By Prof Hannes Rautenbach

DROUGHT

and the weather: 2015/2016 in review

South Africa has been experiencing one of the worst El Niño effects to date. This means that ocean surface temperatures in the Niño 3.4 region over the eastern equatorial Pacific, increased to as high as 28,8°C in October 2015. With ocean surface temperature ranges in the region that compare well with the occurrence of droughts in South Africa, there is reason for concern.

Does this, however, mean that we should be prepared for one of the worst droughts in living memory? The answer is no, because more extreme Niño 3.4 ocean surface temperatures of as high as 29,1°C also occurred in October 1997. It is insightful that the pre-summer rainfall during the 1997/1998 summer season, however, was only slightly below normal, while the post-summer rainfall was above normal and South Africa experienced yet another good harvest year. It is therefore not necessarily the size of an El Niño or 3.4 Niño ocean surface temperatures that can be equated to the magnitude of South African droughts.

Moisture from the Indian Ocean

It is important to remember that most of the moisture that causes summer rainfall over South Africa originates from the Indian Ocean, and this moisture from the ocean can only reach the African continent via onshore air currents. Onshore flow of rain moisture is then spread across Southern Africa by continental flow patterns created by differences in surface and upper air pressure patterns. For example, more rain moisture flows to South Africa from the equator if the pressure over the western parts of the country is lower compared to higher pressures in the east (*Figure 1* left).

In contrast, relatively less rain moisture flows to the summer rainfall region if the air pressure on the west begins to rise, with the result that the west-east air pressure gradient and the flow of air from the humid equatorial regions weaken (*Figure 1* right). Cloud bands then move east so that summer rainfall occurs over the Mozambique Channel or Indian Ocean. The latter are typical conditions that occur during dry years.

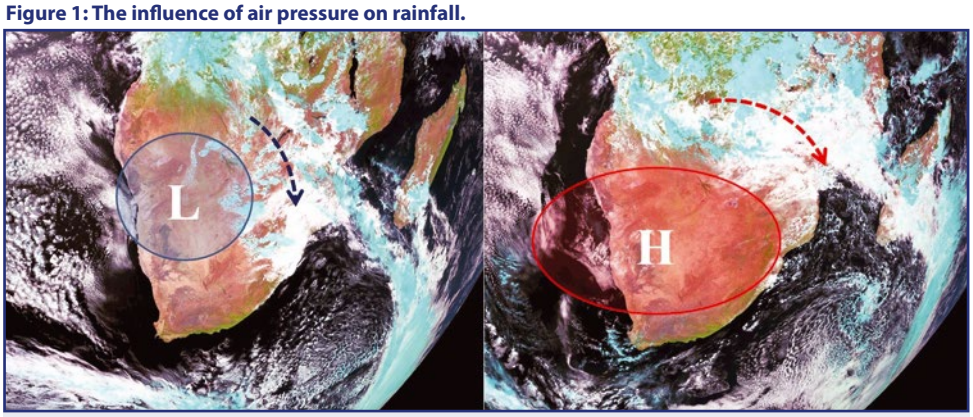
That is what took place from October 2015. High air pressure has mostly come in over the interior from the Atlantic Ocean. These higher air pressure patterns have also accompanied large volumes of air that descend from the upper atmosphere, and thus not only suppressed rainfall but also compressed to cause heat waves.

Extreme summer temperatures

What made the 2015 early summer season exceptional, is that several extreme temperatures were measured. During the heat wave conditions that commenced on 7 November 2015, the highest maximum temperatures on record were respectively measured on 9, 10, 11 and 12 November 2015 by 16, 15, 31 and 12 weather stations of the South African Weather Service respectively. These heat wave conditions were caused by a strongly developed high-pressure system over South Africa.

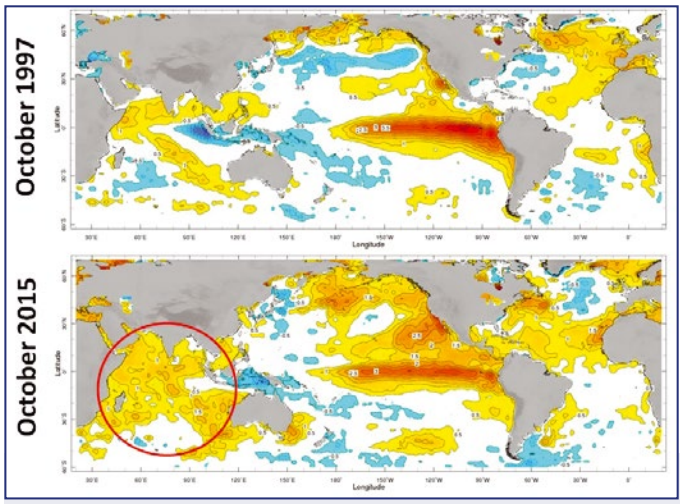
However, why was the 2015/2016 early summer so much drier than the 1997/1998 early summer, while the most extreme El Niño conditions in fact occurred in 1997/1998? The reason for this can probably be attributed to the high ocean

Figure 1: The influence of air pressure on rainfall.



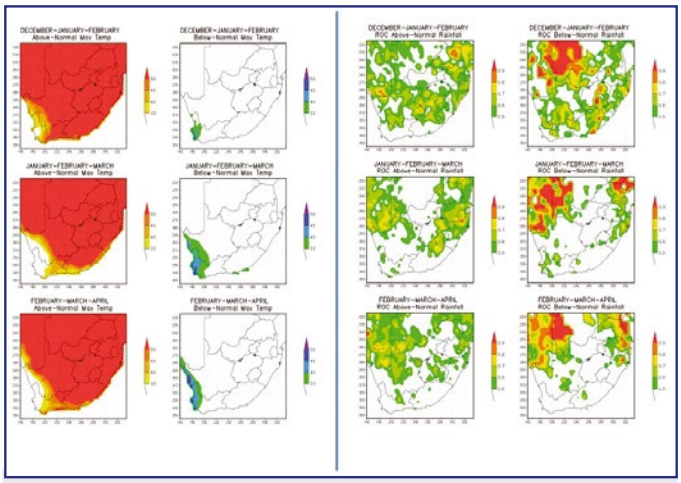
Lower air pressure over the western parts of South Africa can cause rain moisture from the equatorial regions to blow towards the eastern parts of the country (left), while higher air pressure from the west can result in dry conditions (right).

Figure 2: Indian Ocean temperatures.



The biggest difference between the extreme El Niño of 1997/1998 and that of 2015/2016, is the occurrence of warm water across virtually the entire Indian Ocean in 2015/2016.

Figure 3: The latest seasonal forecasts.



The percentage probability of above-normal rainfall expectations for the period December-January-February, January-February-March and February-March-April (far left), and the corresponding percentage probability of below-normal rainfall expectations (second from left). The corresponding skill of the forecast is given to the right – note that forecasts in the white areas can simply be attributed to chance. (Source: South African Weather Service)

surface temperatures which occurred in the Indian Ocean of late. In harmony with El Niño ocean surface temperatures, large areas of both below- and above-normal ocean surface temperatures in the Indian Ocean played a key role in the creation of onshore air currents that blew rain moisture to the African continent, as what occurred during the 1997/1998 El Niño year.

During the 2015/2016 summer season, ocean surface temperatures across the entire Indian Ocean, however, have been abnormally high (*Figure 2*). A warm Indian Ocean can weaken the Indian high pressure cell, which in turn can weaken easterly winds to the African continent. In addition, the warm sea water will encourage evaporation, lifting and rain over the ocean, which can even cause rain moisture to be drawn away from the African continent.

The latter can also lead to higher air pressure being pulled in from the west over South Africa, something which can result in typical heat wave conditions. Were it these conditions that made the 2015/16 summer season so extraordinary? Only time and research will provide answers to these questions in future.

Ocean surface temperatures

An important lesson that we can learn from this, is that it is not only El Niño ocean surface temperatures that influence rainfall over South Africa, but rather ocean surface temperatures across the entire globe. This is also why the latest seasonal rainfall forecasts are compiled by making use of complex coupled ocean-atmosphere models, which take into account the impact of global ocean surface temperatures on the earth's atmospheric circulation when this system is simulated.

The seasonal rainfall and temperature forecasts issued by the South African Weather Service, are a compilation of forecasts from various such ocean-atmosphere models. Historical model results are then also compared with historical observations to determine a forecast's skill or accuracy at a specific point or across a region.

It is essential to take this skill into account when a forecast is analysed, because there may be regions where a forecast weather condition may indeed occur, but where the skill is so poor that the possibility of the forecast occurring can simply be attributed to chance.

Dry and hot weather conditions

The latest seasonal forecasts suggested that the remaining summer season would be dry and warm (to as far as March 2016) (*Figure 3*). In addition to these dry conditions that were forecast, there was a very strong indication, associated with a significant model skill, that maximum temperatures would be significantly higher than normal in January, February and March 2016.

According to the South African Weather Service, there is growing evidence that the possibility of hot and dry conditions across South Africa would continue for the remainder of the summer season. These drier and warmer conditions were expected to be, in terms of the season and especially the midsummer period, out of the ordinary.

The ongoing dry conditions, as well as the expectation for extremely hot conditions for the remainder of the summer season, may worsen the current drought. It is strongly recommended that medium- and short-term weather forecasts should be monitored for early detection of the conditions that may exacerbate or alleviate the drought.

For more information on these forecasts, contact Cobus Olivier on 012 367 6008 or email cobus.olivier@weathersa.co.za. Prof Hannes Rautenbach is involved at the Laboratory for Atmospheric Studies (LAS), Meteorological Unit at the Department of Geography, Geoinformatics and Meteorology of the University of Pretoria. For more information, contact him on 082 480 6579 or email hannes.rautenbach@up.ac.za.