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Reflective Note

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How Do El NINO/ LA Nina Climate Phenomena Affect the West-Southern Indian Ocean Basin?

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Climate variability is an integral part of the climate system. Water and air are among the fundamental elements that drive this system at several scales on the earth's surface. Oscillatory phenomena such as El Nino or La Nina have also always had their place in this system. However, with the disruption of the global climate, the short period of their returns and their strong implications for extreme weather events are very clear, and marked by the rise in sea surface temperature in the South-East Pacific, known as El Nino Zones. Currently, what are their impacts in the Indian Ocean given that it has its own gyre? (Closed circulatory movement of the sea). At high altitudes, the correlation of this phenomenon with the "southern subtropical jet stream" is probably effective.

In general, the average start of the rainy season is during the 2nd decade of November, yet with this phenomenon a delay of 2 months has been observed (Ralinirina, 2015). Therefore, this situation leads us to look for the causes of this delay during the 2020-2021 rainy season over the Central Highlands of Madagascar. The WMO stated that the La Nina was born in August-September 2020 and would disappear in May 2021. Synoptic data for the south-west Indian Ocean and the eastern Pacific from September-December 2020 to January 2021 were analysed: 354 daily synoptic maps, one map per day, published at 0hTU by bom.gov.au. The isobaric values are associated with the analysis of temperature data, minimum, maximum and mean and rainfall for Australia during September, October, November and December 2020 and January 2021.

The result is that during the 2020-2021 La Nina climate event, values at the center of the High Pressure of the Indian Ocean, HPOI, are frequently higher compared to those in 2019-2020. For example, in September and October 2020, half of the observations showed higher values than in 2019. Moreover, they form a dam with a very extensive configuration, projecting isobars into the southwestern Indian Ocean. For the same period, the Australian mainland was subject to low pressure, LP. This is the isobaric situation shown in Fig 1.

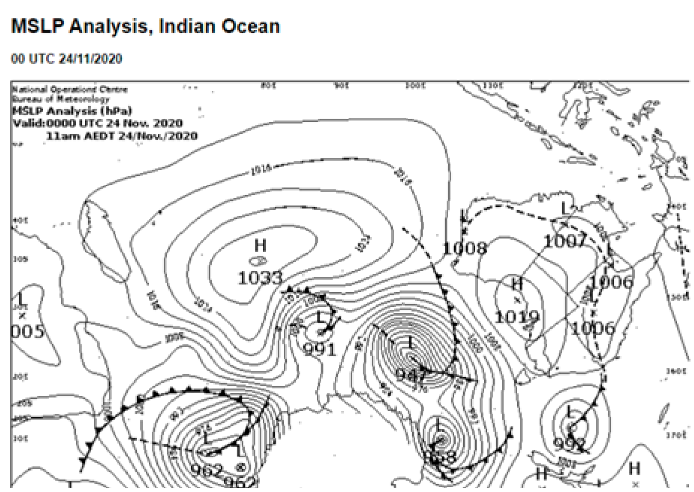

Figure 1: Isobaric situation on the ground on 24 November 2020 at 0h UT

For the same period in the Pacific, the Hum bolt High Pressure has a central value of 1025 h Pa and covers a large part of the South Pacific, spreading over a large area of 50° longitude, the same size as the isobaric field formed by the HPOI, Fig.2.

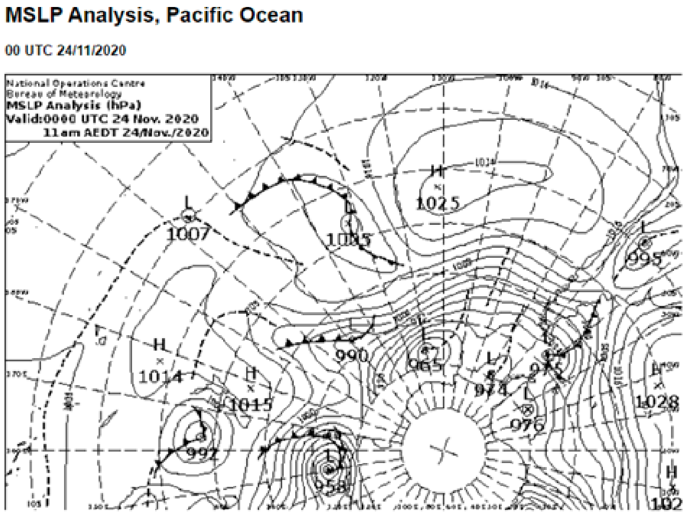

Figure 2: Ground isobaric situation in the Pacific at 0h UT

However, small cells of High Pressure are found alongside this large cell whose weaker center values allow the intrusion of cold fronts into the pass. This type of situation is also present in the Indian Ocean (see Fig. 3).

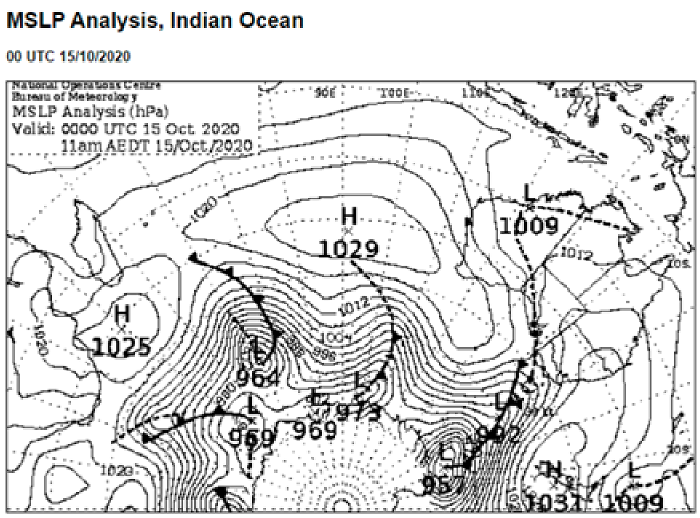

Figure 3: A cold front crossing a barometric pass

According to figures 2 and 3, during the la Nina period, the HPOI and Hum bolt HP are increasing due to air subsidence, with the formation of Low Pressure Areas, LP or L, over Australia by ascending air. Faced with this situation, a jet stream appears aloft in the form of a meander. On its equatorial flank the HP settles and on its polar flank the BP. This configuration presents anomalies: the HPOI has extended to the tropopause, see Fig.4. It accompanies the vector wind at sea level (1000hPa), but Fig.5 shows that the vector wind is at the tropopause. Aloft at the equator, a westerly wind anomaly spreads out. In contrast, in the South Pacific Ocean, the HP at sea level is headed by the LP. (Fig.4 and Fig.5)

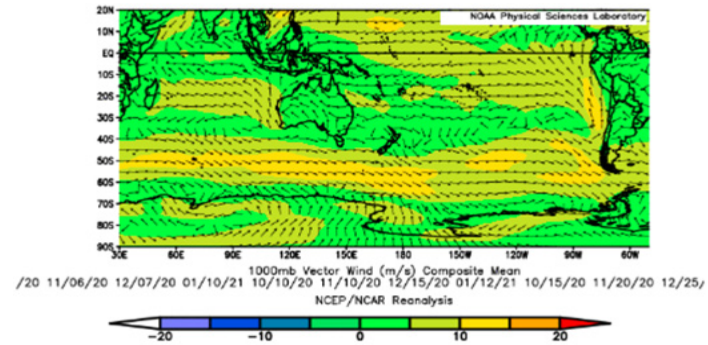

Figure 4: shows well over the Indian Ocean south of the equator and the South Pacific Ocean an anticyclonic wind flow, at 1000hPa.

Fig.5 Wind vector at 150 h Pa

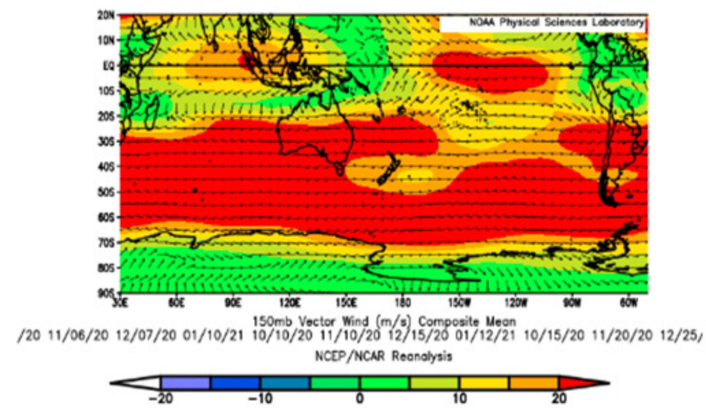

Figure 5: shows over the Indian Ocean south of the equator the presence of an anticyclonic wind flow, and over the South Pacific Ocean a cyclonic flow.

The stagnation of the jet stream at this position persisted on the ground with anticyclonic weather patterns and strong trade winds. The areas of positive rainfall and temperature increases are located over Australia.

The Monthly Weather Review-Australia data for September, October, November and December 2020 showed variability in rainfall. A slight decrease of -0.3% in September, a significant increase of +35% in October, a decrease of -42% in November and an increase of +101% in December were reported. MWR-Australia described the latter height as the highest since 2010.

In conclusion, it is worth noting that the variability of the jet stream pattern has influenced the La Nina weather events and its opposite El Nino. Futura-Sciences researchers in September 2021 predicted the weakening of El Nino and La Nina based on a supercomputer simulation of climate models. And at the same time, we are putting forward the idea of a delay in the succession of seasons. The question is why this warming of the climate is the cause. Hypotheses are proposed for this delay:

Since the el Nino and la Nina climate events were triggered in the intertropical zone, including the Hadley cell, the decrease in the thermal gradient from the equinoxes to the solstices would decrease the horizontal gradient strength of the air in this same zone. And the ITCZ appears later after the summer hemisphere solstice. At ground level, the global warming of the air also decreases the thermal contrast between the warm and cold zones. The heat transfer is slow in the lower elevations due to the decreasing thermal gradient. At higher altitudes, it weakens the jet stream and keeps it in the meandering position, resulting in the persistence of anticyclonic and cyclonic weather patterns.

We would like to thank the people in charge of the www.bom.gov.au and www.cdc.noaa.gov/composite websites for giving us access to the various data and information at their disposal.