J2.3 INTRASEASONAL MODES OF VARIABILITY AFFECTING THE SACZ

Christopher A Cunningham Castro
Iracema F Albuquerque Cavalcanti

Center for Weather Forecast and Climate Prediction (CPTEC/INPE)
Cachoeira Paulista, Brazil

1. INTRODUCTION

The South Atlantic Convergence Zone (SACZ) is one of the most important system determining the summer climate in South America. Previous studies suggested the influence of the 30-60 days oscilation on the variability of the SACZ, as Casarin and Kousky (1986) and Grimm and Silva Dias (1995). Submonthly variability was also related to the convection of the SACZ. (Liebman et al 1999). During the last two decades some researchers have been investigating the intraseasonal variability in the Southern Hemisphere, emphasizing important aspects of regions in the equatorial belt (MJO), or in the SPCZ and SACZ, over the subtropical belt. The objective of this work is to analyse the modes of intraseasonal variability associated with the ZCAS behaviour.

2. DATA AND PROCESSING TECHNIQUES

The analysis were performed applying statistical techniques to 20 years (79 to 99) daily filtered anomaly data from NCEP/NCAR reanalysis and from NOAA-OLR data sets. These were filtered to retain variability between 30 to 90 days. EOF analysis and lagged correlations were applied to meridional wind component, geopotential height and OLR, emphasizing specific areas of the tropical and subtropical regions.

3. RESULTS

a. EOF. The analyses showed a remarkable zonal dipole of OLR variability between the Indonesia region and West Pacific neighboring. Moreover, the eingenvectors show that, most of the time, the West Pacific, including an extension through the SPCZ area, vary with the same sign as the tropical/subtropical region of South America. (Fig.1). Thus the tropical/subtropical portion of South America tends to present an inverse simultaneous convective signal when faced to Indonesia. In the same timescale, the meridional wind pattern showed a characteristic wavetrain PSA-like over the South Pacific Ocean.

The resemblance between the loadings of low and high frequencies, showing similar patterns over South America suggests a connection between intraseasonal and transient disturbances over South America. Indeed, Cavalcanti and Kayano (1999) analysing patterns of high frequency eddies, suggested that wave pulses from the frontal systems could be associated with convection in the SACZ.

Composites of the periods when the amplitudes in the principal component time series have exhibited high values, showed a clear connection among the MJO convection in the equatorial band, the subtropical and extratropical flow, and the convection in the SACZ region. The deep convection in the Indonesian Region belonging to the MJO cycle can "distort" the subtropical flow in the southern neighboring, over the Southern Pacific, creating conditions to establish a teleconnection, via PSA wavetrain, between the Indonesian region and the South America, specially the SACZ region. Whether the activity on the SACZ will be enhanced or inhibited depends on the position of the individual circulation anomalies composing the PSA pattern.

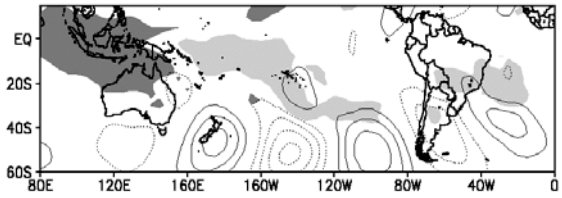

Fig.1 – First empirical orthogonal function of OLR (shaded) and of meridional wind (contour).

b. Correlations. Three areas over South America, representing the climatological position of a SACZ episode (SACZ2) and when it is displaced northward and southward (SACZ1 and SACZ3, respectively) were analysed to evaluate possible teleconnections that could affect the convective behaviour in these three areas.

Lagged global correlations patterns have indicated that convection inside the preferred SACZ areas has a periodic behaviour, with a period around 25 days and it is connected with convection in the Indonesian area. In other words, the convective signal tends to revert at each 25 days in both regions: SACZ and Indonesia. The correlations patterns have showed also that the PSA-like pattern is more intense considering SACZ2 and SACZ3 than SACZ1. Moreover, the convective events occurring in the SACZ region showed a characteristic north-south dipole, between the convective region and the region to the south.

* Corresponding author address: Christopher C Castro, CPTEC/INPE, Cachoeira Paulista, S.P., Brazil; e-mail: castro@cptec.inpe.br

4. CONCLUSION

The interaction among the tropical convection in the Indonesian Region, the austral subtropical flow, and the convection during SACZ episodes was analysed in this study.

One of the results show a "seesaw" convective behaviour existing between the Indonesian region and the tropical portion of South America as a result of the progression of the MJO along the equatorial belt in a wavenumber one pattern. When the convective activity belonging to one extreme of this wave is positionated over the Indonesian region, the region where the convection is inhibited is over the equatorial portions of South America and Atlantic Ocean. At this step there is an east-west OLR dipole between the Indonesian region and the West Tropical Pacific. Some aspects of this behaviour was noticed by Nogues-Peagle and Mo (1997).

Thus, during events of intense MJO convection in the Indonesian region, there is a tendency for inhibition of convection over the Northern Brazil, including the Northeast Region. This situation is inverted when the convective signal of MJO, after have propagated along the Equatorial Pacific, reaches South America. A SACZ episode displaced to the north of its climatological position could be affected by this remote interaction. Therefore, there are evidences that a relationship between the behaviour of a SACZ episode and a MJO episode could exist.

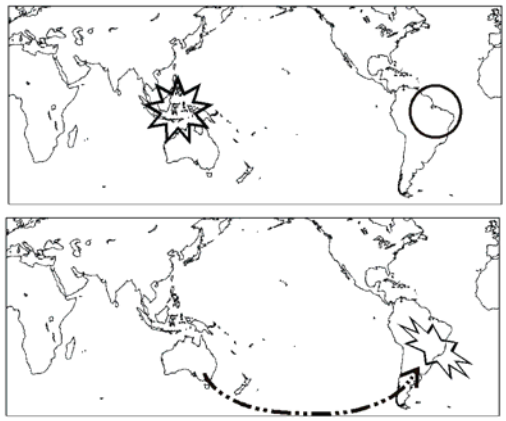

Fig.2 – Scheme showing two types of possible interactions affecting the SACZ region in the intraseasonal band. The upper figure shows the tropical mode and the lower, the subtrotropical mode. The stars represent convective events, the circle denots convection inhibited and the arrow represent the path assumed by the PSA pattern.

On the other hand, this study has also identified characteristics showing a Rossby wave PSA-like in the subtropical portions of Pacific-South America, associated with strong convection in the Indonesian region, also with a variability of 25 days.

The strong MJO periodicity grants to the PSA the characteristic "pulse" inside the intraseasonal band of frequencies. Hence, there is a potential to, periodically, a Rossby wave originated in the Indonesian region to affect the convection in the South America, during a SACZ episode. According to the results obtained in this work the period is nearly 25 days. In a favorable situation this wavetrain can establish an upper level anomalous cyclone over southeastern South America that can contribute to reinforce the characteristic trough belonging to a SACZ episode.

Another ingredient related to the establishment of a SACZ episode is the displacement of synoptic systems over South America which is represented by a wavetrain pattern of high frequency variability from southern Pacific to South America.

Summarizing, the results show that the relation between the Indonesian convection and the SACZ manifest periodically in two ways:

i) straightforward through the equatorially eastward progression of the MJ convective wave;

ii) Indirectly, through a wavetrain PSA-like, when the dominant modes of low and high frequency match appropriately.

REFERENCES

Cavalcanti, I. F. A., and M. T. Kayano, 1999. High-frequency patterns of the atmospheric circulation over southern hemisphere and South America. *Meteor. Atmos. Phys*., **69**, 179-193.

Grimm, A. M., and P. L. Silva Dias, 1995. Use of barotropic models in the study of extratropical response to tropical heat sources. *J. Meteor. Soc. Japan*, **73**, 765-780.

Liebmann, B., G. N. Kiladis, J. A. Marengo, T. Ambrizzi, and J. D. Glick, 1999. Submonthly convective variability over South America and the South Atlantic Convergence Zone. *J. Climate*, **12**, 1877-1891.

Mo, K. C., Ghil, M., 1987. Statistics and dynamics of persistent anomalies. *J. Atmos. Sci.*, **44**, 877-901.

Nogués-Paegle, J., K. C. Mo, 1997. Alternating wet and dry conditions over South America during summer. *Mon. Wea. Rev*., 125, 279-291.

Acknowledgments: The second author wishes to thank IAI/PROSUL/CRN- 055 and CNPq.