	0.2%	3.3%	0.2%	2.4%	300	458	495	0.826	-37	270	43	-36	8.4	94.3%
EC	0.9%	4.1%	0.9%	3.3%	300	455	496	0.826	-41	270	43	-36	8.4	93.2%
ED	0.7%	4.8%	0.7%	4.0%	300	467	496	0.826	-29	270	43	-36	8.4	92.5%
EE	2.7%	7.5%	2.7%	6.7%	300	470	496	0.825	-26	270	40	-35	9.4	89.3%
EF	0.3%	7.8%	0.4%	7.1%	300	473	497	0.825	-24	270	38	-34	10.4	88.9%
EG	0.7%	8.5%	0.6%	7.7%	300	474	497	0.825	-23	270	37	-34	10.4	88.2%
EH	0.2%	8.7%	0.2%	7.9%	300	475	497	0.825	-22	270	36	-34	10.4	87.9%
EI	1.8%	10.5%	1.9%	9.8%	300	476	497	0.825	-21	270	34	-33	11.4	85.8%
EJ	0.4%	11.0%	0.5%	10.4%	300	477	498	0.825	-21	270	31	-33	11.4	85.3%
EK	2.9%	13.9%	3.0%	13.3%	300	480	498	0.824	-18	270	28	-33	11.4	81.9%
EL	2.6%	16.5%	2.8%	16.1%	320	481	494	0.825	-13	270	28	-37	11.4	79.0%
EM	1.2%	17.7%	1.2%	17.4%	320	485	494	0.825	-9	260	16	-37	11.4	77.7%
EN	0.5%	18.3%	0.6%	17.9%	320	487	494	0.825	-7	260	12	-37	11.4	77.1%
EO	0.8%	19.0%	0.8%	18.8%	320	489	494	0.825	-5	260	9	-37	11.4	76.2%
EP	1.0%	20.0%	0.9%	19.7%	320	492	494	0.825	-2	250	6	-37	11.4	75.1%
EQ	4.8%	24.8%	5.2%	24.9%	340	491	486	0.822	5	70	9	-42	10.3	70.1%
ER	9.3%	34.1%	10.0%	35.0%	340	500	487	0.823	13	80	19	-42	10.3	60.5%
ES	1.7%	35.9%	1.9%	36.9%	360	498	480	0.82	18	80	25	-48	8.3	58.8%
ET	2.3%	38.2%	2.5%	39.4%	360	498	480	0.82	18	80	24	-48	8.3	56.6%
EU	0.1%	38.3%	0.1%	39.5%	360	498	480	0.82	18	80	24	-48	8.3	56.5%
EV	1.6%	39.9%	1.8%	41.2%	360	499	480	0.821	19	80	22	-48	8.3	54.9%
EW	1.4%	41.3%	1.5%	42.8%	360	498	481	0.821	17	80	20	-47	9.3	53.5%
EX	2.8%	44.1%	3.1%	45.8%	360	493	481	0.821	12	90	17	-47	9.3	50.9%
EY	1.3%	45.4%	1.3%	47.2%	360	491	481	0.822	10	90	12	-47	9.3	49.6%
EZ	1.1%	46.5%	1.1%	48.3%	360	490	482	0.822	8	90	12	-47	9.3	48.6%
FA	2.1%	48.6%	2.2%	50.5%	360	490	482	0.822	8	90	12	-47	9.3	46.7%
FB	0.8%	49.3%	0.8%	51.3%	360	487	482	0.823	5	100	6	-47	9.3	46.0%
FC	0.4%	49.8%	0.5%	51.8%	360	487	482	0.823	5	100	5	-47	9.3	45.6%
FD	1.7%	51.5%	1.9%	53.6%	360	484	482	0.823	2	100	2	-47	9.3	44.0%
FE	0.2%	51.7%	0.2%	53.9%	360	480	483	0.824	-3	270	4	-47	9.3	43.8%
FF	1.4%	53.2%	1.5%	55.4%	360	480	483	0.824	-3	270	4	-47	9.3	42.5%
FG	1.1%	54.2%	1.1%	56.5%	360	476	483	0.824	-7	270	8	-47	9.3	41.5%
FH	1.4%	55.7%	1.4%	57.9%	360	473	483	0.825	-10	270	12	-47	9.3	40.2%
FI	1.7%	57.4%	1.8%	59.6%	360	468	483	0.825	-15	270	18	-47	9.3	38.6%
FJ	3.6%	61.0%	3.7%	63.3%	360	462	483	0.825	-21	270	26	-48	8.3	35.4%
FK	5.1%	66.1%	5.0%	68.3%	360	459	482	0.825	-23	270	28	-49	7.3	30.8%
FL	4.6%	70.7%	4.6%	72.9%	380	458	475	0.823	-17	270	22	-54	2.5	27.0%
FM	1.1%	71.7%	1.0%	74.0%	380	467	475	0.824	-8	270	10	-55	1.5	26.1%
FN	3.4%	75.1%	3.4%	77.4%	380	467	475	0.824	-8	270	10	-55	1.5	23.3%
FO	3.8%	78.9%	3.8%	81.2%	380	467	474	0.824	-7	260	8	-55	1.5	20.2%
FP	3.8%	82.7%	3.8%	85.0%	380	460	475	0.824	-15	290	15	-55	1.5	17.1%
FQ	4.0%	86.7%	3.9%	88.9%	400	444	470	0.823	-26	280	26	-58	-1.5	13.9%
FR	5.7%	92.4%	5.3%	94.2%	400	432	473	0.824	-41	270	42	-57	-0.5	9.6%
FS	1.8%	94.2%	1.7%	96.0%	400	432	473	0.824	-41	270	42	-57	-0.5	8.2%
FT	0.0%	94.2%	0.1%	96.0%	400	432	473	0.824	-41	270	42	-57	-0.5	8.2%
FU	1.6%	95.9%	1.5%	97.5%	400	432	474	0.825	-42	270	42	-55	1.5	7.0%
FV	0.1%	96.0%	0.1%	97.6%	400	444	475	0.825	-31	260	50	-55	1.5	6.9%
FX	0.3%	96.3%	0.3%	97.9%	400	443	475	0.825	-32	260	50	-55	1.5	6.6%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

October 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-17					
EA	2.9%	2.9%	2.2%	2.2%	320	448	489	0.823	-41	270	45	-41	7.36	94.4%
EB	0.2%	3.1%	0.2%	2.4%	320	450	489	0.823	-39	270	45	-41	7.4	94.2%
EC	1.0%	4.1%	0.9%	3.3%	320	447	489	0.823	-42	270	44	-41	7.4	93.1%
ED	0.6%	4.7%	0.7%	4.0%	320	460	489	0.823	-29	270	43	-40	8.4	92.3%
EE	2.7%	7.4%	2.7%	6.7%	320	465	490	0.823	-25	270	38	-40	8.4	89.3%
EF	0.3%	7.7%	0.4%	7.1%	320	470	491	0.824	-21	270	33	-39	9.4	88.9%
EG	0.6%	8.4%	0.6%	7.7%	320	471	491	0.824	-20	270	32	-39	9.4	88.2%
EH	0.1%	8.5%	0.2%	7.9%	320	472	491	0.824	-19	270	31	-39	9.4	88.1%
EI	1.9%	10.4%	1.9%	9.8%	320	474	492	0.824	-18	270	29	-38	10.4	85.9%
EJ	0.4%	10.8%	0.5%	10.4%	320	476	492	0.824	-16	270	25	-38	10.4	85.4%
EK	2.9%	13.7%	3.0%	13.3%	320	480	493	0.824	-13	270	20	-38	10.4	82.1%
EL	2.6%	16.3%	2.8%	16.1%	320	486	494	0.825	-8	270	12	-37	11.4	79.3%
EM	1.1%	17.4%	1.2%	17.4%	320	489	494	0.825	-5	280	6	-37	11.4	78.1%
EN	0.6%	18.0%	0.6%	17.9%	320	491	494	0.825	-3	290	4	-37	11.4	77.4%
EO	0.8%	18.8%	0.8%	18.8%	320	492	494	0.825	-2	320	2	-37	11.4	76.6%
EP	0.9%	19.6%	0.9%	19.7%	320	493	494	0.825	-1	10	2	-37	11.4	75.6%
EQ	4.7%	24.4%	5.2%	24.9%	320	497	494	0.825	3	70	5	-37	11.4	70.5%
ER	9.3%	33.7%	10.0%	35.0%	340	493	487	0.823	6	70	11	-42	10.3	60.9%
ES	1.7%	35.4%	1.9%	36.9%	340	497	488	0.824	9	90	10	-42	10.3	59.1%
ET	2.4%	37.8%	2.5%	39.4%	360	489	480	0.821	9	100	9	-47	9.3	56.8%
EU	0.0%	37.8%	0.1%	39.5%	360	489	480	0.821	9	100	9	-47	9.3	56.8%
EV	1.7%	39.5%	1.8%	41.2%	360	489	481	0.821	8	110	9	-47	9.3	55.1%
EW	1.4%	40.9%	1.5%	42.8%	360	488	481	0.821	7	120	8	-47	9.3	53.8%
EX	2.9%	43.8%	3.1%	45.8%	360	487	481	0.822	6	150	6	-47	9.3	51.0%
EY	1.2%	45.0%	1.3%	47.2%	360	485	481	0.822	4	200	8	-48	8.3	49.9%
EZ	1.1%	46.0%	1.1%	48.3%	360	483	481	0.823	2	200	10	-48	8.3	48.9%
FA	2.1%	48.2%	2.2%	50.5%	360	480	481	0.823	-1	230	13	-48	8.3	46.9%
FB	0.8%	48.9%	0.8%	51.3%	360	477	482	0.824	-5	240	16	-48	8.3	46.2%
FC	0.4%	49.4%	0.5%	51.8%	360	473	482	0.824	-9	250	17	-48	8.3	45.8%
FD	1.8%	51.2%	1.9%	53.6%	360	470	482	0.824	-12	250	19	-48	8.3	44.1%
FE	0.2%	51.4%	0.2%	53.9%	360	466	482	0.824	-16	260	23	-48	8.3	43.9%
FF	1.4%	52.8%	1.5%	55.4%	360	466	482	0.824	-16	260	23	-48	8.3	42.6%
FG	1.2%	54.0%	1.1%	56.5%	360	463	482	0.825	-19	260	26	-48	8.3	41.5%
FH	1.3%	55.3%	1.4%	57.9%	360	460	482	0.825	-22	270	28	-49	7.3	40.4%
FI	1.8%	57.1%	1.8%	59.6%	360	457	481	0.825	-24	270	30	-49	7.3	38.7%
FJ	3.6%	60.7%	3.7%	63.3%	360	454	481	0.825	-27	280	30	-49	7.3	35.5%
FK	5.0%	65.8%	5.0%	68.3%	360	454	480	0.826	-26	290	27	-50	6.3	31.0%
FL	4.6%	70.4%	4.6%	72.9%	380	450	474	0.823	-24	300	24	-55	1.5	27.1%
FM	1.2%	71.6%	1.0%	74.0%	380	451	474	0.824	-23	290	24	-55	1.5	26.1%
FN	3.3%	74.9%	3.4%	77.4%	380	451	474	0.824	-23	290	24	-55	1.5	23.3%
FO	3.9%	78.8%	3.8%	81.2%	380	451	475	0.825	-24	280	25	-55	1.5	20.2%
FP	3.9%	82.6%	3.8%	85.0%	380	449	475	0.825	-26	280	27	-55	1.5	17.0%
FQ	4.1%	86.7%	3.9%	88.9%	400	438	471	0.823	-33	280	34	-58	-1.5	13.8%
FR	5.7%	92.4%	5.3%	94.2%	400	425	472	0.825	-47	270	48	-57	-0.5	9.5%
FS	1.8%	94.2%	1.7%	96.0%	400	425	472	0.825	-47	270	48	-57	-0.5	8.1%
FT	0.0%	94.2%	0.1%	96.0%	400	425	472	0.825	-47	270	48	-57	-0.5	8.1%
FU	1.6%	95.8%	1.5%	97.5%	400	422	473	0.825	-51	270	59	-57	-0.5	6.9%
FV	0.1%	95.9%	0.1%	97.6%	400	435	473	0.825	-38	270	60	-56	0.5	6.8%
FX	0.3%	96.2%	0.3%	97.9%	400	435	474	0.825	-39	270	60	-56	0.5	6.5%
LDG	3.8%	100.0%	2.1%	100.0%										5.3%

October 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-19					
EA	3.0%	3.0%	2.2%	2.2%	300	455	496	0.826	-41	260	45	-36	8.4	94.6%
EB	0.2%	3.2%	0.2%	2.4%	300	457	496	0.826	-39	270	44	-36	8.4	94.3%
EC	0.9%	4.1%	0.9%	3.3%	300	455	496	0.826	-41	270	43	-36	8.4	93.3%
ED	0.6%	4.7%	0.7%	4.0%	300	468	496	0.826	-28	270	42	-36	8.4	92.5%
EE	2.7%	7.4%	2.7%	6.7%	300	472	497	0.825	-25	270	36	-35	9.4	89.4%
EF	0.3%	7.7%	0.4%	7.1%	300	475	497	0.825	-22	270	36	-34	10.4	89.0%
EG	0.6%	8.3%	0.6%	7.7%	300	476	497	0.825	-21	270	30	-34	10.4	88.3%
EH	0.1%	8.4%	0.2%	7.9%	300	478	497	0.825	-19	270	29	-34	10.4	88.2%
EI	1.8%	10.3%	1.9%	9.8%	300	479	498	0.825	-19	270	27	-33	11.4	86.0%
EJ	0.5%	10.8%	0.5%	10.4%	300	481	498	0.824	-17	270	24	-33	11.4	85.4%
EK	2.8%	13.6%	3.0%	13.3%	300	485	498	0.823	-13	270	19	-33	11.4	82.2%
EL	2.7%	16.3%	2.8%	16.1%	320	484	494	0.825	-10	270	15	-37	11.4	79.2%
EM	1.1%	17.3%	1.2%	17.4%	320	487	494	0.825	-7	270	9	-37	11.4	78.0%
EN	0.5%	17.9%	0.6%	17.9%	320	489	494	0.825	-5	280	6	-37	11.4	77.5%
EO	0.9%	18.7%	0.8%	18.8%	320	491	495	0.825	-4	300	3	-37	11.4	76.5%
EP	0.9%	19.6%	0.9%	19.7%	320	494	495	0.825	-1	20	2	-37	11.4	75.6%
EQ	4.7%	24.3%	5.2%	24.9%	320	498	494	0.825	4	70	7	-36	12.4	70.4%
ER	9.2%	33.5%	10.0%	35.0%	340	496	487	0.823	9	80	12	-42	10.3	61.0%
ES	1.7%	35.2%	1.9%	36.9%	340	499	488	0.823	11	90	12	-42	10.3	59.2%
ET	2.4%	37.5%	2.5%	39.4%	360	490	480	0.821	10	90	11	-47	9.3	56.9%
EU	0.0%	37.5%	0.1%	39.5%	360	490	480	0.821	10	90	11	-47	9.3	56.9%
EV	1.7%	39.3%	1.8%	41.2%	360	491	481	0.821	10	90	11	-47	9.3	55.3%
EW	1.4%	40.6%	1.5%	42.8%	360	490	481	0.821	9	100	9	-47	9.3	53.9%
EX	2.9%	43.5%	3.1%	45.8%	360	486	481	0.822	5	140	5	-47	9.3	51.2%
EY	1.2%	44.7%	1.3%	47.2%	360	483	481	0.822	2	210	7	-47	9.3	50.1%
EZ	1.1%	45.8%	1.1%	48.3%	360	480	481	0.823	-1	230	10	-48	8.3	49.1%
FA	2.1%	47.9%	2.2%	50.5%	360	477	482	0.823	-5	250	14	-48	8.3	47.1%
FB	0.7%	48.7%	0.8%	51.3%	360	474	482	0.824	-8	260	17	-48	8.3	46.4%
FC	0.4%	49.1%	0.5%	51.8%	360	470	482	0.824	-12	260	19	-48	8.3	46.0%
FD	1.8%	50.9%	1.9%	53.6%	360	467	482	0.824	-15	260	21	-48	8.3	44.3%
FE	0.2%	51.1%	0.2%	53.9%	360	462	482	0.825	-20	270	26	-48	8.3	44.1%
FF	1.5%	52.6%	1.5%	55.4%	360	462	482	0.825	-20	270	26	-48	8.3	42.7%
FG	1.1%	53.7%	1.1%	56.5%	360	458	482	0.825	-24	270	29	-48	8.3	41.8%
FH	1.4%	55.1%	1.4%	57.9%	360	455	482	0.825	-27	270	32	-49	7.3	40.5%
FI	1.8%	56.9%	1.8%	59.6%	360	454	482	0.825	-28	270	34	-49	7.3	38.9%
FJ	3.6%	60.5%	3.7%	63.3%	360	452	481	0.826	-29	270	34	-49	7.3	35.6%
FK	5.0%	65.6%	5.0%	68.3%	360	454	481	0.826	-27	280	30	-50	6.3	31.1%
FL	4.6%	70.2%	4.6%	72.9%	380	448	475	0.824	-27	290	28	-55	1.5	27.3%
FM	1.3%	71.4%	1.0%	74.0%	380	449	475	0.824	-26	270	31	-54	2.5	26.2%
FN	3.3%	74.8%	3.4%	77.4%	380	449	475	0.824	-26	270	31	-54	2.5	23.5%
FO	3.9%	78.6%	3.8%	81.2%	380	446	476	0.825	-30	260	33	-54	2.5	20.3%
FP	3.9%	82.5%	3.8%	85.0%	380	444	476	0.826	-32	270	35	-54	2.5	17.2%
FQ	4.1%	86.5%	3.9%	88.9%	400	436	472	0.823	-36	270	40	-57	-0.5	14.0%
FR	5.8%	92.3%	5.3%	94.2%	400	420	473	0.825	-53	270	54	-57	-0.5	9.6%
FS	1.8%	94.1%	1.7%	96.0%	400	420	473	0.825	-53	270	54	-57	-0.5	8.2%
FT	0.1%	94.2%	0.1%	96.0%	400	420	473	0.825	-53	270	54	-57	-0.5	8.1%
FU	1.6%	95.8%	1.5%	97.5%	400	414	474	0.826	-60	270	65	-57	-0.5	6.9%
FV	0.1%	95.9%	0.1%	97.6%	400	426	474	0.826	-48	270	66	-56	0.5	6.8%
FX	0.3%	96.3%	0.3%	97.9%	400	427	475	0.826	-48	270	66	-55	1.5	6.6%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

November 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-25					
EA	2.8%	2.8%	2.2%	2.2%	300	468	496	0.826	-28	280	28	-36	8.4	94.7%
EB	0.1%	3.0%	0.2%	2.4%	300	469	496	0.826	-27	290	28	-35	9.4	94.5%
EC	0.9%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	290	28	-35	9.4	93.4%
ED	0.6%	4.5%	0.7%	4.0%	300	472	496	0.826	-24	290	28	-35	9.4	92.7%
EE	2.5%	7.1%	2.7%	6.7%	300	475	497	0.825	-22	290	26	-34	10.4	89.7%
EF	0.4%	7.5%	0.4%	7.1%	300	478	497	0.825	-19	280	24	-34	10.4	89.2%
EG	0.5%	8.0%	0.6%	7.7%	300	478	497	0.825	-19	280	24	-34	10.4	88.6%
EH	0.2%	8.2%	0.2%	7.9%	300	479	497	0.825	-18	280	23	-34	10.4	88.3%
EI	1.8%	10.0%	1.9%	9.8%	300	480	498	0.825	-18	280	22	-33	11.4	86.3%
EJ	0.4%	10.4%	0.5%	10.4%	300	481	498	0.824	-17	280	21	-33	11.4	85.8%
EK	2.7%	13.2%	3.0%	13.3%	300	484	498	0.823	-14	280	17	-32	12.4	82.6%
EL	2.6%	15.8%	2.8%	16.1%	320	481	494	0.825	-13	290	14	-37	11.4	79.6%
EM	1.2%	17.0%	1.2%	17.4%	320	485	494	0.825	-9	290	10	-37	11.4	78.3%
EN	0.5%	17.5%	0.6%	17.9%	320	487	494	0.825	-7	290	8	-37	11.4	77.8%
EO	0.7%	18.2%	0.8%	18.8%	320	488	494	0.825	-6	290	7	-37	11.4	77.0%
EP	0.8%	19.1%	0.9%	19.7%	320	489	494	0.825	-5	290	6	-37	11.4	76.0%
EQ	4.7%	23.8%	5.2%	24.9%	320	491	494	0.825	-3	310	3	-37	11.4	70.8%
ER	9.2%	33.0%	10.0%	35.0%	340	488	488	0.823	0	40	7	-42	10.3	61.4%
ES	1.8%	34.8%	1.9%	36.9%	340	490	488	0.824	2	50	6	-42	10.3	59.6%
ET	2.3%	37.1%	2.5%	39.4%	340	490	489	0.825	1	40	4	-42	10.3	57.3%
EU	0.0%	37.1%	0.1%	39.5%	340	490	489	0.825	1	40	4	-42	10.3	57.2%
EV	1.7%	38.8%	1.8%	41.2%	340	488	489	0.825	-1	360	1	-42	10.3	55.6%
EW	1.4%	40.2%	1.5%	42.8%	340	486	489	0.825	-3	260	3	-42	10.3	54.1%
EX	2.8%	43.0%	3.1%	45.8%	360	474	481	0.822	-7	260	13	-48	8.3	51.4%
EY	1.4%	44.4%	1.3%	47.2%	360	470	481	0.823	-11	260	22	-48	8.3	50.1%
EZ	1.1%	45.5%	1.1%	48.3%	360	467	482	0.823	-15	260	28	-48	8.3	49.1%
FA	2.1%	47.6%	2.2%	50.5%	360	463	482	0.824	-19	260	36	-48	8.3	47.2%
FB	0.7%	48.3%	0.8%	51.3%	360	458	482	0.824	-24	260	44	-48	8.3	46.5%
FC	0.5%	48.8%	0.5%	51.8%	360	451	482	0.825	-31	260	46	-48	8.3	46.0%
FD	1.8%	50.6%	1.9%	53.6%	360	447	482	0.825	-35	260	50	-48	8.3	44.3%
FE	0.4%	51.1%	0.2%	53.9%	360	443	482	0.825	-39	260	54	-49	7.3	44.0%
FF	1.4%	52.4%	1.5%	55.4%	360	443	482	0.825	-39	260	54	-49	7.3	42.7%
FG	1.2%	53.6%	1.1%	56.5%	360	440	481	0.826	-41	260	55	-49	7.3	41.6%
FH	1.4%	55.0%	1.4%	57.9%	360	439	481	0.826	-42	260	55	-49	7.3	40.4%
FI	1.8%	56.7%	1.8%	59.6%	360	439	481	0.826	-42	270	53	-50	6.3	38.8%
FJ	3.7%	60.4%	3.7%	63.3%	360	442	480	0.826	-38	270	46	-50	6.3	35.5%
FK	5.1%	65.5%	5.0%	68.3%	360	448	479	0.826	-31	280	34	-51	5.3	31.1%
FL	4.5%	70.0%	4.6%	72.9%	360	452	478	0.825	-26	290	26	-52	4.3	27.1%
FM	1.3%	71.3%	1.0%	74.0%	380	446	472	0.825	-26	290	27	-57	-0.5	26.1%
FN	3.2%	74.5%	3.4%	77.4%	380	446	472	0.825	-26	290	27	-57	-0.5	23.5%
FO	3.9%	78.4%	3.8%	81.2%	380	440	472	0.825	-32	280	33	-58	-1.5	20.3%
FP	3.9%	82.3%	3.8%	85.0%	380	433	473	0.826	-40	270	41	-57	-0.5	17.2%
FQ	4.1%	86.4%	3.9%	88.9%	400	422	469	0.824	-47	270	51	-59	-2.5	14.0%
FR	6.0%	92.4%	5.3%	94.2%	400	407	471	0.825	-64	270	65	-59	-2.5	9.4%
FS	1.8%	94.2%	1.7%	96.0%	400	407	471	0.825	-64	270	65	-59	-2.5	8.0%
FT	0.0%	94.2%	0.1%	96.0%	400	407	471	0.825	-64	270	65	-59	-2.5	8.0%
FU	1.7%	95.9%	1.5%	97.5%	400	405	472	0.826	-67	270	74	-58	-1.5	6.8%
FV	0.1%	96.0%	0.1%	97.6%	400	421	472	0.826	-51	270	74	-58	-1.5	6.7%
FX	0.3%	96.3%	0.3%	97.9%	400	421	472	0.826	-51	270	74	-58	-1.5	6.4%
LDG	3.7%	100.0%	2.1%	100.0%										5.2%

November 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-27					
EA	2.8%	2.8%	2.2%	2.2%	300	466	496	0.826	-30	270	32	-35	9.4	94.6%
EB	0.1%	2.9%	0.2%	2.4%	300	467	497	0.826	-30	280	32	-35	9.4	94.5%
EC	0.9%	3.9%	0.9%	3.3%	300	465	497	0.826	-32	280	32	-35	9.4	93.4%
ED	0.6%	4.5%	0.7%	4.0%	300	472	497	0.826	-25	280	31	-35	9.4	92.7%
EE	2.5%	7.0%	2.7%	6.7%	300	476	497	0.825	-21	280	29	-34	10.4	89.7%
EF	0.4%	7.5%	0.4%	7.1%	300	478	498	0.825	-20	280	27	-34	10.4	89.2%
EG	0.5%	8.0%	0.6%	7.7%	300	479	498	0.825	-19	280	27	-33	11.4	88.6%
EH	0.2%	8.2%	0.2%	7.9%	300	479	498	0.825	-19	270	26	-33	11.4	88.3%
EI	1.8%	10.0%	1.9%	9.8%	300	480	498	0.825	-18	270	25	-33	11.4	86.3%
EJ	0.4%	10.4%	0.5%	10.4%	300	481	498	0.824	-17	270	23	-33	11.4	85.8%
EK	2.7%	13.1%	3.0%	13.3%	300	484	498	0.823	-14	270	20	-32	12.4	82.6%
EL	2.6%	15.8%	2.8%	16.1%	320	481	494	0.825	-13	280	16	-37	11.4	79.7%
EM	1.2%	16.9%	1.2%	17.4%	320	485	494	0.825	-9	280	12	-37	11.4	78.4%
EN	0.5%	17.5%	0.6%	17.9%	320	486	494	0.825	-8	270	11	-37	11.4	77.8%
EO	0.7%	18.2%	0.8%	18.8%	320	487	495	0.825	-8	280	10	-37	11.4	77.0%
EP	0.8%	19.0%	0.9%	19.7%	320	487	495	0.825	-8	280	10	-37	11.4	76.1%
EQ	4.7%	23.8%	5.2%	24.9%	320	490	495	0.825	-5	290	5	-36	12.4	70.9%
ER	9.1%	32.9%	10.0%	35.0%	340	491	488	0.823	3	70	7	-42	10.3	61.5%
ES	1.7%	34.6%	1.9%	36.9%	340	493	488	0.824	5	70	7	-42	10.3	59.8%
ET	2.3%	36.9%	2.5%	39.4%	340	492	489	0.825	3	80	5	-42	10.3	57.5%
EU	0.1%	37.0%	0.1%	39.5%	340	492	489	0.825	3	80	5	-42	10.3	57.4%
EV	1.6%	38.6%	1.8%	41.2%	340	488	489	0.825	-1	0	0	-42	10.3	55.9%
EW	1.5%	40.1%	1.5%	42.8%	340	484	489	0.825	-5	260	5	-42	10.3	54.4%
EX	2.8%	42.9%	3.1%	45.8%	340	480	489	0.825	-9	260	13	-42	10.3	51.6%
EY	1.3%	44.2%	1.3%	47.2%	360	467	482	0.824	-15	260	31	-48	8.3	50.4%
EZ	1.1%	45.2%	1.1%	48.3%	360	463	482	0.824	-19	260	31	-48	8.3	49.4%
FA	2.2%	47.4%	2.2%	50.5%	360	458	482	0.824	-24	260	40	-48	8.3	47.3%
FB	0.7%	48.2%	0.8%	51.3%	360	453	482	0.825	-29	260	47	-48	8.3	46.6%
FC	0.4%	48.6%	0.5%	51.8%	360	445	482	0.825	-37	260	50	-48	8.3	46.3%
FD	1.9%	50.5%	1.9%	53.6%	360	442	482	0.825	-40	260	54	-48	8.3	44.5%
FE	0.3%	50.8%	0.2%	53.9%	360	437	482	0.825	-45	270	58	-49	7.3	44.2%
FF	1.5%	52.3%	1.5%	55.4%	360	437	482	0.825	-45	270	58	-49	7.3	42.9%
FG	1.2%	53.4%	1.1%	56.5%	360	434	482	0.826	-48	270	60	-49	7.3	41.8%
FH	1.4%	54.8%	1.4%	57.9%	360	433	481	0.826	-48	270	60	-49	7.3	40.6%
FI	1.9%	56.7%	1.8%	59.6%	360	433	481	0.826	-48	270	58	-50	6.3	38.9%
FJ	3.7%	60.4%	3.7%	63.3%	360	438	481	0.826	-43	270	51	-50	6.3	35.6%
FK	5.0%	65.4%	5.0%	68.3%	360	446	479	0.826	-33	270	51	-50	6.3	31.2%
FL	4.5%	69.9%	4.6%	72.9%	360	451	478	0.825	-27	270	39	-50	6.3	27.3%
FM	1.4%	71.3%	1.0%	74.0%	380	445	473	0.825	-28	280	31	-57	-0.5	26.2%
FN	3.2%	74.4%	3.4%	77.4%	380	445	473	0.825	-28	280	31	-57	-0.5	23.6%
FO	3.9%	78.3%	3.8%	81.2%	380	438	473	0.825	-35	270	38	-57	-0.5	20.4%
FP	4.0%	82.3%	3.8%	85.0%	400	425	469	0.823	-44	270	48	-59	-2.5	17.2%
FQ	4.1%	86.4%	3.9%	88.9%	400	420	470	0.824	-50	270	57	-59	-2.5	14.0%
FR	6.0%	92.4%	5.3%	94.2%	400	403	472	0.825	-69	270	72	-59	-2.5	9.5%
FS	1.8%	94.2%	1.7%	96.0%	400	403	472	0.825	-69	270	72	-58	-1.5	8.1%
FT	0.1%	94.3%	0.1%	96.0%	400	403	472	0.825	-69	270	72	-58	-1.5	8.1%
FU	1.6%	95.9%	1.5%	97.5%	400	398	473	0.825	-75	270	81	-57	-0.5	6.9%
FV	0.1%	96.0%	0.1%	97.6%	400	412	473	0.826	-61	270	81	-57	-0.5	6.8%
FX	0.4%	96.4%	0.3%	97.9%	400	412	474	0.826	-62	270	81	-57	-0.5	6.5%
LDG	3.6%	100.0%	2.1%	100.0%										5.3%

December 50% Route 1														
Way-point De-identi-fied	Time (% of Total)	∑ Time (% of Total)	Dis-tance (% of Total)	∑ Dis-tance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-31					
EA	2.8%	2.8%	2.2%	2.2%	300	466	498	0.826	-32	270	33	-34	10.4	94.6%
EB	0.1%	2.9%	0.2%	2.4%	300	467	498	0.826	-31	280	33	-33	11.4	94.5%
EC	0.9%	3.9%	0.9%	3.3%	300	466	498	0.826	-32	280	33	-33	11.4	93.4%
ED	0.6%	4.5%	0.7%	4.0%	300	472	498	0.826	-26	280	32	-33	11.4	92.7%
EE	2.5%	7.0%	2.7%	6.7%	300	476	499	0.825	-23	280	28	-32	12.4	89.7%
EF	0.4%	7.4%	0.4%	7.1%	300	479	500	0.825	-21	280	25	-31	13.4	89.2%
EG	0.5%	7.9%	0.6%	7.7%	300	481	500	0.825	-19	280	23	-31	13.4	88.6%
EH	0.2%	8.2%	0.2%	7.9%	300	482	500	0.825	-18	280	22	-31	13.4	88.3%
EI	1.7%	9.8%	1.9%	9.8%	300	484	500	0.824	-16	290	19	-31	13.4	86.4%
EJ	0.5%	10.3%	0.5%	10.4%	300	487	500	0.824	-13	290	15	-31	13.4	85.8%
EK	2.7%	13.1%	3.0%	13.3%	300	491	499	0.823	-8	290	9	-31	13.4	82.6%
EL	2.5%	15.6%	2.8%	16.1%	320	491	495	0.823	-4	10	6	-36	12.4	79.8%
EM	1.0%	16.6%	1.2%	17.4%	320	496	495	0.825	1	50	9	-36	12.4	78.6%
EN	0.5%	17.1%	0.6%	17.9%	320	497	495	0.825	2	60	12	-36	12.4	78.0%
EO	0.7%	17.9%	0.8%	18.8%	320	498	495	0.825	3	60	13	-36	12.4	77.2%
EP	0.9%	18.8%	0.9%	19.7%	320	499	495	0.825	4	60	14	-36	12.4	76.2%
EQ	4.5%	23.3%	5.2%	24.9%	320	503	495	0.825	8	70	17	-36	12.4	71.3%
ER	8.9%	32.2%	10.0%	35.0%	320	503	493	0.823	10	80	14	-37	11.4	61.9%
ES	1.7%	33.9%	1.9%	36.9%	340	493	488	0.824	5	130	5	-42	10.3	60.2%
ET	2.3%	36.2%	2.5%	39.4%	340	490	488	0.825	2	180	4	-42	10.3	57.9%
EU	0.1%	36.3%	0.1%	39.5%	340	490	488	0.825	2	180	4	-42	10.3	57.8%
EV	1.6%	37.8%	1.8%	41.2%	340	487	488	0.825	-1	210	7	-42	10.3	56.2%
EW	1.4%	39.2%	1.5%	42.8%	340	485	488	0.825	-3	230	9	-43	9.3	54.9%
EX	2.8%	42.0%	3.1%	45.8%	340	484	488	0.825	-4	240	14	-43	9.3	52.0%
EY	1.3%	43.3%	1.3%	47.2%	360	472	481	0.823	-9	250	23	-48	8.3	50.8%
EZ	1.1%	44.4%	1.1%	48.3%	360	468	481	0.823	-13	250	28	-48	8.3	49.8%
FA	2.1%	46.5%	2.2%	50.5%	360	463	481	0.824	-18	260	36	-48	8.3	47.8%
FB	0.7%	47.2%	0.8%	51.3%	360	458	481	0.824	-23	260	44	-49	7.3	47.1%
FC	0.5%	47.8%	0.5%	51.8%	360	450	481	0.825	-31	260	47	-49	7.3	46.6%
FD	1.8%	49.5%	1.9%	53.6%	360	446	481	0.825	-35	260	50	-49	7.3	45.0%
FE	0.3%	49.8%	0.2%	53.9%	360	442	481	0.825	-39	260	52	-49	7.3	44.7%
FF	1.5%	51.3%	1.5%	55.4%	360	442	481	0.825	-39	260	52	-49	7.3	43.3%
FG	1.1%	52.5%	1.1%	56.5%	360	439	481	0.825	-42	270	52	-50	6.3	42.3%
FH	1.4%	53.8%	1.4%	57.9%	360	438	480	0.826	-42	270	52	-50	6.3	41.1%
FI	1.8%	55.6%	1.8%	59.6%	360	438	480	0.826	-42	270	50	-50	6.3	39.5%
FJ	3.7%	59.2%	3.7%	63.3%	360	439	480	0.826	-41	280	46	-51	5.3	36.2%
FK	5.1%	64.4%	5.0%	68.3%	360	441	479	0.826	-38	290	41	-52	4.3	31.7%
FL	4.6%	69.0%	4.6%	72.9%	360	439	478	0.825	-39	290	40	-52	4.3	27.7%
FM	1.7%	70.6%	1.0%	74.0%	380	426	473	0.825	-47	290	48	-57	-0.5	26.3%
FN	3.0%	73.7%	3.4%	77.4%	380	426	473	0.825	-47	290	48	-57	-0.5	23.8%
FO	4.1%	77.7%	3.8%	81.2%	380	415	473	0.826	-58	280	59	-57	-0.5	20.4%
FP	4.2%	81.9%	3.8%	85.0%	400	402	470	0.824	-68	280	69	-59	-2.5	17.1%
FQ	4.3%	86.2%	3.9%	88.9%	400	397	471	0.825	-74	280	79	-58	-1.5	13.8%
FR	6.4%	92.6%	5.3%	94.2%	400	389	473	0.826	-84	270	86	-57	-0.5	8.9%
FS	1.7%	94.3%	1.7%	96.0%	400	389	473	0.826	-84	270	86	-57	-0.5	7.6%
FT	0.1%	94.4%	0.1%	96.0%	400	389	473	0.826	-84	270	86	-57	-0.5	7.6%
FU	1.7%	96.0%	1.5%	97.5%	400	393	474	0.826	-81	270	88	-56	0.5	6.3%
FV	0.1%	96.1%	0.1%	97.6%	400	411	474	0.826	-63	270	88	-56	0.5	6.2%
FX	0.3%	96.4%	0.3%	97.9%	400	412	474	0.826	-62	270	88	-56	0.5	6.0%
LDG	3.6%	100.0%	2.1%	100.0%										6.0%

December 85% Route 1														
Way-point De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-34					
EA	2.8%	2.8%	2.2%	2.2%	300	463	498	0.826	-35	270	38	-34	10.4	94.7%
EB	0.2%	3.0%	0.2%	2.4%	300	464	498	0.826	-34	270	37	-33	11.4	94.4%
EC	0.8%	3.9%	0.9%	3.3%	300	463	498	0.826	-35	280	37	-33	11.4	93.4%
ED	0.6%	4.5%	0.7%	4.0%	300	471	499	0.826	-28	280	36	-33	11.4	92.7%
EE	2.5%	7.0%	2.7%	6.7%	300	475	499	0.825	-24	280	32	-32	12.4	89.8%
EF	0.4%	7.4%	0.4%	7.1%	300	479	500	0.825	-21	280	28	-31	13.4	89.3%
EG	0.5%	7.9%	0.6%	7.7%	300	480	500	0.825	-20	280	26	-31	13.4	88.7%
EH	0.2%	8.2%	0.2%	7.9%	300	481	500	0.825	-19	280	25	-31	13.4	88.4%
EI	1.8%	9.9%	1.9%	9.8%	300	484	500	0.825	-16	280	22	-31	13.4	86.4%
EJ	0.4%	10.4%	0.5%	10.4%	300	486	500	0.825	-14	280	17	-31	13.4	85.9%
EK	2.7%	13.1%	3.0%	13.3%	300	491	500	0.823	-9	280	11	-31	13.4	82.7%
EL	2.5%	15.6%	2.8%	16.1%	320	493	495	0.824	-2	20	4	-36	12.4	80.0%
EM	1.0%	16.6%	1.2%	17.4%	320	498	495	0.825	3	70	10	-36	12.4	78.8%
EN	0.6%	17.3%	0.6%	17.9%	320	500	495	0.825	5	70	12	-36	12.4	78.1%
EO	0.7%	18.0%	0.8%	18.8%	320	501	495	0.825	6	70	14	-36	12.4	77.3%
EP	0.8%	18.8%	0.9%	19.7%	320	501	495	0.825	6	70	15	-36	12.4	76.4%
EQ	4.5%	23.3%	5.2%	24.9%	320	505	495	0.825	10	70	18	-36	12.4	71.6%
ER	8.9%	32.2%	10.0%	35.0%	320	505	493	0.823	12	80	16	-37	11.4	62.2%
ES	1.7%	33.9%	1.9%	36.9%	340	495	488	0.824	7	100	8	-42	10.3	60.6%
ET	2.3%	36.2%	2.5%	39.4%	340	489	488	0.824	1	180	2	-42	10.3	58.3%
EU	0.0%	36.2%	0.1%	39.5%	340	489	488	0.824	1	180	2	-42	10.3	58.3%
EV	1.7%	37.9%	1.8%	41.2%	340	483	489	0.825	-6	250	8	-42	10.3	56.6%
EW	1.4%	39.2%	1.5%	42.8%	340	480	488	0.825	-8	250	11	-42	10.3	55.3%
EX	2.8%	42.1%	3.1%	45.8%	340	480	488	0.825	-8	250	17	-43	9.3	52.6%
EY	1.3%	43.3%	1.3%	47.2%	340	477	488	0.825	-11	260	24	-43	9.3	51.4%
EZ	1.2%	44.5%	1.1%	48.3%	340	473	488	0.825	-15	260	29	-43	9.3	50.2%
FA	2.1%	46.5%	2.2%	50.5%	360	459	481	0.824	-22	260	40	-48	8.3	48.2%
FB	0.7%	47.3%	0.8%	51.3%	360	454	482	0.824	-28	260	47	-48	8.3	47.6%
FC	0.5%	47.8%	0.5%	51.8%	360	445	482	0.825	-37	260	50	-49	7.3	47.1%
FD	1.9%	49.7%	1.9%	53.6%	360	441	482	0.825	-41	260	54	-49	7.3	45.4%
FE	0.3%	50.0%	0.2%	53.9%	360	436	481	0.825	-45	270	57	-49	7.3	45.1%
FF	1.4%	51.4%	1.5%	55.4%	360	436	481	0.825	-45	270	57	-49	7.3	43.8%
FG	1.2%	52.5%	1.1%	56.5%	360	433	481	0.826	-48	270	59	-49	7.3	42.8%
FH	1.5%	54.0%	1.4%	57.9%	360	433	481	0.826	-48	270	59	-50	6.3	41.5%
FI	1.8%	55.8%	1.8%	59.6%	360	434	481	0.826	-47	270	57	-50	6.3	39.9%
FJ	3.8%	59.5%	3.7%	63.3%	360	435	480	0.826	-45	270	53	-50	6.3	36.6%
FK	5.1%	64.6%	5.0%	68.3%	360	438	479	0.826	-41	280	46	-51	5.3	32.1%
FL	4.6%	69.2%	4.6%	72.9%	360	437	478	0.825	-41	280	44	-52	4.3	28.1%
FM	1.9%	71.1%	1.0%	74.0%	380	423	474	0.825	-51	280	54	-56	0.5	26.6%
FN	2.8%	74.0%	3.4%	77.4%	380	423	474	0.825	-51	280	54	-56	0.5	24.3%
FO	4.2%	78.1%	3.8%	81.2%	380	408	474	0.826	-66	280	67	-56	0.5	20.9%
FP	4.2%	82.3%	3.8%	85.0%	400	395	471	0.824	-76	270	78	-58	-1.5	17.6%
FQ	4.4%	86.7%	3.9%	88.9%	400	392	472	0.825	-80	270	87	-57	-0.5	14.2%
FR	6.4%	93.1%	5.3%	94.2%	400	385	474	0.825	-89	270	93	-56	0.5	9.4%
FS	1.8%	94.9%	1.7%	96.0%	400	385	474	0.825	-89	270	93	-56	0.5	8.1%
FT	0.1%	95.0%	0.1%	96.0%	400	385	474	0.825	-89	270	93	-56	0.5	8.0%
FU	1.7%	96.7%	1.5%	97.5%	400	390	475	0.826	-85	270	95	-55	1.5	6.7%
FV	0.1%	96.8%	0.1%	97.6%	400	410	475	0.826	-65	270	95	-55	1.5	6.7%
FX	0.3%	97.1%	0.3%	97.9%	400	410	475	0.826	-65	270	95	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

APPENDIX 9. SEASONAL FLIGHT PLAN DATA OUTBOUND ROUTE 2

January 50% Route 2

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-27					
CA	2.8%	2.8%	2.2%	2.2%	300	486	500	0.825	-14	280	14	-32	12.4	94.7%
CB	0.2%	3.0%	0.2%	2.4%	300	486	500	0.825	-14	280	14	-32	12.4	94.4%
CC	0.8%	3.8%	0.9%	3.3%	300	486	500	0.825	-14	290	14	-32	12.4	93.4%
CD	0.5%	4.3%	0.6%	4.0%	300	486	500	0.825	-14	290	14	-32	12.4	92.8%
CE	2.8%	7.1%	3.0%	6.9%	300	488	500	0.825	-12	300	12	-32	12.4	89.6%
CF	0.3%	7.4%	0.3%	7.2%	300	489	500	0.825	-11	300	10	-31	13.4	89.2%
CG	0.6%	8.0%	0.8%	8.0%	300	490	500	0.825	-10	310	10	-31	13.4	88.5%
CH	0.2%	8.3%	0.2%	8.2%	300	490	500	0.825	-10	310	9	-31	13.4	88.2%
CI	1.1%	9.3%	1.2%	9.4%	300	491	500	0.824	-9	310	9	-31	13.4	87.0%
CJ	1.3%	10.6%	1.4%	10.7%	300	492	499	0.824	-7	310	7	-31	13.4	85.6%
CK	0.7%	11.3%	0.8%	11.5%	300	493	499	0.823	-6	310	6	-31	13.4	84.6%
CL	0.1%	11.4%	0.1%	11.7%	320	494	499	0.823	-5	320	6	-31	17.4	84.5%
CM	1.6%	13.0%	1.7%	13.4%	320	492	497	0.823	-5	330	6	-33	15.4	82.7%
CN	2.3%	15.3%	2.5%	15.9%	320	491	495	0.824	-4	350	5	-36	12.4	80.1%
CO	0.8%	16.2%	1.0%	16.9%	320	494	495	0.825	-1	30	4	-36	12.4	79.2%
CP	9.5%	25.7%	10.5%	27.4%	320	498	494	0.824	4	70	6	-36	12.4	68.9%
CQ	3.7%	29.4%	4.1%	31.5%	340	490	487	0.823	3	60	9	-42	10.3	64.9%
CR	6.6%	36.0%	7.2%	38.7%	340	490	488	0.825	2	110	2	-42	10.3	58.5%
CS	9.7%	45.7%	10.3%	49.0%	360	477	481	0.822	-4	250	6	-48	8.3	49.2%
CT	2.4%	48.1%	2.5%	51.5%	360	465	482	0.824	-17	260	21	-48	8.3	47.0%
CU	1.1%	49.2%	1.1%	52.6%	360	465	482	0.824	-17	260	21	-48	8.3	46.0%
CV	1.4%	50.6%	1.4%	54.0%	360	461	482	0.825	-21	260	27	-48	8.3	44.8%
CW	1.2%	51.7%	1.2%	55.2%	360	460	482	0.825	-22	260	27	-48	8.3	43.7%
CX	1.5%	53.2%	1.6%	56.7%	360	461	482	0.825	-21	260	26	-48	8.3	42.4%
CY	1.7%	54.9%	1.7%	58.4%	360	463	482	0.825	-19	260	23	-48	8.3	40.8%
CZ	3.8%	58.7%	4.0%	62.5%	360	471	482	0.825	-11	260	20	-49	7.3	37.4%
DA	2.6%	61.4%	2.7%	65.2%	360	467	481	0.825	-14	270	21	-49	7.3	35.1%
DB	5.0%	66.3%	5.1%	70.3%	360	460	481	0.825	-21	270	29	-51	5.3	30.7%
DC	3.7%	70.1%	3.4%	73.8%	380	442	475	0.824	-33	270	41	-54	2.5	27.7%
DD	1.5%	71.5%	1.7%	75.4%	380	442	475	0.824	-33	270	41	-54	2.5	26.4%
DE	5.1%	76.6%	4.8%	80.2%	380	426	476	0.825	-50	280	55	-54	2.5	22.3%
DF	4.9%	81.5%	4.4%	84.6%	380	407	475	0.826	-68	280	73	-55	1.5	18.3%
DG	5.0%	86.5%	4.3%	89.0%	400	393	472	0.825	-79	280	88	-58	-1.5	14.4%
DH	6.6%	93.0%	5.4%	94.4%	400	377	473	0.826	-96	270	99	-57	-0.5	9.5%
DI	1.9%	94.9%	1.7%	96.1%	400	377	473	0.826	-96	270	99	-57	-0.5	8.0%
DJ	1.7%	96.6%	1.5%	97.5%	400	386	474	0.826	-88	260	101	-56	0.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	410	474	0.826	-64	260	100	-56	0.5	6.7%
DL	0.3%	97.0%	0.3%	97.9%	400	411	474	0.826	-63	260	99	-56	0.5	6.5%
LDG	3.0%	100.0%	2.1%	100.0%										5.3%

January 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-30					
CA	2.7%	2.7%	2.2%	2.2%	300	484	500	0.825	-16	270	18	-32	12.4	94.7%
CB	0.2%	2.9%	0.2%	2.4%	300	485	500	0.825	-15	270	17	-31	13.4	94.5%
CC	0.8%	3.8%	0.9%	3.3%	300	483	500	0.825	-17	270	17	-31	13.4	93.5%
CD	0.5%	4.3%	0.6%	4.0%	300	485	500	0.825	-15	280	17	-31	13.4	92.9%
CE	2.7%	7.0%	3.0%	6.9%	300	487	500	0.825	-13	280	14	-31	13.4	89.6%
CF	0.3%	7.4%	0.3%	7.2%	300	488	500	0.825	-12	290	13	-31	13.4	89.3%
CG	0.7%	8.1%	0.8%	8.0%	300	488	500	0.825	-12	290	12	-31	13.4	88.4%
CH	0.1%	8.2%	0.2%	8.2%	300	489	500	0.825	-11	290	12	-31	13.4	88.3%
CI	1.1%	9.3%	1.2%	9.4%	300	490	500	0.824	-10	290	11	-31	13.4	87.1%
CJ	1.3%	10.5%	1.4%	10.7%	300	491	500	0.824	-9	280	10	-31	13.4	85.6%
CK	0.7%	11.3%	0.8%	11.5%	300	492	500	0.823	-8	280	8	-31	13.4	84.7%
CL	0.1%	11.4%	0.1%	11.7%	320	489	497	0.823	-8	290	9	-33	15.4	84.6%
CM	1.6%	12.9%	1.7%	13.4%	320	487	495	0.824	-8	290	8	-36	12.4	82.8%
CN	2.3%	15.2%	2.5%	15.9%	320	492	495	0.824	-3	310	3	-36	12.4	80.2%
CO	0.9%	16.2%	1.0%	16.9%	320	496	495	0.825	1	60	4	-36	12.4	79.2%
CP	9.4%	25.6%	10.5%	27.4%	320	502	495	0.824	7	80	10	-36	12.4	69.0%
CQ	3.7%	29.2%	4.1%	31.5%	340	493	488	0.824	5	80	12	-42	10.3	65.3%
CR	6.4%	35.6%	7.2%	38.7%	340	492	489	0.825	3	80	5	-42	10.3	58.8%
CS	9.8%	45.4%	10.3%	49.0%	360	474	481	0.822	-7	270	9	-47	9.3	49.5%
CT	2.4%	47.8%	2.5%	51.5%	360	459	482	0.824	-23	270	27	-48	8.3	47.2%
CU	1.1%	48.9%	1.1%	52.6%	360	459	482	0.824	-23	270	27	-48	8.3	46.3%
CV	1.4%	50.3%	1.4%	54.0%	360	455	482	0.825	-27	270	32	-48	8.3	45.0%
CW	1.2%	51.4%	1.2%	55.2%	360	455	482	0.825	-27	270	32	-48	8.3	44.0%
CX	1.6%	53.0%	1.6%	56.7%	360	455	482	0.825	-27	270	31	-48	8.3	42.5%
CY	1.6%	54.6%	1.7%	58.4%	360	456	482	0.825	-26	270	29	-48	8.3	41.1%
CZ	3.9%	58.5%	4.0%	62.5%	360	463	482	0.825	-19	270	27	-48	8.3	37.6%
DA	2.7%	61.2%	2.7%	65.2%	380	452	482	0.822	-30	270	31	-53	3.5	35.2%
DB	5.0%	66.2%	5.1%	70.3%	380	450	476	0.823	-26	270	38	-53	3.5	30.9%
DC	3.8%	70.0%	3.4%	73.8%	380	440	476	0.824	-36	270	47	-54	2.5	27.7%
DD	1.5%	71.5%	1.7%	75.4%	380	440	476	0.824	-36	270	47	-54	2.5	26.5%
DE	4.9%	76.4%	4.8%	80.2%	380	425	477	0.825	-52	270	61	-54	2.5	22.5%
DF	4.9%	81.4%	4.4%	84.6%	380	406	476	0.826	-70	280	78	-54	2.5	18.4%
DG	4.9%	86.3%	4.3%	89.0%	400	392	473	0.825	-81	270	94	-57	-0.5	14.6%
DH	6.6%	93.0%	5.4%	94.4%	400	371	474	0.826	-103	270	106	-56	0.5	9.6%
DI	1.9%	94.8%	1.7%	96.1%	400	371	474	0.826	-103	270	106	-56	0.5	8.1%
DJ	1.7%	96.5%	1.5%	97.5%	400	379	475	0.826	-96	270	108	-55	1.5	6.9%
DK	0.1%	96.6%	0.1%	97.6%	400	402	476	0.826	-74	270	106	-55	1.5	6.8%
DL	0.4%	97.1%	0.3%	97.9%	400	403	476	0.826	-73	270	106	-55	1.5	6.5%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

February 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-18					
CA	2.8%	2.8%	2.2%	2.2%	300	489	501	0.825	-12	290	12	-31	13.4	94.6%
CB	0.2%	3.0%	0.2%	2.4%	300	490	501	0.825	-11	290	12	-30	14.4	93.0%
CC	0.9%	3.9%	0.9%	3.3%	300	490	501	0.825	-11	290	11	-30	14.4	92.0%
CD	0.5%	4.4%	0.6%	4.0%	300	491	501	0.825	-10	290	11	-30	14.4	91.3%
CE	2.8%	7.2%	3.0%	6.9%	300	493	501	0.825	-8	280	9	-30	14.4	88.1%
CF	0.2%	7.5%	0.3%	7.2%	300	495	501	0.825	-6	280	6	-30	14.4	87.9%
CG	0.8%	8.2%	0.8%	8.0%	300	496	501	0.824	-5	280	6	-30	14.4	87.0%
CH	0.1%	8.3%	0.2%	8.2%	300	496	501	0.824	-5	280	5	-30	14.4	86.9%
CI	1.1%	9.4%	1.2%	9.4%	300	497	501	0.824	-4	280	4	-30	14.4	85.7%
CJ	1.3%	10.7%	1.4%	10.7%	300	498	501	0.823	-3	290	2	-30	14.4	84.2%
CK	0.8%	11.5%	0.8%	11.5%	300	499	500	0.823	-1	340	1	-30	14.4	83.3%
CL	0.1%	11.6%	0.1%	11.7%	320	500	500	0.823	0	10	1	-32	16.4	83.2%
CM	1.6%	13.2%	1.7%	13.4%	320	498	498	0.823	0	40	3	-32	16.4	81.4%
CN	2.3%	15.5%	2.5%	15.9%	320	498	496	0.824	2	60	7	-35	13.4	78.9%
CO	1.0%	16.4%	1.0%	16.9%	320	501	496	0.825	5	70	11	-35	13.4	77.9%
CP	9.5%	26.0%	10.5%	27.4%	320	507	495	0.824	12	80	15	-36	12.4	67.8%
CQ	3.8%	29.7%	4.1%	31.5%	340	498	487	0.822	11	80	20	-42	10.3	64.0%
CR	6.6%	36.3%	7.2%	38.7%	340	501	488	0.824	13	80	19	-42	10.3	57.4%
CS	9.6%	46.0%	10.3%	49.0%	340	493	481	0.821	12	110	12	-47	5.3	48.5%
CT	2.3%	48.2%	2.5%	51.5%	340	481	482	0.823	-1	210	16	-47	5.3	46.4%
CU	1.1%	49.3%	1.1%	52.6%	360	481	482	0.823	-1	210	16	-47	9.3	45.4%
CV	1.4%	50.7%	1.4%	54.0%	360	472	482	0.824	-10	230	27	-47	9.3	44.2%
CW	1.2%	51.9%	1.2%	55.2%	360	467	483	0.824	-16	240	32	-47	9.3	43.1%
CX	1.5%	53.4%	1.6%	56.7%		462	483	0.825	-21	240	37	-47	-62.0	41.8%
CY	1.7%	55.2%	1.7%	58.4%	360	456	483	0.825	-27	240	43	-48	8.3	40.2%
CZ	4.0%	59.2%	4.0%	62.5%	360	460	483	0.825	-23	250	54	-48	8.3	36.7%
DA	2.8%	62.0%	2.7%	65.2%	360	442	482	0.826	-40	260	62	-48	8.3	34.3%
DB	5.4%	67.4%	5.1%	70.3%	360	439	481	0.826	-42	270	55	-49	7.3	29.7%
DC	3.6%	71.0%	3.4%	73.8%	360	439	479	0.825	-40	280	44	-51	5.3	26.7%
DD	1.7%	72.7%	1.7%	75.4%	360	439	479	0.825	-40	280	44	-51	5.3	25.3%
DE	5.0%	77.7%	4.8%	80.2%	360	441	476	0.824	-35	280	40	-53	3.3	21.2%
DF	4.8%	82.4%	4.4%	84.6%	380	431	473	0.826	-42	270	40	-57	-0.5	17.4%
DG	4.7%	87.1%	4.3%	89.0%	400	426	470	0.824	-44	260	58	-59	-2.5	13.8%
DH	6.1%	93.1%	5.4%	94.4%	400	411	473	0.825	-62	260	68	-57	-0.5	9.3%
DI	1.8%	95.0%	1.7%	96.1%	400	411	473	0.825	-62	260	68	-57	-0.5	8.0%
DJ	1.6%	96.6%	1.5%	97.5%	400	415	475	0.826	-60	260	71	-55	1.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	431	476	0.826	-45	260	71	-54	2.5	6.7%
DL	0.4%	97.1%	0.3%	97.9%	400	432	476	0.826	-44	260	71	-54	2.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

February 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-20					
CA	2.8%	2.8%	2.2%	2.2%	300	488	501	0.825	-13	270	14	-30	14.4	94.6%
CB	0.2%	3.0%	0.2%	2.4%	300	488	501	0.825	-13	280	14	-30	14.4	94.4%
CC	0.9%	3.9%	0.9%	3.3%	300	488	501	0.825	-13	280	14	-30	14.4	93.4%
CD	0.5%	4.4%	0.6%	4.0%	300	490	501	0.825	-11	270	14	-30	14.4	92.7%
CE	2.8%	7.2%	3.0%	6.9%	300	492	501	0.825	-9	270	12	-30	14.4	89.5%
CF	0.2%	7.4%	0.3%	7.2%	300	494	501	0.825	-7	270	10	-30	14.4	89.2%
CG	0.8%	8.2%	0.8%	8.0%	300	494	501	0.825	-7	270	9	-30	14.4	88.3%
CH	0.2%	8.4%	0.2%	8.2%	300	495	501	0.824	-6	260	8	-30	14.4	88.1%
CI	1.1%	9.5%	1.2%	9.4%	300	496	501	0.824	-5	260	7	-29	15.4	86.9%
CJ	1.3%	10.8%	1.4%	10.7%	300	497	501	0.823	-4	260	5	-29	15.4	85.4%
CK	0.6%	11.4%	0.8%	11.5%	300	499	501	0.823	-2	260	3	-29	15.4	84.6%
CL	0.2%	11.6%	0.1%	11.7%	300	499	501	0.823	-2	260	2	-29	15.4	84.3%
CM	1.5%	13.1%	1.7%	13.4%	320	500	498	0.823	2	70	2	-32	16.4	82.6%
CN	2.3%	15.4%	2.5%	15.9%	320	501	496	0.824	5	80	9	-35	13.4	80.2%
CO	1.0%	16.4%	1.0%	16.9%	320	503	496	0.825	7	80	12	-35	13.4	79.1%
CP	9.5%	25.9%	10.5%	27.4%	320	509	495	0.824	14	90	17	-35	13.4	68.9%
CQ	3.7%	29.5%	4.1%	31.5%	340	502	488	0.822	14	80	24	-41	11.3	65.2%
CR	6.5%	36.0%	7.2%	38.7%	340	507	488	0.823	19	90	24	-42	10.3	58.7%
CS	9.6%	45.6%	10.3%	49.0%	360	496	481	0.821	15	100	16	-47	9.3	49.6%
CT	2.6%	48.2%	2.5%	51.5%	360	477	482	0.823	-5	230	16	-47	9.3	47.2%
CU	0.9%	49.0%	1.1%	52.6%	360	477	482	0.823	-5	230	16	-47	9.3	46.4%
CV	1.4%	50.4%	1.4%	54.0%	360	466	483	0.824	-17	240	29	-47	9.3	45.2%
CW	1.2%	51.6%	1.2%	55.2%	360	461	483	0.825	-22	250	34	-47	9.3	44.1%
CX	1.5%	53.1%	1.6%	56.7%	360	456	483	0.825	-27	250	40	-47	9.3	42.7%
CY	1.7%	54.8%	1.7%	58.4%	360	450	483	0.825	-33	250	46	-47	9.3	41.2%
CZ	4.0%	58.8%	4.0%	62.5%	360	453	483	0.825	-30	260	57	-47	9.3	37.6%
DA	2.9%	61.7%	2.7%	65.2%	360	436	483	0.826	-47	270	66	-48	8.3	35.1%
DB	5.4%	67.1%	5.1%	70.3%	360	437	482	0.826	-45	270	61	-49	7.3	30.4%
DC	3.7%	70.8%	3.4%	73.8%	360	436	480	0.825	-44	280	52	-51	5.3	27.3%
DD	1.7%	72.5%	1.7%	75.4%	360	436	480	0.825	-44	280	52	-51	5.3	25.9%
DE	5.0%	77.5%	4.8%	80.2%	360	437	478	0.825	-41	270	48	-52	4.3	21.7%
DF	4.7%	82.2%	4.4%	84.6%	380	427	474	0.826	-47	270	56	-56	0.5	17.9%
DG	4.7%	87.0%	4.3%	89.0%	400	418	472	0.824	-54	270	64	-58	-1.5	14.2%
DH	6.1%	93.1%	5.4%	94.4%	400	405	474	0.825	-69	270	74	-56	0.5	9.6%
DI	1.8%	94.9%	1.7%	96.1%	400	405	474	0.825	-69	270	74	-56	0.5	8.2%
DJ	1.7%	96.7%	1.5%	97.5%	400	407	477	0.826	-70	270	78	-54	2.5	6.9%
DK	0.1%	96.8%	0.1%	97.6%	400	423	477	0.826	-54	270	78	-53	3.5	6.8%
DL	0.3%	97.1%	0.3%	97.9%	400	423	477	0.826	-54	270	78	-53	3.5	6.6%
LDG	2.9%	100.0%	2.1%	100.0%										5.4%

March 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-22					
CA	2.8%	2.8%	2.2%	2.2%	300	487	499	0.825	-12	250	17	-33	11.4	94.7%
CB	0.2%	3.0%	0.2%	2.4%	300	488	499	0.825	-11	250	17	-33	11.4	94.5%
CC	0.9%	3.9%	0.9%	3.3%	300	486	499	0.825	-13	250	16	-32	12.4	93.5%
CD	0.5%	4.4%	0.6%	4.0%	300	489	499	0.825	-10	250	16	-32	12.4	92.8%
CE	2.8%	7.2%	3.0%	6.9%	300	491	499	0.825	-8	250	15	-32	12.4	89.6%
CF	0.2%	7.4%	0.3%	7.2%	300	491	500	0.825	-9	250	14	-31	13.4	89.4%
CG	0.8%	8.1%	0.8%	8.0%	300	491	500	0.825	-9	250	14	-31	13.4	88.5%
CH	0.1%	8.3%	0.2%	8.2%	300	491	500	0.825	-9	260	13	-31	13.4	88.4%
CI	1.2%	9.4%	1.2%	9.4%	300	492	500	0.824	-8	260	12	-31	13.4	87.0%
CJ	1.3%	10.7%	1.4%	10.7%	300	492	500	0.824	-8	270	10	-30	14.4	85.5%
CK	0.8%	11.5%	0.8%	11.5%	300	493	500	0.823	-7	280	8	-30	14.4	84.6%
CL	0.1%	11.6%	0.1%	11.7%	320	493	500	0.823	-7	290	7	-30	18.4	84.5%
CM	1.5%	13.1%	1.7%	13.4%	320	491	498	0.823	-7	300	7	-33	15.4	82.8%
CN	2.4%	15.4%	2.5%	15.9%	320	491	495	0.824	-4	350	5	-35	13.4	80.2%
CO	1.0%	16.4%	1.0%	16.9%	320	495	496	0.825	-1	40	6	-35	13.4	79.2%
CP	9.5%	25.9%	10.5%	27.4%	320	502	495	0.824	7	60	12	-36	12.4	68.9%
CQ	3.8%	29.7%	4.1%	31.5%	340	494	488	0.823	6	70	17	-41	11.3	65.1%
CR	6.5%	36.2%	7.2%	38.7%	340	498	489	0.824	9	80	13	-41	11.3	58.5%
CS	9.5%	45.8%	10.3%	49.0%	360	493	481	0.821	12	130	12	-47	9.3	49.5%
CT	2.6%	48.3%	2.5%	51.5%	360	478	482	0.823	-4	220	18	-47	9.3	47.2%
CU	0.9%	49.2%	1.1%	52.6%	360	478	483	0.823	-5	220	18	-47	9.3	46.4%
CV	1.4%	50.6%	1.4%	54.0%	360	469	483	0.824	-14	240	26	-47	9.3	45.1%
CW	1.2%	51.8%	1.2%	55.2%	360	465	483	0.825	-18	240	31	-47	9.3	44.1%
CX	1.5%	53.3%	1.6%	56.7%	360	460	483	0.825	-23	250	34	-47	9.3	42.7%
CY	1.7%	55.0%	1.7%	58.4%	360	456	483	0.825	-27	250	38	-47	9.3	41.2%
CZ	4.0%	58.9%	4.0%	62.5%	360	462	483	0.825	-21	260	40	-48	8.3	37.6%
DA	2.7%	61.6%	2.7%	65.2%	360	453	482	0.826	-29	270	38	-48	8.3	35.3%
DB	5.3%	66.9%	5.1%	70.3%	360	449	482	0.826	-33	290	36	-49	7.3	30.8%
DC	3.6%	70.5%	3.4%	73.8%	360	440	481	0.825	-41	290	43	-50	6.3	27.7%
DD	1.6%	72.1%	1.7%	75.4%	360	440	481	0.825	-41	290	43	-50	6.3	26.3%
DE	5.0%	77.2%	4.8%	80.2%	360	431	479	0.825	-48	290	51	-51	5.3	22.1%
DF	4.8%	82.0%	4.4%	84.6%	380	416	474	0.826	-58	280	64	-56	0.5	18.2%
DG	4.8%	86.8%	4.3%	89.0%	400	407	471	0.824	-64	270	76	-59	-2.5	14.5%
DH	6.2%	93.0%	5.4%	94.4%	400	398	472	0.826	-74	260	81	-58	-1.5	9.8%
DI	1.9%	95.0%	1.7%	96.1%	400	398	472	0.826	-74	260	81	-58	-1.5	8.4%
DJ	1.6%	96.6%	1.5%	97.5%	400	412	474	0.826	-62	260	77	-56	0.5	7.2%
DK	0.1%	96.7%	0.1%	97.6%	400	434	474	0.826	-40	260	74	-56	0.5	7.1%
DL	0.4%	97.1%	0.3%	97.9%	400	434	474	0.826	-40	260	73	-56	0.5	6.8%
LDG	2.9%	100.0%	2.1%	100.0%										5.7%

March 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-24					
CA	2.8%	2.8%	2.2%	2.2%	300	482	499	0.825	-17	260	20	-33	11.4	94.7%
CB	0.2%	3.0%	0.2%	2.4%	300	483	499	0.825	-16	260	20	-32	12.4	94.4%
CC	0.9%	3.8%	0.9%	3.3%	300	482	499	0.825	-17	260	19	-32	12.4	93.4%
CD	0.5%	4.4%	0.6%	4.0%	300	485	499	0.825	-14	260	19	-32	12.4	92.8%
CE	2.8%	7.2%	3.0%	6.9%	300	486	500	0.825	-14	260	18	-31	13.4	89.6%
CF	0.3%	7.5%	0.3%	7.2%	300	487	500	0.825	-13	260	17	-31	13.4	89.2%
CG	0.7%	8.2%	0.8%	8.0%	300	487	500	0.825	-13	270	17	-31	13.4	88.3%
CH	0.1%	8.3%	0.2%	8.2%	300	487	500	0.825	-13	270	16	-31	13.4	88.2%
CI	1.1%	9.4%	1.2%	9.4%	300	488	500	0.824	-12	270	15	-31	13.4	87.0%
CJ	1.4%	10.8%	1.4%	10.7%	300	490	500	0.824	-10	270	13	-30	14.4	85.4%
CK	0.6%	11.4%	0.8%	11.5%	300	491	500	0.824	-9	270	11	-30	14.4	84.6%
CL	0.2%	11.6%	0.1%	11.7%	320	488	498	0.824	-10	280	11	-33	15.4	84.3%
CM	1.5%	13.1%	1.7%	13.4%	320	486	495	0.824	-9	290	10	-35	13.4	82.7%
CN	2.3%	15.5%	2.5%	15.9%	320	492	496	0.824	-4	330	4	-35	13.4	80.1%
CO	1.0%	16.4%	1.0%	16.9%	320	497	496	0.825	1	60	7	-35	13.4	79.0%
CP	9.4%	25.8%	10.5%	27.4%	320	505	495	0.825	10	70	13	-35	13.4	68.9%
CQ	3.7%	29.6%	4.1%	31.5%	340	497	488	0.823	9	70	19	-41	11.3	65.1%
CR	6.5%	36.1%	7.2%	38.7%	340	501	489	0.823	12	80	17	-41	11.3	58.5%
CS	9.5%	45.6%	10.3%	49.0%	340	494	482	0.821	12	120	13	-47	5.3	49.5%
CT	2.6%	48.1%	2.5%	51.5%	360	472	483	0.823	-11	240	21	-47	9.3	47.2%
CU	0.9%	49.0%	1.1%	52.6%	360	472	483	0.823	-11	240	21	-47	9.3	46.4%
CV	1.4%	50.4%	1.4%	54.0%	360	463	483	0.824	-20	250	30	-47	9.3	45.1%
CW	1.2%	51.5%	1.2%	55.2%	360	459	483	0.825	-24	250	34	-47	9.3	44.0%
CX	1.5%	53.0%	1.6%	56.7%	360	454	483	0.825	-29	260	38	-47	9.3	42.7%
CY	1.7%	54.7%	1.7%	58.4%	360	450	483	0.825	-33	260	42	-47	9.3	41.1%
CZ	4.1%	58.8%	4.0%	62.5%	360	455	483	0.825	-28	270	45	-47	9.3	37.5%
DA	2.8%	61.6%	2.7%	65.2%	360	449	483	0.826	-34	270	45	-47	9.3	35.1%
DB	5.1%	66.7%	5.1%	70.3%	360	448	482	0.826	-34	280	42	-48	8.3	30.7%
DC	3.7%	70.4%	3.4%	73.8%	360	439	481	0.825	-42	280	47	-49	7.3	27.5%
DD	1.6%	72.0%	1.7%	75.4%	360	439	481	0.825	-42	280	47	-49	7.3	26.1%
DE	5.0%	77.1%	4.8%	80.2%	360	430	480	0.825	-50	280	56	-50	6.3	21.9%
DF	4.8%	81.9%	4.4%	84.6%	380	415	475	0.826	-60	270	70	-55	1.5	18.0%
DG	4.9%	86.8%	4.3%	89.0%	400	402	472	0.825	-70	270	82	-58	-1.5	14.2%
DH	6.3%	93.1%	5.4%	94.4%	400	392	473	0.826	-81	270	86	-57	-0.5	9.5%
DI	1.9%	95.0%	1.7%	96.1%	400	392	473	0.826	-81	270	86	-57	-0.5	8.0%
DJ	1.6%	96.6%	1.5%	97.5%	400	406	475	0.826	-69	260	81	-55	1.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	426	475	0.826	-49	260	78	-55	1.5	6.7%
DL	0.4%	97.1%	0.3%	97.9%	400	426	476	0.826	-50	260	78	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

April 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-18					
CA	2.9%	2.9%	2.2%	2.2%	300	475	495	0.826	-20	240	29	-36	8.4	94.6%
CB	0.2%	3.1%	0.2%	2.4%	300	477	496	0.826	-19	250	30	-36	8.4	94.4%
CC	0.9%	4.0%	0.9%	3.3%	300	474	496	0.825	-22	250	31	-36	8.4	93.4%
CD	0.5%	4.5%	0.6%	4.0%	300	479	496	0.825	-17	240	32	-35	9.4	92.7%
CE	2.9%	7.4%	3.0%	6.9%	300	481	497	0.825	-16	240	31	-34	10.4	89.4%
CF	0.2%	7.6%	0.3%	7.2%	300	482	498	0.825	-16	240	30	-34	10.4	89.1%
CG	0.7%	8.4%	0.8%	8.0%	300	483	498	0.825	-15	250	29	-33	11.4	88.2%
CH	0.2%	8.6%	0.2%	8.2%	300	483	498	0.825	-15	250	28	-33	11.4	88.0%
CI	1.1%	9.6%	1.2%	9.4%	300	484	498	0.824	-14	250	26	-33	11.4	86.7%
CJ	1.3%	10.9%	1.4%	10.7%	300	486	498	0.824	-12	250	22	-32	12.4	85.3%
CK	0.7%	11.7%	0.8%	11.5%	300	487	498	0.824	-11	250	18	-32	12.4	84.4%
CL	0.1%	11.8%	0.1%	11.7%	300	488	498	0.824	-10	250	17	-32	12.4	84.3%
CM	1.6%	13.4%	1.7%	13.4%	300	490	498	0.823	-8	250	14	-32	12.4	82.5%
CN	2.4%	15.7%	2.5%	15.9%	300	494	498	0.823	-4	260	8	-31	13.4	79.8%
CO	0.9%	16.6%	1.0%	16.9%	300	496	499	0.822	-3	260	4	-31	13.4	78.8%
CP	9.7%	26.3%	10.5%	27.4%	320	493	495	0.824	-2	290	2	-36	12.4	68.2%
CQ	3.7%	30.1%	4.1%	31.5%	340	490	488	0.823	2	60	9	-41	11.3	64.3%
CR	6.5%	36.6%	7.2%	38.7%	340	498	489	0.824	9	80	13	-41	11.3	57.7%
CS	9.5%	46.1%	10.3%	49.0%	360	493	482	0.821	11	110	11	-47	9.3	48.6%
CT	2.4%	48.5%	2.5%	51.5%	360	484	483	0.823	1	200	8	-47	9.3	46.4%
CU	1.1%	49.6%	1.1%	52.6%	360	483	483	0.823	0	200	8	-47	9.3	45.4%
CV	1.4%	51.0%	1.4%	54.0%	360	479	483	0.824	-4	220	12	-47	9.3	44.2%
CW	1.1%	52.0%	1.2%	55.2%	360	477	483	0.824	-6	230	15	-47	9.3	43.2%
CX	1.5%	53.5%	1.6%	56.7%	360	474	483	0.824	-9	240	19	-47	9.3	41.8%
CY	1.6%	55.1%	1.7%	58.4%	360	469	483	0.825	-14	240	23	-47	9.3	40.4%
CZ	3.9%	59.0%	4.0%	62.5%	360	472	483	0.825	-11	250	34	-47	9.3	36.9%
DA	2.8%	61.8%	2.7%	65.2%	360	459	482	0.826	-23	250	43	-48	8.3	34.5%
DB	5.1%	66.9%	5.1%	70.3%	360	451	481	0.826	-30	260	50	-49	7.3	30.0%
DC	3.6%	70.6%	3.4%	73.8%	360	443	479	0.825	-36	270	51	-51	5.3	26.9%
DD	1.6%	72.2%	1.7%	75.4%	360	436	479	0.825	-43	270	51	-51	5.3	25.5%
DE	5.0%	77.2%	4.8%	80.2%	360	424	477	0.825	-53	270	47	-53	3.3	21.3%
DF	4.7%	81.9%	4.4%	84.6%	380	421	471	0.825	-50	280	52	-58	-1.5	17.4%
DG	4.7%	86.6%	4.3%	89.0%	400	418	468	0.824	-50	280	53	-61	-4.5	13.8%
DH	5.9%	92.5%	5.4%	94.4%	400	418	470	0.825	-52	270	54	-59	-2.5	9.3%
DI	1.8%	94.3%	1.7%	96.1%	400	418	470	0.825	-52	270	54	-59	-2.5	8.0%
DJ	1.5%	95.8%	1.5%	97.5%	400	423	472	0.825	-49	270	55	-58	-1.5	6.8%
DK	0.1%	95.9%	0.1%	97.6%	400	436	472	0.825	-36	270	55	-57	-0.5	6.8%
DL	0.4%	96.4%	0.3%	97.9%	400	436	472	0.825	-36	270	55	-57	-0.5	6.4%
LDG	3.6%	100.0%	2.1%	100.0%										5.3%

April 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-21					
CA	2.9%	2.9%	2.2%	2.2%	300	469	496	0.826	-27	250	33	-36	8.4	94.6%
CB	0.2%	3.1%	0.2%	2.4%	300	471	496	0.826	-25	260	34	-35	9.4	94.4%
CC	0.9%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	260	34	-35	9.4	93.4%
CD	0.6%	4.6%	0.6%	4.0%	300	473	496	0.826	-23	250	35	-35	9.4	92.6%
CE	2.8%	7.3%	3.0%	6.9%	300	475	497	0.825	-22	250	35	-34	10.4	89.4%
CF	0.3%	7.7%	0.3%	7.2%	300	477	498	0.825	-21	250	32	-33	11.4	89.0%
CG	0.7%	8.4%	0.8%	8.0%	300	477	498	0.825	-21	260	31	-33	11.4	88.1%
CH	0.1%	8.5%	0.2%	8.2%	300	479	499	0.825	-20	260	29	-32	12.4	88.0%
CI	1.2%	9.7%	1.2%	9.4%	300	481	499	0.824	-18	260	25	-32	12.4	86.7%
CJ	1.3%	11.0%	1.4%	10.7%	300	483	499	0.824	-16	260	21	-32	12.4	85.2%
CK	0.7%	11.7%	0.8%	11.5%	300	484	499	0.824	-15	260	20	-32	12.4	84.3%
CL	0.1%	11.8%	0.1%	11.7%	320	484	499	0.824	-15	260	20	-32	16.4	84.2%
CM	1.6%	13.4%	1.7%	13.4%	320	478	494	0.825	-16	270	20	-37	11.4	82.4%
CN	2.4%	15.9%	2.5%	15.9%	320	484	495	0.825	-11	270	14	-36	12.4	79.7%
CO	1.0%	16.8%	1.0%	16.9%	320	487	495	0.825	-8	270	11	-36	12.4	78.6%
CP	9.6%	26.4%	10.5%	27.4%	320	492	496	0.824	-4	280	4	-35	13.4	68.2%
CQ	3.7%	30.1%	4.1%	31.5%	340	494	489	0.823	5	70	11	-41	11.3	64.4%
CR	6.5%	36.6%	7.2%	38.7%	340	501	489	0.824	12	90	15	-41	11.3	57.8%
CS	9.5%	46.1%	10.3%	49.0%	360	494	482	0.821	12	100	14	-46	10.3	48.8%
CT	2.4%	48.6%	2.5%	51.5%	360	482	483	0.823	-1	220	6	-46	10.3	46.5%
CU	0.9%	49.4%	1.1%	52.6%	360	482	483	0.823	-1	220	6	-46	10.3	45.7%
CV	1.4%	50.8%	1.4%	54.0%	360	474	483	0.824	-9	250	14	-46	10.3	44.4%
CW	1.2%	52.0%	1.2%	55.2%	360	471	483	0.824	-12	250	18	-47	9.3	43.3%
CX	1.5%	53.5%	1.6%	56.7%	360	468	484	0.825	-16	250	22	-47	9.3	42.0%
CY	1.6%	55.1%	1.7%	58.4%	360	464	483	0.825	-19	250	26	-47	9.3	40.5%
CZ	3.9%	59.0%	4.0%	62.5%	360	466	483	0.825	-17	260	37	-47	9.3	37.0%
DA	2.8%	61.8%	2.7%	65.2%	360	453	483	0.826	-30	260	47	-48	8.3	34.6%
DB	5.1%	66.9%	5.1%	70.3%	360	443	482	0.826	-39	270	55	-49	7.3	30.1%
DC	3.8%	70.7%	3.4%	73.8%	360	435	480	0.825	-49	270	56	-50	6.3	26.8%
DD	1.5%	72.2%	1.7%	75.4%	360	435	480	0.825	-45	270	56	-50	6.3	25.6%
DE	5.0%	77.2%	4.8%	80.2%	360	435	477	0.825	-42	270	53	-53	3.3	21.3%
DF	4.8%	82.0%	4.4%	84.6%	380	423	472	0.826	-49	270	58	-58	-1.5	17.4%
DG	4.6%	86.6%	4.3%	89.0%	400	421	470	0.824	-49	270	59	-59	-2.5	13.9%
DH	6.0%	92.5%	5.4%	94.4%	400	415	472	0.825	-57	270	59	-58	-1.5	9.4%
DI	1.8%	94.4%	1.7%	96.1%	400	415	472	0.825	-57	270	59	-58	-1.5	8.0%
DJ	1.6%	96.0%	1.5%	97.5%	400	418	474	0.826	-56	270	60	-56	0.5	6.8%
DK	0.1%	96.1%	0.1%	97.6%	400	429	474	0.826	-45	270	60	-56	0.5	6.7%
DL	0.3%	96.4%	0.3%	97.9%	400	430	474	0.826	-44	270	60	-56	0.5	6.5%
LDG	3.6%	100.0%	2.1%	100.0%										5.4%

May 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-17					
CA	2.9%	2.9%	2.2%	2.2%	300	468	493	0.826	-25	260	33	-38	6.4	94.6%
CB	0.2%	3.1%	0.2%	2.4%	300	469	494	0.826	-25	250	34	-38	6.4	94.4%
CC	0.9%	4.0%	0.9%	3.3%	300	466	494	0.826	-28	250	35	-37	7.4	93.4%
CD	0.6%	4.6%	0.6%	4.0%	300	472	494	0.826	-22	250	36	-37	7.4	92.6%
CE	2.8%	7.4%	3.0%	6.9%	300	473	495	0.825	-22	250	38	-36	8.4	89.3%
CF	0.3%	7.7%	0.3%	7.2%	320	465	490	0.824	-25	250	44	-40	8.4	88.9%
CG	0.8%	8.5%	0.8%	8.0%	320	465	491	0.824	-26	250	44	-39	9.4	88.1%
CH	0.2%	8.7%	0.2%	8.2%	320	466	491	0.824	-25	250	44	-39	9.4	87.8%
CI	1.2%	9.9%	1.2%	9.4%	320	467	491	0.824	-24	250	43	-39	9.4	86.5%
CJ	1.3%	11.1%	1.4%	10.7%	320	469	491	0.824	-22	250	41	-39	9.4	85.1%
CK	0.8%	11.9%	0.8%	11.5%	320	470	491	0.825	-21	250	39	-38	10.4	84.2%
CL	0.2%	12.1%	0.1%	11.7%	320	472	491	0.825	-19	250	38	-38	10.4	84.0%
CM	1.6%	13.7%	1.7%	13.4%	320	474	493	0.825	-19	240	37	-38	10.4	82.2%
CN	2.4%	16.1%	2.5%	15.9%	320	482	493	0.825	-11	240	33	-38	10.4	79.6%
CO	1.0%	17.0%	1.0%	16.9%	320	484	494	0.825	-10	240	28	-37	11.4	78.5%
CP	9.9%	26.9%	10.5%	27.4%	320	486	494	0.825	-8	240	15	-36	12.4	67.8%
CQ	3.8%	30.7%	4.1%	31.5%	320	496	494	0.824	2	140	2	-36	12.4	63.8%
CR	6.5%	37.2%	7.2%	38.7%	340	496	489	0.824	7	70	12	-41	11.3	57.2%
CS	9.4%	46.6%	10.3%	49.0%	360	497	482	0.821	15	100	18	-46	10.3	48.2%
CT	2.4%	49.0%	2.5%	51.5%	360	496	482	0.822	14	120	14	-47	9.3	46.0%
CU	1.0%	49.9%	1.1%	52.6%	360	496	482	0.822	14	120	14	-47	9.3	45.1%
CV	1.3%	51.2%	1.4%	54.0%	360	492	483	0.823	9	150	11	-47	9.3	43.9%
CW	1.2%	52.4%	1.2%	55.2%	360	490	483	0.824	7	160	11	-47	9.3	42.8%
CX	1.4%	53.8%	1.6%	56.7%	360	487	483	0.824	4	180	10	-47	9.3	41.5%
CY	1.6%	55.4%	1.7%	58.4%	360	482	483	0.824	-1	210	12	-47	9.3	40.1%
CZ	3.9%	59.3%	4.0%	62.5%	360	475	483	0.825	-8	250	24	-47	9.3	36.6%
DA	2.8%	62.1%	2.7%	65.2%	360	456	482	0.826	-26	260	45	-48	8.3	34.1%
DB	5.1%	67.2%	5.1%	70.3%	360	446	481	0.826	-35	260	60	-49	7.3	29.6%
DC	3.5%	70.7%	3.4%	73.8%	380	439	474	0.825	-35	260	50	-56	0.5	26.6%
DD	1.8%	72.6%	1.7%	75.4%	380	439	474	0.825	-35	260	50	-56	0.5	25.1%
DE	4.8%	77.4%	4.8%	80.2%	380	446	472	0.825	-26	280	30	-57	-0.5	21.2%
DF	4.5%	81.9%	4.4%	84.6%	380	444	471	0.825	-27	290	28	-58	-1.5	17.5%
DG	4.6%	86.5%	4.3%	89.0%	400	433	467	0.823	-34	280	36	-62	-5.5	13.9%
DH	5.9%	92.4%	5.4%	94.4%	400	419	468	0.825	-49	280	50	-61	-4.5	9.4%
DI	1.8%	94.2%	1.7%	96.1%	400	419	468	0.825	-49	280	50	-61	-4.5	8.1%
DJ	1.6%	95.8%	1.5%	97.5%	400	417	470	0.825	-53	280	56	-61	-4.5	6.9%
DK	0.1%	95.9%	0.1%	97.6%	400	425	470	0.826	-45	280	57	-59	-2.5	6.8%
DL	0.3%	96.2%	0.3%	97.9%	400	425	470	0.826	-45	280	58	-59	-2.5	6.5%
LDG	3.8%	100.0%	2.1%	100.0%										5.3%

May 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-19					
CA	2.9%	2.9%	2.2%	2.2%	300	460	494	0.826	-34	260	39	-37	7.4	94.6%
CB	0.2%	3.1%	0.2%	2.4%	300	462	494	0.826	-32	260	39	-37	7.4	94.4%
CC	1.0%	4.1%	0.9%	3.3%	300	459	494	0.826	-35	260	40	-37	7.4	93.3%
CD	0.5%	4.6%	0.6%	4.0%	300	465	495	0.826	-30	260	41	-37	7.4	92.6%
CE	2.9%	7.5%	3.0%	6.9%	300	467	496	0.825	-29	260	42	-36	8.4	89.3%
CF	0.3%	7.8%	0.3%	7.2%	300	467	496	0.825	-29	250	44	-35	9.4	88.9%
CG	0.7%	8.5%	0.8%	8.0%	300	468	497	0.825	-29	250	44	-35	9.4	88.0%
CH	0.2%	8.8%	0.2%	8.2%	300	468	497	0.825	-29	250	44	-34	10.4	87.8%
CI	1.1%	9.8%	1.2%	9.4%	300	470	497	0.825	-27	250	43	-34	10.4	86.6%
CJ	1.4%	11.2%	1.4%	10.7%	300	472	497	0.825	-25	250	41	-34	10.4	85.0%
CK	0.7%	12.0%	0.8%	11.5%	300	472	497	0.825	-25	250	39	-33	11.4	84.1%
CL	0.1%	12.1%	0.1%	11.7%	300	474	497	0.824	-23	250	38	-33	11.4	84.0%
CM	1.6%	13.7%	1.7%	13.4%	300	476	497	0.824	-21	250	36	-33	11.4	82.2%
CN	2.5%	16.1%	2.5%	15.9%	300	485	498	0.823	-13	250	33	-32	12.4	79.4%
CO	0.9%	17.0%	1.0%	16.9%	300	487	498	0.823	-11	250	29	-32	12.4	78.4%
CP	9.9%	26.9%	10.5%	27.4%	320	482	495	0.824	-13	260	18	-36	12.4	67.6%
CQ	3.7%	30.7%	4.1%	31.5%	340	488	488	0.823	0	50	3	-41	11.3	63.8%
CR	6.5%	37.2%	7.2%	38.7%	340	499	489	0.824	10	80	14	-41	11.3	57.1%
CS	9.4%	46.6%	10.3%	49.0%	360	499	482	0.821	17	90	21	-46	10.3	48.2%
CT	2.2%	48.8%	2.5%	51.5%	360	499	482	0.822	17	110	17	-47	9.3	46.1%
CU	1.1%	49.9%	1.1%	52.6%	360	499	482	0.822	17	110	17	-47	9.3	45.1%
CV	1.3%	51.2%	1.4%	54.0%	360	495	483	0.823	12	120	13	-47	9.3	43.9%
CW	1.1%	52.2%	1.2%	55.2%	360	491	483	0.823	8	140	9	-47	9.3	43.0%
CX	1.5%	53.7%	1.6%	56.7%	360	484	483	0.824	1	200	8	-47	9.3	41.6%
CY	1.6%	55.3%	1.7%	58.4%	360	477	483	0.824	-6	240	12	-47	9.3	40.2%
CZ	3.8%	59.2%	4.0%	62.5%	360	470	483	0.825	-13	260	27	-47	9.3	36.7%
DA	2.8%	62.0%	2.7%	65.2%	360	451	483	0.825	-32	260	48	-48	8.3	34.2%
DB	5.2%	67.2%	5.1%	70.3%	360	440	482	0.825	-42	260	64	-49	7.3	29.7%
DC	3.5%	70.7%	3.4%	73.8%	360	441	479	0.825	-38	270	52	-51	5.3	26.6%
DD	1.8%	72.5%	1.7%	75.4%	360	441	479	0.825	-38	270	52	-51	5.3	25.1%
DE	4.8%	77.4%	4.8%	80.2%	380	443	473	0.825	-30	270	36	-57	-0.5	21.1%
DF	4.6%	81.9%	4.4%	84.6%	380	443	472	0.825	-29	280	32	-58	-1.5	17.4%
DG	4.5%	86.4%	4.3%	89.0%	400	433	467	0.823	-34	270	39	-61	-4.5	13.9%
DH	5.9%	92.3%	5.4%	94.4%	400	417	469	0.825	-52	270	54	-61	-4.5	9.5%
DI	1.8%	94.1%	1.7%	96.1%	400	417	469	0.825	-52	270	54	-61	-4.5	8.1%
DJ	1.7%	95.8%	1.5%	97.5%	400	415	471	0.826	-56	270	62	-59	-2.5	6.9%
DK	0.1%	95.9%	0.1%	97.6%	400	426	471	0.826	-45	270	63	-58	-1.5	6.8%
DL	0.3%	96.3%	0.3%	97.9%	400	426	472	0.826	-46	270	63	-58	-1.5	6.5%
LDG	3.7%	100.0%	2.1%	100.0%										5.4%

June 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-15					
CA	3.0%	3.0%	2.2%	2.2%	300	445	495	0.826	-50	270	56	-36	8.4	92.4%
CB	0.2%	3.3%	0.2%	2.4%	300	448	495	0.826	-47	270	56	-36	8.4	92.2%
CC	0.9%	4.1%	0.9%	3.3%	300	444	495	0.826	-51	270	55	-36	8.4	91.2%
CD	0.7%	4.8%	0.6%	4.0%	300	450	496	0.826	-36	270	54	-36	8.4	90.5%
CE	3.0%	7.8%	3.0%	6.9%	300	455	496	0.826	-41	270	50	-35	9.4	87.0%
CF	0.3%	8.1%	0.3%	7.2%	300	458	497	0.826	-39	270	45	-35	9.4	86.7%
CG	0.8%	8.9%	0.8%	8.0%	300	459	497	0.826	-38	270	43	-35	9.4	85.8%
CH	0.1%	9.0%	0.2%	8.2%	300	461	497	0.825	-36	270	42	-34	10.4	85.7%
CI	1.2%	10.2%	1.2%	9.4%	300	463	497	0.825	-34	270	40	-34	10.4	84.4%
CJ	1.4%	11.6%	1.4%	10.7%	300	467	497	0.825	-30	270	36	-34	10.4	82.8%
CK	0.8%	12.4%	0.8%	11.5%	300	469	497	0.825	-34	270	33	-34	10.4	81.9%
CL	0.1%	12.5%	0.1%	11.7%	300	471	497	0.825	-26	270	32	-33	11.4	81.8%
CM	1.7%	14.2%	1.7%	13.4%	300	474	497	0.824	-23	270	30	-33	11.4	79.9%
CN	2.4%	16.6%	2.5%	15.9%	300	483	497	0.823	-14	260	24	-33	11.4	77.3%
CO	1.0%	17.6%	1.0%	16.9%	300	486	498	0.823	-12	260	20	-32	12.4	76.2%
CP	10.0%	27.5%	10.5%	27.4%	320	483	494	0.824	-11	270	12	-37	11.4	65.7%
CQ	3.9%	31.5%	4.1%	31.5%	340	484	488	0.823	-4	10	6	-42	10.3	61.8%
CR	6.7%	38.2%	7.2%	38.7%	360	487	481	0.821	6	60	16	-47	9.3	55.2%
CS	9.8%	47.9%	10.3%	49.0%	360	489	481	0.822	8	80	11	-47	9.3	46.2%
CT	2.3%	50.2%	2.5%	51.5%	360	488	482	0.823	6	100	7	-47	9.3	44.2%
CU	1.1%	51.3%	1.1%	52.6%	360	488	482	0.823	6	100	7	-47	9.3	43.2%
CV	1.3%	52.6%	1.4%	54.0%	360	486	482	0.824	4	100	4	-47	9.3	42.0%
CW	1.2%	53.8%	1.2%	55.2%	360	485	482	0.824	3	100	3	-47	9.3	41.0%
CX	1.4%	55.2%	1.6%	56.7%	360	484	483	0.824	1	110	1	-47	9.3	39.7%
CY	1.6%	56.8%	1.7%	58.4%	360	481	483	0.824	-2	260	2	-47	9.3	38.3%
CZ	3.9%	60.7%	4.0%	62.5%	360	474	483	0.825	-9	270	13	-48	8.3	34.8%
DA	2.8%	63.6%	2.7%	65.2%	380	453	476	0.822	-23	270	31	-53	3.5	32.5%
DB	5.2%	68.8%	5.1%	70.3%	380	447	475	0.823	-28	270	41	-54	2.5	28.1%
DC	3.0%	71.8%	3.4%	73.8%	380	455	475	0.824	-20	260	28	-55	1.5	25.7%
DD	2.2%	74.0%	1.7%	75.4%	380	455	475	0.824	-20	260	28	-55	1.5	23.9%
DE	4.8%	78.7%	4.8%	80.2%	380	464	474	0.824	-10	290	10	-56	0.5	20.2%
DF	4.4%	83.2%	4.4%	84.6%	380	460	473	0.825	-13	320	14	-56	0.5	16.6%
DG	4.4%	87.6%	4.3%	89.0%	400	445	468	0.823	-23	290	24	-60	-3.5	13.3%
DH	5.5%	93.2%	5.4%	94.4%	400	438	470	0.824	-32	280	32	-59	-2.5	9.2%
DI	2.0%	95.1%	1.7%	96.1%	400	438	470	0.824	-32	280	32	-59	-2.5	7.8%
DJ	1.5%	96.6%	1.5%	97.5%	400	441	471	0.825	-30	290	30	-59	-2.5	6.7%
DK	0.1%	96.7%	0.1%	97.6%	400	444	471	0.825	-27	290	30	-59	-2.5	6.6%
DL	0.3%	97.1%	0.3%	97.9%	400	443	471	0.825	-28	290	31	-59	-2.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

June 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-17					
CA	3.0%	3.0%	2.2%	2.2%	300	440	496	0.826	-56	270	61	-36	8.4	92.3%
CB	0.2%	3.2%	0.2%	2.4%	300	442	496	0.826	-54	270	61	-36	8.4	92.1%
CC	1.0%	4.2%	0.9%	3.3%	300	439	496	0.826	-57	270	60	-36	8.4	91.0%
CD	0.6%	4.9%	0.6%	4.0%	300	445	496	0.826	-51	270	59	-35	9.4	90.2%
CE	2.9%	7.8%	3.0%	6.9%	300	452	497	0.826	-45	270	54	-35	9.4	86.9%
CF	0.3%	8.1%	0.3%	7.2%	300	456	497	0.826	-41	270	49	-34	10.4	86.6%
CG	0.8%	8.9%	0.8%	8.0%	300	458	497	0.826	-39	270	48	-34	10.4	85.7%
CH	0.2%	9.1%	0.2%	8.2%	300	459	497	0.825	-38	270	46	-34	10.4	85.5%
CI	1.2%	10.3%	1.2%	9.4%	300	461	497	0.825	-36	270	44	-34	10.4	84.1%
CJ	1.4%	11.7%	1.4%	10.7%	300	464	498	0.825	-34	270	41	-33	11.4	82.5%
CK	0.8%	12.4%	0.8%	11.5%	320	457	493	0.825	-36	270	42	-38	10.4	81.7%
CL	0.1%	12.6%	0.1%	11.7%	320	459	493	0.825	-34	270	41	-38	10.4	81.6%
CM	1.7%	14.3%	1.7%	13.4%	320	461	493	0.825	-32	270	38	-38	10.4	79.7%
CN	2.5%	16.8%	2.5%	15.9%	320	471	494	0.825	-23	270	32	-38	10.4	77.0%
CO	1.0%	17.7%	1.0%	16.9%	320	474	494	0.825	-20	270	27	-37	11.4	76.0%
CP	10.1%	27.8%	10.5%	27.4%	320	480	494	0.824	-14	270	16	-37	11.4	65.4%
CQ	3.8%	31.6%	4.1%	31.5%	340	486	488	0.823	-2	20	5	-42	10.3	61.7%
CR	6.7%	38.3%	7.2%	38.7%	360	490	481	0.821	9	60	18	-47	9.3	55.1%
CS	9.6%	47.9%	10.3%	49.0%	360	491	481	0.822	10	80	13	-47	9.3	46.3%
CT	2.4%	50.3%	2.5%	51.5%	360	490	482	0.823	8	90	8	-47	9.3	44.2%
CU	1.1%	51.4%	1.1%	52.6%	360	490	482	0.823	8	90	8	-47	9.3	43.2%
CV	1.3%	52.7%	1.4%	54.0%	360	488	482	0.824	6	90	6	-47	9.3	42.0%
CW	1.1%	53.8%	1.2%	55.2%	360	487	483	0.824	4	100	5	-47	9.3	41.1%
CX	1.5%	55.3%	1.6%	56.7%	360	484	483	0.824	1	110	2	-47	9.3	39.7%
CY	1.6%	56.9%	1.7%	58.4%	360	481	483	0.824	-2	260	3	-47	9.3	38.3%
CZ	3.9%	60.8%	4.0%	62.5%	360	473	483	0.825	-10	270	16	-48	8.3	34.9%
DA	2.7%	63.5%	2.7%	65.2%	360	458	483	0.826	-25	270	33	-48	8.3	32.6%
DB	5.2%	68.7%	5.1%	70.3%	360	451	482	0.825	-31	270	43	-49	7.3	28.2%
DC	3.1%	71.9%	3.4%	73.8%	380	451	475	0.824	-24	270	32	-54	2.5	25.6%
DD	2.2%	74.0%	1.7%	75.4%	380	451	475	0.824	-24	270	32	-54	2.5	23.9%
DE	4.8%	78.8%	4.8%	80.2%	380	463	474	0.825	-11	280	13	-55	1.5	20.1%
DF	4.3%	83.1%	4.4%	84.6%	380	459	474	0.825	-15	300	15	-56	0.5	16.7%
DG	4.5%	87.7%	4.3%	89.0%	400	444	469	0.823	-25	280	28	-60	-3.5	13.3%
DH	5.6%	93.3%	5.4%	94.4%	400	435	471	0.824	-36	270	37	-59	-2.5	9.2%
DI	1.8%	95.1%	1.7%	96.1%	400	435	471	0.824	-36	270	37	-59	-2.5	7.8%
DJ	1.5%	96.6%	1.5%	97.5%	400	440	472	0.825	-32	270	34	-58	-1.5	6.7%
DK	0.1%	96.8%	0.1%	97.6%	400	446	472	0.825	-26	280	34	-58	-1.5	6.6%
DL	0.3%	97.1%	0.3%	97.9%	400	446	472	0.825	-26	280	35	-58	-1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

July 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-10					
CA	3.1%	3.1%	2.2%	2.2%	300	435	493	0.826	-58	270	64	-38	6.4	91.6%
CB	0.2%	3.3%	0.2%	2.4%	300	437	493	0.826	-56	270	64	-38	6.4	91.4%
CC	1.0%	4.3%	0.9%	3.3%	300	434	494	0.826	-60	270	64	-38	6.4	90.3%
CD	0.7%	4.9%	0.6%	4.0%	300	441	494	0.826	-53	270	64	-38	6.4	89.5%
CE	3.1%	8.0%	3.0%	6.9%	300	446	495	0.826	-49	270	62	-37	7.4	86.1%
CF	0.3%	8.3%	0.3%	7.2%	300	448	496	0.826	-48	260	61	-36	8.4	85.8%
CG	0.8%	9.1%	0.8%	8.0%	300	449	496	0.826	-47	260	60	-36	8.4	85.0%
CH	0.2%	9.3%	0.2%	8.2%	300	450	496	0.826	-46	260	60	-35	9.4	84.7%
CI	1.2%	10.5%	1.2%	9.4%	300	452	496	0.825	-44	260	59	-35	9.4	83.4%
CJ	1.4%	11.9%	1.4%	10.7%	300	456	496	0.825	-40	260	56	-35	9.4	81.8%
CK	0.8%	12.7%	0.8%	11.5%	300	457	497	0.825	-40	260	54	-34	10.4	81.0%
CL	0.2%	12.9%	0.1%	11.7%	300	460	497	0.825	-37	260	52	-34	10.4	80.7%
CM	1.6%	14.6%	1.7%	13.4%	300	463	497	0.824	-34	260	49	-34	10.4	78.9%
CN	2.5%	17.1%	2.5%	15.9%	300	476	497	0.824	-21	250	41	-34	10.4	76.2%
CO	1.0%	18.1%	1.0%	16.9%	300	480	497	0.823	-17	250	33	-33	11.4	75.1%
CP	10.2%	28.3%	10.5%	27.4%	320	480	493	0.825	-13	260	16	-38	10.4	64.5%
CQ	3.8%	32.1%	4.1%	31.5%	340	485	487	0.823	-2	40	7	-43	9.3	60.7%
CR	6.8%	38.9%	7.2%	38.7%	360	493	480	0.821	13	70	24	-48	8.3	54.2%
CS	9.6%	48.5%	10.3%	49.0%	360	495	480	0.822	15	80	23	-48	8.3	45.4%
CT	2.3%	50.8%	2.5%	51.5%	360	497	481	0.823	16	90	18	-48	8.3	43.4%
CU	1.1%	51.9%	1.1%	52.6%	360	497	481	0.823	16	90	18	-48	8.3	42.4%
CV	1.3%	53.2%	1.4%	54.0%	360	497	481	0.823	16	100	16	-48	8.3	41.2%
CW	1.1%	54.3%	1.2%	55.2%	360	496	482	0.823	14	100	15	-48	8.3	40.3%
CX	1.5%	55.9%	1.6%	56.7%	360	496	482	0.824	14	110	15	-48	8.3	38.9%
CY	1.5%	57.4%	1.7%	58.4%	360	495	482	0.824	13	110	13	-48	8.3	37.5%
CZ	3.8%	61.2%	4.0%	62.5%	380	485	475	0.821	10	120	11	-53	3.5	34.3%
DA	2.6%	63.9%	2.7%	65.2%	380	481	475	0.821	6	150	7	-53	3.5	32.1%
DB	5.0%	68.9%	5.1%	70.3%	380	475	475	0.822	0	220	12	-53	3.5	28.0%
DC	2.8%	71.7%	3.4%	73.8%	380	467	475	0.823	-8	250	20	-54	2.5	25.7%
DD	2.3%	74.0%	1.7%	75.4%	380	467	475	0.823	-8	250	20	-54	2.5	23.8%
DE	4.7%	78.8%	4.8%	80.2%	380	466	476	0.824	-10	320	10	-54	2.5	20.0%
DF	4.5%	83.2%	4.4%	84.6%	400	461	470	0.821	-9	10	20	-58	-1.5	16.6%
DG	4.4%	87.6%	4.3%	89.0%	400	459	470	0.822	-11	340	13	-58	-1.5	13.3%
DH	5.5%	93.1%	5.4%	94.4%	400	446	472	0.824	-26	260	28	-57	-0.5	9.3%
DI	1.9%	95.0%	1.7%	96.1%	400	446	472	0.824	-26	260	28	-57	-0.5	7.9%
DJ	1.6%	96.6%	1.5%	97.5%	400	438	474	0.825	-36	260	42	-56	0.5	6.7%
DK	0.1%	96.7%	0.1%	97.6%	400	447	474	0.825	-27	260	45	-56	0.5	6.7%
DL	0.3%	97.0%	0.3%	97.9%	400	447	474	0.825	-27	260	46	-56	0.5	6.4%
LDG	3.0%	100.0%	2.1%	100.0%										5.2%

July 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-10					
CA	2.9%	2.9%	2.2%	2.2%	260	428	480	0.79	-52	270	57	-30	6.48	91.5%
CB	0.2%	3.2%	0.2%	2.4%	260	430	480	0.79	-50	270	57	-30	6.5	91.3%
CC	1.1%	4.2%	0.9%	3.3%	260	427	480	0.79	-53	270	57	-29	7.5	90.1%
CD	0.7%	4.9%	0.6%	4.0%	260	434	481	0.79	-47	270	57	-29	7.5	89.4%
CE	3.1%	8.0%	3.0%	6.9%	260	437	482	0.79	-45	270	55	-28	8.5	86.0%
CF	0.3%	8.3%	0.3%	7.2%	260	438	483	0.79	-45	270	53	-27	9.5	85.6%
CG	0.9%	9.2%	0.8%	8.0%	260	439	483	0.79	-44	270	52	-27	9.5	84.7%
CH	0.2%	9.4%	0.2%	8.2%	260	440	483	0.79	-43	270	52	-27	9.5	84.4%
CI	1.2%	10.6%	1.2%	9.4%	260	443	483	0.79	-40	270	51	-27	9.5	83.1%
CJ	1.4%	12.0%	1.4%	10.7%	260	446	484	0.79	-38	260	49	-26	10.5	81.3%
CK	0.9%	12.9%	0.8%	11.5%	320	443	492	0.825	-49	270	59	-39	9.4	80.4%
CL	0.1%	13.0%	0.1%	11.7%	320	446	492	0.825	-46	270	57	-39	9.4	80.3%
CM	1.7%	14.7%	1.7%	13.4%	320	449	492	0.825	-43	270	54	-39	9.4	78.4%
CN	2.5%	17.2%	2.5%	15.9%	320	463	493	0.825	-30	270	45	-38	10.4	75.8%
CO	1.1%	18.3%	1.0%	16.9%	320	469	493	0.826	-24	260	37	-38	10.4	74.5%
CP	10.3%	28.6%	10.5%	27.4%	340	469	486	0.822	-17	270	19	-43	9.3	64.1%
CQ	3.8%	32.5%	4.1%	31.5%	340	489	487	0.823	2	60	8	-43	9.3	60.3%
CR	6.8%	39.2%	7.2%	38.7%	360	498	480	0.821	18	80	27	-48	8.3	53.9%
CS	9.6%	48.8%	10.3%	49.0%	360	499	480	0.822	19	80	25	-48	8.3	45.2%
CT	2.3%	51.1%	2.5%	51.5%	360	499	481	0.823	18	90	20	-48	8.3	43.2%
CU	1.0%	52.1%	1.1%	52.6%	360	499	481	0.823	18	90	20	-48	8.3	42.3%
CV	1.3%	53.4%	1.4%	54.0%	360	498	482	0.823	16	90	18	-48	8.3	41.1%
CW	1.1%	54.5%	1.2%	55.2%	360	497	482	0.823	15	100	17	-48	8.3	40.2%
CX	1.5%	56.0%	1.6%	56.7%	360	497	482	0.824	15	100	16	-48	8.3	38.9%
CY	1.5%	57.5%	1.7%	58.4%	360	496	482	0.824	14	100	15	-48	8.3	37.5%
CZ	3.8%	61.3%	4.0%	62.5%	380	485	475	0.821	10	110	13	-53	3.5	34.2%
DA	2.6%	63.9%	2.7%	65.2%	380	481	475	0.821	6	130	6	-53	3.5	32.1%
DB	5.0%	69.0%	5.1%	70.3%	380	471	475	0.822	-4	240	13	-53	3.5	27.9%
DC	2.9%	71.9%	3.4%	73.8%	380	462	476	0.823	-14	260	23	-53	3.5	25.6%
DD	2.3%	74.2%	1.7%	75.4%	380	462	476	0.823	-14	260	23	-53	3.5	23.7%
DE	4.7%	78.9%	4.8%	80.2%	380	467	476	0.824	-9	300	9	-53	3.5	19.9%
DF	4.4%	83.2%	4.4%	84.6%	400	467	470	0.821	-3	30	18	-57	-0.5	16.6%
DG	4.4%	87.6%	4.3%	89.0%	400	460	470	0.822	-10	330	11	-58	-1.5	13.3%
DH	5.6%	93.1%	5.4%	94.4%	400	442	472	0.824	-30	270	32	-57	-0.5	9.2%
DI	1.9%	95.0%	1.7%	96.1%	400	442	472	0.824	-30	270	32	-57	-0.5	7.9%
DJ	1.6%	96.6%	1.5%	97.5%	400	432	474	0.825	-42	270	47	-55	1.5	6.7%
DK	0.1%	96.7%	0.1%	97.6%	400	440	475	0.825	-35	270	50	-55	1.5	6.6%
DL	0.3%	97.1%	0.3%	97.9%	400	440	475	0.825	-35	270	51	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

August 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-5					
CA	3.1%	3.1%	2.2%	2.2%	320	427	489	0.824	-62	260	71	-41	7.36	90.8%
CB	0.2%	3.3%	0.2%	2.4%	320	430	489	0.824	-59	260	71	-41	7.4	90.6%
CC	1.0%	4.3%	0.9%	3.3%	320	426	489	0.824	-63	260	70	-41	7.4	89.5%
CD	0.7%	5.0%	0.6%	4.0%	320	435	490	0.824	-55	260	69	-41	7.4	88.7%
CE	3.1%	8.1%	3.0%	6.9%	320	441	490	0.824	-49	260	64	-41	7.4	85.4%
CF	0.3%	8.4%	0.3%	7.2%	320	446	491	0.825	-45	260	59	-40	8.4	85.0%
CG	0.9%	9.3%	0.8%	8.0%	320	447	491	0.825	-44	260	57	-40	8.4	84.0%
CH	0.1%	9.4%	0.2%	8.2%	320	449	491	0.825	-42	260	56	-39	9.4	83.9%
CI	1.2%	10.6%	1.2%	9.4%	320	451	491	0.825	-40	260	53	-39	9.4	82.6%
CJ	1.4%	12.0%	1.4%	10.7%	320	456	491	0.825	-35	260	49	-39	9.4	81.1%
CK	0.9%	12.9%	0.8%	11.5%	320	458	492	0.825	-34	260	45	-39	9.4	80.1%
CL	0.1%	13.0%	0.1%	11.7%	320	461	492	0.825	-31	260	43	-39	9.4	80.0%
CM	1.8%	14.8%	1.7%	13.4%	320	464	492	0.825	-28	260	39	-39	9.4	78.2%
CN	2.4%	17.2%	2.5%	15.9%	320	476	492	0.825	-16	260	28	-39	9.4	75.6%
CO	1.0%	18.2%	1.0%	16.9%	320	481	492	0.825	-11	260	19	-39	9.4	74.6%
CP	10.1%	28.3%	10.5%	27.4%	320	490	493	0.824	-3	290	3	-38	10.4	64.3%
CQ	3.9%	32.2%	4.1%	31.5%	320	499	492	0.823	7	70	16	-38	10.4	60.3%
CR	6.7%	38.9%	7.2%	38.7%	360	499	479	0.821	20	70	33	-48	8.3	54.0%
CS	9.8%	48.7%	10.3%	49.0%	360	498	480	0.822	18	70	30	-48	8.3	45.1%
CT	2.5%	51.3%	2.5%	51.5%	360	497	481	0.823	16	80	22	-48	8.3	42.8%
CU	0.8%	52.0%	1.1%	52.6%	360	497	481	0.823	16	80	22	-48	8.3	42.2%
CV	1.3%	53.4%	1.4%	54.0%	360	497	482	0.823	15	80	19	-48	8.3	41.0%
CW	1.1%	54.5%	1.2%	55.2%	360	498	482	0.823	16	90	19	-48	8.3	40.0%
CX	1.5%	56.0%	1.6%	56.7%	360	498	482	0.823	16	90	18	-48	8.3	38.7%
CY	1.5%	57.6%	1.7%	58.4%	360	498	482	0.824	16	90	18	-48	8.3	37.4%
CZ	3.9%	61.4%	4.0%	62.5%	360	493	483	0.824	10	100	14	-47	9.3	34.0%
DA	2.7%	64.1%	2.7%	65.2%	380	483	475	0.821	8	120	8	-53	3.5	31.8%
DB	5.0%	69.1%	5.1%	70.3%	380	475	475	0.822	0	240	3	-53	3.5	27.7%
DC	2.8%	71.8%	3.4%	73.8%	380	466	476	0.823	-10	260	15	-53	3.5	25.5%
DD	2.4%	74.3%	1.7%	75.4%	380	466	476	0.823	-10	260	15	-53	3.5	23.6%
DE	4.9%	79.1%	4.8%	80.2%	380	465	477	0.824	-12	270	15	-53	3.5	19.8%
DF	4.3%	83.4%	4.4%	84.6%	380	472	476	0.825	-4	260	6	-53	3.5	16.4%
DG	4.4%	87.8%	4.3%	89.0%	400	467	471	0.822	-4	260	6	-57	-0.5	13.1%
DH	5.3%	93.1%	5.4%	94.4%	400	456	471	0.823	-15	240	21	-57	-0.5	9.2%
DI	2.0%	95.1%	1.7%	96.1%	400	456	471	0.823	-15	240	21	-57	-0.5	7.7%
DJ	1.5%	96.7%	1.5%	97.5%	400	454	473	0.824	-19	250	28	-56	0.5	6.6%
DK	0.1%	96.8%	0.1%	97.6%	400	461	473	0.824	-12	250	28	-56	0.5	6.5%
DL	0.2%	97.0%	0.3%	97.9%	400	460	473	0.824	-13	250	28	-56	0.5	6.4%
LDG	3.0%	100.0%	2.1%	100.0%										5.2%

August 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-8					
CA	3.1%	3.1%	2.2%	2.2%	300	430	496	0.826	-66	270	73	-36	8.4	90.7%
CB	0.2%	3.3%	0.2%	2.4%	300	433	496	0.826	-63	270	72	-36	8.4	90.5%
CC	1.0%	4.3%	0.9%	3.3%	300	429	496	0.826	-67	270	72	-36	8.4	89.3%
CD	0.7%	5.0%	0.6%	4.0%	320	428	490	0.824	-62	270	74	-40	8.4	88.6%
CE	3.2%	8.1%	3.0%	6.9%	320	435	491	0.824	-56	270	68	-40	8.4	85.1%
CF	0.3%	8.5%	0.3%	7.2%	320	440	491	0.825	-51	270	63	-39	9.4	84.8%
CG	0.8%	9.2%	0.8%	8.0%	320	442	491	0.825	-49	270	61	-39	9.4	83.9%
CH	0.2%	9.5%	0.2%	8.2%	320	443	492	0.825	-49	270	59	-39	9.4	83.7%
CI	1.2%	10.7%	1.2%	9.4%	320	446	492	0.825	-46	270	57	-39	9.4	82.4%
CJ	1.4%	12.1%	1.4%	10.7%	320	451	492	0.825	-41	270	52	-39	9.4	80.9%
CK	0.9%	13.0%	0.8%	11.5%	320	453	492	0.825	-39	270	48	-39	9.4	79.9%
CL	0.1%	13.1%	0.1%	11.7%	320	456	492	0.825	-36	270	46	-39	9.4	79.8%
CM	1.8%	14.9%	1.7%	13.4%	320	459	492	0.825	-33	270	42	-39	9.4	77.9%
CN	2.5%	17.4%	2.5%	15.9%	320	472	492	0.825	-20	260	32	-39	9.4	75.3%
CO	1.0%	18.4%	1.0%	16.9%	320	478	493	0.825	-15	260	22	-38	10.4	74.3%
CP	10.0%	28.4%	10.5%	27.4%	320	488	493	0.824	-5	290	4	-38	10.4	64.0%
CQ	3.9%	32.2%	4.1%	31.5%	340	493	486	0.823	7	70	21	-43	9.3	60.2%
CR	6.7%	38.9%	7.2%	38.7%	360	502	480	0.82	22	70	35	-48	8.3	53.9%
CS	9.7%	48.6%	10.3%	49.0%	360	501	480	0.821	21	80	31	-48	8.3	45.1%
CT	2.5%	51.2%	2.5%	51.5%	360	500	481	0.822	19	80	24	-48	8.3	42.9%
CU	0.8%	51.9%	1.1%	52.6%	360	500	481	0.822	19	80	24	-48	8.3	42.2%
CV	1.3%	53.2%	1.4%	54.0%	360	500	482	0.823	18	90	21	-48	8.3	41.1%
CW	1.1%	54.3%	1.2%	55.2%	360	500	482	0.823	18	90	20	-47	9.3	40.1%
CX	1.5%	55.9%	1.6%	56.7%	360	499	482	0.823	17	90	20	-47	9.3	38.8%
CY	1.5%	57.4%	1.7%	58.4%	360	499	482	0.824	17	90	19	-47	9.3	37.5%
CZ	3.9%	61.3%	4.0%	62.5%	360	493	483	0.824	10	100	15	-47	9.3	34.1%
DA	2.6%	63.9%	2.7%	65.2%	380	483	475	0.821	8	100	9	-52	4.5	31.9%
DB	5.1%	69.0%	5.1%	70.3%	380	472	476	0.822	-4	280	4	-53	3.5	27.8%
DC	2.8%	71.7%	3.4%	73.8%	380	461	477	0.823	-16	280	18	-53	3.5	25.6%
DD	2.4%	74.1%	1.7%	75.4%	380	461	477	0.823	-16	280	18	-53	3.5	23.6%
DE	4.8%	79.0%	4.8%	80.2%	380	460	477	0.823	-17	280	20	-52	4.5	19.8%
DF	4.4%	83.4%	4.4%	84.6%	380	467	477	0.823	-10	290	11	-53	3.5	16.4%
DG	4.4%	87.8%	4.3%	89.0%	400	462	471	0.822	-9	280	10	-57	-0.5	13.1%
DH	5.4%	93.2%	5.4%	94.4%	400	452	472	0.824	-20	260	23	-57	-0.5	9.1%
DI	1.9%	95.0%	1.7%	96.1%	400	452	472	0.824	-20	260	23	-57	-0.5	7.8%
DJ	1.7%	96.7%	1.5%	97.5%	400	448	474	0.825	-26	260	31	-56	0.5	6.6%
DK	0.0%	96.7%	0.1%	97.6%	400	454	474	0.825	-20	270	32	-55	1.5	6.6%
DL	0.3%	97.0%	0.3%	97.9%	400	453	474	0.825	-21	270	32	-55	1.5	6.3%
LDG	3.0%	100.0%	2.1%	100.0%										5.2%

September 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-10					
CA	3.1%	3.1%	2.2%	2.2%	300	459	495	0.826	-36	280	38	-36	8.4	91.7%
CB	0.1%	3.2%	0.2%	2.4%	300	460	495	0.826	-35	280	38	-36	8.4	91.6%
CC	1.0%	4.2%	0.9%	3.3%	300	458	495	0.826	-37	280	38	-36	8.4	90.5%
CD	0.7%	4.8%	0.6%	4.0%	300	461	495	0.826	-34	280	38	-36	8.4	89.8%
CE	3.0%	7.8%	3.0%	6.9%	300	464	496	0.825	-32	280	36	-36	8.4	86.4%
CF	0.2%	8.0%	0.3%	7.2%	300	466	496	0.825	-30	270	35	-35	9.4	86.2%
CG	0.8%	8.8%	0.8%	8.0%	300	466	496	0.825	-30	270	35	-35	9.4	85.3%
CH	0.2%	9.0%	0.2%	8.2%	300	467	497	0.825	-30	270	34	-35	9.4	85.1%
CI	1.2%	10.2%	1.2%	9.4%	300	468	497	0.825	-29	270	33	-34	10.4	83.8%
CJ	1.3%	11.5%	1.4%	10.7%	300	470	497	0.825	-27	270	32	-34	10.4	82.3%
CK	0.9%	12.4%	0.8%	11.5%	300	471	497	0.825	-26	270	31	-34	10.4	81.4%
CL	0.1%	12.5%	0.1%	11.7%	300	472	497	0.825	-25	270	30	-33	11.4	81.2%
CM	1.6%	14.1%	1.7%	13.4%	300	474	497	0.824	-23	270	30	-33	11.4	79.4%
CN	2.4%	16.5%	2.5%	15.9%	300	480	498	0.823	-18	260	28	-33	11.4	76.7%
CO	1.0%	17.5%	1.0%	16.9%	320	476	494	0.825	-18	270	26	-37	11.4	75.7%
CP	10.2%	27.7%	10.5%	27.4%	320	484	494	0.824	-10	280	11	-37	11.4	65.1%
CQ	3.8%	31.5%	4.1%	31.5%	340	487	487	0.824	0	50	11	-43	9.3	61.3%
CR	6.8%	38.3%	7.2%	38.7%	360	490	480	0.821	10	60	21	-48	8.3	54.7%
CS	9.7%	48.1%	10.3%	49.0%	360	490	481	0.822	9	70	18	-48	8.3	45.9%
CT	2.4%	50.5%	2.5%	51.5%	360	490	482	0.823	8	70	13	-47	9.3	43.7%
CU	1.0%	51.5%	1.1%	52.6%	360	490	482	0.823	8	70	13	-47	9.3	42.8%
CV	1.4%	52.9%	1.4%	54.0%	360	490	482	0.823	8	70	11	-47	9.3	41.6%
CW	1.1%	54.0%	1.2%	55.2%	360	490	482	0.824	8	80	10	-47	9.3	40.6%
CX	1.4%	55.4%	1.6%	56.7%	360	490	482	0.824	8	90	9	-47	9.3	39.4%
CY	1.6%	57.1%	1.7%	58.4%	360	490	483	0.824	7	100	8	-47	9.3	37.9%
CZ	3.8%	60.9%	4.0%	62.5%	360	486	483	0.824	3	190	5	-47	9.3	34.6%
DA	2.7%	63.6%	2.7%	65.2%	380	471	475	0.822	-4	240	16	-53	3.5	32.3%
DB	5.0%	68.7%	5.1%	70.3%	380	465	475	0.822	-10	250	23	-54	2.5	28.1%
DC	3.0%	71.6%	3.4%	73.8%	380	468	475	0.823	-7	240	19	-54	2.5	25.8%
DD	2.2%	73.8%	1.7%	75.4%	380	468	475	0.823	-7	240	19	-54	2.5	24.0%
DE	4.7%	78.5%	4.8%	80.2%	380	471	474	0.824	-3	300	4	-55	1.5	20.3%
DF	4.5%	83.0%	4.4%	84.6%	380	464	475	0.825	-11	330	12	-55	1.5	16.7%
DG	4.5%	87.5%	4.3%	89.0%	400	447	469	0.823	-22	300	23	-59	-2.5	13.4%
DH	5.6%	93.1%	5.4%	94.4%	400	436	472	0.824	-36	270	37	-57	-0.5	9.3%
DI	2.0%	95.1%	1.7%	96.1%	400	436	472	0.824	-36	270	37	-57	-0.5	7.8%
DJ	1.5%	96.6%	1.5%	97.5%	400	439	474	0.825	-35	260	44	-56	0.5	6.7%
DK	0.1%	96.7%	0.1%	97.6%	400	451	474	0.825	-23	260	46	-56	0.5	6.6%
DL	0.3%	97.0%	0.3%	97.9%	400	451	474	0.825	-23	260	47	-56	0.5	6.4%
LDG	3.0%	100.0%	2.1%	100.0%										5.2%

September 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-12					
CA	3.1%	3.1%	2.2%	2.2%	300	456	495	0.826	-39	270	43	-36	8.4	91.4%
CB	0.2%	3.3%	0.2%	2.4%	300	458	495	0.826	-37	270	43	-36	8.4	91.2%
CC	0.9%	4.1%	0.9%	3.3%	300	455	496	0.826	-41	270	43	-36	8.4	90.2%
CD	0.7%	4.8%	0.6%	4.0%	300	459	496	0.826	-37	270	43	-36	8.4	89.5%
CE	2.9%	7.7%	3.0%	6.9%	300	462	496	0.826	-34	270	42	-35	9.4	86.2%
CF	0.3%	8.1%	0.3%	7.2%	300	463	497	0.825	-34	270	40	-35	9.4	85.8%
CG	0.8%	8.8%	0.8%	8.0%	300	464	497	0.825	-33	270	40	-34	10.4	85.0%
CH	0.2%	9.0%	0.2%	8.2%	300	464	497	0.825	-33	270	40	-34	10.4	84.7%
CI	1.1%	10.1%	1.2%	9.4%	300	466	497	0.825	-31	270	39	-34	10.4	83.5%
CJ	1.4%	11.5%	1.4%	10.7%	300	467	497	0.825	-30	270	37	-34	10.4	81.9%
CK	0.8%	12.3%	0.8%	11.5%	320	458	493	0.825	-35	270	40	-38	10.4	81.0%
CL	0.2%	12.5%	0.1%	11.7%	320	460	493	0.825	-33	270	40	-38	10.4	80.8%
CM	1.6%	14.2%	1.7%	13.4%	320	461	493	0.825	-32	270	39	-38	10.4	79.1%
CN	2.5%	16.7%	2.5%	15.9%	320	469	494	0.825	-25	270	35	-37	11.4	76.4%
CO	1.0%	17.6%	1.0%	16.9%	320	473	494	0.825	-21	270	30	-37	11.4	75.3%
CP	10.2%	27.9%	10.5%	27.4%	340	474	486	0.822	-12	290	12	-43	9.3	64.9%
CQ	3.9%	31.8%	4.1%	31.5%	340	491	487	0.823	4	70	12	-43	9.3	61.0%
CR	6.6%	38.5%	7.2%	38.7%	360	495	480	0.821	15	70	23	-48	8.3	54.7%
CS	9.7%	48.1%	10.3%	49.0%	360	493	481	0.822	12	70	20	-48	8.3	45.9%
CT	2.5%	50.7%	2.5%	51.5%	360	493	482	0.823	11	80	14	-47	9.3	43.6%
CU	0.9%	51.5%	1.1%	52.6%	360	493	482	0.823	11	80	14	-47	9.3	42.9%
CV	1.4%	52.9%	1.4%	54.0%	360	493	482	0.823	11	90	13	-47	9.3	41.6%
CW	1.1%	54.0%	1.2%	55.2%	360	493	482	0.824	11	90	12	-47	9.3	40.7%
CX	1.4%	55.4%	1.6%	56.7%	360	493	482	0.824	11	90	12	-47	9.3	39.4%
CY	1.5%	57.0%	1.7%	58.4%	360	492	483	0.824	9	90	10	-47	9.3	38.1%
CZ	3.9%	60.9%	4.0%	62.5%	360	485	483	0.824	2	190	3	-47	9.3	34.6%
DA	2.7%	63.6%	2.7%	65.2%	380	466	475	0.822	-9	250	18	-53	3.5	32.3%
DB	5.1%	68.7%	5.1%	70.3%	380	460	475	0.822	-15	260	26	-53	3.5	28.1%
DC	2.9%	71.7%	3.4%	73.8%	380	463	475	0.823	-12	260	21	-54	2.5	25.8%
DD	2.2%	73.9%	1.7%	75.4%	380	463	475	0.823	-12	260	21	-54	2.5	24.0%
DE	4.7%	78.5%	4.8%	80.2%	380	470	475	0.824	-5	260	7	-55	1.5	20.3%
DF	4.5%	83.0%	4.4%	84.6%	380	464	475	0.825	-11	300	11	-55	1.5	16.8%
DG	4.5%	87.5%	4.3%	89.0%	400	447	470	0.823	-23	280	25	-58	-1.5	13.4%
DH	5.7%	93.1%	5.4%	94.4%	400	432	473	0.824	-41	270	42	-57	-0.5	9.3%
DI	1.9%	95.0%	1.7%	96.1%	400	432	473	0.824	-41	270	42	-57	-0.5	7.9%
DJ	1.6%	96.6%	1.5%	97.5%	400	432	474	0.825	-42	270	48	-55	1.5	6.7%
DK	0.1%	96.7%	0.1%	97.6%	400	444	475	0.825	-31	260	50	-55	1.5	6.6%
DL	0.3%	97.1%	0.3%	97.9%	400	443	475	0.825	-32	260	50	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

October 50% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-17					
CA	2.9%	2.9%	2.2%	2.2%	300	458	495	0.826	-37	270	41	-36	8.4	92.9%
CB	0.2%	3.1%	0.2%	2.4%	300	460	495	0.826	-35	270	40	-36	8.4	92.6%
CC	0.9%	4.0%	0.9%	3.3%	300	458	496	0.826	-38	270	40	-36	8.4	91.7%
CD	0.6%	4.6%	0.6%	4.0%	300	463	496	0.826	-33	270	39	-36	8.4	90.9%
CE	2.9%	7.6%	3.0%	6.9%	300	467	496	0.825	-29	270	35	-35	9.4	87.6%
CF	0.3%	7.9%	0.3%	7.2%	300	471	497	0.825	-26	270	31	-35	9.4	87.2%
CG	0.6%	8.5%	0.8%	8.0%	300	472	497	0.825	-25	270	31	-34	10.4	86.5%
CH	0.2%	8.8%	0.2%	8.2%	300	472	497	0.825	-25	270	30	-34	10.4	86.3%
CI	1.2%	9.9%	1.2%	9.4%	300	474	497	0.825	-23	270	29	-34	10.4	84.9%
CJ	1.3%	11.2%	1.4%	10.7%	300	476	497	0.825	-21	260	27	-34	10.4	83.5%
CK	0.8%	12.0%	0.8%	11.5%	300	477	497	0.824	-20	260	26	-33	11.4	82.6%
CL	0.1%	12.1%	0.1%	11.7%	300	478	497	0.824	-19	260	25	-33	11.4	82.5%
CM	1.6%	13.7%	1.7%	13.4%	300	479	497	0.824	-18	260	24	-33	11.4	80.7%
CN	2.5%	16.2%	2.5%	15.9%	300	485	497	0.823	-12	270	19	-33	11.4	78.0%
CO	1.0%	17.2%	1.0%	16.9%	300	487	498	0.823	-11	270	15	-32	12.4	76.8%
CP	9.9%	27.1%	10.5%	27.4%	320	485	494	0.824	-9	300	9	-37	11.4	66.3%
CQ	3.8%	30.9%	4.1%	31.5%	320	485	487	0.823	-2	10	4	-42	6.4	62.6%
CR	6.7%	37.6%	7.2%	38.7%	340	493	489	0.825	4	90	5	-42	10.3	55.9%
CS	9.8%	47.5%	10.3%	49.0%	360	484	481	0.822	3	110	3	-47	9.3	46.8%
CT	2.4%	49.8%	2.5%	51.5%	360	479	482	0.823	-3	250	5	-48	8.3	44.7%
CU	1.1%	50.9%	1.1%	52.6%	360	479	482	0.823	-3	250	5	-48	8.3	43.7%
CV	1.3%	52.2%	1.4%	54.0%	360	476	482	0.824	-6	260	8	-48	8.3	42.6%
CW	1.2%	53.4%	1.2%	55.2%	360	474	482	0.824	-8	260	9	-48	8.3	41.5%
CX	1.5%	54.9%	1.6%	56.7%	360	473	482	0.825	-9	260	11	-48	8.3	40.2%
CY	1.6%	56.5%	1.7%	58.4%	360	471	482	0.825	-11	260	13	-48	8.3	38.7%
CZ	3.9%	60.4%	4.0%	62.5%	360	469	482	0.825	-13	280	18	-48	8.3	35.3%
DA	2.8%	63.2%	2.7%	65.2%	360	461	482	0.826	-21	280	24	-49	7.3	32.8%
DB	5.2%	68.4%	5.1%	70.3%	380	452	474	0.823	-22	290	25	-54	2.5	28.5%
DC	3.1%	71.6%	3.4%	73.8%	380	454	475	0.824	-21	290	22	-54	2.5	26.0%
DD	2.1%	73.6%	1.7%	75.4%	380	454	475	0.824	-21	290	22	-54	2.5	24.3%
DE	4.8%	78.4%	4.8%	80.2%	380	457	475	0.825	-18	280	22	-55	1.5	20.5%
DF	4.4%	82.8%	4.4%	84.6%	380	454	475	0.825	-21	280	24	-55	1.5	17.0%
DG	4.5%	87.4%	4.3%	89.0%	400	442	471	0.823	-29	280	33	-58	-1.5	13.6%
DH	5.7%	93.1%	5.4%	94.4%	400	425	472	0.825	-47	270	48	-57	-0.5	9.3%
DI	1.9%	95.0%	1.7%	96.1%	400	425	472	0.825	-47	270	48	-57	-0.5	7.9%
DJ	1.6%	96.6%	1.5%	97.5%	400	422	473	0.825	-51	270	59	-57	-0.5	6.7%
DK	0.1%	96.8%	0.1%	97.6%	400	435	473	0.825	-38	270	60	-56	0.5	6.6%
DL	0.3%	97.1%	0.3%	97.9%	400	435	474	0.825	-39	270	60	-56	0.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

Octoberr 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-19					
CA	3.0%	3.0%	2.2%	2.2%	300	455	496	0.826	-41	260	45	-36	8.4	92.8%
CB	0.2%	3.2%	0.2%	2.4%	300	457	496	0.826	-39	260	44	-36	8.4	92.5%
CC	0.9%	4.1%	0.9%	3.3%	300	455	496	0.826	-41	260	43	-36	8.4	91.5%
CD	0.6%	4.7%	0.6%	4.0%	300	461	496	0.826	-35	260	42	-35	9.4	90.8%
CE	2.9%	7.6%	3.0%	6.9%	300	465	496	0.825	-31	260	38	-35	9.4	87.5%
CF	0.3%	8.0%	0.3%	7.2%	300	467	497	0.825	-30	270	35	-34	10.4	87.1%
CG	0.8%	8.7%	0.8%	8.0%	300	468	497	0.825	-29	270	34	-34	10.4	86.3%
CH	0.1%	8.8%	0.2%	8.2%	300	468	497	0.825	-29	270	33	-34	10.4	86.2%
CI	1.2%	10.0%	1.2%	9.4%	300	470	497	0.825	-27	270	32	-34	10.4	84.8%
CJ	1.4%	11.4%	1.4%	10.7%	300	472	497	0.825	-25	270	30	-34	10.4	83.2%
CK	0.8%	12.2%	0.8%	11.5%	320	465	492	0.825	-27	270	33	-38	10.4	82.4%
CL	0.1%	12.3%	0.1%	11.7%	320	466	493	0.825	-27	270	32	-38	10.4	82.2%
CM	1.6%	13.9%	1.7%	13.4%	320	468	493	0.825	-25	270	30	-38	10.4	80.5%
CN	2.5%	16.3%	2.5%	15.9%	320	474	493	0.825	-19	270	25	-38	10.4	77.8%
CO	1.0%	17.3%	1.0%	16.9%	320	477	494	0.825	-17	280	21	-37	11.4	76.8%
CP	9.9%	27.2%	10.5%	27.4%	320	483	494	0.824	-11	280	11	-37	11.4	66.3%
CQ	3.9%	31.1%	4.1%	31.5%	340	487	488	0.823	-1	40	3	-42	10.3	62.5%
CR	6.7%	37.7%	7.2%	38.7%	340	496	489	0.823	7	100	8	-42	10.3	55.9%
CS	9.7%	47.4%	10.3%	49.0%	360	485	481	0.823	4	100	4	-47	9.3	46.9%
CT	2.4%	49.8%	2.5%	51.5%	360	476	482	0.823	-6	270	7	-48	8.3	44.8%
CU	1.1%	50.9%	1.1%	52.6%	360	476	482	0.823	-6	270	7	-48	8.3	43.8%
CV	1.4%	52.3%	1.4%	54.0%	360	473	482	0.824	-9	280	10	-48	8.3	42.6%
CW	1.1%	53.3%	1.2%	55.2%	360	472	482	0.825	-10	270	11	-48	8.3	41.6%
CX	1.5%	54.8%	1.6%	56.7%	360	471	482	0.825	-11	270	13	-48	8.3	40.3%
CY	1.7%	56.6%	1.7%	58.4%	360	469	482	0.825	-13	270	15	-48	8.3	38.8%
CZ	3.9%	60.4%	4.0%	62.5%	360	469	482	0.825	-13	270	22	-48	8.3	35.4%
DA	2.7%	63.1%	2.7%	65.2%	360	461	482	0.826	-21	270	27	-49	7.3	33.0%
DB	5.2%	68.3%	5.1%	70.3%	380	452	475	0.823	-23	280	28	-54	2.5	28.7%
DC	3.2%	71.5%	3.4%	73.8%	380	453	475	0.824	-22	280	27	-54	2.5	26.1%
DD	1.9%	73.4%	1.7%	75.4%	380	453	475	0.824	-22	280	27	-54	2.5	24.5%
DE	4.8%	78.3%	4.8%	80.2%	380	454	476	0.825	-22	260	29	-54	2.5	20.7%
DF	4.5%	82.8%	4.4%	84.6%	380	451	476	0.825	-25	260	31	-54	2.5	17.1%
DG	4.4%	87.2%	4.3%	89.0%	400	440	471	0.823	-31	270	39	-57	-0.5	13.7%
DH	5.9%	93.1%	5.4%	94.4%	400	420	473	0.825	-53	270	54	-57	-0.5	9.3%
DI	1.8%	94.9%	1.7%	96.1%	400	420	473	0.825	-53	270	54	-57	-0.5	8.0%
DJ	1.6%	96.6%	1.5%	97.5%	400	414	474	0.826	-60	270	65	-56	0.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	426	474	0.826	-48	270	66	-55	1.5	6.7%
DL	0.4%	97.1%	0.3%	97.9%	400	427	475	0.826	-48	270	66	-55	1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

November 50% Route 2

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-27					
CA	2.9%	2.9%	2.2%	2.2%	300	468	496	0.826	-28	280	28	-36	8.4	94.7%
CB	0.1%	3.0%	0.2%	2.4%	300	469	496	0.826	-27	290	28	-35	9.4	94.6%
CC	1.0%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	290	28	-35	9.4	93.5%
CD	0.5%	4.4%	0.6%	4.0%	300	469	496	0.826	-27	290	28	-35	9.4	92.9%
CE	2.9%	7.3%	3.0%	6.9%	300	471	496	0.825	-25	290	27	-35	9.4	89.5%
CF	0.3%	7.6%	0.3%	7.2%	300	472	497	0.825	-25	290	26	-34	10.4	89.2%
CG	0.7%	8.4%	0.8%	8.0%	300	472	497	0.825	-25	290	26	-34	10.4	88.3%
CH	0.1%	8.5%	0.2%	8.2%	300	473	497	0.825	-24	290	26	-34	10.4	88.2%
CI	1.2%	9.6%	1.2%	9.4%	300	473	497	0.825	-24	290	25	-34	10.4	86.8%
CJ	1.3%	10.9%	1.4%	10.7%	300	474	497	0.825	-23	290	25	-33	11.4	85.4%
CK	0.8%	11.7%	0.8%	11.5%	300	474	498	0.824	-24	290	24	-33	11.4	84.3%
CL	0.1%	11.9%	0.1%	11.7%	320	466	493	0.825	-27	290	28	-38	10.4	84.2%
CM	1.6%	13.4%	1.7%	13.4%	320	468	493	0.825	-25	290	26	-38	10.4	82.5%
CN	2.4%	15.9%	2.5%	15.9%	320	473	493	0.825	-20	290	23	-38	10.4	79.8%
CO	1.0%	16.8%	1.0%	16.9%	320	476	494	0.825	-18	280	20	-37	11.4	78.7%
CP	9.8%	26.7%	10.5%	27.4%	320	479	494	0.825	-15	290	15	-37	11.4	68.1%
CQ	3.8%	30.5%	4.1%	31.5%	340	477	488	0.824	-11	320	11	-42	10.3	64.2%
CR	6.7%	37.1%	7.2%	38.7%	340	485	489	0.824	-4	360	7	-42	10.3	57.6%
CS	9.6%	46.8%	10.3%	49.0%	340	481	488	0.825	-7	290	7	-42	10.3	48.2%
CT	2.4%	49.2%	2.5%	51.5%	360	462	482	0.825	-20	260	25	-48	8.3	46.0%
CU	1.1%	50.3%	1.1%	52.6%	360	462	482	0.825	-20	260	25	-48	8.3	45.0%
CV	1.5%	51.7%	1.4%	54.0%	360	455	482	0.825	-27	260	33	-48	8.3	43.6%
CW	1.2%	52.9%	1.2%	55.2%	360	452	483	0.825	-31	260	37	-48	8.3	42.6%
CX	1.5%	54.4%	1.6%	56.7%	360	448	483	0.825	-35	260	40	-48	8.3	41.2%
CY	1.8%	56.2%	1.7%	58.4%	360	445	483	0.826	-38	270	43	-48	8.3	39.6%
CZ	3.9%	60.1%	4.0%	62.5%	360	451	482	0.826	-31	270	48	-48	8.3	36.1%
DA	2.9%	63.0%	2.7%	65.2%	360	444	482	0.826	-38	270	47	-49	7.3	33.6%
DB	5.1%	68.0%	5.1%	70.3%	360	447	480	0.825	-33	280	40	-50	6.3	29.2%
DC	3.3%	71.3%	3.4%	73.8%	380	444	474	0.825	-30	290	33	-56	0.5	26.5%
DD	1.9%	73.2%	1.7%	75.4%	380	444	474	0.825	-30	290	33	-56	0.5	24.9%
DE	4.9%	78.1%	4.8%	80.2%	380	444	473	0.825	-29	290	31	-57	-0.5	21.0%
DF	4.6%	82.6%	4.4%	84.6%	380	439	473	0.826	-34	280	39	-57	-0.5	17.3%
DG	4.6%	87.2%	4.3%	89.0%	400	426	469	0.824	-43	270	50	-59	-2.5	13.8%
DH	5.9%	93.1%	5.4%	94.4%	400	407	471	0.825	-64	270	65	-59	-2.5	9.4%
DI	1.9%	95.0%	1.7%	96.1%	400	407	471	0.825	-64	270	65	-59	-2.5	8.0%
DJ	1.6%	96.6%	1.5%	97.5%	400	405	472	0.826	-67	270	74	-58	-1.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	421	472	0.826	-51	270	74	-58	-1.5	6.7%
DL	0.4%	97.1%	0.3%	97.9%	400	421	472	0.826	-51	270	74	-58	-1.5	6.4%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

November 85% Route 2														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-28					
CA	2.9%	2.9%	2.2%	2.2%	300	466	496	0.826	-30	270	32	-35	9.4	94.6%
CB	0.1%	3.0%	0.2%	2.4%	300	467	497	0.826	-30	280	32	-35	9.4	94.5%
CC	1.0%	3.9%	0.9%	3.3%	300	465	497	0.826	-32	280	32	-35	9.4	93.4%
CD	0.5%	4.4%	0.6%	4.0%	300	468	497	0.826	-29	280	31	-35	9.4	92.8%
CE	2.9%	7.3%	3.0%	6.9%	300	470	497	0.825	-27	280	30	-34	10.4	89.5%
CF	0.3%	7.6%	0.3%	7.2%	300	471	497	0.825	-26	280	29	-34	10.4	89.1%
CG	0.7%	8.3%	0.8%	8.0%	300	471	497	0.825	-26	280	29	-34	10.4	88.2%
CH	0.1%	8.4%	0.2%	8.2%	300	472	497	0.825	-25	280	28	-34	10.4	88.1%
CI	1.2%	9.6%	1.2%	9.4%	300	472	498	0.825	-26	280	28	-34	10.4	86.8%
CJ	1.4%	11.0%	1.4%	10.7%	300	473	498	0.825	-25	280	28	-34	10.4	85.1%
CK	0.7%	11.7%	0.8%	11.5%	320	465	493	0.825	-28	280	30	-38	10.4	84.3%
CL	0.1%	11.8%	0.1%	11.7%	320	465	493	0.825	-28	280	30	-38	10.4	84.2%
CM	1.7%	13.5%	1.7%	13.4%	320	467	493	0.825	-26	280	29	-38	10.4	82.3%
CN	2.3%	15.8%	2.5%	15.9%	320	473	493	0.825	-20	280	26	-38	10.4	79.8%
CO	1.0%	16.8%	1.0%	16.9%	320	476	494	0.825	-18	280	23	-37	11.4	78.7%
CP	9.9%	26.7%	10.5%	27.4%	320	478	494	0.825	-16	280	18	-37	11.4	68.0%
CQ	3.8%	30.5%	4.1%	31.5%	340	477	488	0.824	-11	300	11	-42	10.3	64.2%
CR	6.7%	37.2%	7.2%	38.7%	340	489	489	0.824	0	30	6	-42	10.3	57.6%
CS	9.6%	46.8%	10.3%	49.0%	340	481	489	0.825	-8	280	9	-42	10.3	48.3%
CT	2.5%	49.3%	2.5%	51.5%	340	467	488	0.825	-21	270	25	-42	10.3	45.8%
CU	0.8%	50.2%	1.1%	52.6%	340	467	488	0.825	-21	270	25	-42	10.3	45.0%
CV	1.5%	51.6%	1.4%	54.0%	360	451	483	0.825	-32	270	36	-48	8.3	43.7%
CW	1.2%	52.8%	1.2%	55.2%	360	447	483	0.825	-36	270	41	-48	8.3	42.6%
CX	1.6%	54.4%	1.6%	56.7%	360	443	483	0.825	-40	270	44	-48	8.3	41.2%
CY	1.7%	56.1%	1.7%	58.4%	360	440	483	0.826	-43	270	48	-48	8.3	39.7%
CZ	4.0%	60.1%	4.0%	62.5%	360	447	482	0.826	-35	270	53	-48	8.3	36.2%
DA	2.9%	62.9%	2.7%	65.2%	360	443	482	0.826	-39	270	52	-49	7.3	33.7%
DB	5.1%	68.0%	5.1%	70.3%	360	446	481	0.825	-35	270	45	-50	6.3	29.3%
DC	3.3%	71.3%	3.4%	73.8%	360	450	479	0.824	-29	280	34	-57	-0.7	26.5%
DD	1.9%	73.2%	1.7%	75.4%	360	450	479	0.824	-29	280	34	-57	-0.7	24.9%
DE	4.8%	77.9%	4.8%	80.2%	380	444	474	0.825	-30	270	35	-56	0.5	21.1%
DF	4.5%	82.5%	4.4%	84.6%	380	438	473	0.826	-35	270	44	-57	-0.5	17.4%
DG	4.6%	87.1%	4.3%	89.0%	400	425	470	0.824	-45	270	56	-59	-2.5	13.9%
DH	6.0%	93.1%	5.4%	94.4%	400	403	472	0.825	-69	270	72	-58	-1.5	9.4%
DI	1.8%	94.9%	1.7%	96.1%	400	403	472	0.825	-69	270	72	-58	-1.5	8.0%
DJ	1.7%	96.6%	1.5%	97.5%	400	398	473	0.826	-75	270	81	-57	-0.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	412	473	0.826	-61	270	81	-57	-0.5	6.7%
DL	0.3%	97.0%	0.3%	97.9%	400	412	473	0.826	-61	270	81	-57	-0.5	6.5%
LDG	3.0%	100.0%	2.1%	100.0%										5.3%

December 50% Route 2

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-30					
CA	2.8%	2.8%	2.2%	2.2%	300	466	498	0.826	-32	270	33	-34	10.4	95.2%
CB	0.1%	2.9%	0.2%	2.4%	300	467	498	0.826	-31	280	33	-33	11.4	95.1%
CC	0.9%	3.9%	0.9%	3.3%	300	466	498	0.826	-32	280	33	-33	11.4	93.9%
CD	0.5%	4.4%	0.6%	4.0%	300	468	498	0.826	-30	280	32	-33	11.4	93.3%
CE	2.8%	7.3%	3.0%	6.9%	300	471	499	0.825	-28	280	30	-33	11.4	90.0%
CF	0.3%	7.6%	0.3%	7.2%	300	473	499	0.825	-26	280	28	-32	12.4	89.6%
CG	0.7%	8.3%	0.8%	8.0%	300	474	500	0.825	-26	280	27	-32	12.4	88.7%
CH	0.1%	8.4%	0.2%	8.2%	300	475	500	0.825	-25	280	27	-32	12.4	88.6%
CI	1.2%	9.6%	1.2%	9.4%	300	476	500	0.825	-24	280	26	-31	13.4	87.3%
CJ	1.3%	10.8%	1.4%	10.7%	300	478	500	0.824	-22	280	24	-31	13.4	85.8%
CK	0.7%	11.6%	0.8%	11.5%	300	479	500	0.824	-21	280	22	-31	13.4	84.9%
CL	0.2%	11.8%	0.1%	11.7%	320	473	495	0.825	-22	290	22	-36	12.4	84.7%
CM	1.6%	13.4%	1.7%	13.4%	320	476	495	0.825	-19	290	19	-36	12.4	82.9%
CN	2.3%	15.7%	2.5%	15.9%	320	482	495	0.825	-13	310	13	-36	12.4	80.3%
CO	0.9%	16.6%	1.0%	16.9%	320	486	495	0.825	-9	330	9	-36	12.4	79.3%
CP	9.5%	26.1%	10.5%	27.4%	320	494	494	0.824	0	30	8	-37	11.4	69.0%
CQ	3.8%	29.9%	4.1%	31.5%	340	489	487	0.823	2	60	11	-42	10.3	65.1%
CR	6.5%	36.4%	7.2%	38.7%	340	488	488	0.825	0	10	1	-42	10.3	58.6%
CS	9.6%	46.0%	10.3%	49.0%	340	481	488	0.825	-7	260	9	-43	9.3	49.2%
CT	2.6%	48.6%	2.5%	51.5%	360	460	482	0.824	-22	260	26	-48	8.3	46.7%
CU	0.8%	49.4%	1.1%	52.6%	360	460	482	0.824	-22	260	26	-48	8.3	45.9%
CV	1.4%	50.8%	1.4%	54.0%	360	454	482	0.825	-28	270	32	-48	8.3	44.7%
CW	1.2%	51.9%	1.2%	55.2%	360	451	482	0.825	-31	270	35	-48	8.3	43.6%
CX	1.6%	53.5%	1.6%	56.7%	360	449	482	0.825	-33	270	37	-48	8.3	42.2%
CY	1.7%	55.2%	1.7%	58.4%	360	447	482	0.825	-35	270	39	-48	8.3	40.7%
CZ	4.0%	59.2%	4.0%	62.5%	360	452	482	0.825	-30	270	42	-49	7.3	37.1%
DA	2.7%	61.9%	2.7%	65.2%	360	446	481	0.826	-35	280	43	-49	7.3	34.7%
DB	5.0%	67.0%	5.1%	70.3%	360	446	480	0.825	-34	280	40	-50	6.3	30.2%
DC	3.6%	70.6%	3.4%	73.8%	380	436	474	0.825	-38	290	40	-55	1.5	27.3%
DD	1.7%	72.2%	1.7%	75.4%	380	436	474	0.825	-38	290	40	-55	1.5	25.9%
DE	5.0%	77.3%	4.8%	80.2%	380	429	474	0.825	-45	290	47	-56	0.5	21.8%
DF	4.7%	82.0%	4.4%	84.6%	380	416	474	0.826	-58	280	62	-57	-0.5	17.9%
DG	4.7%	86.8%	4.3%	89.0%	400	403	471	0.825	-68	280	77	-58	-1.5	14.2%
DH	6.4%	93.2%	5.4%	94.4%	400	389	473	0.826	-84	270	86	-57	-0.5	9.4%
DI	1.8%	95.0%	1.7%	96.1%	400	389	473	0.826	-84	270	86	-57	-0.5	8.0%
DJ	1.7%	96.6%	1.5%	97.5%	400	393	474	0.826	-81	270	88	-56	0.5	6.8%
DK	0.1%	96.7%	0.1%	97.6%	400	412	474	0.826	-62	270	88	-56	0.5	6.7%
DL	0.3%	97.1%	0.3%	97.9%	400	412	474	0.826	-62	270	88	-56	0.5	6.5%
LDG	2.9%	100.0%	2.1%	100.0%										5.2%

December 85% Route 2														
Waypoint De-identified	Time (% of Total)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-32					
CA	2.8%	2.8%	2.2%	2.2%	300	463	498	0.826	-35	270	38	-34	10.4	95.2%
CB	0.2%	3.0%	0.2%	2.4%	300	464	498	0.826	-34	270	37	-33	11.4	94.9%
CC	0.8%	3.9%	0.9%	3.3%	300	463	499	0.826	-36	280	37	-33	11.4	93.9%
CD	0.6%	4.5%	0.6%	4.0%	300	466	499	0.826	-33	280	37	-33	11.4	93.2%
CE	2.7%	7.2%	3.0%	6.9%	300	469	499	0.825	-30	280	34	-33	11.4	90.0%
CF	0.3%	7.5%	0.3%	7.2%	300	471	500	0.825	-29	280	31	-32	12.4	89.6%
CG	0.7%	8.3%	0.8%	8.0%	300	472	500	0.825	-28	280	31	-31	13.4	88.8%
CH	0.2%	8.5%	0.2%	8.2%	300	473	500	0.825	-27	280	30	-31	13.4	88.5%
CI	1.0%	9.5%	1.2%	9.4%	300	474	500	0.825	-26	280	29	-31	13.4	87.3%
CJ	1.4%	10.9%	1.4%	10.7%	300	476	500	0.825	-24	280	27	-31	13.4	85.7%
CK	0.7%	11.6%	0.8%	11.5%	300	478	500	0.824	-22	280	25	-31	13.4	84.8%
CL	0.1%	11.7%	0.1%	11.7%	320	472	495	0.825	-23	280	25	-36	12.4	84.7%
CM	1.6%	13.3%	1.7%	13.4%	320	474	495	0.825	-21	280	22	-36	12.4	82.9%
CN	2.4%	15.7%	2.5%	15.9%	320	481	495	0.825	-14	280	15	-36	12.4	80.3%
CO	0.8%	16.6%	1.0%	16.9%	320	486	495	0.825	-9	310	9	-36	12.4	79.3%
CP	9.4%	26.0%	10.5%	27.4%	320	496	494	0.825	2	50	8	-36	12.4	69.1%
CQ	3.8%	29.8%	4.1%	31.5%	340	492	487	0.823	5	70	13	-42	10.3	65.2%
CR	6.4%	36.2%	7.2%	38.7%	340	489	488	0.825	1	180	1	-42	10.3	58.8%
CS	9.6%	45.8%	10.3%	49.0%	340	477	488	0.825	-11	270	13	-43	9.3	49.4%
CT	2.6%	48.4%	2.5%	51.5%	340	464	488	0.825	-24	270	27	-43	9.3	46.9%
CU	0.8%	49.3%	1.1%	52.6%	340	464	488	0.825	-24	270	27	-43	9.3	46.1%
CV	1.4%	50.6%	1.4%	54.0%	360	450	482	0.825	-32	270	36	-48	8.3	44.8%
CW	1.3%	51.9%	1.2%	55.2%	360	448	482	0.825	-34	270	39	-48	8.3	43.7%
CX	1.5%	53.4%	1.6%	56.7%	360	445	482	0.825	-37	270	41	-48	8.3	42.3%
CY	1.7%	55.0%	1.7%	58.4%	360	444	482	0.826	-38	270	44	-48	8.3	40.8%
CZ	4.0%	59.0%	4.0%	62.5%	360	450	482	0.826	-32	270	48	-48	8.3	37.3%
DA	2.8%	61.8%	2.7%	65.2%	360	443	482	0.826	-39	270	50	-49	7.3	34.8%
DB	5.0%	66.9%	5.1%	70.3%	360	444	481	0.825	-37	280	46	-50	6.3	30.4%
DC	3.8%	70.6%	3.4%	73.8%	380	435	475	0.825	-40	280	45	-55	1.5	27.2%
DD	1.6%	72.2%	1.7%	75.4%	380	435	475	0.825	-40	280	45	-55	1.5	25.9%
DE	4.9%	77.1%	4.8%	80.2%	380	427	474	0.825	-47	280	53	-56	0.5	21.9%
DF	4.8%	82.0%	4.4%	84.6%	380	411	474	0.826	-63	280	71	-56	0.5	18.0%
DG	4.8%	86.8%	4.3%	89.0%	400	399	472	0.825	-73	270	86	-58	-1.5	14.3%
DH	6.4%	93.2%	5.4%	94.4%	400	385	474	0.826	-89	270	93	-56	0.5	9.4%
DI	1.8%	95.0%	1.7%	96.1%	400	385	474	0.826	-89	270	93	-56	0.5	8.1%
DJ	1.7%	96.6%	1.5%	97.5%	400	390	475	0.826	-85	270	95	-55	1.5	6.8%
DK	0.1%	96.8%	0.1%	97.6%	400	410	475	0.826	-65	270	95	-55	1.5	6.8%
DL	0.3%	97.1%	0.3%	97.9%	400	410	475	0.826	-65	270	95	-55	1.5	6.5%
LDG	2.9%	100.0%	2.1%	100.0%										5.3%

APPENDIX 10. SEASONAL FLIGHT PLAN DATA OUTBOUND ROUTE 3

January 50% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-20					
AA	0.5%	2.7%	2.2%	2.2%	300	486	500	0.825	-14	280	14	-32	12.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	486	500	0.825	-14	280	14	-32	12.4	94.4%
AC	0.8%	3.8%	0.9%	3.3%	300	486	500	0.825	-14	290	14	-32	12.4	93.4%
AD	0.5%	4.3%	0.6%	3.9%	300	486	500	0.825	-14	290	14	-32	12.4	92.8%
AE	2.7%	7.1%	2.9%	6.9%	300	488	500	0.825	-12	300	12	-32	12.4	89.6%
AF	0.3%	7.4%	0.3%	7.2%	300	489	500	0.825	-11	310	10	-31	13.4	89.2%
AG	0.6%	8.0%	0.8%	7.9%	300	490	500	0.825	-10	310	10	-31	13.4	88.5%
AH	0.2%	8.2%	0.2%	8.1%	300	490	500	0.825	-10	310	9	-31	13.4	88.2%
AI	1.1%	9.3%	1.2%	9.3%	300	491	500	0.824	-9	310	9	-31	13.4	87.0%
AJ	1.3%	10.5%	1.4%	10.6%	300	492	499	0.824	-7	310	7	-31	13.4	85.5%
AK	0.7%	11.3%	0.8%	11.4%	300	493	499	0.823	-6	310	6	-31	13.4	84.6%
AL	0.1%	11.4%	0.1%	11.5%	320	494	499	0.823	-5	320	6	-31	17.4	84.5%
AM	1.6%	13.0%	1.7%	13.2%	320	492	497	0.823	-5	330	6	-33	15.4	82.7%
AN	1.5%	14.5%	1.6%	14.8%	320	491	495	0.824	-4	340	5	-36	12.4	81.0%
AO	1.1%	15.5%	1.2%	16.0%	320	492	495	0.825	-3	350	4	-36	12.4	79.9%
AP	1.2%	16.7%	1.3%	17.3%	320	493	495	0.825	-2	10	4	-36	12.4	78.6%
AQ	4.4%	21.1%	4.8%	22.1%	320	497	495	0.825	2	60	5	-36	12.4	73.7%
AR	4.3%	25.4%	4.8%	26.9%	320	499	494	0.825	5	70	7	-36	12.4	69.0%
AS	0.5%	25.9%	0.6%	27.5%	340	492	487	0.823	5	60	9	-42	10.3	68.5%
AT	2.2%	28.2%	2.3%	29.8%	340	492	487	0.823	5	60	9	-42	10.3	66.2%
AU	1.8%	30.0%	2.0%	31.8%	340	492	487	0.823	5	60	9	-42	10.3	64.4%
AV	4.4%	34.4%	4.9%	36.7%	340	491	488	0.824	3	70	6	-42	10.3	59.8%
AW	4.6%	39.0%	4.9%	41.6%	360	482	480	0.821	2	110	2	-48	8.3	55.3%
AX	4.6%	43.7%	4.9%	46.5%	360	477	481	0.822	-4	260	5	-48	8.3	50.9%
AY	3.2%	46.8%	3.3%	49.8%	360	470	482	0.823	-12	270	13	-48	8.3	47.9%
AZ	1.9%	48.7%	2.0%	51.8%	360	470	482	0.823	-12	270	13	-48	8.3	46.1%
BA	1.3%	50.0%	1.3%	53.1%	360	468	482	0.824	-14	260	19	-48	8.3	45.0%
BB	0.6%	50.6%	0.6%	53.7%	360	467	482	0.825	-15	260	21	-48	8.3	44.4%
BC	0.5%	51.2%	0.6%	54.3%	360	466	482	0.825	-16	260	23	-48	8.3	43.9%
BD	1.6%	52.7%	1.6%	55.9%	360	465	482	0.825	-17	260	25	-48	8.3	42.4%
BE	1.7%	54.4%	1.6%	57.6%	360	464	482	0.825	-18	260	26	-48	8.3	40.9%
BF	3.0%	57.4%	3.1%	60.7%	360	464	482	0.825	-18	260	26	-48	8.3	38.3%
BG	3.0%	60.3%	3.1%	63.7%	360	467	482	0.825	-15	260	22	-48	8.3	35.6%
BH	0.1%	60.4%	0.1%	63.8%	360	467	482	0.825	-15	260	18	-48	8.3	35.5%
BI	2.2%	62.7%	2.3%	66.1%	360	467	482	0.825	-15	260	18	-48	8.3	33.5%
BJ	4.9%	67.5%	4.9%	71.0%	380	457	476	0.825	-19	270	21	-53	3.5	29.4%
BK	0.7%	68.2%	0.8%	71.7%	380	454	477	0.824	-23	280	27	-53	3.5	28.7%
BL	4.2%	72.5%	4.2%	75.9%	380	454	477	0.824	-23	280	27	-53	3.5	25.2%
BM	5.2%	77.6%	5.1%	81.0%	380	443	477	0.825	-34	290	37	-53	3.5	20.9%
BN	4.9%	82.5%	4.5%	85.5%	400	419	471	0.824	-52	280	55	-58	-1.5	17.0%
BO	2.1%	84.6%	1.9%	87.4%	400	408	472	0.824	-64	270	75	-58	-1.5	15.4%
BP	2.7%	87.3%	2.5%	89.9%	400	408	472	0.825	-64	270	75	-58	-1.5	13.3%
BQ	1.7%	89.0%	1.4%	91.3%	400	399	472	0.826	-73	270	88	-58	-1.5	12.0%
BR	1.3%	90.3%	1.1%	92.4%	400	395	472	0.826	-77	270	93	-58	-1.5	11.0%
BS	2.3%	92.6%	2.1%	94.5%	400	410	472	0.826	-62	270	100	-57	-0.5	9.3%
BT	0.3%	92.9%	0.3%	94.8%	400	407	473	0.826	-66	270	104	-57	-0.5	9.0%
BU	1.5%	94.4%	1.3%	96.2%	400	407	473	0.826	-66	270	104	-57	-0.5	7.9%
BV	0.1%	94.5%	0.1%	96.3%	400	422	474	0.826	-52	260	103	-56	0.5	7.8%
BW	1.4%	95.9%	1.3%	97.6%	400	422	474	0.826	-52	260	103	-56	0.5	6.8%
BX	0.1%	96.0%	0.1%	97.7%	400	410	474	0.826	-64	260	100	-56	0.5	6.7%
BY	0.4%	96.4%	0.3%	98.0%	400	411	474	0.826	-63	260	99	-56	0.5	6.4%
BZ	0.0%	96.4%	0.1%	98.1%	400	411	474	0.826	-63	260	99	-56	0.5	6.4%
LDG	3.6%	100.0%	1.9%	100.0%										5.2%

January 85% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-23					
AA	2.7%	2.7%	2.2%	2.2%	300	484	500	0.8250	-16	270	18	-32	12.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	485	500	0.8250	-15	270	17	-31	13.4	94.4%
AC	0.8%	3.8%	0.9%	3.3%	300	483	500	0.8250	-17	270	17	-31	13.4	93.4%
AD	0.5%	4.3%	0.6%	3.9%	300	485	500	0.8250	-15	270	17	-31	13.4	92.8%
AE	2.7%	7.1%	2.9%	6.9%	300	487	500	0.8250	-13	280	14	-31	13.4	89.6%
AF	0.3%	7.4%	0.3%	7.2%	300	488	500	0.825	-12	290	13	-31	13.4	89.2%
AG	0.7%	8.1%	0.8%	7.9%	300	488	500	0.825	-12	290	12	-31	13.4	88.4%
AH	0.1%	8.2%	0.2%	8.1%	300	489	500	0.825	-11	290	12	-31	13.4	88.3%
AI	1.1%	9.3%	1.2%	9.3%	300	490	500	0.824	-10	290	11	-31	13.4	87.0%
AJ	1.3%	10.6%	1.4%	10.6%	300	491	500	0.824	-9	280	10	-31	13.4	85.6%
AK	0.7%	11.3%	0.8%	11.4%	300	492	500	0.823	-8	280	8	-31	13.4	84.6%
AL	0.1%	11.4%	0.1%	11.5%	320	489	497	0.824	-8	290	9	-33	15.4	84.5%
AM	1.6%	13.0%	1.7%	13.2%	320	487	495	0.824	-8	290	8	-36	12.4	82.8%
AN	1.5%	14.5%	1.6%	14.8%	320	489	495	0.824	-6	290	6	-36	12.4	81.1%
AO	1.1%	15.5%	1.2%	16.0%	320	491	495	0.825	-4	300	4	-36	12.4	80.0%
AP	1.3%	16.8%	1.3%	17.3%	320	495	495	0.825	0	40	2	-36	12.4	78.6%
AQ	4.3%	21.1%	4.8%	22.1%	320	501	495	0.825	6	80	8	-36	12.4	73.9%
AR	4.3%	25.4%	4.8%	26.9%	320	503	495	0.824	8	90	11	-36	12.4	69.2%
AS	0.5%	26.0%	0.6%	27.5%	340	496	488	0.822	8	80	12	-42	10.3	68.6%
AT	2.1%	28.1%	2.3%	29.8%	340	496	488	0.822	8	80	12	-42	10.3	66.5%
AU	1.8%	29.9%	2.0%	31.8%	340	496	488	0.822	8	80	12	-42	10.3	64.6%
AV	4.4%	34.3%	4.9%	36.7%	340	495	488	0.824	7	80	9	-42	10.3	60.1%
AW	4.6%	38.9%	4.9%	41.6%	360	484	481	0.821	3	80	4	-47	9.3	55.6%
AX	4.6%	43.6%	4.9%	46.5%	360	474	481	0.822	-7	270	8	-47	9.3	51.2%
AY	3.6%	47.2%	3.3%	49.8%	360	465	482	0.823	-17	270	18	-48	8.3	47.9%
AZ	1.6%	48.8%	2.0%	51.8%	360	465	482	0.823	-17	270	18	-48	8.3	46.4%
BA	1.3%	50.0%	1.3%	53.1%	360	463	482	0.824	-19	270	25	-48	8.3	45.2%
BB	0.6%	50.7%	0.6%	53.7%	360	461	482	0.825	-21	270	27	-48	8.3	44.6%
BC	0.5%	51.2%	0.6%	54.3%	360	461	482	0.825	-21	270	28	-48	8.3	44.2%
BD	1.7%	52.9%	1.6%	55.9%	360	459	483	0.825	-24	270	30	-48	8.3	42.6%
BE	1.6%	54.5%	1.6%	57.6%	360	458	483	0.825	-25	270	31	-48	8.3	41.2%
BF	3.1%	57.5%	3.1%	60.7%	360	458	483	0.825	-25	270	31	-48	8.3	38.4%
BG	3.1%	60.6%	3.1%	63.7%	360	459	483	0.826	-24	270	28	-48	8.3	35.7%
BH	0.0%	60.6%	0.1%	63.8%	380	452	476	0.823	-24	270	27	-52	4.5	35.6%
BI	2.3%	63.0%	2.3%	66.1%	380	452	476	0.823	-24	270	27	-52	4.5	33.6%
BJ	4.9%	67.8%	4.9%	71.0%	380	452	477	0.823	-25	270	29	-52	4.5	29.5%
BK	0.8%	68.7%	0.8%	71.7%	380	452	478	0.824	-26	270	34	-52	4.5	28.8%
BL	4.1%	72.8%	4.2%	75.9%	380	452	478	0.824	-26	270	34	-52	4.5	25.4%
BM	5.3%	78.0%	5.1%	81.0%	380	441	478	0.825	-37	270	42	-52	4.5	21.0%
BN	4.9%	82.9%	4.5%	85.5%	400	417	472	0.824	-55	280	60	-57	-0.5	17.2%
BO	2.1%	85.0%	1.9%	87.4%	400	406	473	0.825	-67	270	82	-57	-0.5	15.5%
BP	2.8%	87.9%	2.5%	89.9%	400	406	473	0.825	-67	270	82	-57	-0.5	13.3%
BQ	1.6%	89.4%	1.4%	91.3%	400	394	473	0.826	-79	270	95	-57	-0.5	12.1%
BR	1.3%	90.7%	1.1%	92.4%	400	388	473	0.826	-85	270	100	-57	-0.5	11.2%
BS	2.4%	93.1%	2.1%	94.5%	400	402	474	0.826	-72	270	106	-56	0.5	9.3%
BT	0.3%	93.5%	0.3%	94.8%	400	399	474	0.826	-75	270	111	-56	0.5	9.1%
BU	1.6%	95.0%	1.3%	96.2%	400	399	474	0.826	-75	270	111	-56	0.5	7.9%
BV	0.1%	95.1%	0.1%	96.3%	400	414	475	0.826	-61	270	109	-55	1.5	7.8%
BW	1.4%	96.5%	1.3%	97.6%	400	414	475	0.826	-61	270	109	-55	1.5	6.8%
BX	0.1%	96.6%	0.1%	97.7%	400	402	476	0.826	-74	270	106	-55	1.5	6.7%
BY	0.3%	96.9%	0.3%	98.0%	400	403	476	0.826	-73	270	106	-55	1.5	6.5%
BZ	0.1%	97.0%	0.1%	98.1%	400	403	476	0.826	-73	270	105	-55	1.5	6.4%
LDG	3.0%	100.0%	1.9%	100.0%										5.3%

February 50% Route 3

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-19					
AA	2.8%	2.8%	2.2%	2.2%	300	489	501	0.825	-12	290	12	-31	13.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	490	501	0.825	-11	290	12	-30	14.4	94.2%
AC	0.9%	3.8%	0.9%	3.3%	300	490	501	0.825	-11	290	11	-30	14.4	93.2%
AD	0.5%	4.4%	0.6%	3.9%	300	491	501	0.825	-10	290	11	-30	14.4	92.5%
AE	2.8%	7.2%	2.9%	6.9%	300	493	501	0.825	-8	280	9	-30	14.4	89.3%
AF	0.2%	7.4%	0.3%	7.2%	300	495	501	0.825	-6	280	6	-30	14.4	89.0%
AG	0.7%	8.1%	0.8%	7.9%	300	496	501	0.824	-5	280	6	-30	14.4	88.2%
AH	0.1%	8.2%	0.2%	8.1%	300	496	501	0.824	-5	280	5	-30	14.4	88.1%
AI	1.1%	9.3%	1.2%	9.3%	300	497	501	0.824	-4	280	4	-30	14.4	86.8%
AJ	1.3%	10.6%	1.4%	10.6%	300	498	501	0.824	-3	290	2	-30	14.4	85.4%
AK	0.7%	11.3%	0.8%	11.4%	300	499	500	0.823	-1	340	1	-30	14.4	84.4%
AL	0.1%	11.4%	0.1%	11.5%	320	500	500	0.823	0	10	1	-30	18.4	84.3%
AM	1.6%	13.0%	1.7%	13.2%	320	498	498	0.823	0	40	3	-32	16.4	82.5%
AN	1.4%	14.4%	1.6%	14.8%	320	498	496	0.824	2	50	5	-35	13.4	81.0%
AO	1.2%	15.6%	1.2%	16.0%	320	499	496	0.824	3	60	6	-35	13.4	79.7%
AP	1.2%	16.8%	1.3%	17.3%	320	500	496	0.825	4	70	8	-35	13.4	78.4%
AQ	4.4%	21.1%	4.8%	22.1%	320	505	496	0.825	9	80	12	-35	13.4	73.7%
AR	4.4%	25.5%	4.8%	26.9%	320	507	495	0.824	12	80	16	-36	12.4	68.9%
AS	0.5%	26.0%	0.6%	27.5%	340	501	487	0.822	14	80	19	-42	10.3	68.4%
AT	2.0%	28.1%	2.3%	29.8%	340	501	487	0.822	14	80	19	-42	10.3	66.3%
AU	1.8%	29.9%	2.0%	31.8%	340	501	487	0.822	14	80	19	-42	10.3	64.5%
AV	4.5%	34.4%	4.9%	36.7%	340	501	488	0.823	13	80	18	-42	10.3	59.9%
AW	4.5%	38.8%	4.9%	41.6%	360	495	480	0.82	15	80	19	-47	9.3	55.6%
AX	4.6%	43.4%	4.9%	46.5%	360	495	481	0.821	14	100	16	-47	9.3	51.3%
AY	3.1%	46.5%	3.3%	49.8%	360	490	481	0.822	9	150	11	-47	9.3	48.4%
AZ	1.8%	48.3%	2.0%	51.8%	360	490	481	0.822	9	150	11	-47	9.3	46.7%
BA	1.3%	49.6%	1.3%	53.1%	360	484	482	0.823	2	210	14	-47	9.3	45.6%
BB	0.5%	50.2%	0.6%	53.7%	360	481	482	0.824	-1	220	17	-47	9.3	45.1%
BC	0.6%	50.8%	0.6%	54.3%	360	480	482	0.824	-2	220	19	-47	9.3	44.5%
BD	1.5%	52.3%	1.6%	55.9%	360	476	483	0.824	-7	230	23	-47	9.3	43.1%
BE	1.6%	53.9%	1.6%	57.6%	360	471	483	0.825	-12	240	30	-47	9.3	41.7%
BF	3.1%	57.0%	3.1%	60.7%	360	462	483	0.825	-21	250	38	-47	9.3	38.9%
BG	3.1%	60.1%	3.1%	63.7%	360	450	483	0.826	-33	260	47	-48	8.3	36.2%
BH	0.1%	60.2%	0.1%	63.8%	360	437	483	0.826	-46	270	53	-48	8.3	36.1%
BI	2.3%	62.5%	2.3%	66.1%	360	437	483	0.826	-46	270	53	-48	8.3	34.0%
BJ	5.2%	67.8%	4.9%	71.0%	360	431	483	0.826	-52	280	56	-48	8.3	29.4%
BK	0.9%	68.6%	0.8%	71.7%	380	427	477	0.825	-50	280	57	-53	3.5	28.7%
BL	4.5%	73.1%	4.2%	75.9%	380	427	477	0.825	-50	280	57	-53	3.5	25.0%
BM	5.4%	78.5%	5.1%	81.0%	380	424	476	0.826	-52	280	59	-54	2.5	20.5%
BN	5.0%	83.6%	4.5%	85.5%	400	414	471	0.824	-57	280	62	-58	-1.5	16.6%
BO	2.0%	85.6%	1.9%	87.4%	400	417	471	0.825	-54	270	67	-58	-1.5	15.0%
BP	2.8%	88.4%	2.5%	89.9%	400	417	471	0.825	-54	270	67	-58	-1.5	12.9%
BQ	1.6%	90.0%	1.4%	91.3%	400	416	472	0.825	-56	270	70	-58	-1.5	11.7%
BR	1.2%	91.1%	1.1%	92.4%	400	415	472	0.825	-57	270	72	-58	-1.5	10.8%
BS	2.3%	93.5%	2.1%	94.5%	400	430	473	0.825	-43	260	73	-57	-0.5	9.1%
BT	0.3%	93.8%	0.3%	94.8%	400	431	474	0.825	-43	260	73	-56	0.5	8.8%
BU	1.4%	95.2%	1.3%	96.2%	400	431	474	0.825	-43	260	73	-56	0.5	7.8%
BV	0.1%	95.3%	0.1%	96.3%	400	440	475	0.825	-35	260	72	-55	1.5	7.7%
BW	1.4%	96.7%	1.3%	97.6%	400	440	475	0.825	-35	260	72	-55	1.5	6.7%
BX	0.1%	96.8%	0.1%	97.7%	400	431	476	0.826	-45	260	71	-54	2.5	6.6%
BY	0.3%	97.1%	0.3%	98.0%	400	432	476	0.826	-44	260	71	-54	2.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										5.2%
LDG	2.9%	100.0%	1.9%	100.0%										

February 85% Route 3

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-20					
AA	2.8%	2.8%	2.2%	2.2%	300	488	501	0.825	-13	270	14	-30	14.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	488	501	0.825	-13	280	14	-30	14.4	94.4%
AC	0.9%	3.8%	0.9%	3.3%	300	488	501	0.825	-13	280	14	-30	14.4	93.4%
AD	0.5%	4.4%	0.6%	3.9%	300	490	501	0.825	-11	270	14	-30	14.4	92.8%
AE	2.8%	7.1%	2.9%	6.9%	300	492	501	0.825	-9	270	12	-30	14.4	89.6%
AF	0.2%	7.3%	0.3%	7.2%	300	494	501	0.825	-7	270	10	-30	14.4	89.3%
AG	0.7%	8.1%	0.8%	7.9%	300	494	501	0.825	-7	270	9	-30	14.4	88.4%
AH	0.2%	8.3%	0.2%	8.1%	300	495	501	0.824	-6	260	8	-30	14.4	88.2%
AI	1.1%	9.4%	1.2%	9.3%	300	496	501	0.824	-5	260	7	-29	15.4	87.0%
AJ	1.3%	10.6%	1.4%	10.6%	300	497	501	0.823	-4	260	5	-29	15.4	85.5%
AK	0.6%	11.3%	0.8%	11.4%	300	499	501	0.823	-2	260	3	-29	15.4	84.7%
AL	0.2%	11.5%	0.1%	11.5%	320	499	501	0.823	-2	260	2	-29	19.4	84.5%
AM	1.5%	13.0%	1.7%	13.2%	320	500	498	0.823	2	70	2	-32	16.4	82.8%
AN	1.5%	14.5%	1.6%	14.8%	320	501	496	0.824	5	80	7	-35	13.4	81.1%
AO	1.1%	15.5%	1.2%	16.0%	320	502	496	0.824	6	80	8	-35	13.4	80.0%
AP	1.2%	16.7%	1.3%	17.3%	320	502	496	0.825	6	80	10	-35	13.4	78.7%
AQ	4.3%	21.0%	4.8%	22.1%	320	507	496	0.825	11	90	14	-35	13.4	74.1%
AR	4.4%	25.3%	4.8%	26.9%	320	510	495	0.824	15	90	18	-36	12.4	69.3%
AS	0.5%	25.9%	0.6%	27.5%	340	506	488	0.822	18	80	23	-41	11.3	68.8%
AT	2.1%	28.0%	2.3%	29.8%	340	506	488	0.822	18	80	23	-41	11.3	66.6%
AU	1.7%	29.7%	2.0%	31.8%	340	506	488	0.822	18	80	23	-41	11.3	64.9%
AV	4.5%	34.2%	4.9%	36.7%	340	507	488	0.823	19	90	23	-42	10.3	60.3%
AW	4.4%	38.6%	4.9%	41.6%	360	501	481	0.82	20	90	25	-47	9.3	56.1%
AX	4.5%	43.0%	4.9%	46.5%	360	500	481	0.821	19	90	22	-47	9.3	51.9%
AY	3.3%	46.3%	3.3%	49.8%	360	493	482	0.822	11	130	11	-47	9.3	48.8%
AZ	1.7%	48.0%	2.0%	51.8%	360	493	482	0.822	11	130	11	-47	9.3	47.3%
BA	1.2%	49.2%	1.3%	53.1%	360	479	483	0.823	-4	230	14	-47	9.3	46.2%
BB	0.6%	49.8%	0.6%	53.7%	360	476	483	0.824	-7	240	19	-47	9.3	45.6%
BC	0.5%	50.4%	0.6%	54.3%	360	474	483	0.824	-9	240	21	-47	9.3	45.1%
BD	1.6%	52.0%	1.6%	55.9%	360	470	483	0.824	-13	250	26	-47	9.3	43.6%
BE	1.6%	53.6%	1.6%	57.6%	360	465	483	0.825	-18	250	33	-47	9.3	42.2%
BF	3.1%	56.7%	3.1%	60.7%	360	456	484	0.825	-28	260	41	-47	9.3	39.4%
BG	3.2%	59.9%	3.1%	63.7%	360	444	484	0.826	-40	270	50	-47	9.3	36.6%
BH	0.1%	60.0%	0.1%	63.8%	360	433	484	0.826	-51	270	57	-47	9.3	36.5%
BI	2.3%	62.3%	2.3%	66.1%	360	433	484	0.826	-51	270	57	-47	9.3	34.4%
BJ	5.2%	67.5%	4.9%	71.0%	360	429	483	0.826	-54	270	60	-47	9.3	29.8%
BK	0.9%	68.4%	0.8%	71.7%	360	429	483	0.826	-54	270	60	-47	9.3	29.1%
BL	4.5%	72.8%	4.2%	75.9%	380	426	478	0.825	-52	280	62	-52	4.5	25.4%
BM	5.5%	78.4%	5.1%	81.0%	380	421	477	0.826	-56	280	66	-53	3.5	20.8%
BN	5.0%	83.4%	4.5%	85.5%	400	409	472	0.824	-63	270	71	-57	-0.5	16.9%
BO	2.1%	85.5%	1.9%	87.4%	400	411	472	0.825	-61	270	76	-57	-0.5	15.2%
BP	2.8%	88.3%	2.5%	89.9%	400	411	472	0.825	-61	270	76	-57	-0.5	13.1%
BQ	1.6%	89.9%	1.4%	91.3%	400	407	473	0.826	-66	270	78	-57	-0.5	11.9%
BR	1.3%	91.2%	1.1%	92.4%	400	407	473	0.826	-66	270	79	-57	-0.5	10.9%
BS	2.2%	93.4%	2.1%	94.5%	400	422	474	0.825	-52	270	79	-56	0.5	9.3%
BT	0.4%	93.8%	0.3%	94.8%	400	422	475	0.826	-53	270	79	-55	1.5	8.9%
BU	1.4%	95.2%	1.3%	96.2%	400	422	475	0.826	-53	270	79	-55	1.5	7.9%
BV	0.1%	95.3%	0.1%	96.3%	400	432	476	0.826	-44	270	79	-54	2.5	7.8%
BW	1.4%	96.7%	1.3%	97.6%	400	432	476	0.826	-44	270	79	-54	2.5	6.8%
BX	0.1%	96.8%	0.1%	97.7%	400	423	477	0.826	-54	270	78	-53	3.5	6.7%
BY	0.3%	97.1%	0.3%	98.0%	400	423	477	0.826	-54	270	78	-53	3.5	6.5%
BZ	0.1%	97.2%	0.1%	98.1%	400	423	477	0.826	-54	270	77	-53	3.5	6.4%
LDG	2.8%	100.0%	1.9%	100.0%										5.3%

March 50% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-18					
AA	2.8%	2.8%	2.2%	2.2%	300	487	499	0.825	-12	250	17	-33	11.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	488	499	0.825	-11	250	17	-33	11.4	94.2%
AC	0.9%	3.8%	0.9%	3.3%	300	486	499	0.825	-13	250	16	-32	12.4	93.2%
AD	0.5%	4.4%	0.6%	3.9%	300	489	499	0.825	-10	250	16	-32	12.4	92.6%
AE	2.8%	7.2%	2.9%	6.9%	300	491	499	0.825	-8	250	15	-32	12.4	89.3%
AF	0.2%	7.4%	0.3%	7.2%	300	491	500	0.825	-9	250	14	-31	13.4	89.1%
AG	0.7%	8.1%	0.8%	7.9%	300	491	500	0.825	-9	250	14	-31	13.4	88.2%
AH	0.1%	8.2%	0.2%	8.1%	300	491	500	0.825	-9	260	13	-31	13.4	88.1%
AI	1.2%	9.4%	1.2%	9.3%	300	492	500	0.824	-8	260	12	-31	13.4	86.7%
AJ	1.3%	10.7%	1.4%	10.6%	300	492	500	0.824	-8	270	10	-30	14.4	85.3%
AK	0.7%	11.4%	0.8%	11.4%	300	493	500	0.823	-7	280	8	-30	14.4	84.3%
AL	0.1%	11.5%	0.1%	11.5%	320	493	500	0.823	-7	290	7	-30	18.4	84.2%
AM	1.5%	13.0%	1.7%	13.2%	320	491	498	0.823	-7	300	7	-33	15.4	82.5%
AN	1.5%	14.5%	1.6%	14.8%	320	490	495	0.824	-5	330	6	-35	13.4	80.9%
AO	1.2%	15.7%	1.2%	16.0%	320	491	496	0.825	-5	340	6	-35	13.4	79.6%
AP	1.2%	16.9%	1.3%	17.3%	320	493	496	0.825	-3	10	6	-35	13.4	78.3%
AQ	4.4%	21.3%	4.8%	22.1%	320	498	496	0.825	2	50	8	-35	13.4	73.6%
AR	4.5%	25.7%	4.8%	26.9%	320	502	495	0.825	7	60	12	-36	12.4	68.7%
AS	0.5%	26.3%	0.6%	27.5%	340	496	488	0.823	8	60	16	-41	11.3	68.2%
AT	2.1%	28.4%	2.3%	29.8%	340	496	488	0.823	8	60	16	-41	11.3	66.0%
AU	1.8%	30.2%	2.0%	31.8%	340	496	488	0.823	8	60	16	-41	11.3	64.2%
AV	4.5%	34.7%	4.9%	36.7%	340	497	489	0.823	8	70	14	-41	11.3	59.6%
AW	4.5%	39.2%	4.9%	41.6%	360	493	481	0.821	12	90	14	-47	9.3	55.3%
AX	4.6%	43.8%	4.9%	46.5%	360	496	482	0.821	14	110	14	-47	9.3	51.0%
AY	3.4%	47.2%	3.3%	49.8%	360	486	482	0.823	4	180	8	-47	9.3	47.8%
AZ	1.6%	48.8%	2.0%	51.8%	360	486	482	0.823	4	180	8	-47	9.3	46.3%
BA	1.2%	50.0%	1.3%	53.1%	360	479	483	0.824	-4	230	14	-47	9.3	45.3%
BB	0.6%	50.6%	0.6%	53.7%	360	477	483	0.824	-6	240	18	-47	9.3	44.7%
BC	0.5%	51.2%	0.6%	54.3%	360	475	483	0.824	-8	240	20	-47	9.3	44.2%
BD	1.6%	52.8%	1.6%	55.9%	360	472	483	0.824	-11	250	24	-47	9.3	42.7%
BE	1.6%	54.4%	1.6%	57.6%	360	467	483	0.825	-16	250	28	-47	9.3	41.3%
BF	3.1%	57.5%	3.1%	60.7%	360	461	483	0.825	-22	260	33	-47	9.3	38.5%
BG	3.1%	60.6%	3.1%	63.7%	360	455	483	0.826	-28	270	35	-47	9.3	35.8%
BH	0.1%	60.7%	0.1%	63.8%	360	450	483	0.826	-33	280	35	-47	9.3	35.7%
BI	2.4%	63.0%	2.3%	66.1%	360	450	483	0.826	-33	280	35	-47	9.3	33.6%
BJ	5.0%	68.1%	4.9%	71.0%	380	441	478	0.823	-37	290	36	-52	4.5	29.3%
BK	0.7%	68.8%	0.8%	71.7%	380	439	478	0.824	-39	290	41	-52	4.5	28.7%
BL	4.4%	73.2%	4.2%	75.9%	380	439	478	0.824	-39	290	41	-52	4.5	25.1%
BM	5.4%	78.6%	5.1%	81.0%	380	432	478	0.825	-46	290	50	-52	4.5	20.6%
BN	4.9%	83.5%	4.5%	85.5%	400	415	472	0.824	-57	280	63	-57	-0.5	16.7%
BO	2.1%	85.7%	1.9%	87.4%	380	420	475	0.824	-55	270	72	-55	1.5	15.0%
BP	2.7%	88.4%	2.5%	89.9%	380	420	475	0.824	-55	270	72	-55	1.5	12.9%
BQ	1.6%	90.0%	1.4%	91.3%	400	411	472	0.825	-61	260	80	-58	-1.5	11.7%
BR	1.3%	91.2%	1.1%	92.4%	400	410	472	0.826	-62	260	83	-58	-1.5	10.7%
BS	2.2%	93.5%	2.1%	94.5%	400	429	472	0.825	-43	260	84	-58	-1.5	9.0%
BT	0.3%	93.8%	0.3%	94.8%	400	431	472	0.825	-41	260	82	-57	-0.5	8.8%
BU	1.4%	95.2%	1.3%	96.2%	400	431	472	0.825	-41	260	82	-57	-0.5	7.8%
BV	0.1%	95.3%	0.1%	96.3%	400	444	473	0.825	-29	260	77	-56	0.5	7.7%
BW	1.4%	96.7%	1.3%	97.6%	400	444	473	0.825	-29	260	77	-56	0.5	6.7%
BX	0.1%	96.8%	0.1%	97.7%	400	434	474	0.826	-40	260	74	-56	0.5	6.6%
BY	0.3%	97.1%	0.3%	98.0%	400	434	474	0.826	-40	260	73	-56	0.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										5.2%
LDG	2.9%	100.0%	1.9%	100.0%										

March 85% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-21					
AA	2.8%	2.8%	2.2%	2.2%	300	482	499	0.825	-17	260	20	-33	11.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	483	499	0.825	-16	260	20	-32	12.4	94.4%
AC	0.9%	3.8%	0.9%	3.3%	300	482	499	0.825	-17	260	19	-32	12.4	93.4%
AD	0.5%	4.4%	0.6%	3.9%	300	485	499	0.825	-14	260	19	-32	12.4	92.8%
AE	2.8%	7.1%	2.9%	6.9%	300	486	500	0.825	-14	260	18	-31	13.4	89.6%
AF	0.3%	7.4%	0.3%	7.2%	300	487	500	0.825	-13	260	17	-31	13.4	89.2%
AG	0.7%	8.2%	0.8%	7.9%	300	487	500	0.825	-13	270	17	-31	13.4	88.3%
AH	0.1%	8.3%	0.2%	8.1%	300	487	500	0.825	-13	270	16	-31	13.4	88.2%
AI	1.1%	9.4%	1.2%	9.3%	300	488	500	0.824	-12	270	15	-31	13.4	87.0%
AJ	1.4%	10.7%	1.4%	10.6%	300	490	500	0.824	-10	270	13	-30	14.4	85.4%
AK	0.6%	11.4%	0.8%	11.4%	300	491	500	0.824	-9	270	11	-30	14.4	84.6%
AL	0.2%	11.6%	0.1%	11.5%	320	488	498	0.824	-10	280	11	-33	15.4	84.4%
AM	1.5%	13.1%	1.7%	13.2%	320	486	495	0.824	-9	290	10	-35	13.4	82.7%
AN	1.5%	14.6%	1.6%	14.8%	320	488	496	0.824	-8	300	7	-35	13.4	81.1%
AO	1.2%	15.7%	1.2%	16.0%	320	490	496	0.825	-6	310	6	-35	13.4	79.8%
AP	1.2%	16.9%	1.3%	17.3%	320	494	496	0.825	-2	10	4	-35	13.4	78.5%
AQ	4.4%	21.3%	4.8%	22.1%	320	501	496	0.825	5	70	9	-35	13.4	73.8%
AR	4.4%	25.6%	4.8%	26.9%	320	505	495	0.824	10	70	14	-35	13.4	69.0%
AS	0.5%	26.1%	0.6%	27.5%	340	500	488	0.822	12	70	18	-41	11.3	68.5%
AT	2.1%	28.3%	2.3%	29.8%	340	500	488	0.822	12	70	18	-41	11.3	66.3%
AU	1.8%	30.1%	2.0%	31.8%	340	500	488	0.822	12	70	18	-41	11.3	64.5%
AV	4.5%	34.5%	4.9%	36.7%	340	501	489	0.823	12	80	17	-41	11.3	59.9%
AW	4.5%	39.0%	4.9%	41.6%	360	498	481	0.82	17	90	19	-47	9.3	55.6%
AX	4.5%	43.5%	4.9%	46.5%	360	500	482	0.821	18	100	19	-47	9.3	51.4%
AY	3.4%	46.9%	3.3%	49.8%	360	485	483	0.823	2	180	6	-47	9.3	48.2%
AZ	1.6%	48.5%	2.0%	51.8%	360	485	483	0.823	2	180	6	-47	9.3	46.7%
BA	1.3%	49.7%	1.3%	53.1%	360	474	483	0.824	-9	250	18	-47	9.3	45.6%
BB	0.5%	50.3%	0.6%	53.7%	360	471	483	0.824	-12	250	21	-47	9.3	45.1%
BC	0.6%	50.9%	0.6%	54.3%	360	469	483	0.824	-14	250	24	-47	9.3	44.5%
BD	1.6%	52.5%	1.6%	55.9%	360	466	484	0.825	-18	260	27	-47	9.3	43.0%
BE	1.6%	54.1%	1.6%	57.6%	360	461	484	0.825	-23	260	32	-47	9.3	41.6%
BF	3.1%	57.2%	3.1%	60.7%	360	455	484	0.825	-29	270	37	-47	9.3	38.8%
BG	3.1%	60.3%	3.1%	63.7%	360	451	484	0.826	-33	270	41	-47	9.3	36.1%
BH	0.1%	60.4%	0.1%	63.8%	360	447	484	0.826	-37	270	41	-47	9.3	36.0%
BI	2.3%	62.7%	2.3%	66.1%	360	447	484	0.826	-37	270	41	-47	9.3	33.9%
BJ	5.1%	67.8%	4.9%	71.0%	380	438	478	0.826	-40	280	42	-51	5.5	29.5%
BK	0.7%	68.5%	0.8%	71.7%	380	438	479	0.825	-41	280	46	-51	5.5	28.9%
BL	4.4%	72.9%	4.2%	75.9%	380	438	479	0.825	-41	280	46	-51	5.5	25.3%
BM	5.4%	78.3%	5.1%	81.0%	380	431	479	0.825	-48	280	55	-52	4.5	20.8%
BN	5.0%	83.3%	4.5%	85.5%	400	413	473	0.824	-60	270	69	-56	0.5	16.9%
BO	2.0%	85.3%	1.9%	87.4%	400	408	473	0.825	-65	270	80	-57	-0.5	15.3%
BP	2.9%	88.2%	2.5%	89.9%	400	408	473	0.825	-65	270	80	-57	-0.5	13.1%
BQ	1.6%	89.8%	1.4%	91.3%	400	402	473	0.826	-71	270	86	-57	-0.5	11.9%
BR	1.3%	91.1%	1.1%	92.4%	400	401	473	0.826	-72	270	88	-57	-0.5	10.9%
BS	2.3%	93.4%	2.1%	94.5%	400	420	473	0.826	-53	260	88	-57	-0.5	9.2%
BT	0.2%	93.6%	0.3%	94.8%	400	422	474	0.826	-52	260	86	-56	0.5	9.0%
BU	1.6%	95.2%	1.3%	96.2%	400	422	474	0.826	-52	260	86	-56	0.5	7.8%
BV	0.1%	95.3%	0.1%	96.3%	400	435	475	0.826	-40	260	81	-55	1.5	7.7%
BW	1.3%	96.6%	1.3%	97.6%	400	435	475	0.826	-40	260	81	-55	1.5	6.8%
BX	0.1%	96.7%	0.1%	97.7%	400	426	475	0.826	-49	260	78	-55	1.5	6.7%
BY	0.4%	97.1%	0.3%	98.0%	400	427	475	0.826	-48	260	78	-55	1.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										6.4%
LDG	2.9%	100.0%	1.9%	100.0%										5.3%

April 50% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-17					
AA	2.9%	2.9%	2.2%	2.2%	300	475	495	0.826	-20	240	29	-36	8.4	94.5%
AB	0.2%	3.1%	0.2%	2.4%	300	477	496	0.826	-19	250	30	-36	8.4	94.1%
AC	0.9%	4.0%	0.9%	3.3%	300	474	496	0.825	-22	250	31	-36	8.4	93.1%
AD	0.5%	4.5%	0.6%	3.9%	300	479	496	0.825	-17	240	32	-35	9.4	92.4%
AE	2.9%	7.4%	2.9%	6.9%	300	481	497	0.825	-16	240	31	-34	10.4	89.1%
AF	0.2%	7.6%	0.3%	7.2%	300	482	498	0.825	-16	240	30	-33	11.4	88.9%
AG	0.7%	8.3%	0.8%	7.9%	300	483	498	0.825	-15	250	29	-33	11.4	88.0%
AH	0.2%	8.6%	0.2%	8.1%	300	483	498	0.825	-15	250	28	-33	11.4	87.8%
AI	1.1%	9.6%	1.2%	9.3%	300	484	498	0.824	-14	250	26	-33	11.4	86.5%
AJ	1.3%	10.9%	1.4%	10.6%	300	486	498	0.824	-12	250	22	-32	12.4	85.1%
AK	0.7%	11.7%	0.8%	11.4%	300	487	498	0.824	-11	250	18	-32	12.4	84.2%
AL	0.1%	11.8%	0.1%	11.5%	300	488	498	0.824	-10	250	17	-32	12.4	84.1%
AM	1.6%	13.4%	1.7%	13.2%	300	490	498	0.823	-8	250	14	-32	12.4	82.3%
AN	1.5%	14.9%	1.6%	14.8%	300	491	498	0.823	-7	260	9	-31	13.4	80.6%
AO	1.1%	15.9%	1.2%	16.0%	300	493	499	0.823	-6	260	7	-31	13.4	79.4%
AP	1.2%	17.1%	1.3%	17.3%	300	495	499	0.822	-4	260	5	-31	13.4	78.0%
AQ	4.5%	21.6%	4.8%	22.1%	320	490	495	0.825	-5	270	6	-36	12.4	73.2%
AR	4.5%	26.1%	4.8%	26.9%	320	493	495	0.825	-2	310	2	-36	12.4	68.4%
AS	0.5%	26.6%	0.6%	27.5%	340	490	488	0.823	2	50	8	-41	11.3	67.8%
AT	2.2%	28.9%	2.3%	29.8%	340	490	488	0.823	2	50	8	-41	11.3	65.5%
AU	1.8%	30.7%	2.0%	31.8%	340	490	488	0.823	2	50	8	-41	11.3	63.7%
AV	4.5%	35.2%	4.9%	36.7%	340	496	489	0.824	7	70	11	-41	11.3	59.1%
AW	4.6%	39.8%	4.9%	41.6%	360	491	481	0.821	10	80	13	-47	9.3	54.7%
AX	4.6%	44.4%	4.9%	46.5%	360	493	482	0.821	11	100	12	-47	9.3	50.4%
AY	3.1%	47.5%	3.3%	49.8%	360	490	482	0.822	8	130	8	-47	9.3	47.5%
AZ	1.8%	49.3%	2.0%	51.8%	360	490	482	0.822	8	130	8	-47	9.3	45.9%
BA	1.2%	50.5%	1.3%	53.1%	360	487	483	0.823	4	180	7	-47	9.3	44.8%
BB	0.6%	51.1%	0.6%	53.7%	360	486	483	0.824	3	190	8	-47	9.3	44.2%
BC	0.5%	51.7%	0.6%	54.3%	360	485	483	0.824	2	200	9	-47	9.3	43.7%
BD	1.6%	53.3%	1.6%	55.9%	360	483	483	0.824	0	210	10	-47	9.3	42.3%
BE	1.5%	54.8%	1.6%	57.6%	360	480	483	0.824	-3	230	14	-47	9.3	40.9%
BF	3.0%	57.8%	3.1%	60.7%	360	474	483	0.825	-9	240	21	-47	9.3	38.3%
BG	3.1%	60.9%	3.1%	63.7%	360	467	483	0.825	-16	250	29	-47	9.3	35.5%
BH	0.0%	60.9%	0.1%	63.8%	360	457	483	0.826	-26	260	34	-48	8.3	35.5%
BI	2.4%	63.2%	2.3%	66.1%	360	457	483	0.826	-26	260	34	-48	8.3	33.5%
BJ	4.9%	68.1%	4.9%	71.0%	360	447	483	0.826	-36	270	41	-48	8.3	29.2%
BK	0.9%	69.0%	0.8%	71.7%	360	442	482	0.825	-40	270	51	-48	8.3	28.5%
BL	4.3%	73.3%	4.2%	75.9%	360	442	482	0.825	-40	270	51	-48	8.3	24.9%
BM	5.3%	78.6%	5.1%	81.0%	360	437	480	0.825	-43	280	51	-50	6.3	20.3%
BN	4.9%	83.5%	4.5%	85.5%	400	419	470	0.824	-51	280	55	-59	-2.5	16.5%
BO	2.1%	85.7%	1.9%	87.4%	400	420	469	0.824	-49	280	57	-60	-3.5	14.9%
BP	2.7%	88.3%	2.5%	89.9%	400	420	469	0.824	-49	280	57	-60	-3.5	12.8%
BQ	1.6%	89.9%	1.4%	91.3%	400	418	469	0.825	-51	280	59	-60	-3.5	11.6%
BR	1.2%	91.1%	1.1%	92.4%	400	418	470	0.825	-52	270	59	-60	-3.5	10.8%
BS	2.4%	93.5%	2.1%	94.5%	400	430	470	0.825	-40	270	59	-59	-2.5	9.0%
BT	0.2%	93.7%	0.3%	94.8%	400	433	471	0.825	-38	270	59	-59	-2.5	8.8%
BU	1.5%	95.2%	1.3%	96.2%	400	433	471	0.825	-38	270	58	-59	-2.5	7.7%
BV	0.1%	95.3%	0.1%	96.3%	400	442	472	0.825	-30	270	56	-58	-1.5	7.7%
BW	1.3%	96.6%	1.3%	97.6%	400	442	472	0.825	-30	270	56	-58	-1.5	6.7%
BX	0.1%	96.7%	0.1%	97.7%	400	436	472	0.826	-36	270	55	-57	-0.5	6.6%
BY	0.3%	97.0%	0.3%	98.0%	400	436	473	0.826	-37	270	55	-57	-0.5	6.4%
BZ	0.0%	97.0%	0.1%	98.1%										5.2%
LDG	3.0%	100.0%	1.9%	100.0%										

April 85% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-20					
AA	2.9%	2.9%	2.2%	2.2%	300	469	496	0.826	-27	250	33	-36	8.4	94.7%
AB	0.2%	3.1%	0.2%	2.4%	300	471	496	0.826	-25	260	34	-35	9.4	94.4%
AC	0.9%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	260	34	-35	9.4	93.4%
AD	0.6%	4.6%	0.6%	3.9%	300	473	496	0.826	-23	250	35	-35	9.4	92.7%
AE	2.8%	7.3%	2.9%	6.9%	300	475	497	0.825	-22	250	35	-34	10.4	89.5%
AF	0.3%	7.7%	0.3%	7.2%	300	476	498	0.825	-22	250	33	-33	11.4	89.1%
AG	0.7%	8.4%	0.8%	7.9%	300	477	498	0.825	-21	250	32	-33	11.4	88.2%
AH	0.1%	8.5%	0.2%	8.1%	300	477	498	0.825	-21	260	31	-33	11.4	88.1%
AI	1.2%	9.7%	1.2%	9.3%	300	479	499	0.825	-20	260	29	-32	12.4	86.8%
AJ	1.3%	10.9%	1.4%	10.6%	300	481	499	0.824	-18	260	25	-32	12.4	85.3%
AK	0.7%	11.7%	0.8%	11.4%	300	483	499	0.824	-16	260	21	-32	12.4	84.5%
AL	0.1%	11.8%	0.1%	11.5%	300	484	499	0.824	-15	260	20	-32	12.4	84.3%
AM	1.6%	13.4%	1.7%	13.2%	320	478	494	0.825	-16	270	20	-37	11.4	82.6%
AN	1.6%	15.0%	1.6%	14.8%	320	480	494	0.825	-14	270	16	-36	12.4	80.8%
AO	1.1%	16.0%	1.2%	16.0%	320	483	495	0.825	-12	270	13	-36	12.4	79.6%
AP	1.3%	17.3%	1.3%	17.3%	320	486	495	0.825	-9	270	12	-36	12.4	78.2%
AQ	4.5%	21.8%	4.8%	22.1%	320	488	496	0.825	-8	270	9	-36	12.4	73.4%
AR	4.5%	26.2%	4.8%	26.9%	320	493	496	0.825	-3	290	3	-35	13.4	68.5%
AS	0.5%	26.8%	0.6%	27.5%	340	494	489	0.825	5	70	9	-41	11.3	68.0%
AT	2.1%	28.9%	2.3%	29.8%	340	494	489	0.825	5	70	9	-41	11.3	65.8%
AU	1.8%	30.7%	2.0%	31.8%	340	494	489	0.825	5	70	9	-41	11.3	64.0%
AV	4.5%	35.2%	4.9%	36.7%	340	499	489	0.824	10	80	14	-41	11.3	59.4%
AW	4.6%	39.7%	4.9%	41.6%	360	495	482	0.821	13	90	16	-46	10.3	55.0%
AX	4.5%	44.2%	4.9%	46.5%	360	496	482	0.821	14	90	16	-46	10.3	50.8%
AY	3.2%	47.4%	3.3%	49.8%	360	493	483	0.822	10	110	10	-46	10.3	47.8%
AZ	1.7%	49.1%	2.0%	51.8%	360	493	483	0.822	10	110	10	-46	10.3	46.3%
BA	1.2%	50.3%	1.3%	53.1%	360	487	483	0.823	4	160	5	-46	10.3	45.2%
BB	0.6%	50.9%	0.6%	53.7%	360	484	483	0.824	1	210	6	-46	10.3	44.6%
BC	0.5%	51.4%	0.6%	54.3%	360	482	483	0.824	-1	230	8	-46	10.3	44.1%
BD	1.6%	53.0%	1.6%	55.9%	360	479	483	0.824	-4	240	12	-46	10.3	42.7%
BE	1.6%	54.6%	1.6%	57.6%	360	475	484	0.825	-9	250	17	-47	9.3	41.2%
BF	3.0%	57.6%	3.1%	60.7%	360	469	484	0.825	-15	250	24	-47	9.3	38.6%
BG	3.1%	60.7%	3.1%	63.7%	360	461	484	0.825	-23	260	32	-47	9.3	35.8%
BH	0.0%	60.7%	0.1%	63.8%	360	452	484	0.826	-32	270	37	-47	9.3	35.8%
BI	2.3%	63.0%	2.3%	66.1%	360	452	484	0.826	-32	270	37	-47	9.3	33.8%
BJ	5.0%	68.0%	4.9%	71.0%	360	442	483	0.826	-41	270	46	-47	9.3	29.4%
BK	0.9%	68.9%	0.8%	71.7%	380	433	477	0.825	-44	270	59	-52	4.5	28.7%
BL	4.4%	73.2%	4.2%	75.9%	380	433	477	0.825	-44	270	59	-52	4.5	25.0%
BM	5.4%	78.6%	5.1%	81.0%	380	429	477	0.826	-48	270	61	-54	2.5	20.6%
BN	5.0%	83.6%	4.5%	85.5%	400	418	471	0.824	-53	270	61	-58	-1.5	16.6%
BO	2.0%	85.7%	1.9%	87.4%	400	419	471	0.825	-52	270	64	-59	-2.5	15.1%
BP	2.8%	88.4%	2.5%	89.9%	400	419	471	0.825	-52	270	64	-59	-2.5	13.0%
BQ	1.5%	89.9%	1.4%	91.3%	400	417	471	0.825	-54	270	66	-59	-2.5	11.8%
BR	1.3%	91.2%	1.1%	92.4%	400	417	471	0.825	-54	270	66	-59	-2.5	10.9%
BS	2.2%	93.4%	2.1%	94.5%	400	432	471	0.825	-39	270	65	-58	-1.5	9.2%
BT	0.2%	93.6%	0.3%	94.8%	400	430	472	0.825	-42	270	63	-57	-0.5	9.0%
BU	1.5%	95.1%	1.3%	96.2%	400	430	472	0.825	-42	270	63	-57	-0.5	7.9%
BV	0.1%	95.2%	0.1%	96.3%	400	435	473	0.826	-38	270	61	-56	0.5	7.9%
BW	1.4%	96.6%	1.3%	97.6%	400	435	473	0.826	-38	270	61	-56	0.5	6.8%
BX	0.1%	96.7%	0.1%	97.7%	400	429	474	0.826	-45	270	60	-56	0.5	6.8%
BY	0.3%	97.0%	0.3%	98.0%	400	430	474	0.826	-44	270	60	-56	0.5	6.5%
BZ	0.0%	97.0%	0.1%	98.1%										6.5%
LDG	3.0%	100.0%	1.9%	100.0%										5.3%

October 50% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-15					
AA	2.9%	2.9%	2.2%	2.2%	300	458	495	0.826	-37	270	41	-36	8.4	94.0%
AB	0.2%	3.1%	0.2%	2.4%	300	460	495	0.826	-35	270	40	-36	8.4	93.5%
AC	0.9%	4.0%	0.9%	3.3%	300	458	496	0.826	-38	270	40	-36	8.4	92.5%
AD	0.6%	4.6%	0.6%	3.9%	300	463	496	0.826	-33	270	39	-36	8.4	91.8%
AE	2.9%	7.5%	2.9%	6.9%	300	467	496	0.825	-29	270	35	-35	9.4	88.5%
AF	0.3%	7.8%	0.3%	7.2%	300	471	497	0.825	-26	270	31	-35	9.4	88.1%
AG	0.6%	8.5%	0.8%	7.9%	300	472	497	0.825	-25	270	31	-34	10.4	87.4%
AH	0.2%	8.7%	0.2%	8.1%	300	472	497	0.825	-25	270	30	-34	10.4	87.1%
AI	1.2%	9.9%	1.2%	9.3%	300	474	497	0.825	-23	270	29	-34	10.4	85.8%
AJ	1.3%	11.2%	1.4%	10.6%	300	476	497	0.825	-21	260	27	-34	10.4	84.3%
AK	0.8%	11.9%	0.8%	11.4%	300	477	497	0.824	-20	260	26	-33	11.4	83.5%
AL	0.1%	12.0%	0.1%	11.5%	300	478	497	0.824	-19	260	25	-33	11.4	83.4%
AM	1.6%	13.7%	1.7%	13.2%	300	479	497	0.824	-18	260	24	-33	11.4	81.6%
AN	1.6%	15.3%	1.6%	14.8%	300	478	497	0.824	-19	270	22	-33	11.4	79.8%
AO	1.1%	16.3%	1.2%	16.0%	300	479	498	0.823	-19	270	20	-33	11.4	78.6%
AP	1.3%	17.6%	1.3%	17.3%	300	484	498	0.823	-14	270	18	-32	12.4	77.1%
AQ	4.6%	22.3%	4.8%	22.1%	320	479	494	0.825	-15	290	15	-37	11.4	72.1%
AR	4.6%	26.9%	4.8%	26.9%	320	486	494	0.825	-8	310	8	-37	11.4	67.2%
AS	0.5%	27.4%	0.6%	27.5%	340	484	488	0.823	-4	330	4	-42	10.3	66.7%
AT	2.2%	29.6%	2.3%	29.8%	340	484	488	0.823	-4	330	4	-42	10.3	64.5%
AU	1.9%	31.5%	2.0%	31.8%	340	484	488	0.823	-4	330	4	-42	10.3	62.6%
AV	4.6%	36.1%	4.9%	36.7%	340	488	488	0.824	0	20	2	-42	10.3	58.0%
AW	4.5%	40.6%	4.9%	41.6%	340	489	489	0.825	0	30	3	-42	10.3	53.5%
AX	4.7%	45.4%	4.9%	46.5%	360	481	482	0.822	-1	10	1	-47	9.3	49.1%
AY	3.2%	48.6%	3.3%	49.8%	360	481	482	0.823	-1	350	1	-47	9.3	46.2%
AZ	1.9%	50.5%	2.0%	51.8%	360	481	482	0.823	-1	350	1	-47	9.3	44.4%
BA	1.2%	51.7%	1.3%	53.1%	360	480	482	0.824	-2	300	2	-48	8.3	43.3%
BB	0.5%	52.3%	0.6%	53.7%	360	480	482	0.824	-2	290	2	-48	8.3	42.9%
BC	0.6%	52.9%	0.6%	54.3%	360	480	482	0.824	-2	290	3	-48	8.3	42.3%
BD	1.5%	54.4%	1.6%	55.9%	360	479	482	0.824	-3	280	4	-48	8.3	40.9%
BE	1.6%	56.0%	1.6%	57.6%	360	478	482	0.825	-4	280	5	-48	8.3	39.5%
BF	3.0%	59.0%	3.1%	60.7%	360	475	482	0.825	-7	280	8	-48	8.3	36.8%
BG	3.0%	62.0%	3.1%	63.7%	360	470	482	0.825	-12	280	14	-48	8.3	34.2%
BH	0.1%	62.2%	0.1%	63.8%	360	465	482	0.825	-17	280	19	-48	8.3	34.1%
BI	2.3%	64.4%	2.3%	66.1%	360	465	482	0.825	-17	280	19	-48	8.3	32.1%
BJ	4.9%	69.4%	4.9%	71.0%	380	456	475	0.823	-19	280	20	-54	2.5	28.0%
BK	0.3%	69.7%	0.8%	71.7%	380	461	476	0.824	-15	280	18	-54	2.5	27.7%
BL	4.6%	74.3%	4.2%	75.9%	380	461	476	0.824	-15	280	18	-54	2.5	23.9%
BM	5.1%	79.4%	5.1%	81.0%	380	461	476	0.825	-15	280	18	-54	2.5	19.8%
BN	4.6%	84.0%	4.5%	85.5%	400	451	470	0.822	-19	290	19	-58	-1.5	16.2%
BO	1.9%	85.9%	1.9%	87.4%	400	444	471	0.823	-27	290	28	-58	-1.5	14.8%
BP	2.7%	88.6%	2.5%	89.9%	400	444	471	0.823	-27	290	28	-58	-1.5	12.7%
BQ	1.5%	90.1%	1.4%	91.3%	400	437	471	0.824	-34	280	37	-58	-1.5	11.6%
BR	1.1%	91.2%	1.1%	92.4%	400	434	472	0.825	-38	280	42	-58	-1.5	10.8%
BS	2.3%	93.4%	2.1%	94.5%	400	438	472	0.825	-34	270	48	-58	-1.5	9.1%
BT	0.2%	93.7%	0.3%	94.8%	400	437	472	0.825	-35	270	55	-57	-0.5	9.0%
BU	1.6%	95.3%	1.3%	96.2%	400	437	472	0.825	-35	270	55	-57	-0.5	7.8%
BV	0.1%	95.4%	0.1%	96.3%	400	443	473	0.825	-30	270	59	-57	-0.5	7.7%
BW	1.3%	96.7%	1.3%	97.6%	400	443	473	0.825	-30	270	59	-57	-0.5	6.7%
BX	0.1%	96.8%	0.1%	97.7%	400	435	474	0.826	-39	270	60	-56	0.5	6.7%
BY	0.3%	97.1%	0.3%	98.0%	400	435	474	0.826	-39	270	60	-56	0.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										5.2%
LDG	2.9%	100.0%	1.9%	100.0%										

October 85% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-16					
AA	3.0%	3.0%	2.2%	2.2%	300	455	496	0.826	-41	260	45	-36	8.4	94.6%
AB	0.2%	3.2%	0.2%	2.4%	300	457	496	0.826	-39	270	44	-36	8.4	94.3%
AC	0.9%	4.1%	0.9%	3.3%	300	455	496	0.826	-41	270	43	-36	8.4	93.3%
AD	0.6%	4.7%	0.6%	3.9%	300	461	496	0.826	-35	270	42	-35	9.4	92.6%
AE	2.9%	7.6%	2.9%	6.9%	300	465	496	0.825	-31	270	38	-35	9.4	89.2%
AF	0.3%	7.9%	0.3%	7.2%	300	467	497	0.825	-30	270	35	-34	10.4	88.9%
AG	0.8%	8.7%	0.8%	7.9%	300	468	497	0.825	-29	270	34	-34	10.4	88.0%
AH	0.1%	8.8%	0.2%	8.1%	300	468	497	0.825	-29	270	33	-34	10.4	87.9%
AI	1.2%	10.0%	1.2%	9.3%	300	470	497	0.825	-27	270	32	-34	10.4	86.5%
AJ	1.4%	11.4%	1.4%	10.6%	300	472	497	0.825	-25	270	30	-34	10.4	84.8%
AK	0.8%	12.1%	0.8%	11.4%	320	465	492	0.825	-27	270	33	-38	10.4	84.0%
AL	0.1%	12.2%	0.1%	11.5%	320	466	493	0.825	-27	270	32	-38	10.4	83.9%
AM	1.6%	13.8%	1.7%	13.2%	320	468	493	0.825	-25	270	30	-38	10.4	82.1%
AN	1.6%	15.5%	1.6%	14.8%	320	467	493	0.825	-26	270	28	-38	10.4	80.3%
AO	1.2%	16.6%	1.2%	16.0%	320	469	493	0.825	-24	270	26	-38	10.4	79.1%
AP	1.3%	17.9%	1.3%	17.3%	320	474	494	0.825	-20	270	24	-38	10.4	77.7%
AQ	4.6%	22.5%	4.8%	22.1%	320	477	494	0.825	-17	280	18	-37	11.4	72.7%
AR	4.6%	27.1%	4.8%	26.9%	320	484	494	0.825	-10	290	10	-37	11.4	67.8%
AS	0.5%	27.7%	0.6%	27.5%	320	492	493	0.824	-1	320	1	-37	11.4	67.3%
AT	2.1%	29.8%	2.3%	29.8%	320	492	493	0.824	-1	320	1	-37	11.4	65.0%
AU	1.8%	31.7%	2.0%	31.8%	320	492	493	0.824	-1	320	1	-37	11.4	63.1%
AV	4.6%	36.3%	4.9%	36.7%	340	489	488	0.824	1	180	1	-42	10.3	58.5%
AW	4.5%	40.8%	4.9%	41.6%	340	491	489	0.825	2	80	3	-42	10.3	54.1%
AX	4.6%	45.4%	4.9%	46.5%	340	493	489	0.825	4	80	6	-42	10.3	49.6%
AY	3.1%	48.5%	3.3%	49.8%	340	492	488	0.824	4	80	4	-42	10.3	46.6%
AZ	1.8%	50.3%	2.0%	51.8%	340	492	488	0.824	4	80	4	-42	10.3	44.9%
BA	1.3%	51.6%	1.3%	53.1%	360	480	482	0.824	-2	270	3	-47	9.3	43.7%
BB	0.5%	52.1%	0.6%	53.7%	360	479	482	0.824	-3	270	5	-47	9.3	43.2%
BC	0.6%	52.8%	0.6%	54.3%	360	478	482	0.824	-4	270	5	-48	8.3	42.7%
BD	1.5%	54.3%	1.6%	55.9%	360	477	482	0.824	-5	270	6	-48	8.3	41.3%
BE	1.6%	55.9%	1.6%	57.6%	360	476	482	0.825	-6	270	8	-48	8.3	39.9%
BF	3.0%	58.9%	3.1%	60.7%	360	474	483	0.825	-9	260	11	-48	8.3	37.2%
BG	3.0%	61.9%	3.1%	63.7%	360	469	482	0.825	-13	270	17	-48	8.3	34.6%
BH	0.1%	62.0%	0.1%	63.8%	360	463	482	0.825	-19	270	22	-48	8.3	34.5%
BI	2.3%	64.3%	2.3%	66.1%	360	463	482	0.825	-19	270	22	-48	8.3	32.4%
BJ	4.9%	69.2%	4.9%	71.0%	380	455	476	0.825	-21	270	24	-53	3.5	28.3%
BK	0.4%	69.6%	0.8%	71.7%	380	460	476	0.824	-16	270	22	-54	2.5	27.9%
BL	4.5%	74.1%	4.2%	75.9%	380	459	476	0.825	-17	270	24	-54	2.5	24.2%
BM	5.2%	79.3%	5.1%	81.0%	380	459	476	0.825	-17	270	24	-54	2.5	20.0%
BN	4.6%	83.9%	4.5%	85.5%	400	448	470	0.823	-22	280	25	-58	-1.5	16.4%
BO	1.9%	85.8%	1.9%	87.4%	400	443	471	0.823	-28	280	33	-58	-1.5	14.9%
BP	2.7%	88.5%	2.5%	89.9%	400	443	471	0.823	-28	280	33	-58	-1.5	12.9%
BQ	1.5%	90.0%	1.4%	91.3%	400	436	472	0.824	-36	270	42	-57	-0.5	11.7%
BR	1.2%	91.2%	1.1%	92.4%	400	433	472	0.825	-39	270	47	-57	-0.5	10.8%
BS	2.1%	93.3%	2.1%	94.5%	400	440	473	0.825	-33	270	54	-57	-0.5	9.2%
BT	0.2%	93.6%	0.3%	94.8%	400	433	473	0.825	-40	270	61	-56	0.5	9.1%
BU	1.6%	95.2%	1.3%	96.2%	400	433	473	0.825	-40	270	61	-56	0.5	7.9%
BV	0.1%	95.3%	0.1%	96.3%	400	435	474	0.825	-39	270	65	-56	0.5	7.8%
BW	1.3%	96.6%	1.3%	97.6%	400	435	474	0.825	-39	270	65	-56	0.5	6.8%
BX	0.1%	96.7%	0.1%	97.7%	400	427	475	0.826	-48	270	66	-55	1.5	6.8%
BY	0.4%	97.1%	0.3%	98.0%	400	427	475	0.826	-48	270	66	-55	1.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										6.4%
LDG	2.9%	100.0%	1.9%	100.0%										5.3%

November 50% Route 3

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-27					
AA	2.8%	2.8%	2.2%	2.2%	300	468	496	0.826	-28	280	28	-36	8.4	96.1%
AB	0.1%	2.9%	0.2%	2.4%	300	469	496	0.826	-27	290	28	-35	9.4	95.7%
AC	0.9%	3.9%	0.9%	3.3%	300	468	496	0.826	-28	290	28	-35	9.4	94.6%
AD	0.5%	4.4%	0.6%	3.9%	300	469	496	0.826	-27	290	28	-35	9.4	94.0%
AE	2.8%	7.2%	2.9%	6.9%	300	471	497	0.825	-26	290	27	-35	9.4	90.6%
AF	0.3%	7.6%	0.3%	7.2%	300	472	497	0.825	-25	290	26	-34	10.4	90.3%
AG	0.7%	8.3%	0.8%	7.9%	300	472	497	0.825	-25	290	26	-34	10.4	89.4%
AH	0.1%	8.4%	0.2%	8.1%	300	473	497	0.825	-24	290	26	-34	10.4	89.3%
AI	1.2%	9.5%	1.2%	9.3%	300	473	497	0.825	-24	290	25	-34	10.4	87.9%
AJ	1.3%	10.8%	1.4%	10.6%	300	474	497	0.825	-23	290	25	-33	11.4	86.5%
AK	0.8%	11.6%	0.8%	11.4%	300	474	498	0.825	-24	290	24	-33	11.4	85.4%
AL	0.1%	11.8%	0.1%	11.5%	320	466	493	0.825	-27	290	28	-38	10.4	85.3%
AM	1.6%	13.3%	1.7%	13.2%	320	468	493	0.825	-25	290	26	-38	10.4	83.5%
AN	1.6%	14.9%	1.6%	14.8%	320	469	493	0.825	-24	290	25	-38	10.4	81.8%
AO	1.0%	15.9%	1.2%	16.0%	320	470	493	0.825	-23	280	24	-38	10.4	80.6%
AP	1.3%	17.2%	1.3%	17.3%	320	473	493	0.825	-20	280	23	-38	10.4	79.2%
AQ	4.6%	21.8%	4.8%	22.1%	320	475	494	0.825	-19	280	19	-37	11.4	74.2%
AR	4.5%	26.3%	4.8%	26.9%	320	479	494	0.825	-15	290	15	-37	11.4	69.2%
AS	0.5%	26.9%	0.6%	27.5%	340	475	488	0.824	-13	310	13	-42	10.3	68.7%
AT	2.2%	29.1%	2.3%	29.8%	340	475	488	0.824	-13	310	13	-42	10.3	66.4%
AU	1.9%	31.0%	2.0%	31.8%	340	475	488	0.824	-13	310	13	-42	10.3	64.5%
AV	4.5%	35.5%	4.9%	36.7%	340	480	488	0.824	-8	330	9	-42	10.3	59.9%
AW	4.6%	40.1%	4.9%	41.6%	340	481	489	0.825	-8	330	8	-42	10.3	55.3%
AX	4.6%	44.7%	4.9%	46.5%	340	479	489	0.825	-10	300	10	-42	10.3	50.7%
AY	3.5%	48.2%	3.3%	49.8%	360	466	482	0.824	-16	280	17	-47	9.3	47.5%
AZ	1.7%	49.8%	2.0%	51.8%	360	466	482	0.824	-16	280	17	-47	9.3	45.9%
BA	1.3%	51.1%	1.3%	53.1%	360	467	483	0.825	-16	270	21	-47	9.3	44.8%
BB	0.5%	51.6%	0.6%	53.7%	360	466	483	0.825	-17	270	23	-47	9.3	44.3%
BC	0.6%	52.3%	0.6%	54.3%	360	465	483	0.825	-18	270	24	-47	9.3	43.7%
BD	1.6%	53.8%	1.6%	55.9%	360	462	483	0.825	-21	260	27	-48	8.3	42.3%
BE	1.6%	55.4%	1.6%	57.6%	360	459	483	0.825	-24	260	32	-48	8.3	40.8%
BF	3.0%	58.4%	3.1%	60.7%	360	453	483	0.826	-30	270	38	-48	8.3	38.1%
BG	3.1%	61.6%	3.1%	63.7%	360	448	483	0.826	-35	270	43	-48	8.3	35.3%
BH	0.1%	61.7%	0.1%	63.8%	360	442	482	0.826	-40	270	44	-48	8.3	35.2%
BI	2.3%	64.0%	2.3%	66.1%	360	442	482	0.826	-40	270	44	-48	8.3	33.1%
BJ	4.9%	68.9%	4.9%	71.0%	360	443	482	0.826	-39	280	42	-49	7.3	28.9%
BK	0.6%	69.6%	0.8%	71.7%	360	448	481	0.824	-33	280	38	-49	7.3	28.3%
BL	4.4%	74.0%	4.2%	75.9%	360	448	481	0.824	-33	280	38	-49	7.3	24.5%
BM	5.1%	79.1%	5.1%	81.0%	380	442	475	0.825	-33	290	36	-55	1.5	20.2%
BN	4.7%	83.8%	4.5%	85.5%	400	431	470	0.824	-39	290	40	-59	-2.5	16.5%
BO	2.0%	85.8%	1.9%	87.4%	400	423	470	0.824	-47	280	52	-59	-2.5	15.0%
BP	2.6%	88.5%	2.5%	89.9%	400	423	470	0.824	-47	280	52	-59	-2.5	13.0%
BQ	1.6%	90.0%	1.4%	91.3%	400	416	470	0.825	-54	280	60	-60	-3.5	11.8%
BR	1.2%	91.2%	1.1%	92.4%	400	413	470	0.826	-57	280	64	-60	-3.5	10.9%
BS	2.3%	93.5%	2.1%	94.5%	400	422	470	0.826	-48	270	68	-59	-2.5	9.2%
BT	0.3%	93.8%	0.3%	94.8%	400	421	471	0.826	-50	270	73	-59	-2.5	8.9%
BU	1.5%	95.3%	1.3%	96.2%	400	421	471	0.826	-50	270	73	-59	-2.5	7.8%
BV	0.1%	95.4%	0.1%	96.3%	400	430	472	0.826	-42	270	74	-58	-1.5	7.8%
BW	1.4%	96.7%	1.3%	97.6%	400	430	472	0.826	-42	270	74	-58	-1.5	6.7%
BX	0.1%	96.9%	0.1%	97.7%	400	421	472	0.826	-51	270	74	-58	-1.5	6.7%
BY	0.3%	97.2%	0.3%	98.0%	400	421	472	0.826	-51	270	74	-58	-1.5	6.4%
BZ	0.0%	97.2%	0.1%	98.1%										5.2%
LDG	2.8%	100.0%	1.9%	100.0%										

November 85% Route 3														
Waypoint De-identified	Time (% of Total)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-28					
AA	2.8%	2.8%	2.2%	2.2%	300	466	496	0.826	-30	270	32	-35	9.4	96.0%
AB	0.1%	3.0%	0.2%	2.4%	300	467	497	0.826	-30	280	32	-35	9.4	95.5%
AC	0.9%	3.9%	0.9%	3.3%	300	465	497	0.826	-32	280	32	-35	9.4	94.4%
AD	0.5%	4.4%	0.6%	3.9%	300	468	497	0.826	-29	280	31	-35	9.4	93.8%
AE	2.8%	7.3%	2.9%	6.9%	300	470	497	0.825	-27	280	30	-34	10.4	90.5%
AF	0.3%	7.6%	0.3%	7.2%	300	471	497	0.825	-26	280	29	-34	10.4	90.1%
AG	0.7%	8.3%	0.8%	7.9%	300	471	497	0.825	-26	280	29	-34	10.4	89.2%
AH	0.1%	8.4%	0.2%	8.1%	300	472	497	0.825	-25	280	28	-34	10.4	89.1%
AI	1.2%	9.6%	1.2%	9.3%	300	472	497	0.825	-25	280	28	-34	10.4	87.8%
AJ	1.4%	11.0%	1.4%	10.6%	300	473	498	0.825	-25	280	28	-33	11.4	86.1%
AK	0.7%	11.7%	0.8%	11.4%	320	465	493	0.825	-28	280	30	-38	10.4	85.3%
AL	0.1%	11.8%	0.1%	11.5%	320	465	493	0.825	-28	280	30	-38	10.4	85.2%
AM	1.7%	13.5%	1.7%	13.2%	320	467	493	0.825	-26	280	29	-38	10.4	83.3%
AN	1.5%	15.0%	1.6%	14.8%	320	467	493	0.825	-26	280	28	-38	10.4	81.7%
AO	1.2%	16.1%	1.2%	16.0%	320	468	493	0.825	-25	280	27	-38	10.4	80.4%
AP	1.3%	17.4%	1.3%	17.3%	320	472	494	0.825	-22	270	26	-37	11.4	79.0%
AQ	4.5%	22.0%	4.8%	22.1%	320	474	494	0.826	-20	270	22	-37	11.4	74.1%
AR	4.6%	26.6%	4.8%	26.9%	320	478	494	0.825	-16	280	18	-37	11.4	69.1%
AS	0.5%	27.1%	0.6%	27.5%	340	474	488	0.824	-14	290	14	-42	10.3	68.6%
AT	2.2%	29.3%	2.3%	29.8%	340	474	488	0.824	-14	290	14	-42	10.3	66.3%
AU	1.9%	31.2%	2.0%	31.8%	340	474	488	0.824	-14	290	14	-42	10.3	64.4%
AV	4.5%	35.8%	4.9%	36.7%	340	479	488	0.824	-9	310	10	-42	10.3	59.8%
AW	4.6%	40.4%	4.9%	41.6%	340	480	489	0.825	-9	300	8	-42	10.3	55.3%
AX	4.6%	45.1%	4.9%	46.5%	340	478	489	0.825	-11	280	11	-42	10.3	50.7%
AY	3.6%	48.7%	3.3%	49.8%	360	465	482	0.824	-17	270	19	-42	14.3	47.4%
AZ	1.6%	50.2%	2.0%	51.8%	360	465	482	0.824	-17	270	19	-42	14.3	45.9%
BA	1.3%	51.5%	1.3%	53.1%	360	464	483	0.825	-19	270	24	-47	9.3	44.7%
BB	0.5%	52.0%	0.6%	53.7%	360	462	483	0.825	-21	270	26	-47	9.3	44.3%
BC	0.6%	52.7%	0.6%	54.3%	360	461	483	0.825	-22	270	27	-47	9.3	43.7%
BD	1.7%	54.4%	1.6%	55.9%	360	458	483	0.825	-25	270	31	-47	9.3	42.2%
BE	1.6%	55.9%	1.6%	57.6%	360	454	483	0.825	-29	270	36	-48	8.3	40.7%
BF	3.2%	59.1%	3.1%	60.7%	360	448	483	0.826	-35	270	42	-48	8.3	37.9%
BG	3.1%	62.2%	3.1%	63.7%	360	444	483	0.826	-39	270	47	-48	8.3	35.2%
BH	0.1%	62.3%	0.1%	63.8%	360	441	483	0.826	-42	270	47	-48	8.3	35.1%
BI	5.1%	64.6%	2.3%	66.1%	360	441	483	0.826	-42	270	47	-48	8.3	33.1%
BJ	0.6%	69.7%	4.9%	71.0%	360	440	482	0.825	-42	270	46	-48	8.3	28.7%
BK	4.3%	70.3%	0.8%	71.7%	360	447	481	0.825	-34	270	43	-49	7.3	28.2%
BL	5.3%	74.6%	4.2%	75.9%	360	447	481	0.825	-34	270	43	-49	7.3	24.5%
BM	4.7%	79.9%	5.1%	81.0%	380	442	476	0.826	-34	280	40	-54	2.5	20.2%
BN	2.0%	84.7%	4.5%	85.5%	400	429	470	0.824	-41	280	45	-59	-2.5	16.5%
BO	2.7%	86.7%	1.9%	87.4%	400	422	470	0.824	-48	280	56	-59	-2.5	15.0%
BP	1.5%	89.4%	2.5%	89.9%	400	422	470	0.824	-48	280	56	-59	-2.5	12.9%
BQ	1.3%	90.9%	1.4%	91.3%	400	415	471	0.825	-56	270	66	-59	-2.5	11.8%
BR	2.2%	92.1%	1.1%	92.4%	400	412	471	0.826	-59	270	70	-59	-2.5	10.8%
BS	0.3%	94.4%	2.1%	94.5%	400	424	471	0.826	-47	270	74	-59	-2.5	9.2%
BT	1.5%	94.7%	0.3%	94.8%	400	422	472	0.826	-50	270	79	-58	-1.5	8.9%
BU	0.1%	96.2%	1.3%	96.2%	400	422	472	0.826	-50	270	79	-58	-1.5	7.8%
BV	1.4%	96.3%	0.1%	96.3%	400	422	472	0.826	-50	270	79	-58	-1.5	7.8%
BW	0.1%	97.6%	1.3%	97.6%	400	426	473	0.826	-47	270	81	-57	-0.5	6.8%
BX	0.3%	97.7%	0.1%	97.7%	400	412	473	0.826	-61	270	81	-57	-0.5	6.7%
BY	0.0%	98.1%	0.3%	98.0%	400	412	474	0.826	-62	270	81	-57	-0.5	6.4%
BZ	#REF!	98.1%	0.1%	98.1%										6.4%
LDG	2.8%	100.9%	1.9%	100.0%										5.2%

December 50% Route 3														
Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-26					
AA	2.8%	2.8%	2.2%	2.2%	300	466	498	0.826	-32	270	33	-34	10.4	95.9%
AB	0.1%	2.9%	0.2%	2.4%	300	467	498	0.826	-31	280	33	-33	11.4	95.6%
AC	0.9%	3.9%	0.9%	3.3%	300	466	498	0.826	-32	280	33	-33	11.4	94.5%
AD	0.5%	4.4%	0.6%	3.9%	300	468	498	0.826	-30	280	32	-33	11.4	93.8%
AE	2.8%	7.2%	2.9%	6.9%	300	471	499	0.825	-28	280	30	-32	12.4	90.5%
AF	0.3%	7.6%	0.3%	7.2%	300	473	499	0.825	-26	280	28	-32	12.4	90.1%
AG	0.7%	8.3%	0.8%	7.9%	300	474	500	0.825	-26	280	27	-32	12.4	89.3%
AH	0.1%	8.4%	0.2%	8.1%	300	475	500	0.825	-25	280	27	-32	12.4	89.1%
AI	1.2%	9.5%	1.2%	9.3%	300	476	500	0.825	-24	280	26	-31	13.4	87.8%
AJ	1.3%	10.8%	1.4%	10.6%	300	478	500	0.824	-22	280	24	-31	13.4	86.3%
AK	0.7%	11.5%	0.8%	11.4%	300	479	500	0.824	-21	280	22	-31	13.4	85.4%
AL	0.2%	11.8%	0.1%	11.5%	320	473	495	0.825	-22	290	22	-36	12.4	85.1%
AM	1.6%	13.3%	1.7%	13.2%	320	476	495	0.825	-19	290	19	-36	12.4	83.4%
AN	1.5%	14.8%	1.6%	14.8%	320	479	495	0.825	-16	300	16	-36	12.4	81.7%
AO	1.0%	15.8%	1.2%	16.0%	320	481	495	0.825	-14	310	13	-36	12.4	80.6%
AP	1.3%	17.1%	1.3%	17.3%	320	484	495	0.825	-11	320	11	-36	12.4	79.2%
AQ	4.4%	21.5%	4.8%	22.1%	320	490	494	0.825	-4	350	8	-37	11.4	74.2%
AR	4.5%	26.0%	4.8%	26.9%	340	487	487	0.822	0	30	11	-42	10.3	69.5%
AS	0.5%	26.5%	0.6%	27.5%	340	490	487	0.823	3	50	10	-42	10.3	69.0%
AT	2.1%	28.6%	2.3%	29.8%	340	490	487	0.823	3	50	10	-42	10.3	66.8%
AU	1.8%	30.4%	2.0%	31.8%	340	490	487	0.823	3	50	10	-42	10.3	65.0%
AV	4.5%	34.9%	4.9%	36.7%	340	488	488	0.824	0	40	6	-42	10.3	60.4%
AW	4.5%	39.5%	4.9%	41.6%	340	484	488	0.825	-4	320	5	-42	10.3	55.8%
AX	4.7%	44.2%	4.9%	46.5%	360	471	481	0.822	-10	280	12	-47	9.3	51.3%
AY	3.6%	47.7%	3.3%	49.8%	360	465	482	0.824	-17	270	18	-47	9.3	48.0%
AZ	1.6%	49.3%	2.0%	51.8%	360	465	482	0.824	-17	270	18	-47	9.3	46.5%
BA	1.3%	50.6%	1.3%	53.1%	360	463	482	0.825	-19	270	23	-48	8.3	45.3%
BB	0.5%	51.1%	0.6%	53.7%	360	462	482	0.825	-20	270	25	-48	8.3	44.8%
BC	0.6%	51.7%	0.6%	54.3%	360	461	482	0.825	-21	270	26	-48	8.3	44.3%
BD	1.7%	53.4%	1.6%	55.9%	360	460	482	0.825	-22	270	27	-48	8.3	42.7%
BE	1.6%	55.0%	1.6%	57.6%	360	458	483	0.825	-25	270	30	-48	8.3	41.3%
BF	3.0%	58.0%	3.1%	60.7%	360	454	483	0.825	-29	270	34	-48	8.3	38.5%
BG	3.1%	61.2%	3.1%	63.7%	360	449	482	0.826	-33	280	38	-48	8.3	35.7%
BH	0.0%	61.2%	0.1%	63.8%	360	444	482	0.826	-38	280	40	-48	8.3	35.7%
BI	2.3%	63.5%	2.3%	66.1%	360	444	482	0.826	-38	280	40	-48	8.3	33.7%
BJ	5.0%	68.5%	4.9%	71.0%	360	443	482	0.825	-39	280	40	-49	7.3	29.3%
BK	0.5%	69.0%	0.8%	71.7%	360	447	481	0.824	-34	290	38	-49	7.3	28.8%
BL	4.4%	73.5%	4.2%	75.9%	360	447	481	0.824	-34	290	38	-49	7.3	25.0%
BM	5.2%	78.7%	5.1%	81.0%	380	437	476	0.825	-39	290	41	-54	2.5	20.6%
BN	4.8%	83.5%	4.5%	85.5%	400	422	470	0.824	-48	290	51	-58	-1.5	16.8%
BO	2.0%	85.5%	1.9%	87.4%	400	414	471	0.825	-57	280	66	-59	-2.5	15.3%
BP	2.8%	88.4%	2.5%	89.9%	400	414	471	0.825	-57	280	66	-59	-2.5	13.1%
BQ	1.6%	89.9%	1.4%	91.3%	400	405	471	0.826	-66	270	77	-58	-1.5	11.9%
BR	1.2%	91.1%	1.1%	92.4%	400	402	472	0.826	-70	270	80	-58	-1.5	11.0%
BS	2.3%	93.4%	2.1%	94.5%	400	414	472	0.826	-58	270	84	-58	-1.5	9.3%
BT	0.4%	93.8%	0.3%	94.8%	400	412	473	0.826	-61	270	88	-57	-0.5	9.0%
BU	1.5%	95.3%	1.3%	96.2%	400	412	473	0.826	-61	270	88	-57	-0.5	7.9%
BV	0.1%	95.4%	0.1%	96.3%	400	422	474	0.826	-52	270	88	-56	0.5	7.8%
BW	1.4%	96.7%	1.3%	97.6%	400	422	474	0.826	-52	270	88	-56	0.5	6.8%
BX	0.1%	96.9%	0.1%	97.7%	400	412	474	0.826	-62	270	88	-56	0.5	6.7%
BY	0.3%	97.2%	0.3%	98.0%	400	412	474	0.826	-62	270	88	-56	0.5	6.4%
BZ	0.1%	97.3%	0.1%	98.1%	400	412	474	0.826	-62	270	88	-56	0.5	6.4%
LDG	2.7%	100.0%	1.9%	100.0%										5.2%

December 85% Route 3

Waypoint De-identified	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									-28					
AA	2.8%	2.8%	2.2%	2.2%	300	463	498	0.826	-35	270	38	-34	10.4	94.7%
AB	0.2%	3.0%	0.2%	2.4%	300	464	498	0.826	-34	270	37	-33	11.4	94.4%
AC	0.8%	3.9%	0.9%	3.3%	300	463	499	0.826	-36	280	37	-33	11.4	93.4%
AD	0.6%	4.5%	0.6%	3.9%	300	466	499	0.826	-33	280	37	-33	11.4	92.7%
AE	2.7%	7.2%	2.9%	6.9%	300	469	499	0.825	-30	280	34	-33	11.4	89.5%
AF	0.3%	7.5%	0.3%	7.2%	300	471	500	0.825	-29	280	31	-32	12.4	89.2%
AG	0.7%	8.3%	0.8%	7.9%	300	472	500	0.825	-28	280	31	-32	12.4	88.3%
AH	0.2%	8.5%	0.2%	8.1%	300	473	500	0.825	-27	280	30	-31	13.4	88.1%
AI	1.0%	9.5%	1.2%	9.3%	300	474	500	0.825	-26	280	29	-31	13.4	86.9%
AJ	1.4%	10.9%	1.4%	10.6%	300	476	500	0.825	-24	280	27	-31	13.4	85.3%
AK	0.7%	11.6%	0.8%	11.4%	300	478	500	0.825	-22	280	25	-31	13.4	84.4%
AL	0.1%	11.7%	0.1%	11.5%	320	472	495	0.825	-23	280	25	-36	12.4	84.3%
AM	1.6%	13.3%	1.7%	13.2%	320	474	495	0.825	-21	280	22	-36	12.4	82.5%
AN	1.5%	14.7%	1.6%	14.8%	320	477	495	0.825	-18	290	18	-36	12.4	80.9%
AO	1.2%	15.9%	1.2%	16.0%	320	479	495	0.825	-16	290	15	-36	12.4	79.6%
AP	1.3%	17.2%	1.3%	17.3%	320	483	495	0.825	-12	300	12	-36	12.4	78.3%
AQ	4.4%	21.5%	4.8%	22.1%	320	490	495	0.825	-5	340	6	-36	12.4	73.5%
AR	4.3%	25.8%	4.8%	26.9%	320	498	494	0.824	4	60	9	-36	12.4	68.9%
AS	0.5%	26.4%	0.6%	27.5%	340	493	487	0.823	6	60	11	-42	10.3	68.3%
AT	2.2%	28.6%	2.3%	29.8%	340	493	487	0.823	6	60	11	-42	10.3	66.1%
AU	1.8%	30.3%	2.0%	31.8%	340	493	487	0.823	6	60	11	-42	10.3	64.3%
AV	4.4%	34.7%	4.9%	36.7%	340	492	488	0.824	4	70	7	-42	10.3	59.9%
AW	4.6%	39.3%	4.9%	41.6%	340	483	488	0.825	-5	290	5	-42	10.3	55.4%
AX	4.6%	43.9%	4.9%	46.5%	340	476	488	0.825	-12	270	15	-42	10.3	50.8%
AY	3.6%	47.5%	3.3%	49.8%	360	461	482	0.824	-21	270	24	-48	8.3	47.5%
AZ	1.6%	49.1%	2.0%	51.8%	360	461	482	0.824	-21	270	24	-48	8.3	46.1%
BA	1.3%	50.3%	1.3%	53.1%	360	461	483	0.825	-22	270	28	-48	8.3	44.9%
BB	0.6%	50.9%	0.6%	53.7%	360	459	483	0.825	-24	270	29	-48	8.3	44.4%
BC	0.6%	51.6%	0.6%	54.3%	360	459	483	0.825	-24	270	30	-48	8.3	43.8%
BD	1.6%	53.1%	1.6%	55.9%	360	457	483	0.825	-26	270	31	-48	8.3	42.4%
BE	1.6%	54.7%	1.6%	57.6%	360	455	483	0.825	-28	270	34	-48	8.3	41.0%
BF	3.1%	57.8%	3.1%	60.7%	360	451	483	0.826	-32	270	38	-48	8.3	38.2%
BG	3.0%	60.9%	3.1%	63.7%	360	447	483	0.826	-36	270	43	-48	8.3	35.5%
BH	0.1%	61.0%	0.1%	63.8%	360	441	483	0.826	-42	270	46	-48	8.3	35.4%
BI	2.3%	63.3%	2.3%	66.1%	360	441	483	0.826	-42	270	46	-48	8.3	33.4%
BJ	5.0%	68.3%	4.9%	71.0%	360	440	482	0.825	-42	270	46	-48	8.3	29.1%
BK	0.7%	69.0%	0.8%	71.7%	360	444	481	0.825	-37	280	44	-49	7.3	28.4%
BL	4.3%	73.3%	4.2%	75.9%	360	444	481	0.825	-37	280	44	-49	7.3	24.8%
BM	5.2%	78.6%	5.1%	81.0%	380	434	476	0.826	-42	280	47	-49	7.5	20.5%
BN	4.8%	83.4%	4.5%	85.5%	400	418	471	0.824	-53	280	58	-58	-1.5	16.7%
BO	2.1%	85.5%	1.9%	87.4%	400	410	472	0.825	-62	270	75	-58	-1.5	15.1%
BP	2.7%	88.2%	2.5%	89.9%	400	410	472	0.825	-62	270	75	-58	-1.5	13.0%
BQ	1.7%	89.9%	1.4%	91.3%	400	401	472	0.826	-71	270	85	-58	-1.5	11.8%
BR	1.2%	91.0%	1.1%	92.4%	400	399	472	0.826	-73	270	88	-57	-0.5	10.9%
BS	2.3%	93.3%	2.1%	94.5%	400	414	473	0.826	-59	270	92	-57	-0.5	9.2%
BT	0.4%	93.7%	0.3%	94.8%	400	414	473	0.826	-59	270	92	-57	-0.5	8.9%
BU	1.5%	95.2%	1.3%	96.2%	400	413	474	0.826	-61	270	95	-56	0.5	7.8%
BV	0.1%	95.3%	0.1%	96.3%	400	423	475	0.826	-52	270	95	-55	1.5	7.7%
BW	1.4%	96.7%	1.3%	97.6%	400	423	475	0.826	-52	270	95	-55	1.5	6.7%
BX	0.1%	96.8%	0.1%	97.7%	400	410	475	0.826	-65	270	95	-55	1.5	6.6%
BY	0.3%	97.1%	0.3%	98.0%	400	410	476	0.826	-66	270	95	-55	1.5	6.4%
BZ	0.0%	97.1%	0.1%	98.1%										6.4%
LDG	2.9%	100.0%	1.9%	100.0%										5.2%

APPENDIX 11. SEASONAL FLIGHT PLAN DATA RETURN ROUTE 4

January 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									24					
ZA	5.0%	5.0%	4.6%	4.6%	330	571	477	0.82	94	260	98	-51	-0.66	91.8%
ZB	5.0%	10.1%	5.7%	10.3%	330	559	478	0.82	81	270	93	-49	1.3	86.5%
ZC	3.4%	13.5%	3.9%	14.2%	330	554	480	0.82	74	270	81	-48	2.3	82.9%
ZD	3.4%	16.9%	3.8%	18.0%	330	551	481	0.82	70	280	71	-47	3.3	79.4%
ZE	3.5%	20.4%	3.8%	21.9%	330	546	482	0.821	64	280	65	-46	4.3	75.8%
ZF	4.2%	24.6%	4.5%	26.4%	330	533	483	0.822	50	270	59	-46	4.3	71.4%
ZG	4.3%	29.0%	4.6%	30.9%	350	519	478	0.82	41	270	39	-48	6.3	67.2%
ZH	4.9%	33.9%	5.1%	36.0%	350	510	479	0.82	31	270	39	-48	6.3	62.4%
ZI	3.6%	37.5%	3.7%	39.7%	350	503	480	0.821	23	270	28	-48	6.3	58.9%
ZJ	1.8%	39.3%	1.8%	41.4%	350	499	481	0.822	18	270	22	-48	6.3	57.3%
ZK	1.4%	40.7%	1.4%	42.8%	350	497	482	0.823	15	270	20	-47	7.3	55.9%
ZL	1.1%	41.7%	1.1%	43.9%	350	496	482	0.823	14	270	19	-47	7.3	55.0%
ZM	1.8%	43.5%	1.7%	45.7%	350	496	482	0.823	14	260	21	-47	7.3	53.3%
ZN	1.9%	45.4%	1.9%	47.5%	350	497	483	0.823	14	250	24	-46	8.3	51.6%
ZO	0.5%	45.8%	0.5%	48.0%	350	498	483	0.824	15	250	26	-46	8.3	51.1%
ZP	0.8%	46.7%	0.8%	48.8%	350	494	484	0.824	10	250	27	-46	8.3	50.3%
ZQ	2.2%	48.9%	2.2%	51.0%	350	495	484	0.824	11	250	25	-46	8.3	48.3%
ZR	1.1%	49.9%	1.1%	52.2%	350	494	485	0.825	9	250	22	-46	8.3	47.3%
ZS	1.4%	51.3%	1.3%	53.5%	350	492	485	0.825	7	250	18	-45	9.3	46.0%
ZT	3.2%	54.5%	3.1%	56.6%	350	489	485	0.825	4	250	11	-45	9.3	43.2%
ZU	1.1%	55.6%	1.1%	57.6%	350	485	486	0.825	-1	230	6	-45	9.3	42.2%
ZV	0.6%	56.2%	0.6%	58.2%	350	485	486	0.826	-1	230	4	-45	9.3	41.7%
ZW	3.6%	59.8%	3.6%	61.8%	350	484	486	0.825	-2	170	2	-45	9.3	38.4%
ZX	6.2%	66.0%	5.9%	67.8%	370	474	479	0.823	-5	80	10	-50	6.5	33.1%
ZY	3.4%	69.4%	3.2%	71.0%	370	474	479	0.824	-5	70	15	-50	6.5	30.2%
ZZ	0.9%	70.3%	0.9%	71.9%	370	474	479	0.824	-5	70	15	-50	6.5	29.4%
YA	2.1%	72.5%	2.0%	73.8%	370	475	480	0.825	-5	70	15	-50	6.5	27.7%
YB	3.0%	75.5%	2.9%	76.8%	370	476	480	0.825	-4	60	13	-50	6.5	25.2%
YC	3.2%	78.7%	3.1%	79.8%	370	480	481	0.825	-1	50	10	-50	6.5	22.5%
YD	2.8%	81.5%	2.8%	82.6%	390	477	474	0.822	3	10	8	-54	2.5	20.3%
YE	1.1%	82.5%	0.9%	83.6%	390	477	474	0.822	3	10	8	-54	2.5	19.5%
YF	1.3%	83.8%	1.3%	84.8%	390	483	474	0.823	9	330	9	-54	2.5	18.4%
YG	1.6%	85.5%	1.7%	86.5%	390	485	475	0.823	10	320	11	-54	2.5	17.2%
YH	3.2%	88.6%	3.1%	89.6%	390	488	475	0.823	13	310	14	-54	2.5	14.7%
YI	2.6%	91.2%	2.6%	92.2%	390	490	475	0.823	15	310	16	-54	2.5	12.8%
YJ	2.5%	93.7%	2.5%	94.6%	390	493	475	0.824	18	310	19	-54	2.5	10.9%
YK	0.2%	93.9%	0.2%	94.9%	390	494	475	0.824	19	300	20	-54	2.5	10.7%
YL	0.7%	94.6%	0.7%	95.6%	390	494	475	0.824	19	300	20	-54	2.5	10.2%
YM	0.7%	95.3%	0.6%	96.2%	390	495	475	0.824	20	300	20	-54	2.5	9.7%
YN	0.9%	96.2%	0.9%	97.1%	390	495	475	0.824	20	290	20	-54	2.5	9.0%
YO	0.1%	96.4%	0.2%	97.3%	390	495	475	0.824	20	290	20	-54	2.5	8.9%
YP	0.0%	96.4%	0.0%	97.3%	390	495	475	0.824	20	290	20	-54	2.5	8.9%
YQ	0.6%	97.0%	0.5%	97.9%	390	492	476	0.824	16	290	20	-54	2.5	8.4%
LDG	3.0%	100.0%	2.1%	100.0%										7.1%

January 85% Route 4

Way-point	Time (% of Total)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									21					
ZA	5.0%	5.0%	4.6%	4.6%	330	562	477	0.82	85	250	92	-50	0.34	91.7%
ZB	5.1%	10.1%	5.7%	10.3%	330	551	479	0.82	72	270	86	-49	1.3	86.2%
ZC	3.5%	13.6%	3.9%	14.2%	330	552	481	0.82	71	280	75	-47	3.3	82.6%
ZD	3.4%	17.0%	3.8%	18.0%	330	548	482	0.821	66	290	66	-46	4.3	79.1%
ZE	3.5%	20.5%	3.8%	21.9%	330	542	482	0.821	60	290	60	-46	4.3	75.5%
ZF	4.2%	24.7%	4.5%	26.4%	330	531	484	0.822	47	280	53	-45	5.3	71.1%
ZG	4.4%	29.1%	4.6%	30.9%	350	515	479	0.82	36	270	45	-48	6.3	66.8%
ZH	4.9%	34.0%	5.1%	36.0%	350	507	480	0.821	27	270	32	-48	6.3	62.0%
ZI	3.6%	37.6%	3.7%	39.7%	350	499	481	0.822	18	280	19	-47	7.3	58.6%
ZJ	1.7%	39.4%	1.8%	41.4%	350	495	482	0.822	13	290	13	-47	7.3	56.9%
ZK	1.4%	40.8%	1.4%	42.8%	350	491	482	0.823	9	280	11	-47	7.3	55.6%
ZL	1.2%	42.0%	1.1%	43.9%	350	488	482	0.823	6	250	11	-47	7.3	54.5%
ZM	1.7%	43.7%	1.7%	45.7%	350	488	483	0.823	5	240	15	-46	8.3	52.9%
ZN	1.9%	45.6%	1.9%	47.5%	350	490	484	0.824	6	240	19	-46	8.3	51.1%
ZO	0.5%	46.0%	0.5%	48.0%	350	491	484	0.824	7	240	22	-46	8.3	50.6%
ZP	0.8%	46.9%	0.8%	48.8%	350	489	484	0.824	5	240	22	-46	8.3	49.9%
ZQ	2.2%	49.1%	2.2%	51.0%	350	489	485	0.824	4	240	21	-46	8.3	47.8%
ZR	1.2%	50.2%	1.1%	52.2%	350	489	485	0.825	4	240	18	-45	9.3	46.8%
ZS	1.3%	51.5%	1.3%	53.5%	350	487	485	0.825	2	240	14	-45	9.3	45.6%
ZT	3.1%	54.7%	3.1%	56.6%	350	485	486	0.825	-1	220	9	-45	9.3	42.8%
ZU	1.0%	55.7%	1.1%	57.6%	350	481	486	0.826	-5	190	6	-45	9.3	41.8%
ZV	0.6%	56.3%	0.6%	58.2%	350	481	486	0.826	-5	170	5	-45	9.3	41.2%
ZW	3.8%	60.1%	3.6%	61.8%	370	474	479	0.823	-5	180	5	-50	6.5	37.9%
ZX	6.1%	66.2%	5.9%	67.8%	370	477	479	0.823	-2	70	7	-50	6.5	32.7%
ZY	3.4%	69.6%	3.2%	71.0%	370	478	480	0.824	-2	60	12	-50	6.5	29.8%
ZZ	0.9%	70.5%	0.9%	71.9%	370	478	480	0.824	-2	60	12	-50	6.5	29.1%
YA	2.0%	72.5%	2.0%	73.8%	370	479	480	0.825	-1	50	12	-50	6.5	27.4%
YB	3.0%	75.5%	2.9%	76.8%	370	481	481	0.825	0	40	11	-50	6.5	24.9%
YC	3.1%	78.7%	3.1%	79.8%	370	485	481	0.825	4	20	9	-49	7.5	22.3%
YD	2.8%	81.5%	2.8%	82.6%	390	481	474	0.822	7	360	10	-54	2.5	20.1%
YE	0.9%	82.4%	0.9%	83.6%	390	481	474	0.822	7	360	10	-54	2.5	19.3%
YF	1.3%	83.7%	1.3%	84.8%	390	482	475	0.823	7	360	10	-54	2.5	18.3%
YG	1.7%	85.4%	1.7%	86.5%	390	482	475	0.823	7	340	11	-54	2.5	17.0%
YH	3.1%	88.6%	3.1%	89.6%	390	485	475	0.823	10	340	14	-53	3.5	14.5%
YI	2.6%	91.1%	2.6%	92.2%	390	488	475	0.823	13	330	16	-53	3.5	12.6%
YJ	2.4%	93.6%	2.5%	94.6%	390	491	476	0.824	15	330	18	-54	2.5	10.7%
YK	0.2%	93.8%	0.2%	94.9%	390	490	476	0.824	14	320	19	-54	2.5	10.5%
YL	0.8%	94.6%	0.7%	95.6%	390	490	476	0.824	14	320	19	-54	2.5	9.9%
YM	0.6%	95.2%	0.6%	96.2%	390	492	476	0.824	16	320	18	-54	2.5	9.5%
YN	0.9%	96.2%	0.9%	97.1%	390	492	476	0.824	16	310	18	-53	3.5	8.8%
YO	0.1%	96.3%	0.2%	97.3%	390	493	476	0.824	17	310	17	-53	3.5	8.7%
YP	0.0%	96.3%	0.0%	97.3%	390	493	476	0.824	17	310	17	-53	3.5	8.7%
YQ	0.6%	96.9%	0.5%	97.9%	390	493	476	0.824	17	310	18	-53	3.5	8.3%
LDG	3.1%	100.0%	2.1%	100.0%										7.1%

February 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									16					
ZA	5.1%	5.1%	4.6%	4.6%	310	549	480	0.822	69	250	73	-49	-2.62	91.8%
ZB	5.2%	10.3%	5.7%	10.3%	330	527	476	0.82	51	260	68	-51	-0.7	86.3%
ZC	3.7%	14.0%	3.9%	14.2%	330	519	477	0.821	42	260	55	-51	-0.7	82.4%
ZD	3.6%	17.5%	3.8%	18.0%	330	515	478	0.821	37	260	42	-50	0.3	78.8%
ZE	3.7%	21.2%	3.8%	21.9%	330	509	479	0.822	30	270	31	-50	0.3	75.0%
ZF	4.4%	25.6%	4.5%	26.4%	330	507	480	0.823	27	290	27	-49	1.3	70.5%
ZG	4.3%	29.9%	4.6%	30.9%	350	515	477	0.82	38	290	39	-51	3.3	66.3%
ZH	4.7%	34.6%	5.1%	36.0%	350	522	479	0.821	43	270	55	-49	5.3	61.7%
ZI	3.5%	38.1%	3.7%	39.7%	350	525	481	0.821	44	260	74	-47	7.3	58.4%
ZJ	1.6%	39.7%	1.8%	41.4%	350	522	482	0.822	40	250	76	-46	8.3	56.9%
ZK	1.4%	41.1%	1.4%	42.8%	350	518	483	0.822	35	250	71	-46	8.3	55.6%
ZL	1.0%	42.1%	1.1%	43.9%	350	514	483	0.822	31	250	66	-46	8.3	54.6%
ZM	1.6%	43.7%	1.7%	45.7%	350	508	484	0.823	24	250	57	-45	9.3	53.1%
ZN	1.8%	45.6%	1.9%	47.5%	350	500	485	0.823	15	250	45	-45	9.3	51.4%
ZO	0.5%	46.0%	0.5%	48.0%	350	495	485	0.824	10	240	36	-45	9.3	50.9%
ZP	0.8%	46.8%	0.8%	48.8%	350	487	485	0.824	2	230	32	-45	9.3	50.1%
ZQ	2.2%	49.0%	2.2%	51.0%	350	484	485	0.825	-1	230	22	-45	9.3	48.1%
ZR	1.2%	50.2%	1.1%	52.2%	350	481	486	0.825	-5	210	14	-45	9.3	47.0%
ZS	1.4%	51.6%	1.3%	53.5%	350	478	486	0.825	-8	180	10	-45	9.3	45.8%
ZT	3.1%	54.7%	3.1%	56.6%	350	476	486	0.825	-10	140	10	-45	9.3	42.9%
ZU	1.2%	55.8%	1.1%	57.6%	350	477	486	0.826	-9	100	12	-45	9.3	41.9%
ZV	0.6%	56.4%	0.6%	58.2%	350	478	486	0.826	-8	90	13	-45	9.3	41.3%
ZW	3.7%	60.1%	3.6%	61.8%	370	472	479	0.823	-7	80	16	-50	6.5	38.1%
ZX	6.2%	66.3%	5.9%	67.8%	370	468	480	0.823	-12	80	21	-50	6.5	32.7%
ZY	3.3%	69.7%	3.2%	71.0%	370	468	480	0.824	-12	80	24	-50	6.5	29.9%
ZZ	0.9%	70.6%	0.9%	71.9%	370	468	480	0.824	-12	80	24	-50	6.5	29.1%
YA	2.1%	72.7%	2.0%	73.8%	370	469	481	0.825	-12	80	23	-49	7.5	27.4%
YB	3.0%	75.7%	2.9%	76.8%	370	472	481	0.825	-9	70	21	-49	7.5	24.9%
YC	3.1%	78.8%	3.1%	79.8%	370	476	481	0.825	-5	60	16	-49	7.5	22.3%
YD	3.0%	81.8%	2.8%	82.6%	390	474	475	0.823	-1	40	12	-54	2.5	19.9%
YE	0.9%	82.7%	0.9%	83.6%	390	474	475	0.823	-1	40	12	-54	2.5	19.2%
YF	1.3%	84.0%	1.3%	84.8%	390	481	475	0.823	6	360	10	-54	2.5	18.2%
YG	1.6%	85.6%	1.7%	86.5%	390	482	475	0.823	7	340	10	-54	2.5	16.9%
YH	3.1%	88.7%	3.1%	89.6%	390	486	475	0.823	11	320	12	-53	3.5	14.5%
YI	2.5%	91.2%	2.6%	92.2%	390	486	476	0.823	10	310	14	-53	3.5	12.6%
YJ	2.5%	93.8%	2.5%	94.6%	390	491	476	0.824	15	300	15	-53	3.5	10.7%
YK	0.2%	94.0%	0.2%	94.9%	390	491	476	0.824	15	290	15	-53	3.5	10.5%
YL	0.7%	94.7%	0.7%	95.6%	390	491	476	0.824	15	290	15	-53	3.5	10.0%
YM	0.6%	95.3%	0.6%	96.2%	390	492	476	0.824	16	290	15	-53	3.5	9.5%
YN	0.9%	96.2%	0.9%	97.1%	390	492	476	0.824	16	290	16	-53	3.5	8.9%
YO	0.1%	96.3%	0.2%	97.3%	390	492	476	0.824	16	290	16	-53	3.5	8.8%
YP	0.1%	96.4%	0.0%	97.3%	390	492	476	0.824	16	290	16	-53	3.5	8.7%
YQ	0.5%	96.9%	0.5%	97.9%	390	490	476	0.824	14	290	17	-53	3.5	8.3%
LDG	3.1%	100.0%	2.1%	100.0%										7.0%

February 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									14					
ZA	5.0%	5.0%	4.6%	4.6%	310	540	481	0.822	59	250	67	-48	-1.62	91.8%
ZB	5.4%	10.4%	5.7%	10.3%	330	517	477	0.82	40	250	64	-50	0.3	86.0%
ZC	3.7%	14.1%	3.9%	14.2%	330	511	478	0.821	33	250	52	-50	0.3	82.2%
ZD	3.7%	17.8%	3.8%	18.0%	330	508	479	0.822	29	250	37	-49	1.3	78.4%
ZE	3.7%	21.4%	3.8%	21.9%	330	504	480	0.822	24	270	25	-49	1.3	74.6%
ZF	4.4%	25.8%	4.5%	26.4%	330	504	481	0.823	23	310	23	-48	2.3	70.1%
ZG	4.4%	30.2%	4.6%	30.9%	350	511	477	0.82	34	310	34	-50	4.3	65.9%
ZH	4.7%	34.9%	5.1%	36.0%	350	518	480	0.821	38	270	49	-48	6.3	61.3%
ZI	3.4%	38.3%	3.7%	39.7%	350	518	482	0.821	36	270	71	-47	7.3	58.0%
ZJ	1.6%	39.9%	1.8%	41.4%	350	516	483	0.822	33	250	73	-46	8.3	56.5%
ZK	1.4%	41.3%	1.4%	42.8%	350	512	483	0.822	29	250	69	-46	8.3	55.2%
ZL	1.0%	42.3%	1.1%	43.9%	350	508	484	0.823	24	240	64	-45	9.3	54.2%
ZM	1.7%	44.0%	1.7%	45.7%	350	502	485	0.823	17	240	56	-45	9.3	52.6%
ZN	1.8%	45.9%	1.9%	47.5%	350	494	485	0.824	9	230	44	-45	9.3	50.9%
ZO	0.5%	46.3%	0.5%	48.0%	350	490	486	0.824	4	230	36	-45	9.3	50.4%
ZP	0.8%	47.1%	0.8%	48.8%	350	482	486	0.825	-4	220	31	-45	9.3	49.6%
ZQ	2.2%	49.3%	2.2%	51.0%	350	479	486	0.825	-7	210	22	-45	9.3	47.5%
ZR	1.1%	50.5%	1.1%	52.2%	370	469	478	0.821	-9	190	15	-50	6.5	46.5%
ZS	1.5%	51.9%	1.3%	53.5%	370	469	479	0.821	-10	180	13	-50	6.5	45.1%
ZT	3.1%	55.0%	3.1%	56.6%	370	470	479	0.822	-9	160	10	-50	6.5	42.4%
ZU	1.1%	56.2%	1.1%	57.6%	370	471	479	0.823	-8	130	9	-50	6.5	41.4%
ZV	0.6%	56.8%	0.6%	58.2%	370	473	479	0.823	-6	110	8	-50	6.5	40.9%
ZW	3.7%	60.4%	3.6%	61.8%	370	476	479	0.823	-3	70	11	-50	6.5	37.7%
ZX	6.1%	66.5%	5.9%	67.8%	370	474	480	0.823	-6	70	16	-50	6.5	32.5%
ZY	3.3%	69.8%	3.2%	71.0%	370	472	481	0.824	-9	70	20	-49	7.5	29.7%
ZZ	0.9%	70.8%	0.9%	71.9%	370	472	481	0.824	-9	70	20	-49	7.5	28.9%
YA	1.9%	72.7%	2.0%	73.8%	370	473	481	0.825	-8	70	21	-49	7.5	27.3%
YB	3.0%	75.7%	2.9%	76.8%	370	475	481	0.825	-6	60	20	-49	7.5	24.8%
YC	3.2%	78.9%	3.1%	79.8%	370	479	482	0.825	-3	50	16	-49	7.5	22.1%
YD	2.9%	81.8%	2.8%	82.6%	390	477	475	0.823	2	30	12	-54	2.5	19.8%
YE	0.8%	82.6%	0.9%	83.6%	390	477	475	0.823	2	30	12	-54	2.5	19.2%
YF	1.4%	83.9%	1.3%	84.8%	390	482	475	0.823	7	360	12	-53	3.5	18.1%
YG	1.6%	85.6%	1.7%	86.5%	390	481	476	0.823	5	360	12	-53	3.5	16.8%
YH	3.1%	88.6%	3.1%	89.6%	390	485	476	0.823	9	340	12	-53	3.5	14.4%
YI	2.6%	91.3%	2.6%	92.2%	390	487	476	0.824	11	320	13	-53	3.5	12.3%
YJ	2.4%	93.7%	2.5%	94.6%	410	481	469	0.82	12	320	12	-58	-1.5	10.5%
YK	0.2%	93.9%	0.2%	94.9%	410	481	470	0.821	11	310	12	-57	-0.5	10.4%
YL	0.8%	94.7%	0.7%	95.6%	410	481	470	0.821	11	310	12	-57	-0.5	9.8%
YM	0.6%	95.3%	0.6%	96.2%	410	481	470	0.821	11	310	12	-57	-0.5	9.3%
YN	0.9%	96.2%	0.9%	97.1%	410	482	470	0.821	12	300	12	-57	-0.5	8.7%
YO	0.2%	96.4%	0.2%	97.3%	410	482	470	0.821	12	300	12	-57	-0.5	8.5%
YP	0.0%	96.4%	0.0%	97.3%	410	482	470	0.821	12	300	12	-57	-0.5	8.5%
YQ	0.5%	96.9%	0.5%	97.9%	410	482	470	0.821	12	300	13	-57	-0.5	8.2%
LDG	3.1%	100.0%	2.1%	100.0%										6.9%

March 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									20					
ZA	5.1%	5.1%	4.6%	4.6%	330	549	476	0.82	73	250	81	-51	-0.66	91.7%
ZB	5.1%	10.2%	5.7%	10.3%	330	539	477	0.82	62	260	80	-50	0.3	86.2%
ZC	3.6%	13.8%	3.9%	14.2%	330	540	479	0.82	61	270	71	-49	1.3	82.5%
ZD	3.5%	17.3%	3.8%	18.0%	330	539	480	0.82	59	280	61	-48	2.3	78.9%
ZE	3.5%	20.8%	3.8%	21.9%	330	535	481	0.821	54	280	55	-47	3.3	75.3%
ZF	4.2%	25.0%	4.5%	26.4%	330	529	482	0.822	47	290	48	-46	4.3	71.0%
ZG	4.3%	29.3%	4.6%	30.9%	350	522	478	0.82	44	290	45	-49	5.3	66.7%
ZH	4.8%	34.1%	5.1%	36.0%	350	516	479	0.82	37	280	40	-48	6.3	62.1%
ZI	3.6%	37.7%	3.7%	39.7%	350	512	481	0.821	31	260	43	-47	7.3	58.7%
ZJ	1.7%	39.4%	1.8%	41.4%	350	511	482	0.821	29	250	50	-46	8.3	57.0%
ZK	1.3%	40.7%	1.4%	42.8%	350	510	483	0.822	27	250	53	-46	8.3	55.8%
ZL	1.0%	41.7%	1.1%	43.9%	350	508	484	0.823	24	250	53	-45	9.3	54.8%
ZM	1.7%	43.5%	1.7%	45.7%	350	505	484	0.823	21	250	49	-45	9.3	53.2%
ZN	1.9%	45.3%	1.9%	47.5%	350	500	485	0.823	15	240	42	-45	9.3	51.4%
ZO	0.3%	45.7%	0.5%	48.0%	350	497	485	0.824	12	240	37	-45	9.3	51.1%
ZP	0.8%	46.5%	0.8%	48.8%	350	490	486	0.824	4	240	33	-44	10.3	50.3%
ZQ	2.3%	48.8%	2.2%	51.0%	350	486	486	0.824	0	230	26	-44	10.3	48.1%
ZR	1.2%	50.0%	1.1%	52.2%	370	475	479	0.821	-4	220	19	-49	7.5	47.0%
ZS	1.4%	51.4%	1.3%	53.5%	370	471	479	0.821	-8	200	15	-49	7.5	45.8%
ZT	3.3%	54.7%	3.1%	56.6%	370	467	479	0.822	-12	170	14	-49	7.5	42.9%
ZU	1.0%	55.7%	1.1%	57.6%	370	464	479	0.823	-15	140	15	-49	7.5	41.9%
ZV	0.7%	56.4%	0.6%	58.2%	370	464	479	0.823	-15	130	16	-50	6.5	41.3%
ZW	3.7%	60.1%	3.6%	61.8%	370	568	479	0.823	89	110	14	-50	6.5	38.1%
ZX	6.3%	66.4%	5.9%	67.8%	370	471	480	0.823	-9	80	17	-50	6.5	32.7%
ZY	3.3%	69.7%	3.2%	71.0%	370	472	480	0.824	-8	70	21	-49	7.5	29.9%
ZZ	0.9%	70.6%	0.9%	71.9%	370	472	480	0.824	-8	70	21	-49	7.5	29.2%
YA	2.1%	72.7%	2.0%	73.8%	370	474	481	0.825	-7	70	21	-49	7.5	27.4%
YB	3.0%	75.7%	2.9%	76.8%	370	478	481	0.825	-3	60	18	-49	7.5	24.9%
YC	3.1%	78.8%	3.1%	79.8%	370	483	482	0.825	1	40	12	-49	7.5	22.3%
YD	2.9%	81.7%	2.8%	82.6%	390	482	475	0.822	7	350	9	-54	2.5	20.0%
YE	0.8%	82.6%	0.9%	83.6%	390	482	475	0.822	7	350	9	-54	2.5	19.3%
YF	1.3%	83.8%	1.3%	84.8%	390	486	475	0.823	11	310	12	-54	2.5	18.3%
YG	1.7%	85.6%	1.7%	86.5%	390	489	475	0.823	14	300	14	-54	2.5	17.0%
YH	3.0%	88.6%	3.1%	89.6%	390	492	475	0.823	17	280	17	-54	2.5	14.6%
YI	2.6%	91.2%	2.6%	92.2%	390	494	475	0.823	19	270	21	-54	2.5	12.7%
YJ	2.4%	93.6%	2.5%	94.6%	390	495	476	0.823	19	260	24	-53	3.5	10.8%
YK	0.2%	93.8%	0.2%	94.9%	390	498	476	0.824	22	260	25	-53	3.5	10.6%
YL	0.7%	94.5%	0.7%	95.6%	390	498	476	0.824	22	260	25	-53	3.5	10.1%
YM	0.7%	95.2%	0.6%	96.2%	390	498	476	0.824	22	260	25	-53	3.5	9.6%
YN	0.9%	96.2%	0.9%	97.1%	390	497	476	0.824	21	260	26	-53	3.5	8.9%
YO	0.1%	96.3%	0.2%	97.3%	390	494	476	0.824	18	260	26	-53	3.5	8.8%
YP	0.0%	96.3%	0.0%	97.3%	390	494	476	0.824	18	260	26	-53	3.5	8.8%
YQ	0.6%	96.9%	0.5%	97.9%	390	486	476	0.825	10	260	26	-53	3.5	8.4%
LDG	3.1%	100.0%	2.1%	100.0%										7.0%

March 85% Route 4

Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									18					
ZA	5.1%	5.1%	4.6%	4.6%	310	544	483	0.822	61	240	75	-47	-0.62	91.7%
ZB	5.3%	10.4%	5.7%	10.3%	330	529	478	0.82	51	250	76	-49	1.3	86.0%
ZC	3.6%	14.0%	3.9%	14.2%	330	533	480	0.821	53	260	65	-48	2.3	82.3%
ZD	3.4%	17.4%	3.8%	18.0%	330	537	481	0.821	56	280	57	-47	3.3	78.8%
ZE	3.6%	21.0%	3.8%	21.9%	330	533	482	0.821	51	290	51	-47	3.3	75.1%
ZF	4.2%	25.1%	4.5%	26.4%	330	529	483	0.822	46	300	46	-46	4.3	70.8%
ZG	4.3%	29.4%	4.6%	30.9%	350	521	479	0.82	42	300	43	-49	5.3	66.6%
ZH	4.9%	34.3%	5.1%	36.0%	350	515	480	0.82	35	290	36	-48	6.3	61.9%
ZI	3.5%	37.8%	3.7%	39.7%	350	506	482	0.821	24	260	37	-47	7.3	58.6%
ZJ	1.7%	39.5%	1.8%	41.4%	350	504	483	0.822	21	250	46	-46	8.3	56.9%
ZK	1.4%	40.9%	1.4%	42.8%	350	502	484	0.823	18	240	49	-45	9.3	55.6%
ZL	1.0%	41.9%	1.1%	43.9%	350	501	484	0.823	17	240	49	-45	9.3	54.6%
ZM	1.7%	43.7%	1.7%	45.7%	350	498	485	0.823	13	240	46	-45	9.3	53.0%
ZN	1.9%	45.5%	1.9%	47.5%	350	494	485	0.824	9	230	39	-44	10.3	51.3%
ZO	0.5%	46.0%	0.5%	48.0%	350	490	486	0.824	4	230	34	-44	10.3	50.7%
ZP	0.8%	46.8%	0.8%	48.8%	350	483	486	0.825	-3	220	31	-44	10.3	50.0%
ZQ	2.2%	49.0%	2.2%	51.0%	350	479	486	0.825	-7	210	24	-44	10.3	48.0%
ZR	1.3%	50.3%	1.1%	52.2%	350	475	487	0.825	-12	190	19	-44	10.3	46.8%
ZS	1.4%	51.7%	1.3%	53.5%	350	473	487	0.825	-14	180	19	-44	10.3	45.5%
ZT	3.1%	54.8%	3.1%	56.6%	350	474	487	0.825	-13	180	17	-44	10.3	42.7%
ZU	1.2%	56.0%	1.1%	57.6%	350	473	487	0.826	-14	170	15	-44	10.3	41.6%
ZV	0.6%	56.5%	0.6%	58.2%	350	473	487	0.826	-14	160	14	-44	10.3	41.0%
ZW	3.7%	60.3%	3.6%	61.8%	370	469	480	0.823	-11	130	11	-49	7.5	37.8%
ZX	6.1%	66.4%	5.9%	67.8%	370	475	480	0.823	-5	70	13	-49	7.5	32.5%
ZY	3.4%	69.8%	3.2%	71.0%	370	476	481	0.824	-5	60	19	-49	7.5	29.7%
ZZ	0.9%	70.7%	0.9%	71.9%	370	476	481	0.824	-5	60	19	-49	7.5	28.9%
YA	2.0%	72.7%	2.0%	73.8%	370	477	481	0.825	-4	60	19	-49	7.5	27.3%
YB	3.0%	75.7%	2.9%	76.8%	370	481	482	0.825	-1	50	16	-49	7.5	24.8%
YC	3.1%	78.8%	3.1%	79.8%	370	487	482	0.825	5	20	12	-49	7.5	22.2%
YD	2.9%	81.7%	2.8%	82.6%	390	482	475	0.823	7	360	11	-54	2.5	19.9%
YE	0.8%	82.5%	0.9%	83.6%	390	482	475	0.823	7	360	11	-54	2.5	19.3%
YF	1.3%	83.8%	1.3%	84.8%	390	486	475	0.823	11	330	12	-53	3.5	18.3%
YG	1.7%	85.5%	1.7%	86.5%	390	487	475	0.823	12	310	13	-53	3.5	16.9%
YH	3.0%	88.5%	3.1%	89.6%	390	490	475	0.823	15	300	15	-54	2.5	14.6%
YI	2.5%	91.1%	2.6%	92.2%	390	491	475	0.823	16	270	18	-53	3.5	12.6%
YJ	2.5%	93.6%	2.5%	94.6%	410	482	469	0.82	13	250	19	-57	-0.5	10.7%
YK	0.2%	93.9%	0.2%	94.9%	410	486	470	0.82	16	250	20	-57	-0.5	10.5%
YL	0.7%	94.6%	0.7%	95.6%	410	486	470	0.82	16	250	20	-57	-0.5	10.0%
YM	0.7%	95.2%	0.6%	96.2%	410	484	470	0.821	14	250	21	-57	-0.5	9.5%
YN	0.9%	96.2%	0.9%	97.1%	410	485	470	0.821	15	250	21	-57	-0.5	8.8%
YO	0.1%	96.3%	0.2%	97.3%	410	482	470	0.821	12	250	21	-57	-0.5	8.7%
YP	0.0%	96.3%	0.0%	97.3%	410	482	470	0.821	12	250	21	-57	-0.5	8.7%
YQ	0.6%	96.9%	0.5%	97.9%	410	475	470	0.821	5	250	22	-57	-0.5	8.3%
LDG	3.1%	100.0%	2.1%	100.0%										7.0%

April 50% Route 4														
Way-point	∑ Time (% of Total)	Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									21					
ZA	5.1%	5.1%	4.6%	4.6%	330	533	477	0.82	56	260	57	-51	-0.66	91.6%
ZB	5.4%	10.5%	5.7%	10.3%	330	526	477	0.82	49	270	55	-50	0.3	85.9%
ZC	3.6%	14.1%	3.9%	14.2%	330	525	478	0.821	47	280	50	-50	0.3	82.1%
ZD	3.6%	17.7%	3.8%	18.0%	330	527	479	0.821	48	280	48	-49	1.3	78.4%
ZE	3.6%	21.3%	3.8%	21.9%	330	527	480	0.822	47	280	48	-49	1.3	74.7%
ZF	4.2%	25.5%	4.5%	26.4%	330	521	482	0.822	39	270	49	-47	3.3	70.4%
ZG	4.4%	30.0%	4.6%	30.9%	350	516	477	0.82	39	260	53	-50	4.3	66.1%
ZH	4.8%	34.7%	5.1%	36.0%	350	515	480	0.821	35	260	55	-48	6.3	61.5%
ZI	3.6%	38.3%	3.7%	39.7%	350	513	482	0.821	31	260	51	-47	7.3	58.0%
ZJ	1.6%	40.0%	1.8%	41.4%	350	511	483	0.822	28	250	47	-46	8.3	56.5%
ZK	1.4%	41.4%	1.4%	42.8%	350	508	484	0.822	24	250	43	-45	9.3	55.1%
ZL	1.0%	42.4%	1.1%	43.9%	350	506	484	0.823	22	250	38	-45	9.3	54.2%
ZM	1.7%	44.2%	1.7%	45.7%	350	503	484	0.823	19	250	33	-45	9.3	52.5%
ZN	1.7%	45.9%	1.9%	47.5%	350	499	485	0.823	14	250	26	-45	9.3	50.9%
ZO	0.5%	46.4%	0.5%	48.0%	350	496	485	0.824	11	250	21	-45	9.3	50.4%
ZP	0.8%	47.2%	0.8%	48.8%	350	491	486	0.824	5	250	19	-44	10.3	49.6%
ZQ	2.2%	49.4%	2.2%	51.0%	350	488	486	0.825	2	240	13	-44	10.3	47.6%
ZR	1.2%	50.6%	1.1%	52.2%	350	484	487	0.825	-3	210	7	-44	10.3	46.5%
ZS	1.4%	52.0%	1.3%	53.5%	350	482	487	0.825	-5	170	6	-44	10.3	45.2%
ZT	3.3%	55.2%	3.1%	56.6%	370	470	479	0.822	-9	140	9	-49	7.5	42.3%
ZU	1.0%	56.3%	1.1%	57.6%	370	469	480	0.823	-11	120	12	-49	7.5	41.3%
ZV	0.7%	57.0%	0.6%	58.2%	370	468	480	0.823	-12	120	13	-49	7.5	40.7%
ZW	3.7%	60.7%	3.6%	61.8%	370	471	480	0.823	-9	100	13	-49	7.5	37.5%
ZX	6.2%	66.9%	5.9%	67.8%	370	475	480	0.823	-5	70	13	-49	7.5	32.2%
ZY	3.5%	70.4%	3.2%	71.0%	370	480	481	0.824	-1	50	11	-49	7.5	29.2%
ZZ	0.7%	71.1%	0.9%	71.9%	370	480	481	0.824	-1	50	11	-49	7.5	28.7%
YA	2.0%	73.1%	2.0%	73.8%	370	484	481	0.825	3	20	8	-49	7.5	27.0%
YB	3.0%	76.1%	2.9%	76.8%	370	489	481	0.825	8	330	8	-49	7.5	24.4%
YC	3.0%	79.1%	3.1%	79.8%	390	486	474	0.821	12	300	13	-54	2.5	22.0%
YD	2.9%	82.1%	2.8%	82.6%	390	491	474	0.822	17	280	19	-54	2.5	19.7%
YE	0.8%	82.9%	0.9%	83.6%	390	491	474	0.822	17	280	19	-54	2.5	19.1%
YF	1.3%	84.1%	1.3%	84.8%	390	493	474	0.822	19	280	23	-54	2.5	18.1%
YG	1.7%	85.9%	1.7%	86.5%	390	498	474	0.822	24	270	27	-54	2.5	16.7%
YH	2.9%	88.8%	3.1%	89.6%	390	502	474	0.823	28	260	33	-54	2.5	14.5%
YI	2.6%	91.4%	2.6%	92.2%	390	505	474	0.823	31	260	40	-54	2.5	12.5%
YJ	2.4%	93.8%	2.5%	94.6%	390	506	474	0.823	32	250	46	-54	2.5	10.7%
YK	0.1%	93.9%	0.2%	94.9%	390	513	474	0.823	39	250	48	-54	2.5	10.6%
YL	0.7%	94.6%	0.7%	95.6%	390	513	474	0.823	39	250	48	-54	2.5	10.0%
YM	0.6%	95.2%	0.6%	96.2%	390	509	474	0.823	35	250	48	-54	2.5	9.6%
YN	0.9%	96.2%	0.9%	97.1%	390	508	474	0.823	34	250	47	-55	1.5	8.9%
YO	0.2%	96.4%	0.2%	97.3%	390	503	475	0.824	28	250	46	-55	1.5	8.7%
YP	0.0%	96.4%	0.0%	97.3%	390	503	475	0.824	28	250	46	-55	1.5	8.7%
YQ	0.5%	96.9%	0.5%	97.9%	390	487	475	0.825	12	250	45	-55	1.5	8.4%
LDG	3.1%	100.0%	2.1%	100.0%										7.0%

April 85% Route 4														
Way-point	Time (%)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									18					
ZA	5.2%	5.2%	4.6%	4.6%	330	526	478	0.82	48	260	51	-50	0.34	91.5%
ZB	5.3%	10.5%	5.7%	10.3%	330	522	478	0.82	44	270	48	-49	1.3	85.9%
ZC	3.6%	14.1%	3.9%	14.2%	330	524	479	0.821	45	290	45	-49	1.3	82.1%
ZD	3.6%	17.7%	3.8%	18.0%	330	524	480	0.821	44	290	45	-49	1.3	78.4%
ZE	3.6%	21.3%	3.8%	21.9%	330	524	480	0.822	44	290	44	-48	2.3	74.8%
ZF	4.3%	25.6%	4.5%	26.4%	330	518	482	0.823	36	270	43	-47	3.3	70.4%
ZG	4.4%	30.0%	4.6%	30.9%	350	508	478	0.82	30	250	48	-49	5.3	66.0%
ZH	4.9%	34.9%	5.1%	36.0%	350	508	481	0.821	27	250	50	-47	7.3	61.3%
ZI	3.6%	38.5%	3.7%	39.7%	350	507	482	0.822	25	250	48	-46	8.3	57.9%
ZJ	1.7%	40.2%	1.8%	41.4%	350	505	484	0.822	21	250	44	-45	9.3	56.2%
ZK	1.3%	41.5%	1.4%	42.8%	350	503	484	0.823	19	250	40	-45	9.3	55.0%
ZL	1.2%	42.6%	1.1%	43.9%	350	500	485	0.823	15	250	36	-45	9.3	53.9%
ZM	1.6%	44.3%	1.7%	45.7%	350	497	485	0.823	12	240	30	-45	9.3	52.4%
ZN	1.9%	46.1%	1.9%	47.5%	350	493	486	0.824	7	240	24	-44	10.3	50.7%
ZO	0.5%	46.6%	0.5%	48.0%	350	491	486	0.824	5	230	20	-44	10.3	50.2%
ZP	0.8%	47.4%	0.8%	48.8%	350	486	486	0.825	0	230	17	-44	10.3	49.4%
ZQ	2.2%	49.6%	2.2%	51.0%	350	483	487	0.825	-4	210	12	-44	10.3	47.4%
ZR	1.3%	50.9%	1.1%	52.2%	350	481	487	0.825	-6	190	10	-44	10.3	46.3%
ZS	1.3%	52.1%	1.3%	53.5%	350	481	487	0.825	-6	190	9	-44	10.3	45.0%
ZT	3.2%	55.4%	3.1%	56.6%	370	472	480	0.822	-8	170	10	-49	7.5	42.1%
ZU	1.2%	56.5%	1.1%	57.6%	370	469	480	0.823	-11	140	11	-49	7.5	41.1%
ZV	0.6%	57.1%	0.6%	58.2%	370	469	480	0.823	-11	130	12	-49	7.5	40.6%
ZW	3.7%	60.8%	3.6%	61.8%	370	472	480	0.823	-8	110	11	-49	7.5	37.4%
ZX	6.1%	67.0%	5.9%	67.8%	370	478	481	0.823	-3	60	11	-49	7.5	32.1%
ZY	3.4%	70.3%	3.2%	71.0%	370	483	481	0.824	2	30	11	-49	7.5	29.3%
ZZ	0.8%	71.1%	0.9%	71.9%	370	483	481	0.824	2	30	11	-49	7.5	28.6%
YA	2.0%	73.1%	2.0%	73.8%	370	488	481	0.825	7	10	10	-49	7.5	26.9%
YB	2.9%	76.0%	2.9%	76.8%	390	484	474	0.821	10	340	11	-54	2.5	24.6%
YC	3.1%	79.1%	3.1%	79.8%	390	487	474	0.821	13	320	12	-53	3.5	22.1%
YD	2.9%	82.0%	2.8%	82.6%	390	491	475	0.822	16	300	17	-53	3.5	19.8%
YE	0.8%	82.9%	0.9%	83.6%	390	491	475	0.822	16	300	17	-53	3.5	19.1%
YF	1.3%	84.1%	1.3%	84.8%	390	493	475	0.823	18	290	21	-53	3.5	18.1%
YG	1.6%	85.7%	1.7%	86.5%	390	496	475	0.823	21	270	23	-54	2.5	16.9%
YH	3.0%	88.8%	3.1%	89.6%	390	497	475	0.823	22	250	30	-54	2.5	14.6%
YI	2.5%	91.3%	2.6%	92.2%	390	500	475	0.823	25	250	37	-54	2.5	12.5%
YJ	2.4%	93.7%	2.5%	94.6%	410	494	469	0.82	25	240	42	-58	-1.5	10.7%
YK	0.2%	94.0%	0.2%	94.9%	410	501	469	0.82	32	240	44	-58	-1.5	10.5%
YL	0.7%	94.7%	0.7%	95.6%	410	501	469	0.82	32	240	44	-58	-1.5	10.0%
YM	0.6%	95.2%	0.6%	96.2%	410	497	469	0.821	28	240	44	-58	-1.5	9.6%
YN	0.9%	96.2%	0.9%	97.1%	410	496	470	0.821	26	240	43	-58	-1.5	8.9%
YO	0.2%	96.4%	0.2%	97.3%	410	491	470	0.821	21	240	42	-57	-0.5	8.7%
YP	0.0%	96.4%	0.0%	97.3%	410	491	470	0.821	21	240	42	-57	-0.5	8.7%
YQ	0.6%	97.0%	0.5%	97.9%	410	475	470	0.821	5	240	41	-58	-1.5	8.3%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

May 50% Route 4														
Way-point	∑ Time (% of Total)	Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									20					
ZA	5.1%	5.1%	4.6%	4.6%	330	540	480	0.82	60	270	60	-48	2.34	91.6%
ZB	5.2%	10.4%	5.7%	10.3%	330	527	480	0.82	47	270	51	-47	3.3	86.0%
ZC	3.7%	14.1%	3.9%	14.2%	330	516	481	0.821	35	270	36	-47	3.3	82.0%
ZD	3.7%	17.8%	3.8%	18.0%	330	510	482	0.822	28	290	28	-47	3.3	78.2%
ZE	3.7%	21.6%	3.8%	21.9%	330	504	482	0.822	22	290	22	-47	3.3	74.4%
ZF	4.4%	26.0%	4.5%	26.4%	330	503	483	0.823	20	270	24	-46	4.3	69.8%
ZG	4.4%	30.4%	4.6%	30.9%	350	507	478	0.82	29	260	40	-50	4.3	65.5%
ZH	4.8%	35.2%	5.1%	36.0%	350	522	480	0.821	42	260	63	-48	6.3	60.9%
ZI	3.5%	38.7%	3.7%	39.7%	350	523	482	0.821	41	260	60	-46	8.3	57.6%
ZJ	1.6%	40.3%	1.8%	41.4%	350	515	483	0.822	32	260	48	-45	9.3	56.0%
ZK	1.4%	41.7%	1.4%	42.8%	350	508	484	0.822	24	260	39	-45	9.3	54.7%
ZL	1.0%	42.8%	1.1%	43.9%	350	503	485	0.823	18	250	31	-45	9.3	53.7%
ZM	1.7%	44.5%	1.7%	45.7%	350	497	485	0.823	12	250	23	-45	9.3	52.1%
ZN	1.9%	46.4%	1.9%	47.5%	350	491	486	0.824	5	240	14	-44	10.3	50.4%
ZO	0.5%	46.9%	0.5%	48.0%	350	488	486	0.824	2	230	9	-44	10.3	49.9%
ZP	0.8%	47.7%	0.8%	48.8%	350	486	486	0.825	0	220	7	-44	10.3	49.1%
ZQ	2.2%	49.9%	2.2%	51.0%	350	483	486	0.825	-3	160	4	-44	10.3	47.1%
ZR	1.2%	51.0%	1.1%	52.2%	350	480	487	0.825	-7	110	8	-44	10.3	46.0%
ZS	1.4%	52.4%	1.3%	53.5%	350	478	487	0.825	-9	110	11	-44	10.3	44.6%
ZT	3.3%	55.7%	3.1%	56.6%	370	466	479	0.822	-13	110	15	-49	7.5	41.8%
ZU	1.2%	56.9%	1.1%	57.6%	370	469	480	0.823	-11	110	16	-49	7.5	40.7%
ZV	0.6%	57.5%	0.6%	58.2%	370	469	480	0.823	-11	110	16	-49	7.5	40.2%
ZW	3.7%	61.2%	3.6%	61.8%	370	474	480	0.823	-6	80	17	-49	7.5	37.0%
ZX	6.2%	67.4%	5.9%	67.8%	370	478	480	0.823	-2	50	16	-49	7.5	31.7%
ZY	3.5%	70.9%	3.2%	71.0%	370	484	481	0.824	3	20	9	-49	7.5	28.8%
ZZ	0.7%	71.6%	0.9%	71.9%	370	484	481	0.824	3	20	9	-49	7.5	28.2%
YA	1.9%	73.4%	2.0%	73.8%	370	489	482	0.825	7	330	7	-49	7.5	26.6%
YB	3.0%	76.5%	2.9%	76.8%	370	487	475	0.821	12	300	13	-49	7.5	24.2%
YC	3.0%	79.5%	3.1%	79.8%	390	493	475	0.821	18	270	25	-53	3.5	21.7%
YD	2.8%	82.3%	2.8%	82.6%	390	500	475	0.822	25	260	37	-53	3.5	19.5%
YE	0.9%	83.2%	0.9%	83.6%	390	500	475	0.822	25	260	37	-53	3.5	18.8%
YF	1.2%	84.4%	1.3%	84.8%	390	500	475	0.822	25	260	45	-53	3.5	17.9%
YG	1.6%	86.0%	1.7%	86.5%	390	511	475	0.822	36	260	48	-54	2.5	16.6%
YH	3.0%	89.0%	3.1%	89.6%	390	512	475	0.822	37	250	51	-54	2.5	14.3%
YI	2.4%	91.5%	2.6%	92.2%	390	513	475	0.822	38	250	52	-54	2.5	12.4%
YJ	2.3%	93.8%	2.5%	94.6%	390	511	475	0.822	36	250	51	-53	3.5	10.7%
YK	0.1%	93.9%	0.2%	94.9%	390	518	475	0.823	43	250	49	-53	3.5	10.6%
YL	0.8%	94.8%	0.7%	95.6%	390	518	475	0.823	43	250	49	-53	3.5	10.0%
YM	0.6%	95.3%	0.6%	96.2%	390	514	476	0.823	38	250	48	-53	3.5	9.5%
YN	0.9%	96.3%	0.9%	97.1%	390	515	476	0.823	39	260	47	-53	3.5	8.9%
YO	0.1%	96.4%	0.2%	97.3%	390	511	476	0.824	35	260	46	-53	3.5	8.8%
YP	0.0%	96.4%	0.0%	97.3%	390	511	476	0.824	35	260	46	-53	3.5	8.8%
YQ	0.6%	97.0%	0.5%	97.9%	390	496	476	0.824	20	260	46	-53	3.5	8.3%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

May 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									18					
ZA	5.1%	5.1%	4.6%	4.6%	330	534	480	0.82	54	270	53	-47	3.34	91.5%
ZB	5.3%	10.4%	5.7%	10.3%	330	524	481	0.82	43	280	45	-47	3.3	85.8%
ZC	3.7%	14.1%	3.9%	14.2%	330	516	482	0.821	34	290	34	-46	4.3	81.9%
ZD	3.6%	17.7%	3.8%	18.0%	330	508	482	0.822	26	310	27	-46	4.3	78.2%
ZE	3.8%	21.6%	3.8%	21.9%	330	502	482	0.822	20	300	21	-47	3.3	74.3%
ZF	4.4%	26.0%	4.5%	26.4%	330	501	484	0.824	17	280	19	-46	4.3	69.8%
ZG	4.5%	30.5%	4.6%	30.9%	350	500	478	0.82	22	250	35	-49	5.3	65.4%
ZH	4.8%	35.2%	5.1%	36.0%	350	515	481	0.821	34	250	59	-47	7.3	60.8%
ZI	3.5%	38.7%	3.7%	39.7%	350	518	483	0.821	35	260	57	-46	8.3	57.5%
ZJ	1.7%	40.4%	1.8%	41.4%	350	510	484	0.822	26	260	44	-45	9.3	55.8%
ZK	1.3%	41.7%	1.4%	42.8%	350	504	484	0.823	20	250	36	-45	9.3	54.7%
ZL	1.2%	42.9%	1.1%	43.9%	350	499	485	0.823	14	250	29	-45	9.3	53.6%
ZM	1.7%	44.6%	1.7%	45.7%	350	493	485	0.823	8	240	21	-44	10.3	51.9%
ZN	1.9%	46.5%	1.9%	47.5%	350	487	486	0.824	1	220	13	-44	10.3	50.2%
ZO	0.5%	46.9%	0.5%	48.0%	350	484	486	0.825	-2	200	9	-44	10.3	49.7%
ZP	0.8%	47.7%	0.8%	48.8%	350	482	486	0.825	-4	190	7	-44	10.3	49.0%
ZQ	2.2%	49.9%	2.2%	51.0%	350	482	487	0.825	-5	180	6	-44	10.3	47.0%
ZR	1.2%	51.1%	1.1%	52.2%	350	481	487	0.825	-6	150	6	-44	10.3	45.9%
ZS	1.4%	52.5%	1.3%	53.5%	350	479	487	0.825	-8	130	8	-44	10.3	44.5%
ZT	3.2%	55.7%	3.1%	56.6%	370	468	479	0.822	-11	120	12	-49	7.5	41.7%
ZU	1.2%	56.9%	1.1%	57.6%	370	469	480	0.823	-11	110	14	-49	7.5	40.7%
ZV	0.6%	57.5%	0.6%	58.2%	370	470	480	0.823	-10	100	14	-49	7.5	40.1%
ZW	3.7%	61.2%	3.6%	61.8%	370	476	480	0.823	-4	70	14	-49	7.5	36.9%
ZX	6.0%	67.2%	5.9%	67.8%	370	481	480	0.823	1	40	15	-49	7.5	31.8%
ZY	3.5%	70.7%	3.2%	71.0%	370	487	481	0.824	6	10	10	-49	7.5	28.9%
ZZ	0.7%	71.4%	0.9%	71.9%	370	487	481	0.824	6	10	10	-49	7.5	28.3%
YA	2.0%	73.3%	2.0%	73.8%	370	488	482	0.825	6	350	8	-48	8.5	26.6%
YB	2.9%	76.2%	2.9%	76.8%	390	487	475	0.821	12	320	12	-53	3.5	24.3%
YC	3.1%	79.4%	3.1%	79.8%	390	490	475	0.821	15	270	21	-53	3.5	21.8%
YD	2.7%	82.0%	2.8%	82.6%	390	495	475	0.822	20	260	34	-53	3.5	19.7%
YE	0.9%	83.0%	0.9%	83.6%	390	495	475	0.822	20	260	34	-53	3.5	18.9%
YF	1.3%	84.2%	1.3%	84.8%	390	494	475	0.822	19	250	42	-53	3.5	18.0%
YG	1.6%	85.9%	1.7%	86.5%	390	505	475	0.822	30	250	45	-53	3.5	16.7%
YH	3.0%	88.9%	3.1%	89.6%	390	506	475	0.822	31	250	48	-53	3.5	14.3%
YI	2.5%	91.4%	2.6%	92.2%	410	502	470	0.82	32	250	48	-56	0.5	12.4%
YJ	2.3%	93.7%	2.5%	94.6%	410	501	471	0.82	30	250	47	-56	0.5	10.6%
YK	0.1%	93.9%	0.2%	94.9%	410	507	472	0.82	35	250	45	-55	1.5	10.5%
YL	0.8%	94.7%	0.7%	95.6%	410	507	472	0.82	35	250	45	-55	1.5	9.9%
YM	0.6%	95.2%	0.6%	96.2%	410	503	472	0.821	31	250	43	-55	1.5	9.5%
YN	0.9%	96.2%	0.9%	97.1%	410	504	472	0.821	32	250	42	-55	1.5	8.8%
YO	0.2%	96.4%	0.2%	97.3%	410	499	472	0.821	27	250	41	-55	1.5	8.7%
YP	0.0%	96.4%	0.0%	97.3%	410	499	472	0.821	27	250	41	-55	1.5	8.7%
YQ	0.5%	96.9%	0.5%	97.9%	410	486	472	0.821	14	250	40	-55	1.5	8.3%
LDG	3.1%	100.0%	2.1%	100.0%										7.1%

June 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									18					
ZA	5.2%	5.2%	4.6%	4.6%	310	522	491	0.823	31	270	32	-39	7.38	91.4%
ZB	5.5%	10.7%	5.7%	10.3%	330	514	484	0.82	30	270	33	-44	6.3	85.5%
ZC	3.7%	14.4%	3.9%	14.2%	330	509	485	0.821	24	280	25	-43	7.3	81.6%
ZD	3.7%	18.1%	3.8%	18.0%	330	502	485	0.822	17	300	17	-44	6.3	77.8%
ZE	3.8%	22.0%	3.8%	21.9%	330	495	485	0.823	10	310	11	-45	5.3	73.8%
ZF	4.5%	26.5%	4.5%	26.4%	330	494	485	0.824	9	300	9	-45	5.3	69.2%
ZG	4.5%	31.0%	4.6%	30.9%	350	497	479	0.82	18	270	21	-49	5.3	64.8%
ZH	4.9%	35.9%	5.1%	36.0%	350	507	481	0.821	26	270	35	-47	7.3	60.1%
ZI	3.5%	39.4%	3.7%	39.7%	350	508	482	0.822	26	270	35	-46	8.3	56.8%
ZJ	1.7%	41.1%	1.8%	41.4%	350	502	483	0.823	19	260	26	-46	8.3	55.1%
ZK	1.4%	42.5%	1.4%	42.8%	350	496	484	0.823	12	260	18	-45	9.3	53.8%
ZL	1.2%	43.7%	1.1%	43.9%	350	492	485	0.823	7	260	13	-45	9.3	52.8%
ZM	1.7%	45.4%	1.7%	45.7%	350	489	485	0.824	4	250	7	-45	9.3	51.1%
ZN	1.9%	47.3%	1.9%	47.5%	350	485	486	0.824	-1	210	3	-45	9.3	49.4%
ZO	0.5%	47.7%	0.5%	48.0%	350	484	486	0.825	-2	160	3	-44	10.3	48.9%
ZP	0.8%	48.5%	0.8%	48.8%	350	483	486	0.825	-3	140	3	-44	10.3	48.1%
ZQ	2.2%	50.8%	2.2%	51.0%	350	482	486	0.825	-4	120	4	-44	10.3	46.1%
ZR	1.2%	51.9%	1.1%	52.2%	350	481	486	0.825	-5	110	6	-44	10.3	45.1%
ZS	1.4%	53.3%	1.3%	53.5%	350	481	487	0.825	-6	110	6	-44	10.3	43.8%
ZT	3.1%	56.4%	3.1%	56.6%	350	480	487	0.826	-7	110	8	-44	10.3	41.0%
ZU	1.0%	57.5%	1.1%	57.6%	350	480	487	0.826	-7	110	10	-44	10.3	40.0%
ZV	0.7%	58.2%	0.6%	58.2%	370	472	479	0.823	-7	90	14	-50	6.5	39.4%
ZW	3.7%	61.9%	3.6%	61.8%	370	476	479	0.823	-3	70	16	-50	6.5	36.2%
ZX	6.0%	67.9%	5.9%	67.8%	370	479	480	0.823	-1	50	17	-50	6.5	31.1%
ZY	3.5%	71.4%	3.2%	71.0%	370	484	480	0.824	4	20	9	-50	6.5	28.2%
ZZ	0.7%	72.1%	0.9%	71.9%	370	484	480	0.824	4	20	9	-50	6.5	27.6%
YA	2.0%	74.1%	2.0%	73.8%	370	488	481	0.825	7	320	8	-50	6.5	25.9%
YB	2.9%	77.0%	2.9%	76.8%	390	486	473	0.821	13	300	13	-54	2.5	23.6%
YC	3.1%	80.1%	3.1%	79.8%	390	494	474	0.822	20	290	23	-54	2.5	21.1%
YD	2.7%	82.8%	2.8%	82.6%	390	506	474	0.822	32	280	35	-54	2.5	19.0%
YE	0.9%	83.7%	0.9%	83.6%	390	506	474	0.822	32	280	35	-54	2.5	18.3%
YF	1.2%	84.9%	1.3%	84.8%	390	511	474	0.822	37	280	44	-54	2.5	17.4%
YG	1.6%	86.5%	1.7%	86.5%	390	520	474	0.822	46	280	49	-54	2.5	16.1%
YH	2.9%	89.4%	3.1%	89.6%	390	525	473	0.822	52	280	54	-54	2.5	13.9%
YI	2.3%	91.8%	2.6%	92.2%	390	530	474	0.822	56	280	60	-54	2.5	12.2%
YJ	2.3%	94.1%	2.5%	94.6%	390	533	474	0.822	59	280	64	-54	2.5	10.4%
YK	0.1%	94.2%	0.2%	94.9%	390	539	474	0.822	65	280	66	-54	2.5	10.4%
YL	0.7%	94.9%	0.7%	95.6%	390	539	474	0.822	65	280	66	-54	2.5	9.8%
YM	0.6%	95.5%	0.6%	96.2%	390	538	474	0.822	64	280	67	-54	2.5	9.4%
YN	0.8%	96.3%	0.9%	97.1%	390	538	474	0.822	64	280	68	-54	2.5	8.8%
YO	0.2%	96.5%	0.2%	97.3%	390	535	475	0.822	60	270	69	-54	2.5	8.6%
YP	0.0%	96.5%	0.0%	97.3%	390	535	475	0.822	60	270	69	-54	2.5	8.6%
YQ	0.5%	97.0%	0.5%	97.9%	390	517	475	0.822	42	270	69	-54	2.5	8.3%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

June 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									16					
ZA	5.2%	5.2%	4.6%	4.6%	310	518	492	0.824	26	290	27	-39	7.38	91.3%
ZB	5.6%	10.8%	5.7%	10.3%	330	509	485	0.82	24	270	28	-43	7.3	85.4%
ZC	3.7%	14.5%	3.9%	14.2%	330	507	486	0.821	21	300	22	-43	7.3	81.5%
ZD	3.7%	18.2%	3.8%	18.0%	330	499	486	0.822	13	320	16	-43	7.3	77.6%
ZE	3.8%	22.0%	3.8%	21.9%	330	493	485	0.823	8	340	11	-44	6.3	73.7%
ZF	4.5%	26.5%	4.5%	26.4%	330	493	486	0.824	7	330	8	-44	6.3	69.1%
ZG	4.5%	31.1%	4.6%	30.9%	350	494	479	0.82	15	280	16	-48	6.3	64.7%
ZH	4.9%	35.9%	5.1%	36.0%	350	503	481	0.821	22	260	31	-47	7.3	60.0%
ZI	3.6%	39.5%	3.7%	39.7%	350	504	483	0.822	21	260	31	-46	8.3	56.6%
ZJ	1.7%	41.3%	1.8%	41.4%	350	498	484	0.823	14	260	23	-45	9.3	55.0%
ZK	1.4%	42.6%	1.4%	42.8%	350	493	484	0.823	9	250	16	-45	9.3	53.7%
ZL	1.2%	43.8%	1.1%	43.9%	350	489	485	0.824	4	240	11	-45	9.3	52.6%
ZM	1.7%	45.5%	1.7%	45.7%	350	486	485	0.824	1	220	6	-45	9.3	51.0%
ZN	1.9%	47.4%	1.9%	47.5%	350	483	486	0.825	-3	180	4	-44	10.3	49.3%
ZO	0.5%	47.9%	0.5%	48.0%	350	483	486	0.825	-3	170	4	-44	10.3	48.8%
ZP	0.8%	48.7%	0.8%	48.8%	350	483	486	0.825	-3	180	4	-44	10.3	48.0%
ZQ	2.3%	51.0%	2.2%	51.0%	350	483	486	0.825	-3	160	4	-44	10.3	45.9%
ZR	1.2%	52.1%	1.1%	52.2%	350	482	487	0.825	-5	140	5	-44	10.3	44.8%
ZS	1.4%	53.5%	1.3%	53.5%	350	481	487	0.825	-6	130	5	-44	10.3	43.6%
ZT	3.1%	56.7%	3.1%	56.6%	350	480	487	0.826	-7	120	7	-44	10.3	40.8%
ZU	1.0%	57.7%	1.1%	57.6%	350	480	487	0.826	-7	110	8	-44	10.3	39.8%
ZV	0.6%	58.3%	0.6%	58.2%	370	473	479	0.823	-6	90	12	-50	6.5	39.3%
ZW	3.7%	62.0%	3.6%	61.8%	370	478	479	0.823	-1	60	15	-50	6.5	36.1%
ZX	6.0%	68.0%	5.9%	67.8%	370	483	480	0.823	3	40	17	-50	6.5	31.0%
ZY	3.5%	71.5%	3.2%	71.0%	370	487	480	0.824	7	10	11	-50	6.5	28.1%
ZZ	0.7%	72.2%	0.9%	71.9%	370	487	480	0.824	7	10	11	-50	6.5	27.6%
YA	2.0%	74.2%	2.0%	73.8%	370	488	481	0.825	7	350	9	-49	7.5	25.9%
YB	2.9%	77.1%	2.9%	76.8%	390	485	474	0.821	11	320	12	-54	2.5	23.5%
YC	3.1%	80.2%	3.1%	79.8%	390	494	474	0.822	20	300	20	-54	2.5	21.1%
YD	2.7%	82.9%	2.8%	82.6%	390	505	474	0.822	31	290	32	-54	2.5	19.0%
YE	0.9%	83.8%	0.9%	83.6%	390	505	474	0.822	31	290	32	-54	2.5	18.3%
YF	1.2%	84.9%	1.3%	84.8%	390	510	474	0.822	36	290	41	-54	2.5	17.4%
YG	1.6%	86.6%	1.7%	86.5%	390	518	474	0.822	44	280	45	-54	2.5	16.1%
YH	2.9%	89.5%	3.1%	89.6%	390	523	474	0.822	49	280	51	-54	2.5	13.9%
YI	2.3%	91.8%	2.6%	92.2%	390	528	474	0.822	54	280	56	-54	2.5	12.2%
YJ	2.3%	94.1%	2.5%	94.6%	390	532	474	0.822	58	280	60	-54	2.5	10.5%
YK	0.1%	94.2%	0.2%	94.9%	390	537	474	0.822	63	280	62	-54	2.5	10.4%
YL	0.8%	95.0%	0.7%	95.6%	390	537	474	0.822	63	280	62	-54	2.5	9.8%
YM	0.5%	95.5%	0.6%	96.2%	390	536	475	0.822	61	280	53	-54	2.5	9.4%
YN	0.9%	96.4%	0.9%	97.1%	390	537	475	0.822	62	280	64	-54	2.5	8.7%
YO	0.1%	96.5%	0.2%	97.3%	390	534	475	0.823	59	280	65	-53	3.5	8.7%
YP	0.0%	96.5%	0.0%	97.3%	390	534	475	0.823	59	280	65	-53	3.5	8.7%
YQ	0.5%	97.0%	0.5%	97.9%	390	519	476	0.824	43	280	65	-53	3.5	8.3%
LDG	3.0%	100.0%	2.1%	100.0%										7.1%

July 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									12					
ZA	5.2%	5.2%	4.6%	4.6%	330	526	487	0.82	39	250	42	-42	8.34	91.5%
ZB	5.4%	10.6%	5.7%	10.3%	330	508	487	0.82	21	250	29	-41	9.3	85.7%
ZC	3.8%	14.4%	3.9%	14.2%	330	498	488	0.821	10	320	11	-41	9.3	81.6%
ZD	3.8%	18.2%	3.8%	18.0%	330	491	487	0.822	4	10	20	-42	8.3	77.7%
ZE	3.8%	22.0%	3.8%	21.9%	330	487	486	0.823	1	20	11	-43	7.3	73.8%
ZF	4.5%	26.4%	4.5%	26.4%	330	491	487	0.824	4	250	8	-44	6.3	69.2%
ZG	4.5%	30.9%	4.6%	30.9%	330	492	481	0.82	11	240	23	-47	3.3	64.8%
ZH	5.1%	36.0%	5.1%	36.0%	350	491	482	0.822	9	250	16	-47	7.3	59.9%
ZI	3.7%	39.7%	3.7%	39.7%	350	484	483	0.823	1	220	3	-46	8.3	56.4%
ZJ	1.8%	41.5%	1.8%	41.4%	350	480	484	0.823	-4	130	4	-45	9.3	54.7%
ZK	1.4%	42.9%	1.4%	42.8%	350	478	485	0.824	-7	120	7	-45	9.3	53.4%
ZL	1.1%	44.0%	1.1%	43.9%	350	476	485	0.824	-9	110	9	-45	9.3	52.3%
ZM	1.7%	45.7%	1.7%	45.7%	350	475	485	0.824	-10	110	11	-45	9.3	50.7%
ZN	2.0%	47.7%	1.9%	47.5%	350	474	486	0.825	-12	100	13	-45	9.3	48.9%
ZO	0.5%	48.2%	0.5%	48.0%	350	474	486	0.825	-12	100	14	-45	9.3	48.4%
ZP	0.8%	49.0%	0.8%	48.8%	350	475	486	0.825	-11	100	15	-45	9.3	47.7%
ZQ	2.3%	51.3%	2.2%	51.0%	350	474	486	0.825	-12	100	16	-45	9.3	45.6%
ZR	1.1%	52.4%	1.1%	52.2%	350	474	486	0.826	-12	90	17	-45	9.3	44.6%
ZS	1.4%	53.8%	1.3%	53.5%	350	474	486	0.826	-12	90	18	-45	9.3	43.3%
ZT	3.1%	56.9%	3.1%	56.6%	350	473	486	0.826	-13	80	19	-45	9.3	40.5%
ZU	1.1%	58.0%	1.1%	57.6%	350	478	485	0.826	-7	80	20	-45	9.3	39.4%
ZV	0.6%	58.6%	0.6%	58.2%	370	470	478	0.823	-8	80	25	-51	5.5	38.9%
ZW	3.7%	62.3%	3.6%	61.8%	370	472	478	0.823	-6	70	26	-51	5.5	35.8%
ZX	6.2%	68.5%	5.9%	67.8%	370	473	479	0.824	-6	60	22	-51	5.5	30.6%
ZY	3.4%	72.0%	3.2%	71.0%	370	481	479	0.825	2	40	12	-51	5.5	27.7%
ZZ	0.7%	72.6%	0.9%	71.9%	370	481	479	0.825	2	40	12	-51	5.5	27.2%
YA	2.0%	74.6%	2.0%	73.8%	370	487	479	0.825	8	350	9	-51	5.5	25.5%
YB	2.9%	77.5%	2.9%	76.8%	390	485	472	0.821	13	310	13	-55	1.5	23.2%
YC	3.1%	80.6%	3.1%	79.8%	390	494	473	0.822	21	290	24	-55	1.5	20.8%
YD	2.6%	83.2%	2.8%	82.6%	390	507	474	0.822	33	280	39	-55	1.5	18.7%
YE	0.9%	84.1%	0.9%	83.6%	390	507	474	0.822	33	280	39	-55	1.5	18.0%
YF	1.1%	85.3%	1.3%	84.8%	390	512	474	0.822	38	270	51	-54	2.5	17.1%
YG	1.6%	86.9%	1.7%	86.5%	390	524	474	0.822	50	270	57	-54	2.5	15.9%
YH	2.8%	89.7%	3.1%	89.6%	390	530	474	0.822	56	270	63	-54	2.5	13.8%
YI	2.4%	92.1%	2.6%	92.2%	390	536	474	0.822	62	270	68	-54	2.5	12.0%
YJ	2.2%	94.3%	2.5%	94.6%	390	540	474	0.822	66	270	73	-54	2.5	10.3%
YK	0.0%	94.3%	0.2%	94.9%	390	549	475	0.822	74	270	75	-54	2.5	10.3%
YL	0.8%	95.1%	0.7%	95.6%	390	549	475	0.822	74	270	75	-54	2.5	9.7%
YM	0.6%	95.6%	0.6%	96.2%	390	547	475	0.822	72	270	76	-53	3.5	9.3%
YN	0.8%	96.4%	0.9%	97.1%	390	548	475	0.822	73	270	77	-53	3.5	8.7%
YO	0.1%	96.6%	0.2%	97.3%	390	544	476	0.822	68	270	78	-53	3.5	8.6%
YP	0.1%	96.7%	0.0%	97.3%	390	544	476	0.822	68	270	78	-53	3.5	8.5%
YQ	0.5%	97.1%	0.5%	97.9%	390	524	476	0.822	48	270	78	-53	3.5	8.2%
LDG	2.9%	100.0%	2.1%	100.0%										7.0%

July 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									11					
ZA	5.2%	5.2%	4.6%	4.6%	330	521	487	0.82	34	240	40	-41	9.34	91.4%
ZB	5.5%	10.7%	5.7%	10.3%	330	504	488	0.821	16	240	27	-40	10.3	85.5%
ZC	3.8%	14.5%	3.9%	14.2%	330	497	488	0.822	9	330	11	-41	9.3	81.5%
ZD	3.7%	18.2%	3.8%	18.0%	330	495	487	0.822	8	360	24	-42	8.3	77.6%
ZE	3.8%	22.0%	3.8%	21.9%	330	492	487	0.823	5	360	14	-43	7.3	73.7%
ZF	4.5%	26.4%	4.5%	26.4%	330	488	487	0.824	1	230	7	-43	7.3	69.2%
ZG	4.6%	31.0%	4.6%	30.9%	330	495	489	0.825	6	230	21	-42	8.3	64.5%
ZH	4.9%	36.0%	5.1%	36.0%	350	487	482	0.822	5	240	14	-46	8.3	59.8%
ZI	3.8%	39.8%	3.7%	39.7%	350	481	484	0.823	-3	180	4	-46	8.3	56.2%
ZJ	1.7%	41.5%	1.8%	41.4%	350	481	484	0.823	-3	170	5	-45	9.3	54.6%
ZK	1.5%	43.0%	1.4%	42.8%	350	479	485	0.824	-6	140	6	-45	9.3	53.2%
ZL	1.1%	44.1%	1.1%	43.9%	350	477	485	0.824	-8	130	8	-45	9.3	52.1%
ZM	1.7%	45.9%	1.7%	45.7%	350	476	486	0.825	-10	120	10	-45	9.3	50.5%
ZN	2.0%	47.8%	1.9%	47.5%	350	475	486	0.825	-11	110	12	-45	9.3	48.7%
ZO	0.5%	48.3%	0.5%	48.0%	350	474	486	0.825	-12	110	13	-45	9.3	48.2%
ZP	0.8%	49.1%	0.8%	48.8%	350	475	486	0.825	-11	110	13	-45	9.3	47.5%
ZQ	2.2%	51.3%	2.2%	51.0%	350	474	486	0.825	-12	100	15	-45	9.3	45.5%
ZR	1.3%	52.5%	1.1%	52.2%	350	474	486	0.826	-12	100	16	-45	9.3	44.3%
ZS	1.4%	53.9%	1.3%	53.5%	350	475	486	0.826	-11	90	16	-45	9.3	43.1%
ZT	3.1%	57.0%	3.1%	56.6%	350	475	486	0.826	-11	80	17	-45	9.3	40.3%
ZU	1.0%	58.0%	1.1%	57.6%	350	481	486	0.826	-5	70	18	-45	9.3	39.3%
ZV	0.7%	58.7%	0.6%	58.2%	370	473	478	0.823	-5	70	22	-51	5.5	38.7%
ZW	3.7%	62.4%	3.6%	61.8%	370	476	479	0.823	-3	60	23	-51	5.5	35.6%
ZX	6.0%	68.4%	5.9%	67.8%	370	477	479	0.824	-2	50	21	-51	5.5	30.6%
ZY	3.4%	71.8%	3.2%	71.0%	370	485	479	0.825	6	20	12	-51	5.5	27.7%
ZZ	0.7%	72.5%	0.9%	71.9%	370	485	479	0.825	6	20	12	-51	5.5	27.1%
YA	2.0%	74.5%	2.0%	73.8%	390	482	472	0.821	10	360	13	-55	1.5	25.5%
YB	3.0%	77.5%	2.9%	76.8%	390	485	472	0.821	13	330	13	-55	1.5	23.2%
YC	3.0%	80.5%	3.1%	79.8%	390	494	473	0.822	21	300	22	-55	1.5	20.8%
YD	2.6%	83.1%	2.8%	82.6%	390	506	474	0.822	32	280	36	-54	2.5	18.8%
YE	0.9%	84.0%	0.9%	83.6%	390	506	474	0.822	32	280	36	-54	2.5	18.0%
YF	1.3%	85.3%	1.3%	84.8%	390	512	474	0.822	38	280	47	-54	2.5	17.1%
YG	1.5%	86.8%	1.7%	86.5%	390	522	474	0.822	48	270	53	-54	2.5	15.9%
YH	2.9%	89.7%	3.1%	89.6%	390	526	474	0.822	52	270	59	-54	2.5	13.8%
YI	2.3%	92.0%	2.6%	92.2%	390	534	474	0.822	60	270	64	-54	2.5	12.0%
YJ	2.3%	94.3%	2.5%	94.6%	390	539	475	0.822	64	280	68	-53	3.5	10.3%
YK	0.0%	94.3%	0.2%	94.9%	390	545	475	0.822	70	280	71	-53	3.5	10.3%
YL	0.8%	95.1%	0.7%	95.6%	390	545	475	0.822	70	280	71	-53	3.5	9.7%
YM	0.6%	95.6%	0.6%	96.2%	390	545	475	0.822	70	280	72	-53	3.5	9.3%
YN	0.8%	96.4%	0.9%	97.1%	390	546	476	0.822	70	280	72	-52	4.5	8.7%
YO	0.1%	96.6%	0.2%	97.3%	390	543	476	0.822	67	280	73	-52	4.5	8.6%
YP	0.1%	96.7%	0.0%	97.3%	390	543	476	0.822	67	280	73	-52	4.5	8.5%
YQ	0.5%	97.1%	0.5%	97.9%	390	527	477	0.823	50	280	73	-52	4.5	8.2%
LDG	2.9%	100.0%	2.1%	100.0%										7.0%

August 50% Route 4														
Way-point	∑ Time (% of Total)	Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									8					
ZA	5.2%	5.2%	4.6%	4.6%	310	517	492	0.824	25	240	31	-39	7.38	91.4%
ZB	5.5%	10.7%	5.7%	10.3%	330	497	486	0.821	11	240	21	-43	7.3	85.5%
ZC	3.9%	14.6%	3.9%	14.2%	330	489	486	0.822	3	250	4	-43	7.3	81.4%
ZD	3.8%	18.4%	3.8%	18.0%	330	486	486	0.823	0	140	1	-43	7.3	77.4%
ZE	3.8%	22.1%	3.8%	21.9%	330	488	487	0.823	1	350	2	-43	7.3	73.6%
ZF	4.3%	26.5%	4.5%	26.4%	330	496	488	0.824	8	270	9	-42	8.3	69.1%
ZG	4.6%	31.0%	4.6%	30.9%	350	494	482	0.82	12	260	17	-46	8.3	64.6%
ZH	4.9%	35.9%	5.1%	36.0%	350	488	484	0.822	4	240	10	-45	9.3	59.9%
ZI	3.8%	39.7%	3.7%	39.7%	350	480	485	0.823	-5	160	5	-45	9.3	56.3%
ZJ	1.8%	41.5%	1.8%	41.4%	350	476	485	0.824	-9	120	9	-45	9.3	54.6%
ZK	1.4%	42.9%	1.4%	42.8%	350	475	485	0.824	-10	110	11	-45	9.3	53.3%
ZL	1.1%	44.0%	1.1%	43.9%	350	474	486	0.824	-12	100	13	-44	10.3	52.2%
ZM	1.7%	45.7%	1.7%	45.7%	350	473	486	0.825	-13	100	14	-44	10.3	50.6%
ZN	1.9%	47.7%	1.9%	47.5%	350	473	486	0.825	-13	100	15	-44	10.3	48.8%
ZO	0.5%	48.1%	0.5%	48.0%	350	473	486	0.825	-13	100	15	-44	10.3	48.3%
ZP	0.8%	48.9%	0.8%	48.8%	350	474	486	0.825	-12	100	16	-44	10.3	47.6%
ZQ	2.3%	51.2%	2.2%	51.0%	350	473	486	0.825	-13	90	18	-45	9.3	45.5%
ZR	1.1%	52.3%	1.1%	52.2%	350	473	486	0.826	-13	90	20	-45	9.3	44.5%
ZS	1.4%	53.7%	1.3%	53.5%	350	472	486	0.826	-14	90	21	-45	9.3	43.2%
ZT	3.2%	56.9%	3.1%	56.6%	350	470	486	0.826	-16	80	24	-45	9.3	40.4%
ZU	1.0%	57.9%	1.1%	57.6%	350	476	486	0.826	-10	80	27	-45	9.3	39.4%
ZV	0.7%	58.6%	0.6%	58.2%	370	467	478	0.824	-11	80	33	-51	5.5	38.8%
ZW	3.6%	62.3%	3.6%	61.8%	370	469	479	0.824	-10	70	35	-51	5.5	35.7%
ZX	6.2%	68.4%	5.9%	67.8%	370	467	479	0.824	-12	70	33	-51	5.5	30.5%
ZY	3.5%	71.9%	3.2%	71.0%	370	476	479	0.825	-3	50	24	-51	5.5	27.6%
ZZ	0.6%	72.5%	0.9%	71.9%	370	476	479	0.825	-3	50	24	-51	5.5	27.1%
YA	2.1%	74.6%	2.0%	73.8%	370	483	479	0.825	4	30	17	-51	5.5	25.3%
YB	2.9%	77.4%	2.9%	76.8%	390	482	473	0.822	9	360	14	-55	1.5	23.1%
YC	3.1%	80.5%	3.1%	79.8%	390	491	473	0.822	18	310	18	-55	1.5	20.7%
YD	2.4%	82.9%	2.8%	82.6%	390	503	473	0.822	30	290	32	-55	1.5	18.8%
YE	1.1%	84.0%	0.9%	83.6%	390	503	473	0.822	30	290	32	-55	1.5	17.9%
YF	1.3%	85.3%	1.3%	84.8%	390	510	473	0.822	37	280	44	-55	1.5	17.0%
YG	1.5%	86.8%	1.7%	86.5%	390	520	473	0.822	47	280	50	-55	1.5	15.8%
YH	2.9%	89.6%	3.1%	89.6%	390	525	473	0.822	52	270	57	-55	1.5	13.7%
YI	2.3%	91.9%	2.6%	92.2%	390	531	473	0.822	58	270	65	-55	1.5	12.0%
YJ	2.3%	94.2%	2.5%	94.6%	390	534	473	0.822	61	270	71	-55	1.5	10.3%
YK	0.0%	94.2%	0.2%	94.9%	390	534	473	0.822	61	270	71	-55	1.5	10.3%
YL	0.8%	95.0%	0.7%	95.6%	390	544	473	0.822	71	270	74	-55	1.5	9.7%
YM	0.6%	95.6%	0.6%	96.2%	390	540	474	0.822	66	270	75	-55	1.5	9.2%
YN	0.8%	96.4%	0.9%	97.1%	390	541	474	0.822	67	270	76	-55	1.5	8.7%
YO	0.2%	96.6%	0.2%	97.3%	390	535	474	0.822	61	270	76	-54	2.5	8.5%
YP	0.0%	96.6%	0.0%	97.3%	390	535	474	0.823	61	270	76	-54	2.5	8.5%
YQ	0.5%	97.0%	0.5%	97.9%	390	512	475	0.824	37	270	77	-54	2.5	8.1%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

August 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									7					
ZA	5.2%	5.2%	4.6%	4.6%	310	512	493	0.824	19	230	30	-38	8.38	91.3%
ZB	5.6%	10.8%	5.7%	10.3%	330	492	486	0.821	6	220	21	-42	8.3	85.3%
ZC	3.9%	14.7%	3.9%	14.2%	330	485	487	0.822	-2	180	5	-42	8.3	81.2%
ZD	3.8%	18.4%	3.8%	18.0%	330	487	487	0.823	0	210	3	-43	7.3	77.3%
ZE	3.8%	22.2%	3.8%	21.9%	330	490	487	0.823	3	360	6	-43	7.3	73.4%
ZF	4.4%	26.6%	4.5%	26.4%	330	492	489	0.824	3	260	5	-42	8.3	68.8%
ZG	4.4%	31.1%	4.6%	30.9%	350	490	483	0.821	7	240	15	-45	9.3	64.5%
ZH	5.0%	36.1%	5.1%	36.0%	350	485	484	0.822	1	220	10	-45	9.3	59.6%
ZI	3.8%	39.8%	3.7%	39.7%	350	480	485	0.823	-5	170	7	-45	9.3	56.1%
ZJ	1.8%	41.6%	1.8%	41.4%	350	477	485	0.824	-8	130	9	-44	10.3	54.4%
ZK	1.4%	43.0%	1.4%	42.8%	350	475	486	0.824	-11	120	10	-44	10.3	53.1%
ZL	1.1%	44.1%	1.1%	43.9%	350	475	486	0.824	-11	110	12	-44	10.3	52.0%
ZM	1.7%	45.8%	1.7%	45.7%	350	474	486	0.825	-12	110	13	-44	10.3	50.4%
ZN	1.9%	47.8%	1.9%	47.5%	350	473	486	0.825	-13	110	14	-44	10.3	48.7%
ZO	0.5%	48.2%	0.5%	48.0%	350	473	486	0.825	-13	100	15	-44	10.3	48.2%
ZP	0.8%	49.0%	0.8%	48.8%	350	474	486	0.825	-12	100	15	-44	10.3	47.5%
ZQ	2.3%	51.3%	2.2%	51.0%	350	474	486	0.825	-12	100	17	-44	10.3	45.4%
ZR	1.1%	52.4%	1.1%	52.2%	350	474	486	0.826	-12	90	18	-45	9.3	44.4%
ZS	1.4%	53.8%	1.3%	53.5%	350	474	486	0.826	-12	80	20	-45	9.3	43.2%
ZT	3.1%	56.9%	3.1%	56.6%	350	473	486	0.826	-13	80	23	-45	9.3	40.3%
ZU	1.1%	58.0%	1.1%	57.6%	370	470	478	0.823	-8	70	30	-51	5.5	39.4%
ZV	0.6%	58.6%	0.6%	58.2%	370	470	479	0.824	-9	70	31	-51	5.5	38.9%
ZW	3.8%	62.3%	3.6%	61.8%	370	472	479	0.824	-7	70	34	-51	5.5	35.7%
ZX	6.0%	68.4%	5.9%	67.8%	370	471	479	0.824	-8	60	31	-51	5.5	30.6%
ZY	3.5%	71.9%	3.2%	71.0%	370	480	479	0.825	1	40	23	-51	5.5	27.7%
ZZ	0.6%	72.5%	0.9%	71.9%	370	480	479	0.825	1	40	23	-51	5.5	27.2%
YA	1.9%	74.4%	2.0%	73.8%	370	488	480	0.825	8	20	17	-51	5.5	25.5%
YB	3.0%	77.4%	2.9%	76.8%	390	484	473	0.822	11	360	17	-55	1.5	23.2%
YC	3.0%	80.3%	3.1%	79.8%	390	491	473	0.822	18	330	18	-55	1.5	20.9%
YD	2.5%	82.8%	2.8%	82.6%	390	503	474	0.822	29	300	30	-55	1.5	18.9%
YE	1.1%	84.0%	0.9%	83.6%	390	503	474	0.822	29	300	30	-55	1.5	18.0%
YF	1.1%	85.1%	1.3%	84.8%	390	510	473	0.822	37	290	41	-55	1.5	17.2%
YG	1.6%	86.7%	1.7%	86.5%	390	519	473	0.822	46	280	47	-55	1.5	16.0%
YH	2.8%	89.5%	3.1%	89.6%	390	523	473	0.822	50	270	54	-55	1.5	13.7%
YI	2.3%	91.8%	2.6%	92.2%	410	522	469	0.82	53	270	58	-58	-1.5	12.0%
YJ	2.3%	94.1%	2.5%	94.6%	410	524	469	0.82	55	270	64	-58	-1.5	10.3%
YK	0.0%	94.1%	0.2%	94.9%	410	524	469	0.82	55	270	64	-58	-1.5	10.3%
YL	0.9%	95.0%	0.7%	95.6%	410	524	469	0.82	55	270	64	-58	-1.5	9.7%
YM	0.6%	95.6%	0.6%	96.2%	410	528	470	0.821	58	260	68	-57	-0.5	9.3%
YN	0.8%	96.4%	0.9%	97.1%	410	529	470	0.821	59	260	68	-57	-0.5	8.7%
YO	0.2%	96.6%	0.2%	97.3%	410	522	470	0.821	52	260	69	-57	-0.5	8.5%
YP	0.0%	96.6%	0.0%	97.3%	410	522	470	0.821	52	260	69	-57	-0.5	8.5%
YQ	0.5%	97.0%	0.5%	97.9%	410	501	471	0.821	30	260	69	-57	-0.5	8.2%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

September 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									14					
ZA	5.2%	5.2%	4.6%	4.6%	310	529	492	0.823	37	250	41	-38	8.38	91.5%
ZB	5.4%	10.6%	5.7%	10.3%	330	515	486	0.82	29	260	36	-42	8.3	85.6%
ZC	3.7%	14.3%	3.9%	14.2%	330	508	487	0.821	21	290	21	-42	8.3	81.7%
ZD	3.7%	18.0%	3.8%	18.0%	330	498	486	0.822	12	310	12	-43	7.3	77.9%
ZE	3.8%	21.8%	3.8%	21.9%	330	491	486	0.823	5	290	4	-43	7.3	74.0%
ZF	4.5%	26.3%	4.5%	26.4%	330	489	487	0.824	2	230	5	-43	7.3	69.3%
ZG	4.6%	30.9%	4.6%	30.9%	350	491	480	0.82	11	250	17	-47	7.3	64.8%
ZH	5.0%	35.9%	5.1%	36.0%	350	499	482	0.821	17	260	24	-46	8.3	60.0%
ZI	3.6%	39.4%	3.7%	39.7%	350	499	484	0.822	15	260	22	-45	9.3	56.6%
ZJ	1.7%	41.2%	1.8%	41.4%	350	496	484	0.823	12	270	14	-45	9.3	55.0%
ZK	1.4%	42.6%	1.4%	42.8%	350	493	485	0.823	8	280	9	-45	9.3	53.7%
ZL	1.0%	43.6%	1.1%	43.9%	350	491	485	0.824	6	300	6	-45	9.3	52.7%
ZM	1.7%	45.3%	1.7%	45.7%	350	489	486	0.824	3	300	4	-44	10.3	51.1%
ZN	2.0%	47.3%	1.9%	47.5%	350	486	486	0.824	0	20	2	-44	10.3	49.3%
ZO	0.5%	47.8%	0.5%	48.0%	350	485	486	0.825	-1	60	2	-44	10.3	48.8%
ZP	0.8%	48.6%	0.8%	48.8%	350	485	486	0.825	-1	80	3	-44	10.3	48.1%
ZQ	2.2%	50.7%	2.2%	51.0%	350	482	486	0.825	-4	90	6	-45	9.3	46.1%
ZR	1.2%	51.9%	1.1%	52.2%	350	480	486	0.825	-6	90	9	-45	9.3	45.0%
ZS	1.4%	53.3%	1.3%	53.5%	350	479	486	0.825	-7	90	11	-45	9.3	43.8%
ZT	3.1%	56.4%	3.1%	56.6%	350	478	486	0.826	-8	80	14	-45	9.3	41.0%
ZU	1.0%	57.4%	1.1%	57.6%	350	481	486	0.826	-5	80	16	-45	9.3	40.0%
ZV	0.6%	58.0%	0.6%	58.2%	350	481	486	0.826	-5	70	17	-45	9.3	39.5%
ZW	3.8%	61.8%	3.6%	61.8%	370	473	479	0.823	-6	70	22	-51	5.5	36.2%
ZX	6.1%	67.9%	5.9%	67.8%	370	473	479	0.824	-6	60	22	-51	5.5	31.0%
ZY	3.7%	71.6%	3.2%	71.0%	370	480	479	0.825	1	40	17	-51	5.5	28.0%
ZZ	0.5%	72.1%	0.9%	71.9%	370	480	479	0.825	1	40	17	-51	5.5	27.6%
YA	2.0%	74.0%	2.0%	73.8%	370	487	480	0.825	7	10	14	-50	6.5	25.9%
YB	2.9%	76.9%	2.9%	76.8%	390	486	473	0.821	13	340	15	-55	1.5	23.6%
YC	3.1%	80.0%	3.1%	79.8%	390	496	473	0.822	23	300	23	-55	1.5	21.1%
YD	2.5%	82.6%	2.8%	82.6%	390	507	474	0.822	33	290	35	-54	2.5	19.2%
YE	1.0%	83.6%	0.9%	83.6%	390	507	474	0.822	33	290	35	-54	2.5	18.4%
YF	1.2%	84.8%	1.3%	84.8%	390	510	474	0.822	36	280	43	-54	2.5	17.5%
YG	1.6%	86.4%	1.7%	86.5%	390	517	474	0.822	43	280	46	-54	2.5	16.2%
YH	2.9%	89.3%	3.1%	89.6%	390	519	474	0.822	45	280	48	-54	2.5	14.0%
YI	2.4%	91.7%	2.6%	92.2%	390	521	474	0.822	47	280	50	-54	2.5	12.2%
YJ	2.3%	94.0%	2.5%	94.6%	390	522	474	0.823	48	270	53	-54	2.5	10.5%
YK	0.0%	94.0%	0.2%	94.9%	390	527	474	0.823	53	270	54	-55	1.5	10.5%
YL	0.8%	94.8%	0.7%	95.6%	390	527	474	0.823	53	270	54	-55	1.5	9.9%
YM	0.6%	95.4%	0.6%	96.2%	390	525	474	0.823	51	270	54	-55	1.5	9.5%
YN	0.9%	96.3%	0.9%	97.1%	390	525	474	0.823	51	270	54	-55	1.5	8.8%
YO	0.1%	96.4%	0.2%	97.3%	390	521	474	0.823	47	270	54	-55	1.5	8.7%
YP	0.0%	96.4%	0.0%	97.3%	390	521	474	0.823	47	270	54	-55	1.5	8.7%
YQ	0.6%	97.0%	0.5%	97.9%	390	507	475	0.824	32	270	54	-55	1.5	8.3%
LDG	3.0%	100.0%	2.1%	100.0%										7.0%

September 85% Route 4														
Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									13					
ZA	5.2%	5.2%	4.6%	4.6%	310	524	493	0.823	31	240	38	-38	8.38	91.4%
ZB	5.4%	10.6%	5.7%	10.3%	330	510	487	0.82	23	250	33	-42	8.3	85.5%
ZC	3.8%	14.4%	3.9%	14.2%	330	507	487	0.821	20	300	20	-42	8.3	81.5%
ZD	3.7%	18.1%	3.8%	18.0%	330	496	487	0.822	9	340	14	-42	8.3	77.7%
ZE	3.8%	21.9%	3.8%	21.9%	330	488	487	0.823	1	360	4	-43	7.3	73.8%
ZF	4.6%	26.5%	4.5%	26.4%	330	484	488	0.824	-4	190	7	-43	7.3	69.0%
ZG	4.6%	31.1%	4.6%	30.9%	350	486	481	0.821	5	230	16	-47	7.3	64.5%
ZH	4.9%	36.0%	5.1%	36.0%	350	494	482	0.821	12	250	21	-46	8.3	59.8%
ZI	3.6%	39.6%	3.7%	39.7%	350	495	484	0.822	11	250	19	-45	9.3	56.4%
ZJ	1.8%	41.4%	1.8%	41.4%	350	493	485	0.823	8	260	11	-45	9.3	54.6%
ZK	1.3%	42.7%	1.4%	42.8%	350	492	485	0.823	7	300	7	-44	10.3	53.5%
ZL	1.2%	43.8%	1.1%	43.9%	350	490	485	0.824	5	340	6	-44	10.3	52.4%
ZM	1.7%	45.6%	1.7%	45.7%	350	489	486	0.824	3	360	6	-44	10.3	50.8%
ZN	1.8%	47.4%	1.9%	47.5%	350	488	486	0.825	2	360	4	-44	10.3	49.1%
ZO	0.5%	47.9%	0.5%	48.0%	350	488	486	0.825	2	350	3	-44	10.3	48.6%
ZP	0.8%	48.7%	0.8%	48.8%	350	488	486	0.825	2	10	3	-44	10.3	47.8%
ZQ	2.2%	50.9%	2.2%	51.0%	350	485	486	0.825	-1	70	4	-44	10.3	45.8%
ZR	1.2%	52.0%	1.1%	52.2%	350	482	486	0.825	-4	90	7	-45	9.3	44.8%
ZS	1.4%	53.4%	1.3%	53.5%	350	481	486	0.825	-5	80	9	-45	9.3	43.5%
ZT	3.1%	56.5%	3.1%	56.6%	350	480	486	0.826	-6	70	12	-45	9.3	40.8%
ZU	1.2%	57.7%	1.1%	57.6%	350	483	486	0.826	-3	70	15	-45	9.3	39.7%
ZV	0.6%	58.2%	0.6%	58.2%	350	484	486	0.826	-2	70	16	-45	9.3	39.1%
ZW	3.7%	61.9%	3.6%	61.8%	370	477	479	0.823	-2	60	20	-50	6.5	36.0%
ZX	6.0%	67.9%	5.9%	67.8%	370	478	479	0.824	-1	50	20	-50	6.5	30.9%
ZY	3.7%	71.6%	3.2%	71.0%	370	486	479	0.824	7	20	17	-50	6.5	27.8%
ZZ	0.5%	72.0%	0.9%	71.9%	370	486	479	0.824	7	20	17	-50	6.5	27.4%
YA	2.0%	74.0%	2.0%	73.8%	390	485	472	0.821	13	360	18	-55	1.5	25.9%
YB	2.9%	76.9%	2.9%	76.8%	390	489	473	0.821	16	340	18	-55	1.5	23.6%
YC	3.1%	80.0%	3.1%	79.8%	390	495	473	0.822	22	320	22	-55	1.5	21.1%
YD	2.5%	82.5%	2.8%	82.6%	390	506	474	0.822	32	300	33	-54	2.5	19.1%
YE	1.0%	83.5%	0.9%	83.6%	390	506	474	0.822	32	300	33	-54	2.5	18.3%
YF	1.2%	84.7%	1.3%	84.8%	390	509	474	0.822	35	290	39	-54	2.5	17.4%
YG	1.6%	86.3%	1.7%	86.5%	390	514	474	0.822	40	280	41	-54	2.5	16.2%
YH	2.9%	89.2%	3.1%	89.6%	390	516	474	0.822	42	280	43	-54	2.5	14.0%
YI	2.4%	91.6%	2.6%	92.2%	390	518	474	0.822	44	280	45	-54	2.5	12.2%
YJ	2.3%	93.9%	2.5%	94.6%	390	519	474	0.823	45	280	47	-54	2.5	10.5%
YK	0.1%	94.0%	0.2%	94.9%	390	522	474	0.823	48	280	48	-54	2.5	10.4%
YL	0.8%	94.8%	0.7%	95.6%	390	522	474	0.823	48	280	48	-54	2.5	9.8%
YM	0.6%	95.4%	0.6%	96.2%	390	521	474	0.823	47	280	48	-54	2.5	9.4%
YN	0.9%	96.3%	0.9%	97.1%	390	521	475	0.823	46	280	48	-54	2.5	8.7%
YO	0.1%	96.4%	0.2%	97.3%	390	519	475	0.823	44	280	48	-54	2.5	8.6%
YP	0.0%	96.4%	0.0%	97.3%	390	519	475	0.823	44	280	48	-54	2.5	8.6%
YQ	0.5%	96.9%	0.5%	97.9%	390	508	475	0.824	33	280	48	-54	2.5	8.3%
LDG	3.1%	100.0%	2.1%	100.0%										7.0%

October 50% Route 4

Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									20					
ZA	5.1%	5.1%	4.6%	4.6%	330	535	482	0.82	53	260	55	-46	4.34	91.5%
ZB	5.4%	10.5%	5.7%	10.3%	330	522	483	0.82	39	270	45	-45	5.3	85.8%
ZC	3.7%	14.2%	3.9%	14.2%	330	514	485	0.821	29	280	31	-44	6.3	81.9%
ZD	3.7%	17.9%	3.8%	18.0%	330	509	485	0.822	24	280	25	-44	6.3	78.0%
ZE	3.7%	21.7%	3.8%	21.9%	330	507	486	0.822	21	270	22	-44	6.3	74.2%
ZF	4.4%	26.1%	4.5%	26.4%	330	506	487	0.823	19	280	20	-43	7.3	69.6%
ZG	4.4%	30.5%	4.6%	30.9%	350	502	480	0.82	22	300	22	-48	6.3	65.3%
ZH	4.9%	35.4%	5.1%	36.0%	350	506	480	0.821	26	290	26	-48	6.3	60.5%
ZI	3.6%	39.0%	3.7%	39.7%	350	508	482	0.822	26	280	30	-47	7.3	57.1%
ZJ	1.7%	40.7%	1.8%	41.4%	350	506	482	0.822	24	270	29	-46	8.3	55.5%
ZK	1.4%	42.1%	1.4%	42.8%	350	504	483	0.823	21	270	28	-46	8.3	54.2%
ZL	1.0%	43.2%	1.1%	43.9%	350	502	483	0.823	19	260	25	-46	8.3	53.2%
ZM	1.7%	44.9%	1.7%	45.7%	350	499	484	0.823	15	260	22	-46	8.3	51.6%
ZN	1.9%	46.8%	1.9%	47.5%	350	495	484	0.824	11	260	19	-45	9.3	49.9%
ZO	0.3%	47.1%	0.5%	48.0%	350	493	485	0.825	8	250	17	-45	9.3	49.5%
ZP	0.8%	48.0%	0.8%	48.8%	350	489	485	0.825	4	240	15	-45	9.3	48.7%
ZQ	2.3%	50.3%	2.2%	51.0%	350	486	485	0.825	1	230	12	-45	9.3	46.6%
ZR	1.2%	51.5%	1.1%	52.2%	350	483	486	0.825	-3	210	10	-45	9.3	45.5%
ZS	1.3%	52.7%	1.3%	53.5%	350	482	486	0.825	-4	200	7	-45	9.3	44.3%
ZT	3.3%	56.0%	3.1%	56.6%	370	472	478	0.822	-6	160	7	-50	6.5	41.4%
ZU	1.0%	57.0%	1.1%	57.6%	370	472	479	0.823	-7	120	8	-50	6.5	40.5%
ZV	0.7%	57.7%	0.6%	58.2%	370	472	479	0.823	-7	110	8	-50	6.5	39.9%
ZW	3.7%	61.5%	3.6%	61.8%	370	474	479	0.823	-5	110	7	-50	6.5	36.7%
ZX	6.1%	67.5%	5.9%	67.8%	370	478	480	0.823	-2	80	4	-50	6.5	31.6%
ZY	3.7%	71.2%	3.2%	71.0%	370	484	480	0.824	4	350	5	-50	6.5	28.4%
ZZ	0.5%	71.7%	0.9%	71.9%	370	484	480	0.824	4	350	5	-50	6.5	28.1%
YA	2.0%	73.7%	2.0%	73.8%	370	490	480	0.825	10	320	10	-50	6.5	26.3%
YB	3.0%	76.7%	2.9%	76.8%	390	489	472	0.821	17	310	16	-55	1.5	23.9%
YC	3.0%	79.7%	3.1%	79.8%	390	496	473	0.821	23	300	23	-55	1.5	21.5%
YD	2.6%	82.3%	2.8%	82.6%	390	504	473	0.822	31	290	32	-55	1.5	19.5%
YE	1.0%	83.4%	0.9%	83.6%	390	504	473	0.822	31	290	32	-55	1.5	18.7%
YF	1.3%	84.6%	1.3%	84.8%	390	507	473	0.822	34	290	37	-55	1.5	17.7%
YG	1.6%	86.3%	1.7%	86.5%	390	513	473	0.822	40	280	41	-55	1.5	16.4%
YH	2.9%	89.2%	3.1%	89.6%	390	516	473	0.822	43	280	45	-55	1.5	14.2%
YI	2.4%	91.6%	2.6%	92.2%	390	519	473	0.822	46	270	50	-55	1.5	12.4%
YJ	2.3%	93.9%	2.5%	94.6%	390	521	473	0.822	48	270	53	-55	1.5	10.6%
YK	0.0%	93.9%	0.2%	94.9%	390	527	473	0.822	54	270	56	-55	1.5	10.6%
YL	0.8%	94.8%	0.7%	95.6%	390	527	473	0.822	54	270	56	-55	1.5	10.0%
YM	0.6%	95.3%	0.6%	96.2%	390	524	473	0.823	51	270	56	-55	1.5	9.6%
YN	0.9%	96.3%	0.9%	97.1%	390	525	473	0.823	52	270	57	-55	1.5	8.9%
YO	0.1%	96.4%	0.2%	97.3%	390	520	473	0.823	47	270	57	-55	1.5	8.8%
YP	0.0%	96.4%	0.0%	97.3%	390	520	473	0.823	47	270	57	-55	1.5	8.8%
YQ	0.6%	97.0%	0.5%	97.9%	390	505	473	0.824	32	270	58	-56	0.5	8.4%
LDG	3.0%	100.0%	2.1%	100.0%										7.1%

October 85% Route 4														
Way-point	Time (%)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									18					
ZA	5.2%	5.2%	4.6%	4.6%	330	528	483	0.82	45	250	50	-45	5.34	91.5%
ZB	5.5%	10.7%	5.7%	10.3%	330	516	484	0.82	32	260	39	-44	6.3	85.6%
ZC	3.7%	14.4%	3.9%	14.2%	330	512	485	0.821	27	290	27	-43	7.3	81.7%
ZD	3.6%	18.0%	3.8%	18.0%	330	505	486	0.822	19	290	19	-43	7.3	77.9%
ZE	3.8%	21.8%	3.8%	21.9%	330	503	486	0.823	17	300	17	-43	7.3	74.0%
ZF	4.4%	26.2%	4.5%	26.4%	330	504	487	0.824	17	310	17	-43	7.3	69.5%
ZG	4.4%	30.6%	4.6%	30.9%	350	500	480	0.82	20	320	21	-47	7.3	65.1%
ZH	5.0%	35.6%	5.1%	36.0%	350	505	481	0.821	24	310	25	-47	7.3	60.3%
ZI	3.5%	39.1%	3.7%	39.7%	350	507	482	0.822	25	290	26	-47	7.3	57.0%
ZJ	1.7%	40.8%	1.8%	41.4%	350	504	483	0.822	21	270	25	-46	8.3	55.4%
ZK	1.4%	42.2%	1.4%	42.8%	350	500	483	0.823	17	260	24	-46	8.3	54.1%
ZL	1.0%	43.3%	1.1%	43.9%	350	497	484	0.823	13	250	23	-46	8.3	53.1%
ZM	1.7%	45.0%	1.7%	45.7%	350	495	484	0.824	11	250	20	-46	8.3	51.5%
ZN	1.9%	46.9%	1.9%	47.5%	350	492	485	0.824	7	240	17	-45	9.3	49.8%
ZO	0.5%	47.3%	0.5%	48.0%	350	490	485	0.825	5	240	16	-45	9.3	49.3%
ZP	0.8%	48.1%	0.8%	48.8%	350	486	485	0.825	1	230	15	-45	9.3	48.6%
ZQ	2.2%	50.3%	2.2%	51.0%	350	483	485	0.825	-2	220	13	-45	9.3	46.5%
ZR	1.2%	51.5%	1.1%	52.2%	350	480	486	0.825	-6	200	11	-45	9.3	45.5%
ZS	1.4%	52.9%	1.3%	53.5%	350	480	486	0.825	-6	190	9	-45	9.3	44.1%
ZT	3.2%	56.1%	3.1%	56.6%	370	472	478	0.822	-6	170	8	-50	6.5	41.3%
ZU	1.0%	57.2%	1.1%	57.6%	370	472	479	0.823	-7	140	7	-50	6.5	40.4%
ZV	0.7%	57.9%	0.6%	58.2%	370	472	479	0.823	-7	130	7	-50	6.5	39.8%
ZW	3.7%	61.6%	3.6%	61.8%	370	474	479	0.823	-5	130	6	-50	6.5	36.6%
ZX	6.0%	67.6%	5.9%	67.8%	370	479	480	0.823	-1	50	2	-50	6.5	31.5%
ZY	3.7%	71.3%	3.2%	71.0%	370	485	480	0.824	5	360	7	-50	6.5	28.4%
ZZ	0.5%	71.8%	0.9%	71.9%	370	485	480	0.824	5	360	7	-50	6.5	28.0%
YA	2.0%	73.8%	2.0%	73.8%	370	490	480	0.825	10	340	11	-50	6.5	26.3%
YB	2.9%	76.7%	2.9%	76.8%	390	489	473	0.821	16	330	16	-55	1.5	23.9%
YC	3.1%	79.8%	3.1%	79.8%	390	495	473	0.821	22	310	23	-55	1.5	21.5%
YD	2.6%	82.4%	2.8%	82.6%	390	503	474	0.822	29	300	30	-55	1.5	19.5%
YE	1.0%	83.4%	0.9%	83.6%	390	503	474	0.822	29	300	30	-55	1.5	18.7%
YF	1.2%	84.6%	1.3%	84.8%	390	507	473	0.822	34	290	35	-55	1.5	17.8%
YG	1.6%	86.2%	1.7%	86.5%	390	511	473	0.822	38	290	38	-55	1.5	16.5%
YH	3.0%	89.2%	3.1%	89.6%	390	514	473	0.822	41	280	42	-55	1.5	14.2%
YI	2.4%	91.6%	2.6%	92.2%	390	517	473	0.822	44	280	46	-55	1.5	12.4%
YJ	2.3%	94.0%	2.5%	94.6%	390	519	473	0.822	46	280	49	-55	1.5	10.6%
YK	0.0%	94.0%	0.2%	94.9%	390	523	473	0.823	50	270	51	-55	1.5	10.6%
YL	0.8%	94.8%	0.7%	95.6%	390	523	473	0.823	50	270	51	-55	1.5	10.0%
YM	0.6%	95.4%	0.6%	96.2%	390	520	473	0.823	47	270	51	-55	1.5	9.6%
YN	0.9%	96.3%	0.9%	97.1%	390	519	473	0.823	46	260	52	-55	1.5	8.9%
YO	0.1%	96.4%	0.2%	97.3%	390	515	474	0.824	41	260	52	-55	1.5	8.8%
YP	0.0%	96.4%	0.0%	97.3%	390	515	474	0.824	41	260	52	-55	1.5	8.8%
YQ	0.6%	97.0%	0.5%	97.9%	390	499	474	0.824	25	260	53	-55	1.5	8.4%
LDG	3.0%	100.0%	2.1%	100.0%										7.1%

November 50% Route 4														
Way-point	Σ Time (% of Total)	Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									27					
ZA	5.2%	5.2%	4.6%	4.6%	330	547	479	0.82	68	260	70	-49	1.34	91.5%
ZB	5.3%	10.5%	5.7%	10.3%	330	532	479	0.82	53	270	60	-48	2.3	85.9%
ZC	3.6%	14.1%	3.9%	14.2%	330	521	481	0.821	40	270	46	-47	3.3	82.1%
ZD	3.8%	17.9%	3.8%	18.0%	330	515	482	0.821	33	270	36	-47	3.3	78.2%
ZE	3.8%	21.6%	3.8%	21.9%	330	508	483	0.822	25	280	26	-46	4.3	74.3%
ZF	4.4%	26.0%	4.5%	26.4%	330	504	484	0.823	20	290	21	-46	4.3	69.9%
ZG	4.6%	30.6%	4.6%	30.9%	350	502	477	0.82	25	290	25	-50	4.3	65.4%
ZH	4.9%	35.5%	5.1%	36.0%	350	508	479	0.821	29	280	32	-49	5.3	60.6%
ZI	3.5%	39.1%	3.7%	39.7%	350	516	480	0.821	36	270	45	-48	6.3	57.3%
ZJ	1.8%	40.8%	1.8%	41.4%	350	519	481	0.822	38	270	51	-47	7.3	55.6%
ZK	1.3%	42.1%	1.4%	42.8%	350	519	482	0.822	37	260	53	-47	7.3	54.4%
ZL	1.1%	43.2%	1.1%	43.9%	350	518	482	0.822	36	260	54	-47	7.3	53.4%
ZM	1.6%	44.8%	1.7%	45.7%	350	517	483	0.823	34	260	52	-46	8.3	51.9%
ZN	1.9%	46.7%	1.9%	47.5%	350	514	484	0.823	30	260	48	-46	8.3	50.2%
ZO	0.4%	47.1%	0.5%	48.0%	350	512	484	0.824	28	260	45	-46	8.3	49.8%
ZP	0.8%	47.9%	0.8%	48.8%	350	504	484	0.824	20	260	42	-46	8.3	48.9%
ZQ	2.2%	50.1%	2.2%	51.0%	370	495	477	0.82	18	260	37	-51	5.5	46.9%
ZR	1.2%	51.3%	1.1%	52.2%	370	492	477	0.821	15	260	29	-50	6.5	45.9%
ZS	1.3%	52.6%	1.3%	53.5%	370	489	477	0.821	12	260	23	-50	6.5	44.7%
ZT	3.2%	55.8%	3.1%	56.6%	370	486	478	0.821	8	260	14	-50	6.5	41.9%
ZU	1.1%	56.8%	1.1%	57.6%	370	482	479	0.822	3	270	7	-50	6.5	41.0%
ZV	0.7%	57.5%	0.6%	58.2%	370	482	479	0.822	3	290	4	-50	6.5	40.4%
ZW	3.6%	61.2%	3.6%	61.8%	370	484	479	0.822	5	350	5	-50	6.5	37.2%
ZX	6.1%	67.3%	5.9%	67.8%	370	487	479	0.823	8	350	9	-50	6.5	32.0%
ZY	3.4%	70.7%	3.2%	71.0%	370	492	480	0.824	12	320	12	-50	6.5	29.1%
ZZ	0.7%	71.4%	0.9%	71.9%	370	492	480	0.824	12	320	12	-50	6.5	28.5%
YA	2.0%	73.4%	2.0%	73.8%	370	496	480	0.824	16	300	17	-50	6.5	26.9%
YB	2.8%	76.2%	2.9%	76.8%	370	499	480	0.825	19	300	20	-50	6.5	24.5%
YC	3.2%	79.4%	3.1%	79.8%	390	497	473	0.821	24	290	26	-54	2.5	21.9%
YD	2.6%	82.0%	2.8%	82.6%	390	503	473	0.822	30	290	32	-55	1.5	19.9%
YE	1.1%	83.1%	0.9%	83.6%	390	503	473	0.822	30	290	32	-55	1.5	19.1%
YF	1.3%	84.4%	1.3%	84.8%	390	505	473	0.822	32	290	36	-55	1.5	18.1%
YG	1.6%	86.0%	1.7%	86.5%	390	510	473	0.822	37	280	38	-55	1.5	16.8%
YH	2.9%	88.9%	3.1%	89.6%	390	512	473	0.822	39	280	40	-55	1.5	14.5%
YI	2.5%	91.4%	2.6%	92.2%	390	513	473	0.822	40	280	41	-55	1.5	12.6%
YJ	2.4%	93.8%	2.5%	94.6%	390	513	473	0.822	40	280	41	-55	1.5	10.9%
YK	0.1%	93.9%	0.2%	94.9%	390	514	473	0.823	41	280	41	-56	0.5	10.8%
YL	0.8%	94.7%	0.7%	95.6%	390	514	473	0.823	41	280	41	-56	0.5	10.2%
YM	0.6%	95.3%	0.6%	96.2%	390	513	473	0.823	40	280	41	-56	0.5	9.7%
YN	0.9%	96.2%	0.9%	97.1%	390	513	473	0.823	40	280	41	-56	0.5	9.0%
YO	0.1%	96.4%	0.2%	97.3%	390	511	473	0.823	38	280	40	-56	0.5	8.9%
YP	0.0%	96.4%	0.0%	97.3%	390	511	473	0.823	38	280	40	-56	0.5	8.9%
YQ	0.6%	96.9%	0.5%	97.9%	390	504	473	0.824	31	280	51	-56	0.5	8.5%
LDG	3.1%	100.0%	2.1%	100.0%										7.2%

November 85% Route 4														
Way-point	Time (%)	Σ Time (% of Total)	Distance (% of Total)	Σ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									24					
ZA	5.1%	5.1%	4.6%	4.6%	330	539	480	0.82	59	250	64	-48	2.34	91.5%
ZB	5.4%	10.5%	5.7%	10.3%	330	524	480	0.82	44	260	54	-47	3.3	85.8%
ZC	3.7%	14.3%	3.9%	14.2%	330	514	482	0.821	32	260	40	-47	3.3	81.8%
ZD	3.7%	18.0%	3.8%	18.0%	330	509	482	0.821	27	260	30	-46	4.3	78.0%
ZE	3.7%	21.8%	3.8%	21.9%	330	505	483	0.822	22	290	22	-46	4.3	74.1%
ZF	4.4%	26.2%	4.5%	26.4%	330	504	484	0.823	20	310	20	-45	5.3	69.6%
ZG	4.4%	30.6%	4.6%	30.9%	350	501	478	0.82	23	310	23	-50	4.3	65.2%
ZH	4.9%	35.6%	5.1%	36.0%	350	507	479	0.821	28	290	28	-49	5.3	60.5%
ZI	3.6%	39.2%	3.7%	39.7%	350	513	481	0.822	32	270	40	-48	6.3	57.0%
ZJ	1.8%	40.9%	1.8%	41.4%	350	513	481	0.822	32	260	47	-47	7.3	55.4%
ZK	1.3%	42.2%	1.4%	42.8%	350	513	482	0.822	31	260	49	-47	7.3	54.2%
ZL	1.1%	43.3%	1.1%	43.9%	350	513	482	0.823	31	260	50	-47	7.3	53.2%
ZM	1.6%	44.9%	1.7%	45.7%	350	511	483	0.823	28	260	48	-46	8.3	51.7%
ZN	1.9%	46.8%	1.9%	47.5%	350	509	484	0.823	25	250	45	-46	8.3	49.9%
ZO	0.5%	47.3%	0.5%	48.0%	350	507	484	0.824	23	250	41	-46	8.3	49.4%
ZP	0.8%	48.1%	0.8%	48.8%	350	499	485	0.824	14	250	39	-45	9.3	48.6%
ZQ	2.2%	50.3%	2.2%	51.0%	370	491	477	0.82	14	250	34	-50	6.5	46.6%
ZR	1.1%	51.3%	1.1%	52.2%	370	488	477	0.821	11	250	26	-50	6.5	45.7%
ZS	1.4%	52.7%	1.3%	53.5%	370	485	478	0.821	7	250	21	-50	6.5	44.4%
ZT	3.2%	55.9%	3.1%	56.6%	370	484	478	0.821	6	250	12	-50	6.5	41.6%
ZU	1.1%	57.0%	1.1%	57.6%	370	482	479	0.822	3	280	4	-50	6.5	40.7%
ZV	0.6%	57.5%	0.6%	58.2%	370	483	479	0.822	4	340	4	-50	6.5	40.2%
ZW	3.7%	61.3%	3.6%	61.8%	370	485	479	0.823	6	360	7	-50	6.5	36.9%
ZX	6.0%	67.3%	5.9%	67.8%	370	488	479	0.823	9	360	11	-50	6.5	31.8%
ZY	3.5%	70.8%	3.2%	71.0%	370	492	480	0.824	12	340	13	-50	6.5	28.9%
ZZ	0.7%	71.5%	0.9%	71.9%	370	492	480	0.824	12	340	13	-50	6.5	28.3%
YA	1.9%	73.3%	2.0%	73.8%	370	496	480	0.824	16	320	16	-50	6.5	26.7%
YB	3.0%	76.4%	2.9%	76.8%	390	492	473	0.821	19	310	19	-54	2.5	24.2%
YC	3.0%	79.4%	3.1%	79.8%	390	496	473	0.821	23	300	24	-54	2.5	21.8%
YD	2.6%	82.0%	2.8%	82.6%	390	502	473	0.822	29	300	30	-55	1.5	19.8%
YE	1.1%	83.0%	0.9%	83.6%	390	502	473	0.822	29	300	30	-55	1.5	18.9%
YF	1.3%	84.3%	1.3%	84.8%	390	505	473	0.822	32	290	34	-55	1.5	17.9%
YG	1.6%	86.0%	1.7%	86.5%	390	509	473	0.822	36	290	36	-55	1.5	16.7%
YH	2.9%	88.9%	3.1%	89.6%	390	511	473	0.822	38	290	37	-55	1.5	14.4%
YI	2.5%	91.3%	2.6%	92.2%	390	512	473	0.822	39	290	39	-55	1.5	12.6%
YJ	2.5%	93.8%	2.5%	94.6%	390	512	473	0.823	39	290	39	-55	1.5	10.7%
YK	0.1%	93.9%	0.2%	94.9%	390	511	473	0.823	38	290	38	-55	1.5	10.6%
YL	0.8%	94.7%	0.7%	95.6%	390	511	473	0.823	38	290	38	-55	1.5	10.0%
YM	0.6%	95.3%	0.6%	96.2%	390	511	473	0.823	38	290	38	-55	1.5	9.6%
YN	0.8%	96.1%	0.9%	97.1%	390	510	473	0.823	37	290	37	-56	0.5	9.0%
YO	0.2%	96.4%	0.2%	97.3%	390	510	473	0.823	37	290	37	-56	0.5	8.8%
YP	0.0%	96.4%	0.0%	97.3%	390	510	473	0.823	37	290	37	-56	0.5	8.8%
YQ	0.5%	96.8%	0.5%	97.9%	390	505	473	0.824	32	290	37	-56	0.5	8.4%
LDG	3.2%	100.0%	2.1%	100.0%										7.2%

December 50% Route 4

Way-point	∑ Time (% of Total)	Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									30					
ZA	5.1%	5.1%	4.6%	4.6%	330	563	478	0.82	85	270	87	-50	0.34	91.7%
ZB	5.1%	10.2%	5.7%	10.3%	330	555	479	0.82	76	270	84	-48	2.3	86.2%
ZC	3.6%	13.7%	3.9%	14.2%	330	549	480	0.82	69	270	76	-47	3.3	82.5%
ZD	3.6%	17.3%	3.8%	18.0%	330	543	481	0.821	62	280	64	-47	3.3	78.9%
ZE	3.6%	20.8%	3.8%	21.9%	330	534	481	0.821	53	280	53	-47	3.3	75.3%
ZF	4.3%	25.1%	4.5%	26.4%	330	523	482	0.822	41	290	42	-47	3.3	70.9%
ZG	4.5%	29.6%	4.6%	30.9%	350	514	477	0.82	37	290	38	-50	4.3	66.5%
ZH	5.0%	34.6%	5.1%	36.0%	350	515	478	0.82	37	290	39	-49	5.3	61.7%
ZI	3.6%	38.1%	3.7%	39.7%	350	518	479	0.821	39	280	45	-49	5.3	58.3%
ZJ	1.7%	39.8%	1.8%	41.4%	350	520	480	0.822	40	270	49	-48	6.3	56.7%
ZK	1.3%	41.1%	1.4%	42.8%	350	520	481	0.822	39	270	50	-48	6.3	55.5%
ZL	1.1%	42.1%	1.1%	43.9%	350	519	481	0.822	38	270	51	-47	7.3	54.5%
ZM	1.8%	43.9%	1.7%	45.7%	350	517	482	0.822	35	260	51	-47	7.3	52.9%
ZN	1.8%	45.7%	1.9%	47.5%	350	514	483	0.823	31	260	49	-46	8.3	51.2%
ZO	0.5%	46.2%	0.5%	48.0%	350	511	483	0.823	28	260	46	-46	8.3	50.7%
ZP	0.8%	47.0%	0.8%	48.8%	350	503	484	0.824	19	260	43	-46	8.3	49.9%
ZQ	2.1%	49.1%	2.2%	51.0%	370	493	476	0.82	17	260	38	-51	5.5	47.9%
ZR	1.2%	50.3%	1.1%	52.2%	370	490	477	0.82	13	260	29	-51	5.5	46.9%
ZS	1.4%	51.7%	1.3%	53.5%	370	486	477	0.821	9	250	24	-51	5.5	45.6%
ZT	3.2%	54.9%	3.1%	56.6%	370	484	478	0.821	6	250	17	-50	6.5	42.8%
ZU	1.1%	56.0%	1.1%	57.6%	370	478	478	0.822	0	240	11	-50	6.5	41.8%
ZV	0.6%	56.6%	0.6%	58.2%	370	478	478	0.822	0	240	9	-50	6.5	41.3%
ZW	3.8%	60.4%	3.6%	61.8%	370	478	479	0.822	-1	230	3	-50	6.5	38.0%
ZX	6.3%	66.6%	5.9%	67.8%	370	477	479	0.823	-2	70	7	-50	6.5	32.7%
ZY	3.6%	70.2%	3.2%	71.0%	370	477	480	0.824	-3	60	13	-50	6.5	29.7%
ZZ	0.7%	70.9%	0.9%	71.9%	370	477	480	0.824	-3	60	13	-50	6.5	29.1%
YA	2.1%	73.0%	2.0%	73.8%	370	480	480	0.825	0	90	13	-50	6.5	27.3%
YB	3.0%	76.0%	2.9%	76.8%	370	484	480	0.825	4	30	12	-50	6.5	24.9%
YC	3.2%	79.2%	3.1%	79.8%	370	491	481	0.825	10	350	13	-50	6.5	22.2%
YD	2.8%	82.0%	2.8%	82.6%	390	491	474	0.822	17	320	17	-54	2.5	19.9%
YE	0.9%	83.0%	0.9%	83.6%	390	491	474	0.822	17	320	17	-54	2.5	19.2%
YF	1.3%	84.3%	1.3%	84.8%	390	497	474	0.822	23	300	24	-54	2.5	18.2%
YG	1.7%	85.9%	1.7%	86.5%	390	502	474	0.822	28	300	28	-54	2.5	16.9%
YH	3.0%	88.9%	3.1%	89.6%	390	507	474	0.822	33	290	33	-54	2.5	14.6%
YI	2.6%	91.5%	2.6%	92.2%	390	512	474	0.822	38	290	38	-54	2.5	12.6%
YJ	2.4%	93.8%	2.5%	94.6%	390	516	474	0.822	42	290	42	-54	2.5	10.8%
YK	0.1%	94.0%	0.2%	94.9%	390	519	474	0.822	45	280	45	-54	2.5	10.7%
YL	0.8%	94.8%	0.7%	95.6%	390	519	474	0.822	45	280	45	-54	2.5	10.1%
YM	0.5%	95.3%	0.6%	96.2%	390	519	474	0.823	45	280	46	-54	2.5	9.8%
YN	0.9%	96.2%	0.9%	97.1%	390	520	474	0.823	46	280	47	-55	1.5	9.1%
YO	0.1%	96.3%	0.2%	97.3%	390	518	474	0.823	44	280	47	-55	1.5	9.0%
YP	0.1%	96.4%	0.0%	97.3%	390	518	474	0.823	44	280	47	-55	1.5	8.9%
YQ	0.5%	96.9%	0.5%	97.9%	390	508	474	0.823	34	280	48	-55	1.5	8.5%
LDG	3.1%	100.0%	2.1%	100.0%										7.2%

December 85% Route 4

Way-point	Time (%)	∑ Time (% of Total)	Distance (% of Total)	∑ Distance (% of Total)	Flight Level ('100 ft)	Ground Speed (kts)	True Airspeed (kts)	Mach Number	Wind Com-ponent (kts)	Wind Direction (°)	Wind Strength (kts)	Outside Air Temp (°C)	ISA DEV (°C)	Remain Fuel (% of Trip Fuel)
TO									27					
ZA	5.1%	5.1%	4.6%	4.6%	330	557	479	0.82	78	270	79	-49	1.34	91.6%
ZB	5.2%	10.2%	5.7%	10.3%	330	552	480	0.82	72	280	77	-48	2.3	86.1%
ZC	3.5%	13.8%	3.9%	14.2%	330	545	481	0.82	64	280	67	-47	3.3	82.4%
ZD	3.5%	17.3%	3.8%	18.0%	330	536	481	0.821	55	280	55	-47	3.3	78.8%
ZE	3.7%	21.0%	3.8%	21.9%	330	527	482	0.821	45	290	45	-46	4.3	75.0%
ZF	4.2%	25.2%	4.5%	26.4%	330	520	483	0.822	37	300	37	-46	4.3	70.7%
ZG	4.5%	29.7%	4.6%	30.9%	350	512	477	0.82	35	300	35	-50	4.3	66.3%
ZH	4.9%	34.6%	5.1%	36.0%	350	512	479	0.82	33	290	35	-49	5.3	61.5%
ZI	3.5%	38.2%	3.7%	39.7%	350	515	480	0.821	35	280	39	-48	6.3	58.1%
ZJ	1.8%	39.9%	1.8%	41.4%	350	516	481	0.822	35	280	42	-48	6.3	56.5%
ZK	1.3%	41.2%	1.4%	42.8%	350	515	481	0.822	34	270	43	-47	7.3	55.3%
ZL	1.1%	42.3%	1.1%	43.9%	350	513	482	0.822	31	260	45	-47	7.3	54.3%
ZM	1.6%	43.9%	1.7%	45.7%	350	511	482	0.823	29	260	46	-47	7.3	52.7%
ZN	1.9%	45.8%	1.9%	47.5%	350	509	483	0.823	26	250	45	-46	8.3	51.0%
ZO	0.5%	46.3%	0.5%	48.0%	350	506	484	0.824	22	250	43	-46	8.3	50.6%
ZP	0.8%	47.1%	0.8%	48.8%	350	498	484	0.824	14	250	40	-46	8.3	49.7%
ZQ	2.2%	49.4%	2.2%	51.0%	370	489	476	0.82	13	250	35	-51	5.5	47.7%
ZR	1.2%	50.5%	1.1%	52.2%	370	485	477	0.82	8	250	26	-51	5.5	46.6%
ZS	1.3%	51.8%	1.3%	53.5%	370	482	477	0.821	5	240	21	-51	5.5	45.5%
ZT	3.2%	55.0%	3.1%	56.6%	370	479	478	0.821	1	230	14	-50	6.5	42.7%
ZU	1.2%	56.2%	1.1%	57.6%	370	474	478	0.822	-4	210	9	-50	6.5	41.6%
ZV	0.6%	56.8%	0.6%	58.2%	370	474	479	0.822	-5	200	7	-50	6.5	41.1%
ZW	3.8%	60.5%	3.6%	61.8%	370	476	479	0.822	-3	180	3	-50	6.5	37.8%
ZX	6.1%	66.7%	5.9%	67.8%	370	481	479	0.823	2	30	5	-50	6.5	32.6%
ZY	3.5%	70.2%	3.2%	71.0%	370	480	480	0.823	0	40	11	-50	6.5	29.6%
ZZ	0.8%	71.0%	0.9%	71.9%	370	480	480	0.823	0	40	11	-50	6.5	28.9%
YA	2.0%	73.0%	2.0%	73.8%	370	483	480	0.825	3	30	12	-50	6.5	27.3%
YB	2.9%	76.0%	2.9%	76.8%	370	488	481	0.825	7	10	13	-50	6.5	24.9%
YC	3.2%	79.2%	3.1%	79.8%	370	492	481	0.825	11	350	14	-49	7.5	22.2%
YD	2.8%	82.0%	2.8%	82.6%	390	489	474	0.822	15	330	17	-54	2.5	19.9%
YE	0.9%	82.9%	0.9%	83.6%	390	489	474	0.822	15	330	17	-54	2.5	19.2%
YF	1.3%	84.2%	1.3%	84.8%	390	496	474	0.822	22	310	22	-54	2.5	18.2%
YG	1.6%	85.9%	1.7%	86.5%	390	500	474	0.822	26	310	26	-54	2.5	16.9%
YH	3.1%	88.9%	3.1%	89.6%	390	505	474	0.822	31	300	30	-54	2.5	14.5%
YI	2.5%	91.4%	2.6%	92.2%	390	510	474	0.823	36	300	35	-54	2.5	12.7%
YJ	2.4%	93.8%	2.5%	94.6%	390	513	474	0.823	39	290	39	-54	2.5	10.9%
YK	0.2%	94.0%	0.2%	94.9%	390	515	474	0.823	41	290	41	-54	2.5	10.7%
YL	0.7%	94.7%	0.7%	95.6%	390	515	474	0.823	41	290	41	-54	2.5	10.2%
YM	0.6%	95.3%	0.6%	96.2%	390	516	474	0.823	42	290	42	-54	2.5	9.7%
YN	0.9%	96.2%	0.9%	97.1%	390	516	474	0.823	42	290	42	-54	2.5	9.0%
YO	0.1%	96.3%	0.2%	97.3%	390	516	474	0.823	42	290	43	-54	2.5	8.9%
YP	0.0%	96.3%	0.0%	97.3%	390	516	474	0.823	42	290	43	-54	2.5	8.9%
YQ	0.6%	96.9%	0.5%	97.9%	390	508	474	0.823	34	280	44	-54	2.5	8.5%
LDG	3.1%	100.0%	2.1%	100.0%										7.2%

APPENDIX 12. AVERAGE WIND COMPONENTS (KTS) 2011 TO 2018

Date	2011	2012	2013	2014			2015			2016			2017			2018		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-Jan		-25	-47							-28				-25	-25		-27	
02-Jan		-32	-41							-22				-19	-19	-25		
03-Jan		-30	-39							-18			-11	-11		-12	-11	
04-Jan		-27	-41							-17			-22		-22			
05-Jan		-30	-37							-24			-31	-31	-31	-18	-18	
06-Jan		-25	-32							-27			-23					
07-Jan		-26	-38								-24	-27			-15			
08-Jan		-33	-41								-20			-15	-15		-21	
09-Jan		-34	-38							-24				-11		-28		
10-Jan		-33	-44							-39				-24			-15	
11-Jan		-35	-37							-39	-52	-44		-23	-23		-6	
12-Jan		-27	-44							-40	-58	-45		-19	-19		5	
13-Jan		-27	-40							-50		-52			-31	0		
14-Jan		-33								-44	-52			-32	-32	-5		
15-Jan		-31								-40	-37			-26	-26		-11	
16-Jan		-31								-56		-51			-21			
17-Jan		-30								-18		-51		-23	-23	-15		
18-Jan		-27									-46			-17	-17	-25		
19-Jan		-30									-48			-14	-14	-20		
20-Jan		-29									-45			-24	-24	-21		
21-Jan											-50			-15	-15	-13		
22-Jan														-17	-17	-22		
23-Jan													-7	-7		-27		
24-Jan												-13	-10	-10			-29	
25-Jan											-23			-20		-28		
26-Jan										-24	-23			-19		-31		
27-Jan											-29			-24	-24		-27	
28-Jan										-21				-22	-22	-29		
29-Jan										-24	-22		-20	-20	-20		-23	
30-Jan												-35	-13					
31-Jan										-15			-21	-21	-21	-49		-25
01-Feb										-20					-22	-28	-28	
02-Feb		-22								-19			-20	-20	-19		-27	
03-Feb		-22									-25		-25		-25		-36	
04-Feb		-23								-18	-16			-28			-31	
05-Feb		-28								-24			-28	-28		-28		
06-Feb		-41								-27			-21		-21		-27	
07-Feb										-19			-15		-15		-21	
08-Feb		-32								-35			-14		-15		-27	
09-Feb		-32										-21		-15	-15		-22	
10-Feb		-30										-20		-21	-21		-17	
11-Feb		-27										-18			-19	-15		
12-Feb		-27									-21			-26	-24		-20	
13-Feb											-24		-25	-25	-25		-22	
14-Feb		-30									-26		-21	-21	-21		-25	
15-Feb		-27								-13				-17			-33	
16-Feb		-33									-12				-18			-27
17-Feb		-34								-17			-15					-27
18-Feb		-39									-16		-13				-27	
19-Feb										-16			-12	-12			-13	
20-Feb											-28		-18	-18	-18			
21-Feb		-38									-28		-12	-12	-12			-4
22-Feb										-28				-22				-10
23-Feb		-34								-20				-20				-17
24-Feb										-15	-15			-16	-16			-18
25-Feb		-30								-23	-23			-19	-19			-17
26-Feb		-24								-27			-27	-27	-27			-15
27-Feb		-26								-28	-29		-13					-16
28-Feb										-23	-25		-18	-18	-18			-23

Date	2011	2012	2013	2014			2015			2016			2017		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-Mar		-32	-26					-31		-22	-20			-20	
02-Mar			-19								-16			-13	
03-Mar		-28	-20							-20				-23	
04-Mar		-20	-29							-28				-22	
05-Mar		-18	-29								-23			-20	-19
06-Mar			-32							-28				-21	-21
07-Mar		-21	-29						-20	-26				-23	
08-Mar		-24	-26					-28		-48	-24			-31	
09-Mar		-27	-23	-30	-27			-25				-26	-30	-30	
10-Mar		-24	-14		-29			-26			-26			-22	-22
11-Mar		-24	-12	-22				-35				-22	-20		-20
12-Mar		-29	-14	-18				-31				-21	-32	-32	
13-Mar			-22	-19				-34				-20			
14-Mar		-39	-36	-24			-32	-31			-27		-16	-16	
15-Mar		-37	-34	-20	-18		-28	-29	-28		-21		-8	-8	
16-Mar		-37	-36	-24				-33		-23	-19		-11	-11	
17-Mar		-29	-36	-24	-21			-33			-24		-18	-18	
18-Mar		-33	-28		-11		-35			-34	-30		-13	-13	
19-Mar		-37	-27	-22	-18	-17	-29			-30			-15	-15	-15
20-Mar		-28	-25		-13			-24		-26	-26		-15	-15	
21-Mar		-23	-23	-22				-26	-26		-25		-24	-24	
22-Mar		-25	-28	-26				-19			-28	-24	-24	-24	
23-Mar		-43	-38	-28				-18		-26				-27	-27
24-Mar			-33	-30	-37			-23	-23	-18			-27	-26	
25-Mar		-41	-22	-22	-23	-26	-27	-25		-22	-23		-14	-14	
26-Mar		-33	-34	-16	-19	-16	-23			-21	-21		-19		-20
27-Mar		-29	-30		-13			-13		-22			-12	-12	-11
28-Mar		-35	-31		-13			-13				-26			-24
29-Mar			-28			-11	-17	-18				-22	-24		-24
30-Mar		-43	-28			-14		-27				-18	-23	-23	-23
31-Mar		-34	-31		-18			-20			-19		-18	-18	
01-Apr		-31			-30					-28	-23	-14	-20		
02-Apr		-30		-29	-35						-23	-23	-26	-26	
03-Apr		-24				-30					-27		-22	-22	
04-Apr		-27		-32		-17					-21		-21	-21	-21
05-Apr		-26			-19						-16		-19	-19	
06-Apr		-24			-23						-17		-22	-22	
07-Apr		-23			-24						-18		-26		
08-Apr		-32				-11				-13			-14	-14	
09-Apr		-26				-6				-9			-11	-11	-12
10-Apr		-22				-11				-13			-12	-12	
11-Apr		-21				-19					-7		-14	-14	
12-Apr		-12			-26					-14				-20	
13-Apr		-15		-18	-18						-22		-22	-22	
14-Apr		-22		-9	-9						-21		-25	-25	
15-Apr		-19		-14	-13					-27	-17	-19	-20		-20
16-Apr		-20		-15							-21				-27
17-Apr		-32			-16						-20				-31
18-Apr		-28			-21							-23		-30	-30
19-Apr		-29			-24	-15				-36	-29	-28	-32	-31	-31
20-Apr		-23			-21					-37	-36	-35		-29	-29
21-Apr		-23		-22						-36			-29	-29	
22-Apr		-20		-28							-38		-23		-23
23-Apr				-34						-36	-36		-18	-18	-18
24-Apr		-22		-34							-29		-21		
25-Apr		-29		-26						-26	-25		-10		
26-Apr		-25		-27	-26					-27	-27		-14		
27-Apr		-26		-28	-28					-26			-17		-16
28-Apr		-24			-29	-26						-17			-16
29-Apr		-20		-27	-27						-28			-11	-11
30-Apr		-24		-30							-27	-26		-16	

Date	2011	2012	2013	2014			2015			2016			2017		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-May	-31	-28	-21	-30	-30				-17		-23			-3	
02-May	-31	-24	-28		-28	-22		-23				-20		-10	
03-May		-30	-29			-14		-15			-29	-21		-12	
04-May	-20	-28	-25		-22				-23	-21	-22			-12	-12
05-May		-34		-24	-23		-31	-26	-24	-14	-17				-8
06-May	-19	-30	-25	-23	-22			-18		-8	-9			-13	-13
07-May	-9	-30	-28	-25			-20			-7				-16	-17
08-May	-7	-29	-30	-24	-23		-23	-19		-12					-16
09-May	1	-21	-17	-15	-13			-25		-21	-15	-17			-18
10-May	-33	-19	-18	-18	-16			-19		-23				-24	-24
11-May	-35	-21	-19		-26	-20	-21			-24	-21	-17		-23	-22
12-May	-29	-23	-18	-23	-28	-13	-23	-24		-22				-15	-15
13-May	-20	-25	-15		-31	-8	-25	-21		-27				-20	-20
14-May	-2	-24	-22		-25	-8	-12	-21		-27				-21	-21
15-May	-24		-26		-22	-15	-19	-24			-25		-21	-21	
16-May	-18	-22	-28		-20		-20	-19		-17			-23	-23	
17-May	-11	-18	-30	-27	-27		-14	-12		-20			-21	-21	
18-May	-10	-10	-29	-28			-10	-14				-12		-15	
19-May	-14	-17	-23	-26			-12			-25	-20	-12		-12	
20-May	-12	-18	11	-20	-22		-10	-21			-23			-13	
21-May	-15	-15	-7	-15	-13				-7			-15		-11	-11
22-May	-17	-17	-5	-19			-7	-4	-4		-18			-9	-9
23-May	-32	-18	-2	-20	-20		-13	-11		-9				-11	-9
24-May	-18	-22	-2	-24			-14			-10			-6	-6	
25-May	-22	-14	-5	-17	-17			-15		-17			-9	-9	-9
26-May	-32	-14	-11			-8	-10	-8		-15					-8
27-May	-13	-13	-20	-18			-9				-16		-4	-4	-4
28-May	-17	-18	-18	-18		-14		-10			-5		-7	-7	-7
29-May	-14	-17	-16	-20				-6		-8				-7	
30-May		-14	-18	-18			-5				-7		-9	-9	
31-May	-14	-15	-14	-14			-12	-12			-8		-10		
01-Jun	-48	-21	-13	-8	-9		-26	-30		-8					-9
02-Jun	-23	-19	-20		-6		-27				-14		-9		-9
03-Jun	-13	-17	-12		-14			-27		-15				-16	-17
04-Jun	-10	-21	-12	-25	-24		-24	-21		-23	-20	-15			-22
05-Jun	1	-23	-3		-24	-24	-16			-30		-18			-17
06-Jun	-14	-19	1	-14	-12			-22		-32	-30	-21		-16	-16
07-Jun	-13	-16	0	-13			-16			-25				-18	-18
08-Jun	-20	-18		-15			-13	-13		-22				-13	-13
09-Jun	-17		-15	-25			-15					-8	-15	-14	-15
10-Jun	-10		1	-25	-24		-15				-13			-10	
11-Jun	-18		5	-20	-17			-15		-7				-1	-1
12-Jun	-17		4		-13		-14	-14		-3	-2		-5		-5
13-Jun	-7		-13	-9	-7	-7		-16		3			-5		
14-Jun	2		-10			-10		-17		8			-6		
15-Jun	-16		0		-4		-21	-20			-6		-6	-6	
16-Jun	-9		-6	-7	-5		-15					0	-2		
17-Jun	-17		-5	-8	-8			-11	-6			-10	1		1
18-Jun	-15		-4		-11		-11			-7	-4	-2	-3	-3	
19-Jun	-2		-3		-18		-9			7				-9	
20-Jun	-8		-4	-21	-21		-5	-5	-6	5	6	2		-9	-9
21-Jun	-8		-2	-12	-12		-4	-4			-1				-6
22-Jun	-13		-5		-4		-6	-4		-7				-3	-3
23-Jun	-16		-9		-2	-2		-8		-9					-3
24-Jun	-23		-9	-8	-5		-13			-2	-3	-4		-6	-6
25-Jun	-15		-3	-7	-8		-16				1		-4	-4	
26-Jun	-6		1	-12			-13				3		7	7	7
27-Jun	-11		-7	-16	-16		-4			6	5			2	
28-Jun	-24		3	-13				1		3	4			-9	
29-Jun	-6		3	-13			1	2		0	0			-6	
30-Jun	-1		2	-5			0			-1				-3	-3

Date	2011	2012	2013	2014			2015			2016			2017		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-Jul	-1	-2	13	-3			-4			-6				0	0
02-Jul	-18	-22	8	-8			-6			-1	-5	-4		1	
03-Jul	-10	-8	6	-14		-17	-4			-7	-8		1	1	
04-Jul	-8	-10	-1	-15			-2	-2				1			
05-Jul	-10	-11	-5	-16			-12			-8				7	7
06-Jul	-8		-7	-8	-6		-11			-11			4	4	4
07-Jul	-6	-17	-13	-7	-6		-9	-18			-12	-12		5	
08-Jul	-8	-16	-18		-8	-5	-9	-7		-7	-7	-4	9	9	
09-Jul	-6	-8	-13	-6			-11				-4		4	4	
10-Jul	-10	3	-5	0			-15			-5	0	2		-2	
11-Jul	2	3	-6		-1		-19			-3			-4	-4	
12-Jul	2	-6	-9	-10			-18			-2	-2	3	-1		
13-Jul	2	-11	-11	-4	-5			-16		-3			0	0	
14-Jul	-3	-18	-12	6				-17		-4			5		
15-Jul	-8	-13	-6				-15			-3			7		7
16-Jul	-8	2	-9				-11			1	3	-3	8	8	
17-Jul	-3	6	-4		4		0	-1		4			3	3	
18-Jul	-2	0	-6		-3			-4	-6	6			3	3	
19-Jul	-5	-35	-11		-5		-8			6	3	3	7	7	
20-Jul	-14	-5	2	-3			-10				2	6		5	
21-Jul	-15	3	8	1			-14				-1	4	3	3	
22-Jul	-17	2	0	-2		-5	-12			0	0			-1	-1
23-Jul	-16	-7	-3		1		-12			-5	-4	0	8	8	9
24-Jul	-3	-17	-2	-3				-10				-1			
25-Jul	-19	-7	-3	-10			-7			-8				2	
26-Jul	-19	-5	-1	-13	-13		-2			-3			1	1	
27-Jul	-4	-26	-1	-6	-4		-1			-1			3		3
28-Jul	-10	-10	-7	-9			-2	-1		-7	-5	-4	7	7	7
29-Jul	-1	-9	-6	-5			-2				-5		7	7	7
30-Jul	-11	-6	-9	-4			-2	-2		-6	-6			5	5
31-Jul	-12	-6	-6		7		-2	-1		-5	-4	-3	4		
01-Aug	-10	-2					0	-1		-1	4	3	2		
02-Aug	-10	-3		-1	1		2				6		-4		-4
03-Aug	-5	-4		-2			0	-2		-3				-10	-10
04-Aug	-8	-6		-4			-6	-3	-4			-4		-11	
05-Aug	-18	4		-5			-7	-6				0	-14	-14	
06-Aug	-21	0		-6	-7		-5			-2	-2		-4		
07-Aug	-13	-3		-8			2	3			2		1		
08-Aug	-5	-3		-2								7	7	7	
09-Aug	-3	-9		-1			9			-5	-2	4	5	5	
10-Aug	3	-6			-2		7				3		-3	-3	
11-Aug	3	-9			2		8			-3				3	
12-Aug	3	-10			-7	2	4			1				3	3
13-Aug	-2	-12		-12		-5		5		4	4	5	-1		-1
14-Aug	6	-15		-11	-11			3			4		3	3	
15-Aug	9	-14		-7			-7				3			6	
16-Aug	7	-12			-11		-4	-3		4			-5	-5	
17-Aug	-2	-12		-11				-1		2				-2	
18-Aug	-14	-14		-1	-2		-8			-4			-5		
19-Aug	-12	-14		1			-6			-13			-4		
20-Aug	-7	-16		-3			-11			-17			-4		
21-Aug		-7			-7		-10			-13			-5		
22-Aug	-14			-7	-7		-7	-9		-8	-7		0		
23-Aug	-9			-4			-1				-6		-1	-1	
24-Aug	-1				1		3			2			-1	-1	
25-Aug	-8				-2			2			1	3	-1		
26-Aug				-7			-5				-6		-3	-3	
27-Aug				-4		0		0			-7		-3	-3	
28-Aug	10				-7		-6	-4		-8			-3	-3	
29-Aug	14				-1	1	-7					5	-8		
30-Aug				-5			-11					-4		-4	
31-Aug	-9			-2	0		-15	-16	-12	-5	-6	-4	-9	-10	

Date	2011	2012	2013	2014			2015			2016			2017		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-Sep	-4				6			-9	-8	-2			-6		
02-Sep	-2			-1			-12	-10	-12	-11	-9	-7	2		
03-Sep	1			-5	-1	6		-13		-1			2		
04-Sep	2			5				-10			0		-2		-2
05-Sep					9			-5			-1			-5	-5
06-Sep	7				6		-4			-10	-7	-1	-5	-5	
07-Sep				7	8			-2		-6			-6		
08-Sep	-1			-5			-2			-2			-8		
09-Sep	-4			-6			-5			-2			-6		
10-Sep	-5			1			-5			1			-10	-10	
11-Sep	-7				6		-4	-2		-4	-2		-18		
12-Sep	-3			-2	1		0			-10	-3	2	-16		
13-Sep	-2				1		3			-4			-6	-5	
14-Sep	-7			-4			-5	-3		-1	0	-3		-9	-9
15-Sep	-6			-6	-2			-13				-4	-13		-13
16-Sep	-2			-6	-2	0		-8				-7	-10	-10	
17-Sep	-2			-9				-12			-11		-8	-8	
18-Sep	-7			-11			-24	-17	-16		-2	-2	-6	-5	
19-Sep	-6			-3					-9		0			-11	-11
20-Sep	-6			-6				-18				-1	-7		
21-Sep	-11			-3				-13				-2	-7		
22-Sep	-16			-6			-8		-1	-6				-10	
23-Sep	-15			-13			-3	-4				-3	-7	-7	
24-Sep	-16			-14		-4	-6	-5		-12	-8	-5	-6		-6
25-Sep	-13				-14		-15	-13				-3			-13
26-Sep	-16				-8		-21	-20				-8			-9
27-Sep	-15			-10	-10			-21	-17			-10		-8	-7
28-Sep	-15			-11	-9			-17	-12		-13			-21	
29-Sep	-14			-14			-20	-18		-5	-5				-13
30-Sep	-17			-9				-10			1		-9	-9	-9
01-Oct	-11	-11			-12		-8	-8		-7	-2	1			-10
02-Oct	-15	-13		-6	-5			1				-1		-12	-14
03-Oct	-16			-3	-3		-2				-7		-21		
04-Oct	-12	-23		-4			-5	-5		-10	-6	-4	-20		
05-Oct	-18	-24		-8	-9		-4	-7	-6	-13			-21	-25	
06-Oct	-22	-19			-6		-1			-19	-19	-17	-21		
07-Oct	-23	-20			-8			-5				-18	-16		
08-Oct	-25	-16			-13	-11	-12			-22	-21	-18	-14		
09-Oct	-23	-7			-12	-6		-12				-9	-18	-19	
10-Oct	-16	-11			-12	-2		-17			-13			-13	
11-Oct	-16	-11		-13		-3		-13			-9			-20	
12-Oct	-12	-9		-10	-7		-13				-9		0	-14	
13-Oct	-16	-11		-6				-9				-8	-14		
14-Oct	-18	-12		-9			-18					1	-14		
15-Oct	-20	-11		-19	-8		-18					-8		-13	
16-Oct	-24	-10			-6		-14				-12		-19	-18	
17-Oct	-32	-13				-8	-13			-9				-9	
18-Oct	-33	-15				-13		-16			-6			-11	
19-Oct	-21	-17		-16			-15			-10			-15		
20-Oct	-3	-22		-14			-13	-13				-7	-10		
21-Oct	3	-21		-16				-10				-11	-11		
22-Oct	-4	-22			-15		-14	-5		-12					-14
23-Oct	-9	-22			-23	-14		4		-13			-23		
24-Oct	-15	-22		-19			-6	-5		-18	-14	-10		-24	-15
25-Oct	-24	-35		-11			-17					-7			-11
26-Oct	-29	-36		-12			-19					-7	-23		
27-Oct	-31	-31		-18			-19	-20				-10	-28		
28-Oct	-31			-21				-15	-15		-20		-27		
29-Oct	-25					-15	-16				-22		-22		
30-Oct	-26			-15	-16		-18	-17			-20		-17		
31-Oct	-24	-29		-14			-19				-14			-17	

Date	2011	2012	2013	2014			2015			2016			2017		
				Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3	Route 1	Route 2	Route 3
01-Nov	-15	-23						-22			-10		-11		
02-Nov	-9	-24					-24	-24		-7			-10		
03-Nov	-18	-30						-26	-12			-12	-13		
04-Nov	-28	-22						-19	-13		-16			-5	
05-Nov		-19						-22			-20		-6		
06-Nov	-20	-19					-24				-23		-15		
07-Nov	-16	-19					-26	-25			-12				-14
08-Nov	-17	-21					-24	-24		-14			-19		-21
09-Nov	-21	-19					-26		-14	-19			-20		
10-Nov	-25	-13						-26	-17	-14			-20		
11-Nov	-28	-7					-27	-26		-8				-17	
12-Nov	-20	-11					-27			-14				-20	
13-Nov	-18	-12					-31	-27	-24	-11				-18	
14-Nov	-32	-12						-17			-22				
15-Nov	-28	-15						-18			-7				-23
16-Nov		-22					-22			-12				-23	-23
17-Nov		-23					-24	-24		-16					-19
18-Nov		-26					-21			-11					-19
19-Nov		-18					-18						-27		-21
20-Nov		-25					-20						-31		
21-Nov		-30						-27							-25
22-Nov		-26						-19		-17			-27		
23-Nov		-24					-14	-15		-19	-22				-28
24-Nov		-30					-11			-16				-24	
25-Nov		-35					-13	-16			-23		-16		
26-Nov		-22						-19		-22			-19		
27-Nov		-22					-23			-22	-18	-16		-20	
28-Nov		-24					-26			-22			-19		
29-Nov		-25					-28					-21		-20	
30-Nov		-22					-32				-24				-15
01-Dec	-18	-19					-30				-21			-25	
02-Dec	-22	-18					-32	-30	-30		-17			-28	
03-Dec	-22	-15					-29			-30	-24	-22	-31		
04-Dec	-23	-18					-32	-31	-5		-37			-33	
05-Dec	-28	-25							-18	-42	-40	-25	-32		
06-Dec	-41	-22					-40	-29	-25			-20			-22
07-Dec	-34	-27						-38	-33			-10			-24
08-Dec	-23	-31						-29				-13		-22	
09-Dec	-24	-26					-34	-30				-23		-14	
10-Dec	-25	-26						-15				-20		-12	
11-Dec	-19	-21						-28				-17		-19	
12-Dec	-19	-23						-29			-27		-25		
13-Dec	-24	-28					-35				-29	-25	-25		
14-Dec	-19						-31	-30			-25			-30	
15-Dec	-22	-25					-28				-20			-34	
16-Dec	-26	-26					-29				-28			-31	
17-Dec	-27	-34					-24	-20			-25		-32		
18-Dec	-29	-26						-12		-17				-36	
19-Dec	-35	-31					-13	-14			-15		-35		
20-Dec	-36	-21					-13	-13		-17				-22	
21-Dec	-38	-20					-17	-17				-13	-18		
22-Dec	-28	-18					-18	-13		-20				-18	
23-Dec	-32	-22					-23	-19				-23			-17
24-Dec	-37	-16					-26	-23			-24				-14
25-Dec	-34	-16					-34	-28			-23	-23		-31	-15
26-Dec	-26	-11					-26				-23			-20	
27-Dec	-26	-19					-23				-22	-18		-22	
28-Dec	-24	-27						-20	-26		-18				-17
29-Dec	-19	-24					-24				-15			-24	
30-Dec	-16						-28				-17		-26		
31-Dec	-24	-55					-36			-25				-22	

APPENDIX 13. PASSENGER LOAD FACTORS AND TRIP FUEL REQUIREMENTS

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-Jan		75.00%	79.60%	72.2%		37.80%	38.30%	37.7%
02-Jan		77.80%	85.10%	84.6%		37.10%	38.30%	38.3%
03-Jan		75.50%	74.50%	81.7%		37.00%	36.90%	37.2%
04-Jan		75.80%	73.40%			37.30%	36.60%	
05-Jan		76.30%	79.50%	88.7%		38.20%	37.70%	37.3%
06-Jan		83.70%	73.30%			37.80%	38.30%	
07-Jan		85.80%	78.70%			38.10%	38.80%	
08-Jan		87.40%	75.10%	84.6%		38.10%	37.10%	37.7%
09-Jan		78.30%	91.10%	85.9%		38.50%	37.50%	38.2%
10-Jan		74.00%	88.80%	93.4%		39.10%	37.10%	37.1%
11-Jan		62.00%	74.80%	78.5%		38.50%	37.40%	36.2%
12-Jan		62.20%	72.40%	80.1%		36.80%	36.60%	34.8%
13-Jan		57.80%	72.00%	67.0%		39.10%	36.40%	34.5%
14-Jan		61.80%	67.50%	72.7%		39.90%	38.10%	35.1%
15-Jan		72.40%	82.70%	69.0%		39.40%	38.40%	36.5%
16-Jan		59.80%	84.40%			39.00%	38.20%	
17-Jan			79.20%	77.1%			37.90%	37.1%
18-Jan		54.90%	54.30%	31.0%		38.90%	36.90%	34.9%
19-Jan		33.80%	49.80%	86.0%		37.60%	35.20%	37.7%
20-Jan		46.70%	49.30%	72.0%		37.20%	35.10%	36.9%
21-Jan		39.20%	54.90%	67.9%		38.10%	35.80%	36.0%
22-Jan			88.70%	56.6%			37.60%	36.2%
23-Jan			79.00%	53.4%			36.80%	36.9%
24-Jan		80.30%	47.60%	47.4%		38.20%	34.70%	37.0%
25-Jan		79.50%	48.60%	57.5%		37.70%	34.40%	37.3%
26-Jan		88.50%	64.40%	56.1%		37.60%	36.70%	36.9%
27-Jan		67.50%	53.30%	80.3%		38.90%	36.70%	38.6%
28-Jan		67.60%	70.90%	64.2%		37.30%	37.70%	37.7%
29-Jan		84.20%	67.60%	52.7%		37.40%	37.40%	36.6%
30-Jan		54.90%	76.20%			38.30%	37.40%	
31-Jan		62.20%	69.10%	79.9%		36.40%	36.80%	38.4%
01-Feb		46.90%	50.70%	69.0%		35.30%	36.10%	39.0%
02-Feb		46.10%	36.30%	62.0%		35.40%	35.60%	37.7%
03-Feb		40.00%	39.00%	73.3%		35.90%	35.70%	38.3%
04-Feb		48.10%	67.90%	45.5%		35.80%	37.40%	36.5%
05-Feb		49.30%	54.60%	32.4%		37.00%	37.40%	35.6%
06-Feb		52.40%	46.50%	45.3%		36.20%	36.70%	36.1%
07-Feb		42.20%	32.10%	58.2%		35.70%	34.80%	36.2%
08-Feb		69.60%	42.30%	45.6%		38.00%	35.50%	36.4%
09-Feb		40.30%	45.90%	50.2%		36.10%	35.30%	35.6%
10-Feb		38.10%	85.80%	78.8%		36.50%	37.40%	37.1%
11-Feb		44.90%	83.90%	55.5%		36.00%	37.30%	35.7%
12-Feb		42.40%	70.30%	42.1%		35.60%	37.90%	35.3%
13-Feb		43.50%	39.00%	38.9%		36.30%	35.50%	35.8%
14-Feb		54.10%	40.80%	50.2%		35.90%	35.80%	36.4%
15-Feb		60.30%	39.50%	32.4%		35.80%	35.80%	36.5%
16-Feb		47.20%	41.90%	31.5%		34.50%	37.30%	35.9%
17-Feb			50.00%	68.1%			35.70%	38.1%
18-Feb		53.00%	50.90%	85.5%		35.10%	35.20%	38.0%
19-Feb		84.80%	45.40%	85.9%		37.90%	34.10%	36.8%
20-Feb		75.80%	56.60%			38.30%	35.70%	
21-Feb		77.40%	54.40%	93.1%		38.20%	35.20%	36.6%
22-Feb		69.00%	52.30%	90.9%		37.60%	35.50%	37.1%
23-Feb		71.80%	59.80%	76.6%		37.00%	35.90%	37.2%
24-Feb		51.60%	71.70%	86.5%		36.20%	36.80%	37.6%
25-Feb		66.70%	75.40%	87.0%		37.00%	36.50%	37.8%
26-Feb		74.20%	79.30%	88.2%		38.40%	37.50%	37.4%
27-Feb		78.50%	86.20%	74.5%		38.30%	38.10%	37.0%
28-Feb		81.90%	85.60%	64.2%		38.30%	37.50%	37.3%

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-Mar		66.5%	84.5%			36.8%	37.4%	
02-Mar		56.8%	82.2%			36.9%	37.1%	
03-Mar		49.9%	76.4%			36.1%	37.1%	
04-Mar		63.9%	77.6%			37.6%	37.9%	
05-Mar		56.4%	69.9%			37.2%	35.9%	
06-Mar		68.2%	60.7%			37.0%	36.4%	
07-Mar		61.2%	72.0%			36.7%	36.9%	
08-Mar			44.3%				36.4%	
09-Mar		74.6%	44.6%			37.9%	37.4%	
10-Mar		69.1%	74.1%			37.4%	37.8%	
11-Mar		80.3%	73.4%			38.2%	37.8%	
12-Mar		87.1%	75.9%			37.8%	37.7%	
13-Mar		87.4%				37.6%		
14-Mar		86.2%	84.9%			38.0%	37.1%	
15-Mar		91.5%	90.5%			37.4%	37.0%	
16-Mar		88.4%	80.9%			37.5%	36.5%	
17-Mar		86.5%	84.2%			37.7%	37.4%	
18-Mar		81.5%	81.9%			38.3%	37.1%	
19-Mar		83.1%	92.3%			38.2%	36.8%	
20-Mar		88.9%	71.3%			38.1%	36.4%	
21-Mar		83.2%	70.4%			38.5%	37.2%	
22-Mar		83.5%	80.8%			38.3%	37.5%	
23-Mar		83.1%	85.3%			37.7%	38.0%	
24-Mar		85.2%	84.6%			37.6%	37.8%	
25-Mar		84.1%	85.8%			37.1%	38.0%	
26-Mar		80.9%	85.1%			37.5%	37.9%	
27-Mar		77.0%	85.3%			37.7%	37.8%	
28-Mar		80.7%	81.8%			38.0%	38.3%	
29-Mar		73.9%	81.3%			37.6%	38.4%	
30-Mar		74.5%	87.2%			37.0%	37.5%	
31-Mar		79.6%	81.8%			36.7%	37.7%	
01-Apr		87.0%	87.0%			37.5%	37.8%	
02-Apr		87.9%	80.3%			38.1%	38.0%	
03-Apr		75.4%	84.0%			38.0%	38.0%	
04-Apr		90.2%	82.6%			37.8%	37.3%	
05-Apr		92.3%	85.6%			37.6%	37.7%	
06-Apr		87.3%	80.2%			37.3%	37.4%	
07-Apr		79.4%	83.2%			37.1%	37.9%	
08-Apr		87.9%	72.2%			36.8%	36.1%	
09-Apr		79.2%	69.4%			36.4%	36.1%	
10-Apr		79.3%	59.0%			36.9%	35.0%	
11-Apr		92.8%	56.2%			36.5%	35.2%	
12-Apr		82.1%	69.3%			37.4%	36.9%	
13-Apr		80.8%	82.0%			37.8%	37.1%	
14-Apr		75.6%	82.9%			36.9%	38.2%	
15-Apr		81.6%	75.8%			37.3%	37.2%	
16-Apr		71.3%	83.9%			37.0%	37.9%	
17-Apr		83.1%	76.4%			37.5%	37.9%	
18-Apr		82.0%	71.1%			38.3%	38.3%	
19-Apr		80.1%	82.0%			38.1%	38.2%	
20-Apr		76.8%	83.3%			37.5%	38.3%	
21-Apr		43.2%	80.4%			36.9%	38.3%	
22-Apr		62.5%	82.6%			38.1%	38.1%	
23-Apr		71.4%	86.3%			38.5%	37.9%	
24-Apr		67.9%	84.8%			38.1%	37.3%	
25-Apr		64.9%	62.9%			37.0%	35.4%	
26-Apr		71.2%	66.1%			37.4%	36.2%	
27-Apr		73.0%	65.4%			37.8%	36.5%	
28-Apr		55.8%	67.1%			36.9%	36.2%	
29-Apr		69.9%	68.7%			37.7%	35.8%	
30-Apr		82.0%	68.5%			37.7%	37.6%	

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-May	68.5%	75.2%	75.6%		36.6%	37.6%	35.8%	
02-May	62.9%	85.3%	51.6%		37.5%	38.2%	35.0%	
03-May	61.4%	83.3%	46.4%		36.0%	37.8%	34.4%	
04-May	55.2%	71.6%	66.0%		35.8%	36.9%	35.2%	
05-May		63.1%	81.8%			34.5%	35.7%	
06-May		76.1%	77.3%			35.2%	35.8%	
07-May	50.1%	60.3%	53.2%		35.7%	34.8%	35.0%	
08-May	85.9%	81.8%	52.9%		37.8%	36.6%	35.6%	
09-May	81.4%	90.6%	59.6%		37.8%	36.6%	36.1%	
10-May	90.5%	56.8%	63.9%		37.3%	36.5%	36.7%	
11-May	87.7%	87.6%	71.0%		37.5%	36.3%	37.2%	
12-May	90.3%	45.1%	71.1%		37.5%	35.5%	36.5%	
13-May	78.4%	57.5%	76.8%		36.7%	36.7%	36.9%	
14-May		84.9%	66.2%			38.3%	36.7%	
15-May	79.0%	88.3%	64.9%		36.8%	37.8%	36.2%	
16-May	91.1%	90.6%	79.6%		37.3%	37.3%	37.9%	
17-May	96.7%	54.4%	60.5%		36.4%	35.5%	36.1%	
18-May	92.2%	52.1%	67.5%		36.5%	35.9%	36.0%	
19-May	53.8%	89.5%	79.1%		34.5%	37.0%	36.4%	
20-May	57.0%	83.0%	83.3%		34.2%	38.0%	37.1%	
21-May	47.9%	74.8%	52.3%		34.0%	37.1%	35.4%	
22-May	79.0%	71.8%	44.0%		33.8%	37.1%	35.4%	
23-May	79.4%	77.4%	77.1%		35.0%	36.1%	35.8%	
24-May	75.8%	52.4%	48.1%		35.3%	35.0%	35.1%	
25-May	51.0%	66.6%	60.2%		35.1%	36.2%	34.9%	
26-May	40.8%	69.1%	70.8%		33.6%	36.5%	35.9%	
27-May	73.3%	58.6%	74.2%		35.6%	36.0%	35.0%	
28-May	81.4%	74.4%	77.4%		35.6%	35.7%	35.8%	
29-May	100.0%	94.6%	67.9%		36.3%	36.9%	35.1%	
30-May	100.0%	95.7%	87.6%		36.2%	37.0%	36.6%	
31-May	95.8%	91.5%	80.6%		36.6%	36.9%	36.0%	
01-Jun	85.9%	77.5%	76.0%		37.5%	35.8%	35.8%	
02-Jun	89.8%	73.0%	87.2%		37.8%	36.4%	36.1%	
03-Jun	85.3%	59.1%	93.1%		37.5%	35.9%	37.0%	
04-Jun	70.6%	89.9%	84.0%		36.3%	37.8%	37.6%	
05-Jun	90.9%	78.0%	58.9%		36.8%	37.5%	35.5%	
06-Jun	80.2%	83.4%	58.6%		37.1%	38.2%	35.5%	
07-Jun	88.6%	86.3%	57.5%		36.5%	37.5%	35.5%	
08-Jun	42.9%	65.3%	89.6%		34.2%	36.7%	37.3%	
09-Jun	78.5%	53.1%	90.8%		35.2%	36.2%	37.5%	
10-Jun	60.9%	57.8%	94.5%		35.3%	35.8%	36.7%	
11-Jun	85.9%	78.6%	62.8%		37.2%	36.0%	34.1%	
12-Jun	97.0%	100.0%	55.5%		36.8%	36.5%	34.5%	
13-Jun	95.5%	69.3%	49.5%		36.9%	34.0%	33.9%	
14-Jun	83.4%	73.2%	61.6%		36.5%	34.3%	34.9%	
15-Jun	78.3%	55.4%	72.2%		36.5%	34.5%	35.3%	
16-Jun	72.3%	95.4%	70.7%		35.9%	35.2%	35.2%	
17-Jun	70.5%	76.4%	65.0%		34.8%	35.7%	34.5%	
18-Jun	78.0%	99.5%	55.4%		35.5%	35.4%	34.6%	
19-Jun	98.2%	64.8%	51.1%		37.0%	33.5%	34.1%	
20-Jun	100.0%	100.0%	72.1%		35.5%	34.3%	35.7%	
21-Jun	92.2%	73.8%	81.3%		35.7%	35.5%	35.3%	
22-Jun	100.0%	83.0%	82.5%		36.0%	36.0%	35.3%	
23-Jun	93.6%	71.9%	95.2%		36.1%	35.5%	36.3%	
24-Jun	91.3%	100.0%	78.3%		36.3%	36.2%	35.3%	
25-Jun	84.2%	94.6%	83.0%		37.1%	35.9%	35.3%	
26-Jun	98.5%	98.8%	72.6%		36.5%	36.0%	34.1%	
27-Jun	93.0%	89.2%	90.8%		36.1%	35.0%	35.2%	
28-Jun	96.2%	97.2%	89.0%		35.6%	35.8%	37.1%	
29-Jun	100.0%	74.0%	89.3%		35.9%	35.1%	35.9%	
30-Jun	93.8%	70.1%	99.7%		35.4%	35.1%	36.5%	

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-Jul	92.7%	80.1%	100.0%		35.4%	35.6%	36.0%	
02-Jul	98.0%		99.1%		36.3%		36.0%	
03-Jul	100.0%	93.6%	95.1%		36.1%	36.8%	35.6%	
04-Jul	100.0%	90.8%	100.0%		36.1%	36.7%	35.7%	
05-Jul	91.0%	66.1%	92.9%		36.8%	35.3%	35.3%	
06-Jul	48.9%	41.0%	81.3%		34.3%	34.4%	34.8%	
07-Jul	49.3%	88.4%	78.4%		34.9%	35.8%	34.8%	
08-Jul	87.6%	97.7%	100.0%		35.9%	35.9%	35.6%	
09-Jul	71.8%	89.8%	70.6%		36.1%	36.3%	34.7%	
10-Jul	93.5%	96.4%	81.9%		36.8%	35.8%	35.2%	
11-Jul	93.5%	94.9%	76.9%		37.7%	36.3%	35.7%	
12-Jul	99.1%	91.6%	80.7%		37.2%	33.4%	35.0%	
13-Jul	78.1%	57.7%	69.3%		37.2%	34.2%	35.1%	
14-Jul	89.9%	55.5%	81.9%		36.9%	34.5%	34.7%	
15-Jul	97.3%	96.9%	96.0%		36.7%	36.2%	35.5%	
16-Jul	87.9%	100.0%	65.0%		36.8%	36.1%	33.9%	
17-Jul	100.0%	92.1%	98.0%		36.1%	35.5%	36.1%	
18-Jul	80.3%	69.3%	91.1%		35.5%	34.3%	35.3%	
19-Jul	62.0%	56.7%	83.4%		34.7%	33.8%	35.1%	
20-Jul	90.2%	48.8%	64.2%		35.7%	33.6%	34.4%	
21-Jul	72.9%	89.9%	57.7%		35.6%	34.7%	34.4%	
22-Jul	77.5%	81.0%	67.1%		36.3%	35.3%	34.5%	
23-Jul	79.6%	100.0%	80.5%		35.4%	36.5%	35.1%	
24-Jul	84.5%	91.8%	71.5%		36.7%	36.5%	33.7%	
25-Jul	90.6%	84.2%	77.9%		35.6%	36.2%	35.2%	
26-Jul	88.6%	56.3%	65.8%		35.2%	34.5%	34.1%	
27-Jul	82.5%	67.5%	71.8%		35.1%	34.4%	34.8%	
28-Jul	92.6%	99.8%	93.2%		35.8%	35.3%	35.0%	
29-Jul	91.6%	84.6%	72.4%		34.9%	35.7%	34.5%	
30-Jul	97.6%	88.7%	82.7%		36.1%	36.4%	34.7%	
31-Jul	100.0%	100.0%	84.4%		35.8%	36.7%	35.2%	
01-Aug	97.0%	99.9%	94.7%		35.7%	34.8%	35.8%	
02-Aug	99.1%	72.1%	87.7%		35.2%	34.7%	35.8%	
03-Aug	94.4%	74.2%	77.5%		33.7%	35.2%	35.8%	
04-Aug	92.4%	66.6%	79.8%		36.5%	35.6%	36.2%	
05-Aug	97.5%	90.0%	88.8%		36.4%	36.7%	36.7%	
06-Aug	92.1%	85.1%	81.3%		36.6%	35.8%	35.7%	
07-Aug	100.0%	100.0%	85.0%		35.4%	36.5%	34.9%	
08-Aug	100.0%	90.3%	93.8%		35.4%	35.7%	35.1%	
09-Aug	98.9%	100.0%	96.9%		35.3%	36.1%	35.2%	
10-Aug	99.2%	66.0%	74.5%		34.6%	34.4%	35.2%	
11-Aug	87.1%	91.5%	75.8%		35.0%	36.3%	34.6%	
12-Aug	98.9%	89.8%	99.4%		35.3%	35.4%	36.0%	
13-Aug	99.1%	100.0%	85.2%		35.6%	35.3%	35.2%	
14-Aug	98.8%	95.8%	85.7%		35.8%	35.6%	35.3%	
15-Aug	100.0%	88.5%	95.5%		36.7%	35.9%	36.1%	
16-Aug	100.0%	84.6%	95.7%		36.3%	35.2%	36.9%	
17-Aug	100.0%	92.7%	99.8%		36.1%	35.7%	36.2%	
18-Aug	97.1%	77.7%	99.0%		35.9%	35.7%	36.8%	
19-Aug	100.0%	93.1%			36.8%	37.2%		
20-Aug	91.7%	93.8%	85.1%		36.4%	37.3%	35.8%	
21-Aug	95.7%	93.1%	82.2%		36.8%	37.2%	35.3%	
22-Aug	97.4%	96.1%	90.0%		36.0%	36.5%	35.6%	
23-Aug	86.4%	91.2%	90.5%		35.1%	36.4%	35.4%	
24-Aug	84.9%	95.6%	83.0%		35.5%	36.1%	35.7%	
25-Aug	98.1%	95.3%	97.9%		35.3%	36.1%	36.6%	
26-Aug	97.4%	92.6%	100.0%		35.8%	36.5%	36.4%	
27-Aug	100.0%	96.6%	97.9%		35.5%	36.8%	36.0%	
28-Aug	100.0%	96.7%	97.6%		36.4%	36.9%	36.4%	
29-Aug	100.0%	94.9%	88.5%		36.5%	36.2%	36.2%	
30-Aug	100.0%	83.4%	83.3%		36.6%	36.4%	36.3%	
31-Aug	82.1%	99.9%	85.7%		35.9%	36.6%	36.6%	

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-Sep	100.00%	94.30%	82.7%		36.70%	36.20%	36.2%	
02-Sep	95.90%	97.00%	77.4%		36.40%	36.60%	34.8%	
03-Sep	88.50%	90.00%	78.4%		36.30%	35.50%	35.1%	
04-Sep	93.10%	99.70%	79.6%		35.80%	36.30%	35.3%	
05-Sep	92.40%	92.60%	70.4%		35.70%	35.90%	36.0%	
06-Sep	99.60%	98.20%	70.8%		36.00%	36.60%	36.1%	
07-Sep	93.30%	80.00%	63.4%		35.70%	35.00%	34.7%	
08-Sep	96.70%	72.30%	72.0%		35.30%	34.90%	35.9%	
09-Sep	74.80%	39.70%	80.5%		34.00%	33.20%	35.7%	
10-Sep	69.60%	90.10%	57.1%		34.60%	35.60%	34.9%	
11-Sep	98.20%	87.60%	54.4%		36.60%	35.80%	35.4%	
12-Sep	95.20%	96.60%	59.9%		35.50%	36.30%	36.2%	
13-Sep	83.10%	59.70%	92.7%		34.00%	34.30%	36.2%	
14-Sep	77.90%	100.00%	85.0%		35.20%	34.50%	36.9%	
15-Sep	61.30%	65.80%	91.6%		35.00%	36.70%	37.3%	
16-Sep	76.80%	86.50%	87.3%		34.40%	36.60%	37.0%	
17-Sep	76.60%	95.60%	80.7%		36.20%	37.00%	35.9%	
18-Sep	94.00%	97.50%	59.7%		37.20%	36.90%	34.9%	
19-Sep	99.80%	100.00%	59.2%		37.10%	36.40%	36.1%	
20-Sep	87.10%	81.40%	57.9%		37.30%	36.10%	35.2%	
21-Sep	85.50%	91.00%	77.9%		36.80%	36.50%	36.7%	
22-Sep	77.20%	86.70%	77.9%		34.60%	35.50%	36.4%	
23-Sep	97.70%	83.00%	85.0%		35.90%	36.40%	37.4%	
24-Sep	99.90%	98.30%	80.5%		36.10%	36.80%	36.4%	
25-Sep	95.10%	84.50%	54.4%		36.80%	36.50%	35.9%	
26-Sep	90.60%	92.30%	58.8%		37.40%	37.20%	34.7%	
27-Sep	71.80%	80.60%	77.8%		34.90%	36.70%	36.1%	
28-Sep	75.20%	65.40%	83.0%		35.40%	35.80%	37.9%	
29-Sep	83.10%	77.50%	95.8%		36.90%	35.60%	37.1%	
30-Sep	95.00%	96.90%	94.4%		37.10%	36.00%	37.0%	
01-Oct	100.00%	100.00%	91.5%		36.70%	36.30%	37.4%	
02-Oct	96.30%	99.20%	76.9%		36.40%	37.00%	36.3%	
03-Oct	100.00%	94.40%	82.4%		36.00%	36.60%	37.7%	
04-Oct	94.60%	98.10%	54.0%		36.00%	36.80%	35.6%	
05-Oct	89.10%	94.40%	56.9%		35.10%	37.10%	36.1%	
06-Oct	75.10%	92.50%	74.4%		33.80%	37.50%	37.2%	
07-Oct	87.00%	86.30%	72.7%		35.70%	38.10%	36.2%	
08-Oct	77.90%	89.20%	90.1%		36.00%	37.70%	37.4%	
09-Oct	98.70%	91.50%	86.0%		36.90%	37.40%	37.1%	
10-Oct	82.40%	94.10%	72.0%		36.60%	37.10%	35.9%	
11-Oct	74.90%	96.20%	74.4%		35.80%	36.70%	36.6%	
12-Oct	78.60%	97.20%	68.8%		35.90%	37.00%	35.6%	
13-Oct	82.40%	92.70%	69.9%		35.10%	36.60%	35.8%	
14-Oct	87.00%	88.90%	93.9%		36.40%	36.00%	37.0%	
15-Oct	87.40%	92.60%	91.7%		37.10%	37.10%	37.1%	
16-Oct	90.20%	94.40%	82.7%		37.40%	37.00%	37.5%	
17-Oct	89.30%	97.00%	92.3%		36.90%	36.80%	36.9%	
18-Oct	88.40%	95.10%	90.6%		36.70%	36.70%	36.7%	
19-Oct	86.70%	70.40%	60.3%		36.50%	36.00%	36.6%	
20-Oct	94.00%	47.90%	70.4%		36.90%	35.50%	35.9%	
21-Oct	88.40%	80.50%	92.4%		36.10%	37.10%	37.0%	
22-Oct	76.10%	91.60%	88.2%		35.60%	37.00%	37.6%	
23-Oct	100.00%	87.80%	57.9%		36.00%	37.20%	36.4%	
24-Oct	97.00%	94.40%	63.4%		36.60%	37.10%	37.1%	
25-Oct	87.40%	71.90%	80.3%		36.20%	36.30%	37.9%	
26-Oct	59.60%	77.70%	74.6%		35.80%	36.40%	37.4%	
27-Oct	88.50%	75.90%	68.0%		36.10%	36.50%	37.3%	
28-Oct	90.00%	89.30%	83.9%		36.90%	37.70%	37.6%	
29-Oct	92.60%	86.00%	78.8%		36.80%	38.00%	37.8%	
30-Oct	93.70%	80.90%	88.6%		36.90%	37.30%	37.4%	
31-Oct	89.90%	94.50%	89.5%		37.40%	37.20%	37.7%	

Date	Passenger Load Factor				Actual Trip Fuel			
	2015	2016	2017	2018	2015	2016	2017	2018
01-Nov	88.40%	94.40%	99.0%		37.10%	36.90%	36.93%	
02-Nov	82.90%	76.40%	92.6%		38.00%	35.80%	36.96%	
03-Nov	72.90%	83.20%	76.9%		36.60%	36.60%	36.44%	
04-Nov	78.00%	91.30%	94.6%		36.50%	37.50%	36.44%	
05-Nov	80.20%	89.80%			38.00%	37.80%		
06-Nov	89.60%	68.20%	75.2%		37.50%	36.80%	36.39%	
07-Nov	87.30%	76.00%	60.8%		37.60%	37.00%	35.74%	
08-Nov	85.50%	61.70%	65.1%		38.00%	36.40%	36.45%	
09-Nov	75.50%	37.70%	90.1%		34.70%	35.50%	37.15%	
10-Nov		67.40%	88.6%			35.50%	37.34%	
11-Nov	90.40%	89.40%	89.6%		37.80%	37.40%	37.20%	
12-Nov	78.20%	80.30%	78.7%		38.20%	36.50%	37.70%	
13-Nov	85.30%	76.30%	87.6%		37.60%	36.30%	37.83%	
14-Nov	88.50%	76.30%	69.0%		37.50%	37.50%	38.08%	
15-Nov	94.10%	82.00%	63.4%		37.20%	36.40%	36.96%	
16-Nov	76.40%	88.40%	53.5%		37.90%	36.70%	36.33%	
17-Nov	81.40%	65.60%	75.8%		37.40%	36.50%	37.20%	
18-Nov	78.10%	88.40%	89.2%		37.30%	36.40%	37.96%	
19-Nov	64.80%		69.3%		36.10%		36.99%	
20-Nov	77.90%		67.0%		37.30%		37.45%	
21-Nov	79.10%		43.5%		37.70%		36.32%	
22-Nov	59.70%	72.70%	55.0%		36.30%	36.50%	36.92%	
23-Nov	81.80%	81.90%	41.9%		35.40%	37.40%	36.59%	
24-Nov	60.60%	78.10%	84.7%		35.20%	36.40%	38.18%	
25-Nov	71.80%	59.30%	89.3%		35.60%	36.80%	36.89%	
26-Nov	57.50%	68.80%	86.8%		36.90%	36.30%	37.51%	
27-Nov	78.90%	87.50%	80.9%		37.50%	37.30%	37.35%	
28-Nov	83.50%	82.20%	63.0%		38.20%	37.80%	36.54%	
29-Nov	80.60%	79.30%	62.8%		38.40%	38.80%	36.69%	
30-Nov	82.30%	84.50%	76.7%		37.90%	38.10%	37.22%	
01-Dec	77.00%	84.40%	76.2%		38.60%	37.90%	37.85%	
02-Dec	85.50%	87.30%	80.5%		38.10%	37.20%	38.62%	
03-Dec	74.40%	83.30%	80.1%		38.00%	38.30%	38.34%	
04-Dec	77.50%	79.80%	75.8%		37.00%	38.60%	38.67%	
05-Dec	72.20%	75.40%	76.0%		37.40%	38.60%	38.24%	
06-Dec	79.80%	79.30%	76.5%		38.60%	38.40%	38.65%	
07-Dec	79.00%	84.10%	77.6%		38.40%	38.10%	38.24%	
08-Dec	79.90%	88.90%	79.6%		38.40%	38.00%	37.86%	
09-Dec	76.30%	85.40%	81.8%		38.10%	38.20%	36.99%	
10-Dec	83.10%	88.10%	92.4%		37.40%	37.70%	37.16%	
11-Dec	84.00%	82.40%	85.3%		37.90%	38.30%	37.30%	
12-Dec	84.30%	80.30%	83.1%		38.00%	38.50%	38.27%	
13-Dec	80.30%	78.90%	83.0%		38.40%	38.70%	38.21%	
14-Dec	80.00%	83.10%	79.2%		38.60%	38.10%	38.33%	
15-Dec	84.40%	85.90%	75.3%		38.00%	38.10%	38.76%	
16-Dec	80.30%	82.60%	77.9%		37.60%	38.40%	38.13%	
17-Dec	85.90%	79.90%	78.7%		37.90%	38.20%	38.32%	
18-Dec	80.10%	79.70%	79.8%		36.80%	37.00%	38.87%	
19-Dec	76.70%	87.60%	81.7%		36.30%	37.80%	38.76%	
20-Dec	81.60%	83.40%	76.2%		36.70%	37.10%	37.35%	
21-Dec	57.00%	82.20%	61.4%		35.90%	37.00%	36.19%	
22-Dec	84.60%	92.70%	77.9%		36.50%	37.50%	36.85%	
23-Dec	57.30%	86.50%	80.0%		36.00%	38.10%	37.38%	
24-Dec	51.20%	68.20%	79.7%		36.70%	36.90%	37.43%	
25-Dec	45.60%	26.90%	85.0%		36.10%	34.90%	37.92%	
26-Dec	50.20%	41.10%	70.0%		36.80%	35.50%	36.56%	
27-Dec	58.30%	60.00%	89.7%		36.10%	36.50%	37.78%	
28-Dec	66.50%	67.30%	85.6%		37.30%	36.50%	37.39%	
29-Dec	77.70%	65.30%	85.7%		36.70%	35.90%	37.85%	
30-Dec	78.30%	87.90%	88.0%		37.90%	37.20%	37.78%	
31-Dec	79.20%	88.70%	85.5%		38.80%	37.80%	37.70%	

APPENDIX 14. SAMPLE MODELLING OF TRIP FUEL AND PAYLOAD CAPACITY

TRIP FUEL AND PAYLOAD CAPABILITY MODELLING

$$\overline{WC} = k_a \sin\left(\pi(\frac{n_c + k_z}{180})\right) + \frac{k_{av}\,(n_c - k_c)}{365} + k_o$$

$$Trip\ Fuel_i = k_1 + k_{2_i} e^{k_3 WC}$$

Input Data

SELECTED ROUTE = 1

ka =	12.4	kav =	0.88	k0 =	-17.1	k1 =	2.63%	k3 =	-0.00200
kz =	233.8	kc =	241			k2i =	33.70%	Ref Date =	01-Jan-16

	nc =	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747
Basic Data																		
Date		01-Jan-18	02-Jan-18	03-Jan-18	04-Jan-18	05-Jan-18	06-Jan-18	07-Jan-18	08-Jan-18	09-Jan-18	10-Jan-18	11-Jan-18	12-Jan-18	13-Jan-18	14-Jan-18	15-Jan-18	16-Jan-18	17-Jan-18
Calculated Mean		-27.14	-27.22	-27.31	-27.39	-27.47	-27.54	-27.61	-27.68	-27.74	-27.80	-27.86	-27.91	-27.96	-28.01	-28.05	-28.09	-28.12
Standard Deviation		6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94	6.94
Average of MC Calc		-27.07	-27.16	-27.24	-27.32	-27.40	-27.47	-27.54	-27.61	-27.67	-27.73	-27.79	-27.84	-27.89	-27.94	-27.98	-28.02	-28.05
Wind Component Probability Or More Favourable (kts)																		
50% Probability	50%	-27.04	-27.13	-27.21	-27.29	-27.37	-27.44	-27.51	-27.58	-27.64	-27.70	-27.76	-27.81	-27.86	-27.91	-27.95	-27.99	-28.02
55% Probability	55%	-27.86	-27.95	-28.03	-28.11	-28.19	-28.26	-28.33	-28.40	-28.46	-28.52	-28.58	-28.63	-28.68	-28.73	-28.77	-28.81	-28.84
60% Probability	60%	-28.74	-28.83	-28.91	-28.99	-29.07	-29.15	-29.22	-29.28	-29.35	-29.41	-29.46	-29.52	-29.57	-29.61	-29.65	-29.69	-29.72
65% Probability	65%	-29.63	-29.71	-29.80	-29.88	-29.96	-30.03	-30.10	-30.17	-30.23	-30.29	-30.35	-30.40	-30.45	-30.50	-30.54	-30.58	-30.61
70% Probability	70%	-30.62	-30.71	-30.79	-30.87	-30.95	-31.02	-31.10	-31.16	-31.23	-31.29	-31.34	-31.39	-31.44	-31.49	-31.53	-31.57	-31.60
75% Probability	75%	-31.74	-31.82	-31.91	-31.99	-32.07	-32.14	-32.21	-32.28	-32.34	-32.40	-32.46	-32.51	-32.56	-32.61	-32.65	-32.68	-32.72
80% Probability	80%	-32.88	-32.96	-33.05	-33.13	-33.21	-33.28	-33.35	-33.42	-33.48	-33.54	-33.60	-33.65	-33.70	-33.75	-33.79	-33.83	-33.86
85% Probability	85%	-34.24	-34.33	-34.42	-34.50	-34.57	-34.65	-34.72	-34.79	-34.85	-34.91	-34.97	-35.02	-35.07	-35.11	-35.15	-35.19	-35.23
90% Probability	90%	-35.91	-36.00	-36.08	-36.16	-36.24	-36.32	-36.39	-36.45	-36.52	-36.58	-36.63	-36.69	-36.74	-36.78	-36.82	-36.86	-36.89
95% Probability	95%	-38.52	-38.61	-38.69	-38.77	-38.85	-38.92	-39.00	-39.06	-39.13	-39.19	-39.24	-39.29	-39.34	-39.39	-39.43	-39.47	-39.50
Fuel Requirement Calculation																		
Probability of Load Availability		85%																
Wind Component (kts)		-34.24	-34.33	-34.41	-34.49	-34.57	-34.64	-34.71	-34.78	-34.85	-34.91	-34.96	-35.01	-35.06	-35.11	-35.15	-35.19	-35.22
Trip Fuel Requirement (%)		38.72%	38.72%	38.73%	38.74%	38.74%	38.75%	38.75%	38.76%	38.76%	38.77%	38.77%	38.77%	38.78%	38.78%	38.78%	38.79%	38.79%
Bookable Passengers		258	258	257	257	257	257	257	257	256	256	256	256	256	256	256	256	256
Load Factor Potential		81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%	81%
Probability of Passenger Load Factor Capability																		
Required Load Factor Capability		81%																
Maximum Allowable Trip Fuel		38.75%																
Maximum Wind Component (kts)		-34.71																
Probability of Load Factor Available		86%	86%	86%	85%	85%	85%	85%	84%	84%	84%	84%	84%	83%	83%	83%	83%	83%
Monte Carlo Simulation																		
Iteration	Random Number	Wind Components ->																
1	0.1107	-35.62	-35.71	-35.80	-35.88	-35.96	-36.03	-36.10	-36.17	-36.23	-36.29	-36.35	-36.40	-36.45	-36.49	-36.54	-36.57	-36.61
2	0.6987	-23.52	-23.61	-23.70	-23.78	-23.85	-23.93	-24.00	-24.07	-24.13	-24.19	-24.25	-24.30	-24.35	-24.39	-24.43	-24.47	-24.51
3	0.0159	-42.04	-42.13	-42.21	-42.29	-42.37	-42.45	-42.52	-42.58	-42.65	-42.71	-42.76	-42.82	-42.86	-42.91	-42.95	-42.99	-43.02
4	0.3028	-30.72	-30.81	-30.89	-30.97	-31.05	-31.13	-31.20	-31.26	-31.33	-31.39	-31.44	-31.50	-31.54	-31.59	-31.63	-31.67	-31.70
5	0.9485	-15.82	-15.91	-15.99	-16.07	-16.15	-16.23	-16.30	-16.36	-16.43	-16.49	-16.54	-16.60	-16.65	-16.69	-16.73	-16.77	-16.80

APPENDIX 15. TYPICAL ROUTING

http://www.gcmap.com/