APPENDIX

Additional Bibliography

The following references were evaluated but not cited in this work. They are however included for potential use, in the broader context, for other researchers.

1) Ahmad, B. and Tyler, L., "The two-dimensional resolution kernel associated with retrieval of ionosphere and atmospheric refractivity profiles by abelian inversion of radio occultation phase data," *Radio Science,* Vol. 33, No. 1, pp. 129-142, Jan.-Feb. 1998. This is a very modern paper using satellite technology for tomography to scan the planetary atmospheres. This approach constitutes a study on its own and deserves to be evaluated for the purpose of building and analysing the vertical structures of refractivity models, using this technique to gather the necessary data.
2) Allen, K.C. and Liebe, H.J., "Tropospheric Absorption and Dispersion of Millimetre and Sub-millimetre waves," *IEEE Transactions on Antennas and Propagation,* Vol. 31, No. 1, pp. 221-223, January 1983. The algorithm of the program is described and a sample of calculations provided.
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pp. 57-78, 1984. The lecture deals with broadcasting coverage propagation problems. Multipath and reflections are discussed, and numerous measurements presented.

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phenomenon caused problems with the microwave communications in the area and that justified further investigation.

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67) Isaacs, R. and Deblonde, G., "Millimetre wave moisture sounding: The effect of clouds," *Radio Science,* Vol. 22, No. 3, pp. 367-377, May-June 1987. The paper outlines a satellite technique for scanning the terrestrial atmosphere for the effect of clouds in different frequency bands for the radiative transfer, and results. The water vapour profile retrieval models are used, the results demonstrated, errors assessed and discussed.

68) Ishihara, T. and Felsen, L., "Hybrid Ray-Mode Parameterisation of High Frequency Propagation in an Open Wave-guide with Bilinear Transverse Refractive Index: Numerical Results and Quality Assessment," *IEEE Transactions on Antennas and Propagation,* Vol. 39, No. 6, pp. 780-788, June 1991. This paper should be studied with its companion paper, which contains a numerical study of various parameterisations developed for source-excited wave propagation in an open wave-guide with a bi-linearly varying refractive index used for modelling of surface ducts.

69) Ishihara, T. and Felsen, L., "Hybrid Ray-Mode Parameterisation of High Frequency Propagation in an Open Wave-guide with Inhomogeneous Transverse Refractive Index: Formulation and Application to a Bi-linear Surface Duct," *AGARD Conference Proceedings,* No. 453, pp. 17.1-17.15, San Diego, California, USA, 1989. The paper adopts a general methodology for a plane stratified medium with a bilinear refractive index profile making a continuous refracting open wave guide an idealised model for a leaky surface duct in the earth's troposphere. The conventional alternatives, modal and ray fields are then developed, and the detailed implementation of these options is presented.

70) Jha, K., Verma, A. and Tewari, R., "Radio wave attenuation due to formation of tropospheric thermal lenses," *Indian Journal of Radio and Space Physics,* Vol. 21, No. 1, pp. 1-4, February 1992, India. The attenuation of thermal lenses is outlined in the lower atmosphere and the additional attenuation, which needs to be taken into account for beyond the horizon services, is evaluated as a function of range.

71) Jha, K., Verma, A. and Tewari, R., "Atmospheric Effects and Interference in Point to Point Communication," *Journal of Institution of Electronics and Telecommunications Engineering,* Vol. 35, No. 6, pp. 317-322, 1989. The concept of thermal lenses is reviewed. The instantaneous changes of meteorological conditions leading to various types of fading are coupled with the tropospheric propagation characteristics.

72) Jones, T., "The Role of Fronts in Anomalous Microwave Propagation," *Seventh International Conference on Antennas and Propagation,* ICAP 91, Vol. 1, No. 333, pp. 185-188, April 1991, York, UK. The paper deals with a radio-meteorological study of the weather fronts in Europe and their influence on microwave radio links. The possibility of producing a signature of signal levels for different front/link configurations exists.

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76) Kalinin, A., Nadenko, L., Gavrilina, V. and Panova, R., "The Influence of Multipath Propagation on the Performance Characteristics of Line-of-sight Radio-Relay Channels," *Proceedings of the Eight Colloquim on Microwave Communication,* pp. 475-476, August 1986, Budapest, Hungry. The paper reports on the monitoring of microwave links still using an analogue system. The results of a contribution of intermodulation from multipath propagation on the noise levels are discussed.

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79) Kheirallah, H. and Rizk, M., "Statistics of layer formation in Mersa Matruh, Egypt," *Electronic Letters, UK,* Vol. 24, No. 7, pp. 381-382, March 1988. The paper presents the statistical observations of the formation of super-refractive and sub-refractive layers in Egypt by showing the role of the humidity gradient in determining the type of propagation modes.

80) Kheirallah, H. and Shaalan, A., "Study of tropospheric surface refractivity in Egypt," *Electronics Letters,* Vol. 25, No. 17, No. 1172-1174, August 1989. The monthly surface refractivity in locations around the country is reported in order to compile a database. The measured results are compared with refractivity figures calculated from meteorological data. Both sets of numerical values match well enough for radio use.

81) Kheirallah, H., Rashwan, H. and Aboul-Saoud, A. "M-profile ray tracing technique for multipath propagation," *Electronics Letters,* Vol. 23, No. 2, pp. 82-83, January 1987. A profile is defined

and the path trajectory reviewed according to the transmitter height and the angle-of-arrival along the path length.

82) Knorr, J., "Guide EM waves with atmospheric ducts," *Microwaves & RF,* Vol. 24, No. 5, pp. 67-70, May 1985. This paper is of a general or even popular nature. It explains how the elevated duct layer works, what the features are and its characteristics. The treatment is simplified and of a little scientific value.

83) Ko, H., Sari, H., Skura, J., J., "Anomalous microwave propagation through atmospheric ducts," *Johns Hopkins APL Technical Digest,* Vol. 4, No. 1, 12-26, January 1983. This is a classic overview with classification regarding different propagation modes. The traditional vertical profiles of tropospheric refraction are discussed and the anomalous propagation is described, including the operational effects. Typical models stemming from the parabolic equation solutions are given.

84) Koshel, K., "Numerical Solution of the Tropospherical Propagation Problems for Ultra-short Radio Waves. An Elevated Receiver," *Soviet Journal of Communications Technology and Electronics, USA,* Vol. 32, No. 11, pp. 151-153, Nov. 1987. The paper is a continuation of a previous one, dealing numerically with a solution to the propagation in surface atmospheric layers.

85) Koshel, K. and Shishkarev, A., "Influence of layer and anisotropy fluctuations of the refractive index on the beyond the horizon SHF propagation in the troposphere over the sea when there is evaporation duct," *Waves in Random Media,* Vol. 3, pp. 25-38, 1993, UK. The paper is one of many covering the broader field of research by this group of authors. It therefore treats only certain aspects of this theme and ideally should be studied together with the rest of the papers quoted. However, it makes mention of a very important factor, namely that the fluctuations have gaussian function characteristics.

86) Kriezis, Em.E., Pantelakis, P., Antonopoulos, C.S. and Papagiannakis, A.G., "Full Vector Beam Propagation Method for Axially Dependent 3-D Structures," *IEEE Transactions on Magnetics,* Vol. 33, No. 2, pp. 1540-1543, March 1997. The paper presents an application from the field of integrated optics, possibly fibre optics, with a changing refractivity index along the direction of propagation. Mathematically the problem is formulated as the 3-D structure in a vectorial scheme and Maxwell's equations are used. The scope of the paper is to incorporate the missing term, thus leading to more accurate simulations of practical optical components.

87) Krutikov, M., Muzafarov, R. and Rodionov, M., "Tropospheric Fluctuation Error of Ranging Measurements on Oblique Maritime Routes," *Telecommunications Radio Engineering 2, (USA),* Vol. 44, No. 8, pp. 61-6, April 1989. The paper deals with structural functions of the refractive

index gradient, spatial distortions in a randomly inhomogeneous troposphere and the introduction of layers in the troposphere along altitude.

88) Kukushkin, A. and Sinitsin, V., "Rays and modes in a Nonuniform troposphere," *Radio Science,* Vol. 18, No. 4, pp. 573-581, July-August 1983. The paper considers tropospheric super-refraction and ducting in the medium of a double well profile. The ray modal technique is used to describe diffraction.

89) Kukushkin, A., "Coherence Function of the Field in the Stratified-Nonuniform Troposphere," *Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika,* Vol. 27, No. 1, pp. 18-27, January 1984. The paper deals with duct propagation above seawater. A modified M index of refraction is used and a statistical approach is adopted using the Schroedinger equation for the trapped modes. The paper is complicated, difficult to follow, and of little practical value.

90) Kulshrestha, S. and Srivastav, S., "Characterisation of Indian troposphere in relation to communication: Radio refractivity gradients and ducting," *Indian Journal of Radio and Space Physics,* Vol. 19, No. 5-6, pp. 319-325, Oct.-Dec. 1990. The paper presents the results of a refractivity study around India obtained by processing of meteorological data from the weather stations. All forms of ducting are described from the vertical profiles point of view, along with particular seasonal and climatic differences.

91) Kuo, Shen, Fu, Chao, Rottger, and Liu, "Altitude dependence of vertical velocity spectra observed by VHF radar," *Radio Science,* Vol. 20, No. 6, pp. 1349-1354, Nov.-Dec. 1985. The paper relates to the structure of the media and gathers data by a means of radar in the mesosphere-stratosphere-troposphere region for gravity waves. The data is interpreted by using existing theoretical results/models. Curve fitting techniques are also applied.

92) Kursinski, E., Hajj, G., Hardy, K., Romans, L. and Schofield, J., "Observing tropospheric water vapour by radio occultation using the global positioning system," *Geophysical Research Letters,* Vol. 22, No. 17, pp. 2365-2368, September 1995, USA. New GPS technology is used to monitor and measure the water vapour content in the troposphere below the tropopause. The accuracy of the vertical resolution is discussed together with the vertical profiles of temperature, pressure and refractivity. A modified formula is presented.

93) Lake, Julian S., "Atmospheric Refraction: A Neglected Fundamental Comes of Age," *Defence Electronics,* pp. 22-23, October 1982. The paper gives a general overview of ducts and their importance, especially in the military environment over the seawaters.

94) Lam, W. I., and Webster, A. R., "Microwave Propagation on Two Line-of-sight Over Sea Paths," *IEEE Transactions on Antennas and Propagation,* Vol. AP-33, No. 5, pp. 510-516, May 1985. The paper reflects on a study of propagation on two radio links operating on a frequency of 10

GHz. A typical method of direct and reflected rays is used in order to analyse the severe fading characteristics associated with those meteorological conditions, exhibiting relatively slow changes. It was also found that the combined effects of the specular (mirror-like) sea reflection and the formation of atmospheric layers cause most of the severe fading.

95) Lang, R. P., "Angle of Arrival Measurements on Slanted Paths at 11.6GHz," *Third International Conference on Antennas and Propagation,* ICAP 83, Vol. 2, No. 2, pp. 166-168, April 1983, Norwich, England. Experiments regarding the monitoring of a radio link arereported, propagation effects related to multipath phenomena and angle of arrivals are measured, and prospective applications to satellite communications are considered.

96) Lekner, J., "Properties of a chiral slab wave-guide," *Journal of the European optical Society,* Vol. 6, No. 3, pp. 373-384, May 1997. The paper deals with wave-guide propagation and is not of direct interest to the present survey.

97) Levy, M. and Craig, K., "Assessment of anomalous propagation predictions using mini sonde refractivity data and the parabolic equation method," *AGARD Conference Proceedings* No. 453, pp. 25/1-25/12, San Diego, May 1989, USA. The parabolic equation method is used to accommodate measurement errors, fluctuations in the refractivity data, and noise from mini sondes. This serves for forecasting microwave propagation in the troposphere and in some cases may be tested against measured RF signals. A probability map indicating levels of confidence in these predictions should now accompany the forecasts.

98) Levy, M., Craig, K., Champion, R., Eastment, J. and Whitehead, N., "Airborne measurements of anomalous propagation over the English Channel," *Seventh International Conference on Antennas and Propagation,* (ICAP 91), Vol. 1, No. 333, pp. 173-176, York, UK, 1991. The report deals with measurements recorded during fights over the English Channel to investigate 2-dimensional refractivity structures leading to super-refraction and ducting in the area.

99) Levy, M., "Parabolic equation Modelling of Propagation over Irregular Terrain," *Electronics Letters, (UK),* Vol. 26, No. 15, pp. 1153-1155, July 1990. This presents an extension of the finite difference method implemented in the parabolic equation method to accommodate diffraction over irregular terrain for the field strength calculation with arbitrary two-dimensional refractive index model.

100) Liebe, H., "MPN-an atmospheric millimetre-wave propagation model," *International Journal of Infrared and Millimetre Waves,* Vol. 10, No. 6, pp. 631-650, 1989. The radio refractivity of the troposphere is analysed as a function of frequency in addition to normal meteorological parameters. This paper is outside the scope of the present research interests.

101) Lochtie, G. D. and Mehler, M. J., "Sensitivity of tri-linear refractivity models to perturbations in refractivity," *Eight International Conference on Antennas and Propagation,* Vol. 1, No. 370, pp. 344-347, April 1993, Edinburgh, UK. The paper deals with the accuracy of measurements of refractivity profiles when it is approximated by a tri-linear profile and makes a comparison of attenuation with that obtained from the parabolic wave equation.

102) Lundborg, B. and Thide, B., "Standing waves pattern of HF radio waves in the ionospheric reflection region 1. General formulas," *Radio Science,* Vol. 20, No. 4, pp. 947-958, July-August 1985. The paper presents an analytic solution in addition to the known numerical solution by Budden and Ginzburg methods. It basically determines the field strength in the vicinity of the horizontally stratified ionosphere plasma reflection.

103) Lundborg, B., "Analytic description of the electromagnetic wave field for effective refractive indices with infinity," *Radio Science,* Vol. 22, No. 5, pp.787-802, Sep.-Oct. 1987. The paper deals with the horizontally stratified ionosphere and offers the general analytical solution for the waves impinging vertically, where the effective refractive index is specified with regard to its form. In conclusion this type of wave equation may occur in other wave propagation problems.

104) Maekawa, Y., Chang, N. S. and Miyazaki, A., "Rapid changes in depolarisation due to thunderclouds obtained from the CS-3 beacon signal observation," *1992 IEEE,* pp. 744-751. The paper presents observations of depolarisation of signals at 20 GHz by ice crystals in thunderclouds in rapidly influencing the satellite link transmissions.

105) Marcus, S., "Propagation in surface ducts over irregular terrain," *Antennas and Propagation Society Symposium 1991 Digest,* Vol. 3, pp. 1784-1787, London, Ontario, Canada, 1991. The paper analyses a duct over rough irregular surface. A bilinear modified profile is adopted up to 10m in height using the implicit finite difference/Green function.

106) Markina, N., Naumov, A. and Sumin, M., "Determination of the altitude profiles of the refractive index of the atmosphere at optical and microwaves wavelengths from atmospheric thermal radio emission," *Radiophysics and Quantum Electronics,* Vol. 30, No. 8, pp. 704-712, August 1987. The quantitative results presented characterise the general possibilities of determining the altitude profiles of the refractive index of the atmosphere at optical and microwave wavelengths from radiometric data.

107) Masoudi, H., Jamid, H. and Al-Bader, S., "Effect of elevated tropospheric layer on radio-wave propagation in surface duct," *Electronics Letters,* Vol. 25, No. 11, pp. 748-750, May 1989. The parabolic equation is used with the modified refractive index and the bilinear model to determine the confinement within the duct.

108) McArtur, R., “Propagation Modelling over Irregular Terrain Using the Split-Step Parabolic equation Method,” *International Conference – Radar 92,* IEE Conference Publication 1992, No. 365, pp. 54-57, Brighton, England 1992. The paper extends the split step solution of the parabolic equation method of an existing computer model used for propagation over a smooth spherical earth to irregular terrain.

109) McCormick, G., “Propagation Explosion on 220 MHz,” *73 Amateur Radio's Technical Journal, USA,* Vol. 275, pp. 90-93, August 1983. The paper is a product of a radio-amateurs' inquiry, made on the basis of properties of 220 MHz propagation compared to the HF propagation-characteristics.

110) Misme Pierre, “The correlation Between the Electric Field at a Great Distance and a New Radio-Meteorological Parameter,” *IRE Transactions on Antennas and Propagation,* pp. 289- 292, July 1958. The paper investigates a troposcatter link at 1GHz frequency and at 370 km distance for a useful gradient. Analysis relates to the parameter of stability for equal refractive gradients of the atmosphere, which is characterised by the greatest stability and permits the highest fields to be received from a great distance.

111) Musson-Genon, L., Sylvie Gauthier and Bruth, E., “A simple method to determine evaporation duct height in the sea surface boundary layer,” *Radio Science,* Vol. 27, No. 5, pp. 635-644, Sep.-Oct. 1992. The aim of the paper is to determine the evaporation duct height at sea by using analytical solutions from numerical weather prediction models. The paper discusses how propagation conditions lead to duct formulation when trapping conditions exist in the layer. When above the layer, normal super- or sub-refraction conditions exist.

112) Narayana Rao, D., Krishna Reddy, K., Ravi, K., Rao, S. and Kesava Murthy, M., “Effect of Fresnel zone clearance on propagation characteristics of microwave links in hilly terrain,” *Indian Journal of Radio and Space Physics,* Vol. 20, No. 1, pp. 29-38, February 1991. The paper is a classic analysis of fading as the first Fresnel zone clearance is obstructed. An example of the specific radio links is taken with different antenna heights. Propagation characteristics are obtained as cumulative distributions of the hourly median of a basic transmission loss.

113) Narayana Rao, D., Bhaskara Rao, S., Ravi, K. and Krishna Reddy, K., “Tropospheric effects on microwave propagation in hilly terrains,” *Seventh International Conference on Antennas and Propagation,* (ICAP 91), Vol. 1, No.333, pp. 58-62, April 1991, York, UK. The paper examines two microwave links for multipath fading, leading to the conclusion that this may be successfully remedied by space diversity. Two separations of the antennas diversity systems are therefore recommended as a solution.

114) Narayana Rao, D. and Kesava Murthy, M., "Microwave Propagation Characteristics over Hilly Terrain," *Indian Journal of Radio and Space Physics,* Vol. 14, No. 4, pp. 83-87, August 1985. The fading characteristics are obtained from the radio link by monitoring its performance. The results are classified according to the seasons of the year and the nature of the fading. Fading duration and depths investigated.

115) Narayana, D., Krishna Reddy, K., Vijaya Kumar, T. and Rao, S., "An Experimental Investigation on the Performance of LOS Microwave Links in Southern India," *Indian Journal of Radio and Space Physics,* Vol. 24, No. 1, pp. 24-28, February 1995, India. LOS microwave link measurements are reported. These lead to the climatic characteristics through the study of their performance. Meteorological phenomena were observed over the Madras region. These caused severe fading degradation of the quality of reception.

116) Nastrom, G. and Gage, K., "Enhanced frequency spectra of winds at the mesoscale based on radar profiler observations," *Radio Science,* Vol. 25, No. 5, pp. 1039-1047, Sep.-Oct. 1990. The paper presents measurements of the horizontal winds by radar wind profilers. The results relate to the climatic and weather features of the atmosphere, which play an important role in the dynamics of the large-scale circulation.

117) Okafuji, Satoshi and Inenaga, "Tatsuya Excitation Analysis of Symmetric the Waves Guided Through Symmetric Kerr-Like Non-linear Slab Wave-guides," *Electronics and Communications in Japan,* Part II, Vol. 80, No. 5, pp. 24-30, May 1997. The paper deals with the propagation of a TE_0 mode in a slab wave-guide made of non-linear sandwiched layers. The first analytical solution for the mode is derived from the relationship between power and the refractive index.

118) Oyinloye, J., "Characteristics of non-ionised media and radio wave propagation in equatorial areas- A Review," *Telecommunication Journal,* Vol. 55, No. 2, pp. 115-129, 1988, Switzerland. The paper treats tropospheric propagation in Nigeria in its first part and shows the changes of surface refractivity over a year. The second part describes the rainfall characteristics in equatorial regions.

119) Pappert, R., Paulus, R. and Tappert, F., "Sea echo in tropospheric ducting environments," *Radio Science*, Vol. 27, No. 2, pp. 189-209, March-April 1992. The paper compares the results generated by the parabolic equation with those from the Engineers Refractive Effects Prediction System (EREPS) at a frequency of 9.6 GHz, for the standard atmosphere. It also examines the situation for 14 and 28 m evaporation ducts, with the same wind speeds of 10, 20, 30, and 40 knots.

120) Pappert, R., "Conversion of radiation modes to trapped modes due to lateral inhomogeneity of a simple elevated layer," *Radio Science,* Vol. 17, No. 2, pp. 305-322, March-April 1982. The

paper describes conversions of the modes in tropospheric ducts in the microwave frequency range (e.g. 3 GHz) between layers of different elevations.

121) Patterson, W., “Comparison of evaporation duct and path loss models,” *Radio Science,* Vol. 20, No. 5, pp. 1061-1068, Sep.-Oct. 1985. The paper primarily evaluates the three deterministic computer models for the accuracy of their predictions based on the quality of the meteorological input data, which is so difficult to obtain. In conclusion it is pointed out that the statistically sound input data is difficult to get. This presents a major obstacle.

122) Paulus, R., “VOCAR: An Experiment in Variability of Coastal Atmospheric Refractivity,” *IEEE International Geoscience and Remote Sensing Symposium, Proceedings of IGARSS 1994,* Vol. 1, pp. 386-388, Pasadena, California, USA, 1994. The aim of the paper is to provide a method to remotely sense the refractive structure of the atmosphere. The ducting occurrence is particularly important in the study but statistical processing of the measurement results is also stressed.

123) Paulus, R., “Practical application of evaporation duct model,” *Radio Science,* Vol. 20, No. 4, pp. 887-896, July-August 1985. The paper mitigates the propagation measurements of the duct heights with those from the evaporation duct model, as the occurrence of duct heights over sea is often greater than 40 m and is related to stability in the surface layer.

124) Pereira-Netto, A. and Dhein, N., “Reduction of fading due to ducts in line-of-sight links by path inclination,” *Proceedings of ISAP 85,* No. 252-4, pp. 1071-1074. The conference paper reports on microwave links situated in the tropical equatorial region of the Amazon where tropospheric ducts are observed. The M-profiles are measured and depicted with the results showing an improvement by comparison with a computer simulation.

125) Ponomaryov, V. and Gorb, A., “Determination of turbulent atmosphere, statistical characteristics,” *Fifth International Conference on Antennas and Propagation (ICAP 87),* Vol. 2, No. 274, pp. 239-241, 1987, London, England. The paper deals with a solution to the restoration problem as one of inverse problems. A statistical approach is adopted as usual.

126) Prasad, M., Dutta, H., Sarkar, S. and Reddy, B. “Fading reduction in microwave LOS links using antenna beam tilting techniques,” *Radio Science,* Vol. 26, No. 3, pp. 751-758, May-June 1991. The paper discuses multipath fading depending on the tilt of antennas in the link. It shows statistics outlining the differences based on the change of design of link for different tilts.

127) Prasad, M., Sharma, S., Sain, M. and Reddy, B., “Transhorizon VHF TV signal propagation over mixed land-sea paths,” *IEEE Transactions on Broadcasting,* Vol. 38, No. 1, pp. 33-37, March 1992. The paper deals with observed measurements of the broadcasting signals, allocating these to different percentage of time for events and further relating those to different modes and

mechanisms such as ducting, scattering and reflections. The effort ties up these observations with the climatic and seasonal weather effects, as well as with mixed over land and over sea propagation.

128) Rana, D., Webster, A., and Sylvain, M., "Statistical characterisation of line-of-sight links," *Radio Science,* Vol. 27, No. 6, pp. 783-796, Nov.-Dec. 1992. The paper presents the statistical approach to modelling of the atmospheric refractivity. It analyses the measured quantities in terms of their probability. The statistical models built this way, open opportunities for computer simulation analysis and verification of the data, either measured, or proposed.

129) Rao, D. N., Reddy, K. K. and Bhaskara Rao, S. V., "A comparative study of scintillation analysis over two LOS links at 7 GHz in Southern India," *Propagation IEE Conference Publication,* Vol. 2, No. 407, pp. 174-177, Stevenage, England 1995. The paper deals with the scintillation fading on an LOS microwave link. Turbulence causes rapid fluctuations superimposed on much larger but slower variations caused by multipath fading.

130) Rao, D., Ravi, K. and Murphy, K., "Multipath Effects observed over long hop hilly terrain Line-of-sight microwave links," *20th European Microwave Conference 1990,* Vol. 2, pp. 1437-1442, September 1990, Budapest, Hungry. The paper correlates the deep fading periods with different atmospheric structures, and attributes the percentage of time for events to certain hours of the day, as a form of the refractivity gradient on the specific link.

131) Ranger, M., Regnier, J-L., Andreu, M. and La Pape, Y., "A program for the calculation of radio-wave transmission loss over the spherical Earth and over obstacles," *Conference on Terrestrial Propagation Characteristics in Modern Systems of Communications, Surveillance, Guidance and Control* (ADARD-CP-407), pp. 9.1-9.12, Ontario, Canada, Oct. 1986. The paper basically compares two different algorithms in the form of computer programmmes to evaluate the path loss. It makes mention of the exponential atmosphere refractivity model.

132) Reddy, L., "Some Factors Affecting the Performance of line-of-sight microwave links over the southeastern parts of India," *U.R.S.I. Open Symposium on Wave Propagation and Remote Sensing,* pp. 9.5.1-9.5.6, Bradford, UK. Unique daytime multipath fading over coast and the nocturnal power fading are described. A two-path quadruple diversity system with adaptive receivers is proposed as a remedy for line-of-sight microwave links in tropical maritime climate.

133) Ricci, P. and Florio, A., " MM-Wave Region Propagation Experiments by Satellite," *Conference on Atmospheric Propagation in the UV, Visible, IR and MW-Wave Region and Related Systems Aspects (AGARD-CP-454),* pp. 12.1-12.10, Copenhagen, Denmark, Oct. 1989. The paper deals with a satellite experiment for RF propagation at higher frequency bands of 30-50 GHz for broadcasting purposes, initially, with a possible extension to the 90 and 135 GHz bands.

The attenuation from ice, water and other impairments to the signal is evaluated in the long-term observations.

134) Richhardia, M., "Simulate tropospheric amplitude scintillation," *Microwaves & RF,* pp. 79-82, April 1985. The paper deals with effects of atmospherically induced amplitude scintillation on RF signals that may be simulated with this simple technique based on a theory that describes wave propagation in a turbulent atmosphere.

135) Richter, J., "Review of recent developments in evaporation ducting assessment," *Terrestrial Propagation Characteristics in Modern Systems of Communications, Surveillance, Guidance and Control,* (AGARD-CP-407), pp. 11.1-11.9, Oct. 1986, Ottawa, Ontario, Canada. The paper offers some comments on the additional work done for over sea ducts. The sensitivities of duct height values to meteorological inputs and agreements between different path loss models are compared to those developed by Jeske, Hitney, and Rotheram.

136) Robinson, S.E., "The profile-algorithm for microwave-delay estimation from water vapour radiometer data," *Radio Science,* Vol. 23, No. 3, pp. 401-408, May-June 1988. The algorithm for estimation of tropospheric microwave path delays from Water Vapour Radiometer data has been developed. It first uses the observable with an emission model to determine an approximate form of the vertical water vapour distribution profile, which is then explicitly integrated and estimates the wet path delays. The accuracy of this algorithm has been examined for two channels, water vapour radiometer (WVR) data, using path delays and simulated / computed results from archived radiosond data.

137) Rocken, Ch., Van Hove, T. and Ware, R., "Near real-time GPS sensing of atmospheric water vapour," *Geophisical Research Letters,* Vol. 24, No. 24, pp. 3221-3224, Dec. 1997. The paper outlines the GPS application for weather predictions as far as the water vapour is concerned globally. It presents an opportunity to model the radio-refractivity function.

138) Rogers, T., "Statistical Assessment of the Variability of Atmospheric Propagation Effects in Southern California Coast Area," *IEEE International Geoscience and Remote Sensing Symposium,* Proceedings of IGARSS 1994, Vol. 1, pp. 389-393, Pasadena, California, USA. The effect from horizontal inhomogeneities in the atmospheric refractive structure on the RF propagation is the subject of discussion in the paper.

139) Rogers, T., "Effects of the Variability of Atmospheric Refractivity on Propagation Estimates," *IEEE Transactions on Antennas and Propagation,* Vol. 44, No. 4, April 1996. The paper's objective is to minimise the error of propagation estimates obtained from radio measurements. The temporal and spatial samplings of atmospheric refractivity are taken from a propagation

experiment designed to extract the data. The work basically revolves around the operational requirement for which the observations are made and the statistics attached.

140) Rotheram, S., "Microwave duct propagation over the sea," *Third International Conference on Antennas and Propagation,* (ICAP 83), Vol. 2, pp. 9-13, April 1983, Norwich, England. The paper treats different ducting cases over seawater. Analysing different meteorological aspects of the refractivity profiles and their applications to the solutions from Wave-guide Mode Theory does it all. Other earlier titles are quoted in the references.

141) Royrvik, O., "Relationship between scattered power and correlation time in VHF radar signals," *Radio Science,* Vol. 20, No. 2, pp. 212-220, March-April 1985. The paper deals with the atmosphere turbulence, which plays a central role in generating the refractive index irregularities that backscatter the radio waves.

142) Sarkar, S., Dutta, H., Prasad, M. and Reddy, B., "Tropospheric water vapour over India," *Sixth International Conference on Antennas and Propagation,* (ICAP 89), Vol. 2, No. 301, pp. 302-306, April 1989, Coventry, UK. The paper deals with refractivity profiles indirectly by analysing the water vapour density at the surface and at different isobaric levels, and the integrated water vapour density over India. Average values of the results may be used to predict path attenuation due to water vapour for earth-to-space paths at different frequencies and elevation angles.

143) Sarma, S. and Pasricha, P., "Measurements of the Radio Refractive Index Structure Parameter C_n^2 with a microwave refractometer in tropical latitudes," *Australian Journal of Physics,* Vol. 42, No. 5, pp. 573-580, 1989. The paper deals with the turbulence of the troposphere. Its applications are to troposcatter systems depending on the spatial distribution of radio index fluctuations appropriate to microwaves. The spatial spectral distribution along altitude is used to analyse the refractive index fluctuations.

144) Sengupta, N., "Anomalous propagation conditions observed over a LOS path at 6.7GHz," *Fourth International Conference on Antennas and Propagation (ICAP 85),* pp. 494-497, Coventry, England, April 1985. The atmospheric effects on microwave propagation are studied by monitoring a line-of-sight link in India, close to the eastern coast, between Dum Dum and Andul, for the signal enhancements. These variations have been analysed for supporting meteorological parameters following surface ducting conditions.

145) Schemm, C., Manzi, L. and Ko, H., "A predictive system for estimating the effects of range- and time-dependent anomalous refraction on electromagnetic wave propagation," *Johns Hopkins APL Technical Digest (USA),* Vol. 8, No. 4, pp. 394-403, Oct.-Dec. 1987. The numerical model of the atmospheric boundary layer and the anomalous propagation layer is the Electromagnetic Parabolic Equation code (EMPE) to predict meteorological data at times and locations where

measurements are not available. It takes estimates of refractivity obtained from the boundary-layer-model output to predict propagation loss as a function of height and range.

146) Sharma, R. and Subramanian, D., "Radio Refractive index associated with the onset phase of Southwest monsoon," *Mausam,* Vol. 35, No. 4, pp. 476-470, 1984, India. The refractive index is studied in a vertical model of the atmosphere and variations of it are confined to the wet component of the index. Seasonal variations are analysed. As the properties are of a climatic nature, they are used for synoptic predictions and are also important to radio-meteorology.

147) Simakova, N. and Yakubov, V., "Singular Regularisation in the Solution of the Inverse Problem of Refraction," *Soviet Journal of Communications Technology and Electronics,* (USA), Vol. 35, No. 3, pp. 24-31, 1990. A method is proposed for the singular regularisation of a numerical solution for the inverse problem. It is shown by example of the refractivity N- profile of the troposphere that the efficiency of the method is quite high, especially for the observations of refraction near the horizon.

148) Sivaramakrishnan, T., "Surface radio refractivity over Sriharikota Island," *Indian Journal of Physics,* Vol. 63B, No. 4, pp. 482-485, December 1989, India. The paper reports on the local annual changes of the radio refractivity. The purpose of the measurements is to produce propagation data for the operational requirements in the UHF bands.

149) Strauss, B., Andre, M. and Calmat, S., "Case Studies of Ducting Conditions in the Lower Troposphere," *Fourth International Conference on Antennas and Propagation (ICAP 85) Proceedings No. 248,* pp. 283-286, April 1985, Coventry England. The paper reports on the experiment involving an aircraft for the measurement of atmospheric refractivity and spatial characteristics of ducting conditions.

150) Strauss, B., Andre, M. and Calmant, S., "Case studies of ducting conditions in the lower troposphere," *Fourth International Conference on Antennas and Propagation (ICAP 85)*, Proceedings No. 248, pp. 283-286, Coventry, England 1985. The paper presents the results of measurements taken over the Mediterranean Sea by an aircraft, in order to research ducting effects for statistical estimates of the refractivity.

151) Sen, A., Karmakar, P., Das, T., Rahaman, M. and Devbarman, S., "A theoretical estimate of relative contribution of refractivity towards group delay," *Indian Journal of Radio and Space Physics,* Vol. 20, No. 1, pp. 26-28, February 1991. The paper reports on experiments conducted in India to determine a correlation between the group delay of a signal and "the wet term" of the refractivity profiles. The analysis was focused around altitude of the profiles.

152) Sevgi, L. and Ercan, O., "Intrinsic mode (IM)-parabolic equation (PE) comparisons on radio wave propagation," *25th European Microwave Conference 1995,* Conference Proceedings, Vol. 1,

pp. 269-275, Bologna, Italy, September 1995. The paper compares results obtained by two different computational methods. The agreement obtained at the points of comparison is excellent when two different frequencies are used.

153) Sittrop, H., Gravestejin, H. and Heemskerk, H., "The Influence of the Evaporation Duct on the Angle of Arrival and Amplitude of the Back-scattered Signal from Targets Low above the Sea," *Atmospheric Propagation Effects through Natural and Man-Made Obscurants for Visible to MM-wave Radiation,* AGARD Meeting, May 1993, No. 542, pp. 4.1-4.13, Palma de Mallorca, Spain. The paper reports on experiments with ducting at sea. The Jeske-Paulus model processes the measurements taken on radar scatter. The analysis indicates a misinterpretation of the target at 6-7 m above water. On the radar screen it is shown at a height of between 200-300 m. A comparison is made with PEM (parabolic equation model) prediction.

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