A BRIEF CLIMATOLOGICAL ASSESSMENT OF LARGE-SCALE ATMOSPHERIC PARAMETERS RELATED TO SEVERE LOCAL CONVECTION OVER SOUTH AMERICA BASED ON NCEP-DOE REANALYSIS-II DATA.

Ernani de Lima Nascimento[1]

[1]*Instituto Tecnológico SIMEPAR, Centro Politécnico da UFPR, Caixa Postal 19100, Curitiba/PR, CEP. 81531-990, Brazil. (Current affiliation: Météo-France, Dprévi/PI, 42 Av G. Coriolis, Toulouse Cedex 1, 31057, France; ernani.nascimento@meteo.fr)*

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I. INTRODUCTION

The present investigation is inspired by recent studies conducted by Harold Brooks and collaborators where vertical atmospheric profiles extracted from the NCAR-NCEP Reanalysis data are successfully employed to estimate the global distribution of large scale environments supportive of severe convective weather (Brooks *et al* 2003, Brooks and Anderson 2004, Brooks 2006). In agreement with observational studies (e.g., Schwarzkopf 1982, Zipser *et al* 2006), results from those global analysis highlight subtropical South America, east of the Andes Mountain Range, as an important "hot spot" for severe convection. Recent documentation of significant severe weather episodes in that part of the world concur to that finding (e.g., Held *et al* 2006, Nascimento and Doswell 2006).

This work presents an assessment of the spatial and temporal distribution of large-scale forcing mechanisms for severe thunderstorms (STS) over South America (SA) for the 6-yr period from 2000 to 2005 utilizing data from the NCEP-DOE Reanalysis II (R-2).

II. METHODOLOGY

No standardized systematic documentation of STS exists in SA, which hampers climatological studies using direct reports of severe weather. However, an indirect evaluation of their climatological distribution can be carried out using large-scale environmental conditions as proxy for the development of severe deep convection (Brooks *et al.* 2003). Following such approach, we use data from R-2 for the period enclosing 1 January 2000 to 31 December 2005 to extract regularly-spaced atmospheric profiles — through the entire troposphere — over SA that are employed to compute parameters which are relevant to characterizing large-scale environments conducive to STS development. The R-2 data are provided with a 2.5° x 2.5° horizontal grid spacing and at 28 vertical levels from surface to the stratosphere. Further description on R-2 can be found in Kanamitsu *et al* (2002).

The main focus in this work is on the mid-latitude/subtropical type of severe convection, which is usually associated with storms capable (mainly) of producing large hail and damaging winds. The tropical type of severe local convection, related to storms producing copious amounts of rain, is only indirectly addressed in this work. This means that we are basically interested in environments where strong vertical wind shear is present in addition to the general requirement of low-level moisture availability and presence of conditional instability (valid for all forms of deep moist convection).

Because R-2 data allow only the examination of large-scale atmospheric features and do not provide a detailed close-up view of the atmosphere at the low-levels, we emphasize our analysis on convective-related parameters that are computed either at the mid-troposphere (namely, the 700hPa to 500hPa lapse rate; MLLR) or that refer to a deep tropospheric layer (namely, the 0-6km vertical wind shear, represented in this work by the Bulk Richardson number shear; BRNSHR; e.g. Stensrud *et al* 1997). The exception to that rule is the computation of the level of free convection (LFC), which provides meaningful information regarding low-level moisture availability and the general propensity to convection to be triggered. It is not our aim to discriminate potentially tornadic environments, which would require better sampling of the low level vertical wind shear (Brooks *et al* 2003), not available by R-2.

The results discussed here do not represent a true climatology of STS conditions because of the intrinsic limitations of the data source and the relatively short period being studied. Nevertheless, the results add value to the task of improving our understanding about the distribution of severe weather environments in SA (Nascimento and Doswell 2006).

III. RESULTS

Figure 1 depicts the 2000-to-2005 average fields for MLLR and BRNSHR at 12Z for January (austral summer), May (austral autumn), August (austral winter) and November (austral spring). Contours of MLLR above 6.2°C/km — i.e., temperature drop greater than 6.2°C/km — are coloured; colour-shaded areas indicate BRNSHR above 20 m^2/s^2, with values above 40 m^2/s^2 being also highlighted by thick contours. The analysis will focus on the sector of SA east of the Andes, avoiding the region of very steep topography of the Andes which can lead to less representative values of MLLR and BRNSHR.

The general geographic distribution of MLLR and BRNSHR shows larger magnitude of these parameters in the subtropics and mid-latitudes of SA throughout the year, as expected. The highest values of MLLR (see first column of Fig. 1) remained "anchored" over central Argentina — just east of the Andes — and displayed little seasonal variability, showing only a hint that Uruguay, northeastern Argentina and extreme southern Brazil experienced slightly higher MLLRs during May, August and November as compared to January.

The deep-layer vertical wind shear displayed a much more evident seasonal variability (second column of Fig. 1). Lower average values of BRNSHR were detected for January, when baroclinicity is weaker. Similar patterns were also found for 00Z, 06Z and 18Z (not shown). Of particular interest is the region of the triple border Brazil-Argentina-Paraguay (BrArPa) where a significant variation in BRNSHR is evident throughout the year.

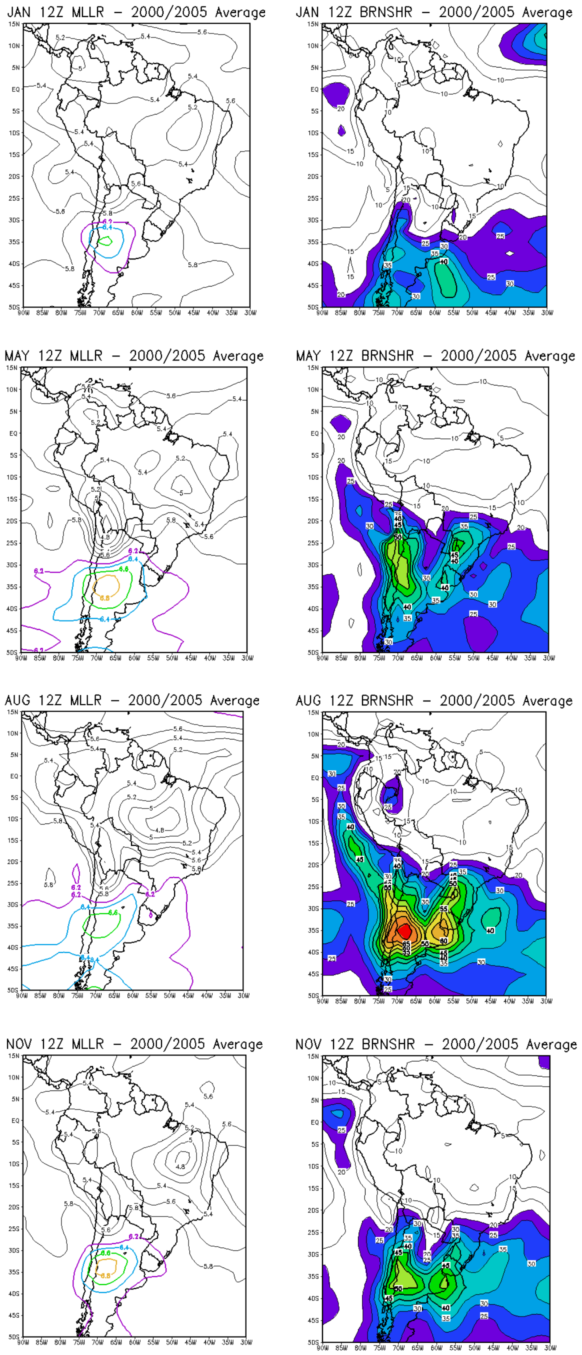

FIG. 1: Six-year average fields of MLLR (first column; °C/km) and BRNSHR (second column; m^2/s^2) at 12Z for selected months. See text for details.

This is better characterized with the aid of the first panel of Figure 2, which shows the average annual variability of BRNSHR for the grid point closest to BrArPa. Higher values of BRNSHR were found from mid-winter to early spring, with lower values toward summer, which is consistent with previous studies (Nascimento 2004). Our general perception is that the strongest thunderstorms in that particular region occur during spring, which seems in part related to an increase in vertical wind shear. The red curve in Fig.2 shows the steady decrease in the height of LFC during spring indicating an increase in moisture availability. In fact, winter thunderstorms are much less common in that region (in agreement with high LFCs during that time of the year).

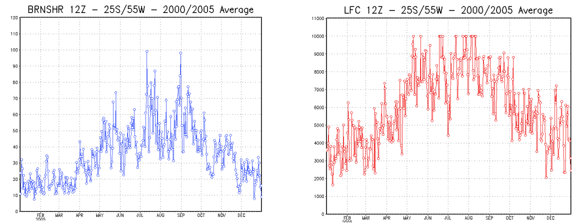

FIG. 2: Time series showing the evolution of BRNSHR (blue; m^2/s^2) and LFC (red; m AGL) during the "average year" corresponding to the 2000-2005 period for the location 25S-55W (triple border Brazil- Argentina- Paraguay).

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