RELATIONSHIP BETWEEN CROSS-EQUATORIAL FLOW, TRADE WIND FLOW AND FAVOURABLE CONDITIONS OF THE CYCLOGENESIS OVER THE MOZAMBICA CHANNEL

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Abstract

This work consists of study ing impact of the trade winds and the cross-equatorial monsoon flow on the cyclogenesis over the Mozambica channel during the southern summers (November-April) for the period 1979-2002. The meridional and zonal wind, the vorticity at the 850 hPa pressure levels, issued from the data analysis of the European centre ECMWF have been studies. The correlation method shows us the interrelationship between the vorticity, Juan de Nova sea level pressure representative of the Mozambica channel, the meridional and zonal wind.

Introduction

Madagascar is regularly touched by the cyclonic systems that take birth over the Indian Ocean or over the Mozambica channel which can produce some very important quantities of water and violent winds. The latter provoke considerable material damage which multiply the number of without shelter people and isolate the localities which in the following days of serious sanitary problems have, food problems while reverberating thus on the human life and on the economic growth. Otherwise, a cyclone is a natural phenomenon. Indeed, no one can stop it from being born. The only possible measures rise from a clear understanding of their formation and their development. These arrangements are destined to minimize the impact of this phenomenon on the socioeconomic life of the Malagasy. However, the understanding of their formation and their development is most studied in climatology nowadays. For this study, we are interested in the formation conditions of the cyclonic system. The recent studies concerning the interactions between the equatorial waves and the cyclonic activity in the South-western basin of the Indian ocean show that the MJO (Madden Julian Oscillation) and

the waves of the Rossby modulate the cyclonic activity in this basin during the Southern summers (November-April)**[1][2],** the MJO and the ER waves in their wet phase contribute in a meaningful way to a potential increase of the instability over the Mozambica channel **[3]**. Later on, we wonder, if the seasonal circulation as the cross-equatorial monsoon flow and the trade wind participate in the cyclogenesis over the Mozambica channel. Then, the purpose of this work is to study the potential impact of this monsoon flow and the trade wind on the cyclonic activity over the Mozambica channel.

Data and methodology

For this study, we used the horizontal wind (meridian and zonal components), the vorticity with a pressure level at 850 hPa issued from the daily reanalysis data of the ERA-40 **[4]** from the European centre ECWMM experiment that is available online at the synoptic scale with a grille of 2.5°x2.5° at the rate of two observations each day and a spatial resolution of 0°-30°S/0°-60°E during 24 years southern summers for the period 1979-2002.

At first, we have superposed the average and the standard deviation to value the regions or the period of the strong variability of meridian and zonal wind.
The interrelationship has for goal to value the contribution of the cross-equatorial monsoon flow and the trade wind in the southern summer on the cyclogenesis over the Mozambica channel.
We studies the interrelationship coefficient between the vorticity representative of the Mozambica channel and the meridian wind at 850 hPa level that represented the monsoon flow and the zonal wind that represented the trade wind.
Then, we calculated the interrelationship coefficient between Juan de Nova sea level pressure that is located in the entry of the channel and the zonal wind and the meridian wind at 850 hPa level pressure during 1979-2002 period.

Results

We could notice that on the average, there are two feedings at low level (850 hPa) in the channel the first one is by the North via the monsoon flow and the second one, by the South via the contouring of the trade wind flow caused by the presence of the island. The figure 1 helps us to follow the temporal evolution of the meridian wind to the entry (0°-10°S; 35°-

45°E) and to the exit (20°-30°S; 30°-40°E) of the channel before and during the cyclogenesis. It appears in the North part of the channel that in majority, the component of the meridian wind (negative values) comes from North. The superposition of the average and the standard deviation indicates the limits of such an analysis. We can notice that 3 days before the cyclogenesis, this monsoon flow strengthens because it goes from an average value of 3 ms^{-1} to about 4 ms^{-1}on the cyclogenesis day. Concerning the exit of the channel, visibly the variability becomes very important because we think of a trade wind flow contouring Madagascar by the South. Yet, we notice that the average component is from the South (positive values) but this contribution remains weak and is in concordance with the hypothesis of a recess of winds at the cyclogenesis time with an evacuation of the convergent flux upwards by the convection. The wind strengthens and adopts the South component during the 3 days before the cyclogenesis episode. These results come therefore a priori to reinforce the idea that the cyclogenesis is made favourable by the combination of a monsoon flow by the North and a trade wind flow deviated after the passage of Madagascar and going back up in the channel.

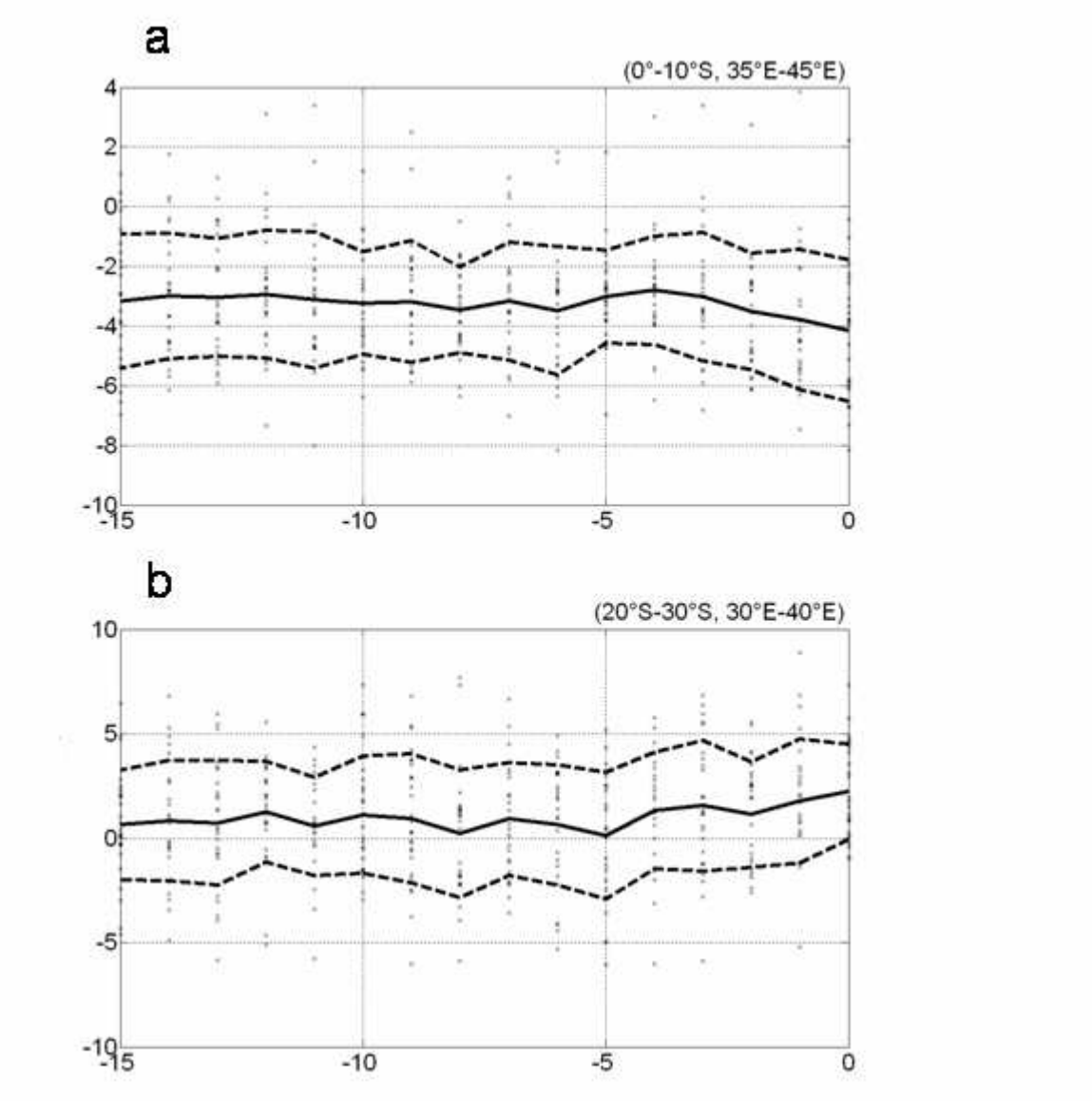

Figure 1: Evolution of the meridional vorticity during the period preceding the cyclogenesis event at the entry (a) and at the exit (b) of the Mozambica Channel. These zones correspond to the regions of the strong variability of the meridian wind. The average and the standard deviation are shown in solid line and dotted line

To sum up, the monsoon flow (in the North) seems major and contributes to the starting point of the cyclogenesis. In the South, the contribution seems to be rather a consequence of the setting up of the deep convection at the cyclogenesis time.

The figure 2 highlights the relationship between mean vorticity in the region of the cyclogenesis (15°-25°S; 35°E-45°E) and two wind components. We can note a correlation between the vorticity, representative of the channel (indicator of the cyclonic activity) and the Northern and Southern parts of the channel as it is shown in figure 2.

Concerning the zonal wind (Fig. 2a), the average vorticity that is generally negative in this sector (15°-25°S; 35°-45°E) presents the negative correlation coefficients with the zonal wind in the Northwest part of the channel and vice versa in the Southern part. A minimum is noticed along the Northern coast of Mozambica and a maximum at the exit of the Mozambica Channel on full sea. Concerning the correlation of the average vorticity with the meridian component of wind (Fig. 2b), we can notice nearly a reversed situation namely the positive correlation coefficients in the North and the negative correlation coefficients in the Southern. Nevertheless, we can see some significant differences on the position of the minima. Indeed, in the Northern part, the maximum of the correlation coefficients is situated at the entry in the Northwest of Madagascar and the minimum of the correlation coefficients along the Southern coast of Mozambica.

It appears that the cyclogenesis over the Mozambica Channel is positively correlated with the monsoon flow in the North, see the contouring of the trade winds flow in the South but it is also concomitant with the setting up of convection leading to a recess of the convergent flow in the channel.

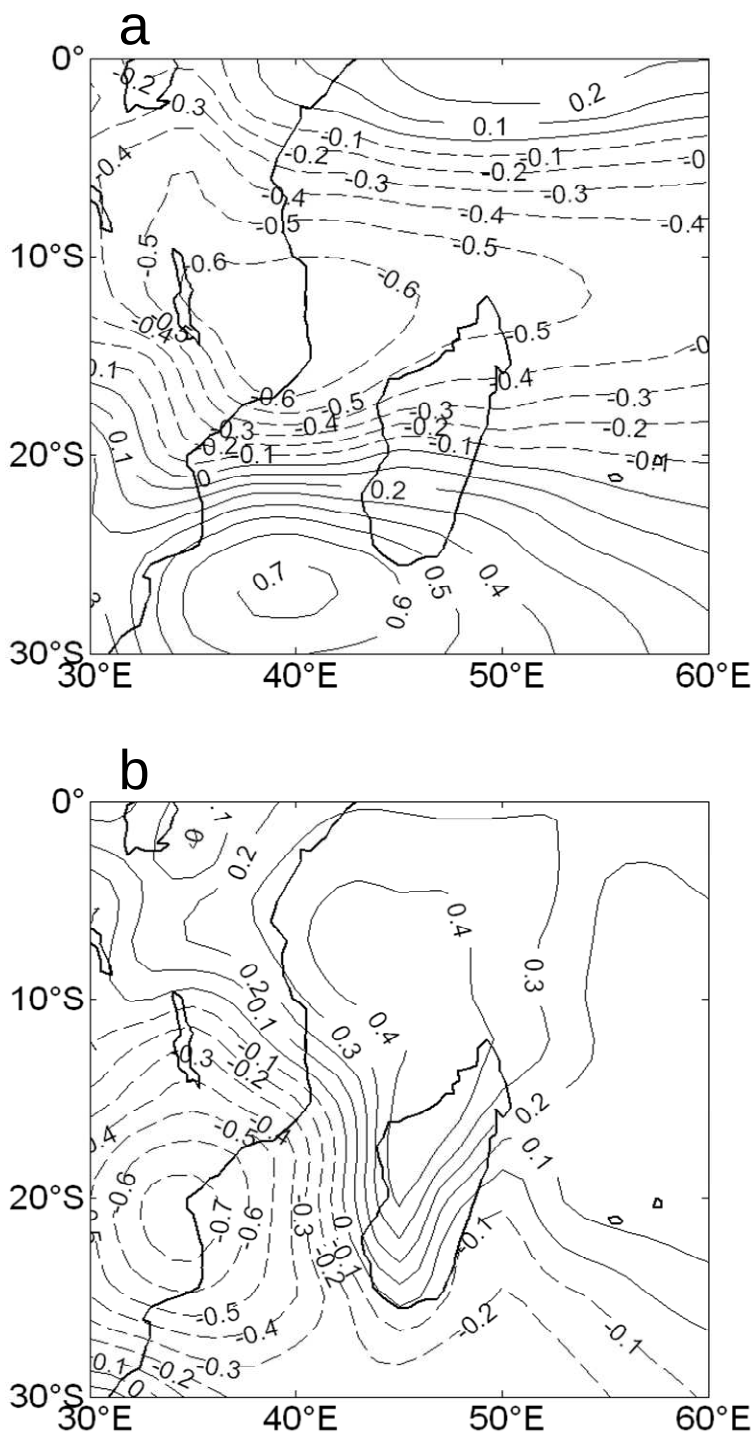

Figure 2: Geographic configuration of the correlation between the mean vorticity of the Mozambica Channel and the zonal wind (a) and the meridian wind (b) at 850 hPa during the southern summer (November-April) in 1979-2002 period

The figure 3 presents the correlation between the pressure in the station of the Juan de Nova (whose place is indicated by a cross in the figure) and the zonal wind (Fig. 3a) and the meridian wind (Fig. 3b) at 850 hPa. In the two cards, we can clearly see that the pressure presents a relatively strong correlation with the monsoon flow following the zonal component than the meridian component. It appears that the pressure decreases (resp. increases) when the zonal component of the monsoon flow (flow of west) increases (resp. decreases) (Fig. 3a) and that the meridian component of the monsoon flow decreases (resp. increases) because the correlation coefficients are positive (Fig. 3b). For the Southern part, where the trade wind flow is deviated, it appears that this positive correlation coefficient at the South is the origin of the one mentioned for the figure 2 namely the concomitance with the cyclogenesis activity indicated by a decrease of the pressure.

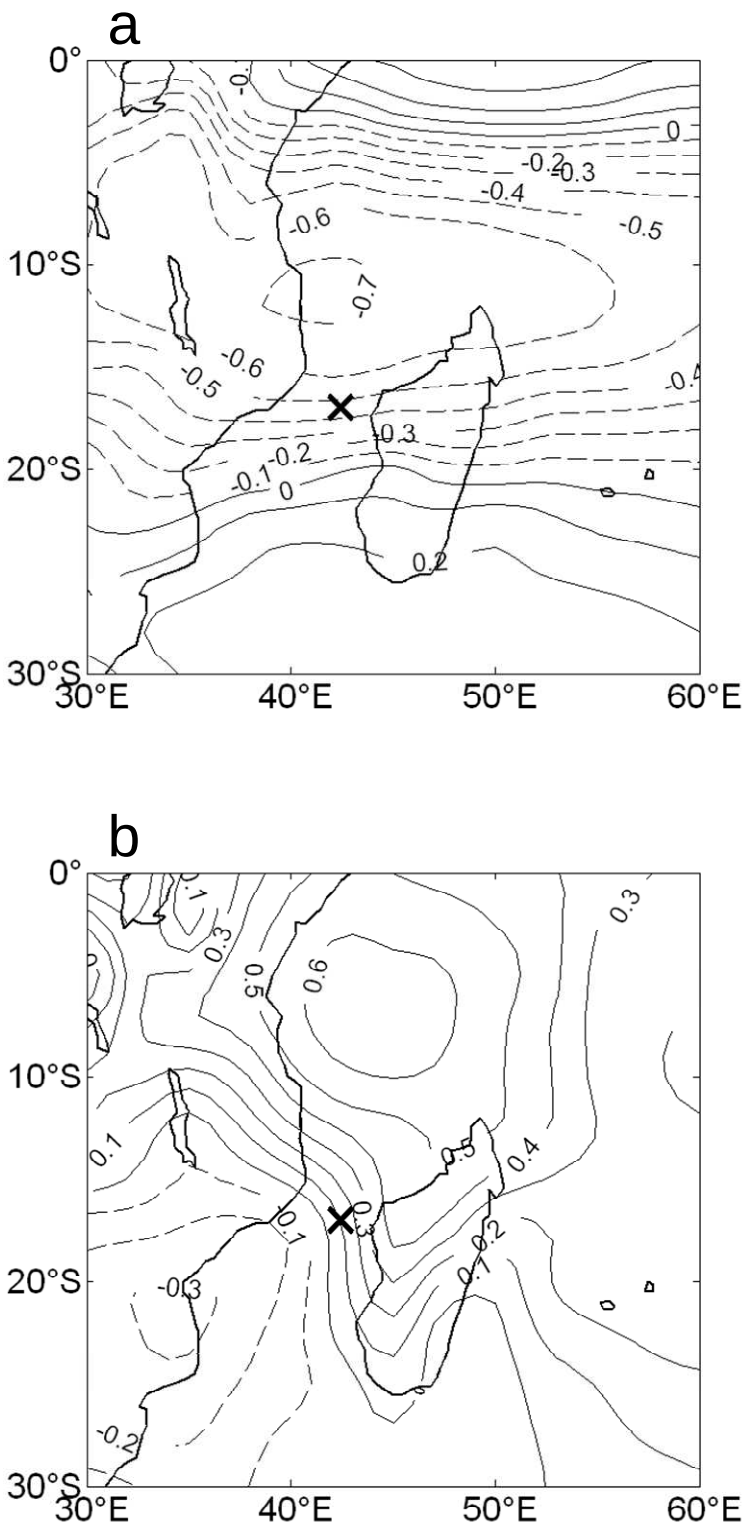

Figure 3: Geographic configuration of the correlation between the pressure reading in the station of the Juan de Nova (indicat by a cross) and the zonal wind (a) and meridian wind (b) at 850 hPa during the southern summer in 1979-2002

Conclusion and discussion

A correlation study on the monsoon flow allowed us to confirm what we had sensed up to now **[5]** namely a relatively significant correlation between the latter and the favourable conditions of the cyclogenesis namely the vorticity structure in the channel and the pressure raised in the station of Juan de Nova which helps to localize and to follow the meteorological systems. We have also already studied the correlation between the monsoon flow and the OLR found in the channel but the results show us that these are weakly correlated. This work could show the relationship between Cross-equatorial monsoon flow and cyclogenesis in the Mozambica Channel. However, a lot of elements are taken into account in the formation of a cyclonic system. If they are necessary, they are not sufficient. Indeed, Gerald Donque **[6]** signalled that the Mozambica Channel has its particularity during the southern summer. The favourable conditions to the cyclogenesis are united there: quasi-permanent barometric depression, sufficient latitude, hot sea. It is also necessary to make sure that the confusion between interrelationship and causality exists. That two phenomena are correlated implies in no way which one is cause of the other. Then, we used the composite method which permits us to present the favourable conditions for the cyclogenesis development over the Mozambica Channel and in particular the instability factors with the humid and instable air by the monsoon flow and the trade wind **[3]**. In perspective, we are going to study the impact of the climatic anomaly on the monsoon flow and indirectly on the cyclogenesis over the channel.

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