Variations of South America summer circulation on subseasonal time scales

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INTRODUCTION

Upper-tropospheric circulation over South America during austral summer presents some well-defined regional-scale systems such as the Bolivian high, a prominent warm-core anticyclone that establishes itself over the elevated Altiplano of the central Andes. Previous observational and modeling studies revealed that the position of the Bolivian high is primarily determined by Amazonian precipitation. Also it is documented that intraseasonal and interannual rainfall variability in the region of the Altiplano is closely linked to changes in intensity and position of the Bolivian high (Lenters and Cook, 1999).

The motivation of this research is to provide a large-scale understanding of upper-level summer circulation variability on subseasonal time scales over South America, with a particular emphasis on its relationship to tropical convection and Rossby wave propagation.

DATA AND METHODOLOGY

The dataset consists on 15 years (1979-93) of global reanalyses from the European Centre for Medium Range Weather Forecasts. Daily averages of the NOAA satellite outgoing long wave radiation (OLR) field are used as a proxy of tropical convection. Here, summer refers to the austral season and is defined as the period from 1 December through 28 February. Perturbations of atmospheric variables and OLR are defined here as the difference between each daily value and the time mean for each individual season, removing in that sense any interannual variability from the series (Berbery and Vera, 1996). The 300-hPa meridional wind perturbation in the South American sector (60°S-0, 110°W-20°E) was expanded in rotated extended empirical orthogonal functions (REEOFs) of four 1-day lag units. Composites of various fields are computed based on the temporal coefficients of leading REEOFs in order to isolate the signals associated with the extreme values of these fluctuations.

RESULTS

The dominant mode over tropical South America (hereafter is referred as IS mode) is characterized by a short-scale quasistationary wave pattern along the 25°S. Kalnay et al (1986) reported the presence of a similar Rossby wave train during summer of 1979 and performing global simulations they concluded that such pattern was maintained by the convection over both, the Amazon and South Pacific Convergence Zone (SPCZ).

A spectral analysis of IS mode temporal coefficient revealed significant signals on periods of 40-70 days, 15-25 days and also on synoptic time scales. Positive (negative) events of this mode were defined from the time when the coefficient was greater (smaller) than 0.8 times of its own standard deviation, for more than 5 consecutive days, until the time when the next crossing of this threshold occurs. Composite fields associated with the extreme phases of this mode were computed averaging over all events. The average duration for both positive and negative events is around 8 days.

Positive events (Fig. 1a) display an enhancement of the convection over subtropical Argentina, the Altiplano and also over eastern Brazil and surrounding oceans. A strengthening of the SPCZ, located further east, and an inhibited South Atlantic Convergence Zone (SACZ) are also evident. During this phase, the Bolivian high makes stronger and shifts further east of its climatological position. At middle latitudes, cold fronts move eastward, enhancing low-level northerly flow on the eastern slope of the Andes.

Negative events (Fig. 1b) are associated with an intensification and southward extension of the SACZ and inhibited convection over subtropical plains and Altiplano. The Bolivian high is located further west and gets weaken. Successive frontal systems penetrate into tropical latitudes and remain quasistationary over southeastern Brazil. There, they contribute to tap moisture from the Amazon to SACZ region while they inhibit the southward flow of moisture on the eastern slope of the Andes.

Many authors have reported this summer precipitation seesaw pattern over tropical South America from the analysis of OLR or precipitation data (Paegle et al., 2000). However, our results show that such summer precipitation variations are related with a clearly defined mode of variability of the upper-level circulation.

Future research under PROSUR

During this project the investigation will continue focusing on:

- ➢ Understand the mechanisms associated with the transition between the opposites phases of the IS Mode: (remote and local forcings)
- ➢ Understand the modulation of the synoptic-scale waves by the IS mode (westward propagation)
- ➢ Explore the significance of both fast (20-25 days) and slow (30-70 days) intraseasonal signals on upper-level summer circulation.
- ➢ Document year to year variations of the IS Mode and relate to SST changes over Pacific and Atlantic Ocean
- ➢ Investigate how intraseasonal, interannual and long term variations of summer circulation relate to the frequency of extreme rainfall events over La Plata river Basin

REFERENCES

Berbery, E. H., and C. S. Vera, 1996: Characteristics of the Southern hemisphere winter storm track with filtered and unfiltered data. *J. Atmos. Sci.*, **53**, 468-481

Kalnay, E., K.Mo, and J. Paegle, 1986: Large-Amplitude, Short-Scale Stationary Rossby Waves In The Southern Hemisphere: Observations And Mechanistic Experiments To Determine Their Origin. *J. Atmos. Sci.*, **43**, 252-275.

Lenters, J.D. and K. H. Cook, 1999: Summertime Precipitation Variability over South America: Role of the Large-Scale Circulation. *Mon. Wea. Rev*

Paegle, J. N., Lee. A. Byerle and K. Mo, 2000: Intraseasonal modulation of South American Summer Precipitation. *Mon.Wea.Rev*. Vol. 128, No. 3, pp. 837–850

Strengthened Bolivian High & Weakened SACZ | **Weakened Bolivian High & Intensified SACZ**

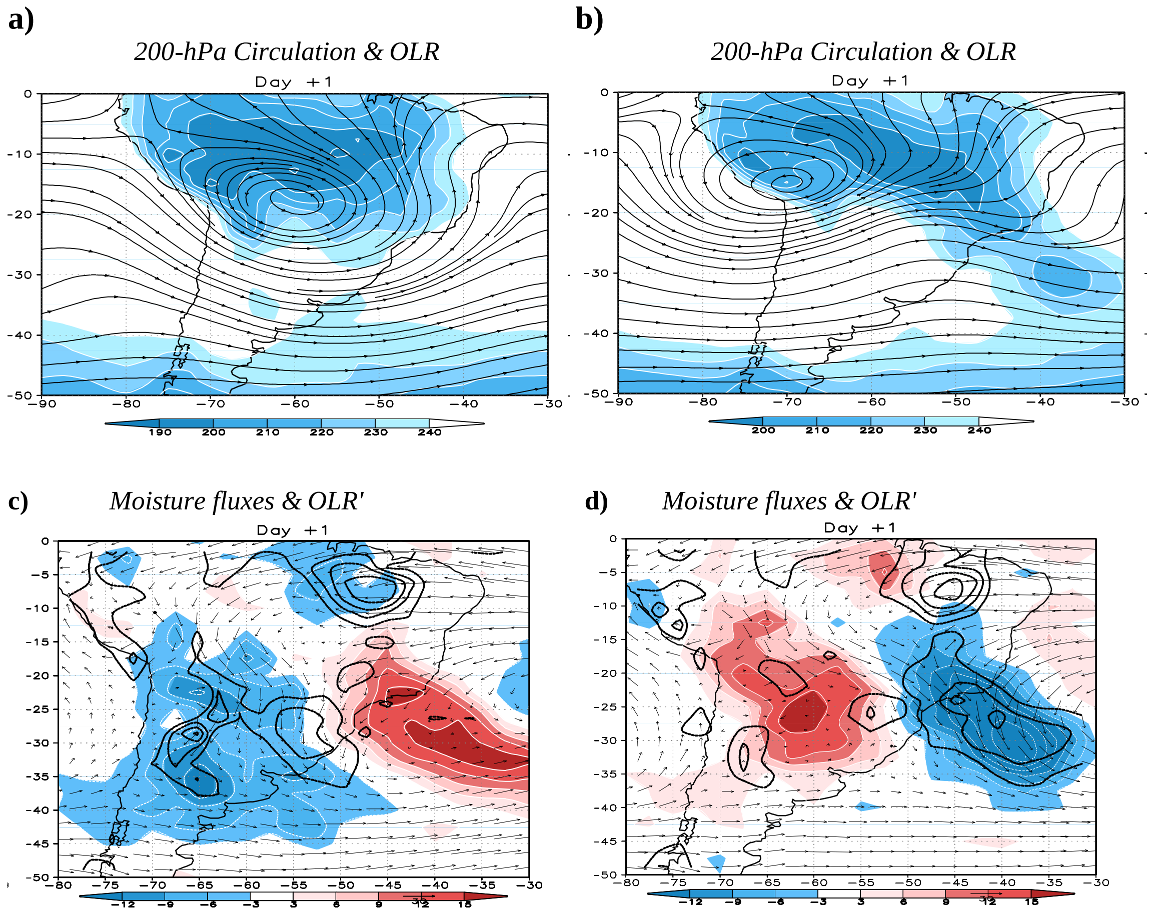

Figure 1: *Composite fields of 200-hPa circulation and OLR during (a) positive and (b) negative events of IS mode. OLR contours less than 240Wm^{-2} are shaded. Composite fields of vertically integrated moisture fluxes (vectors) and OLR' (shaded) for (c) positive and (d) negative events of IS mode.*