P2.13 RELATIONSHIPS BETWEEN THE LARGE-SCALE ENSO PROCESSES AND THE PECULIARITIES OF REGIONAL CLIMATE ON THE TERRITORY OF BRAZIL.

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1. INTRODUCTION*

The correlation of some regional climatic anomalies with ENSO events is well known and documented. Many investigations were devoted to the discovery of these ENSO influence zones, the statistical analysis of data series bearing information on the ENSO signal, and regional anomalies of meteorological and hydrological parameters (Ropelewski & Halpert 1987; Kiladis & Diaz 1989; Grimm et al. 1998). It seems interesting and important to investigate in detail the behavior of various meteorological parameters in the zones of largest impact, beginning from the synoptic scale, in order to understand the processes that are responsible for the ENSO influence on the weather.

2. DATA AND METHODOLOGY

When we investigate the correlation between processes in various spatial scales it is desirable to have similarity in the time scales for these processes. It means, the time series of the studied meteorological parameters should contain only synoptic, annual and inter-annual components. For this reason we study interrelation between averaged values of standard meteorological characteristics and some functionals from modified Ertel's potential vorticity (MPV). Note that MPV is not only conserved under the adiabatic assumption but it is the adiabatic invariant in classical mechanic sense, that is, it varies slowly in weather and climate processes (Kurgansky & Pisnichenko, 2000)

In this study we analyzed the time series over the period 1976-1987 of precipitation and some meteorological parameters of atmospheric circulation over South Brazil (comprising the states of Paraná, Santa Catarina, and Rio Grande de Sul), North Brazil (Amazonas, Pará, Rondônia, Roraima, Amapá), and the whole Southern Hemisphere. For the analysis of the time series we have restricted ourselves to the month of November, taking into account that during this month occurs the largest anomaly of precipitation in South Brazil (Grimm et al. 1998) and a perceptible enough one is observed over North Brazil (Fig. 1a, 1b). To be sure that the mean-area precipitation is not strongly sensitive to the set of meteorological stations, we used also a set reduced to half the original number. In this case the behavior of the curves almost didn't change and the absolute values changed not more than 6%.

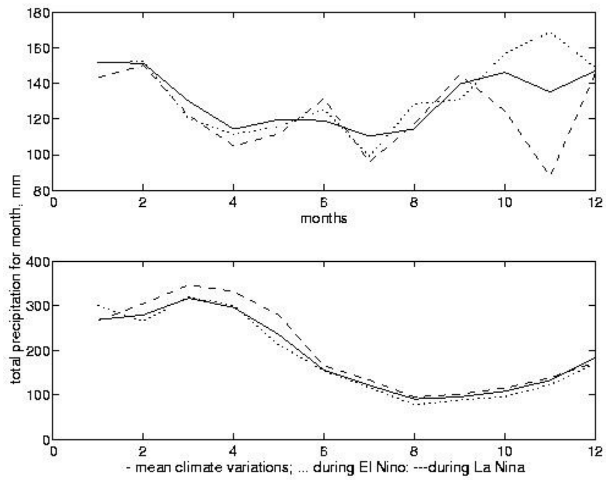

Fig. 1

To characterize the regional circulation, we considered the following parameters for the area under study: mean surface pressure; vorticity charge, and the mean weighted over all the air mass of kinetic energy, available potential energy, divergence of humidity fluxes, vertical velocity, Brunt-Väisäla frequency, and temperature. To characterize the large-scale atmospheric circulation, we considered the same parameters listed above, but calculated over South America and all the Southern Hemisphere. We also computed the angular momentum components, as well as the first 15 coefficients of spherical harmonics in the decomposition of geopotential and potential vorticity fields for the Southern Hemisphere. For El Niño and La Nina years we analyzed in detail also the fields of geopotential, potential vorticity, temperature, and humidity fluxes divergence. For South Brazil we also carried out the principal component analysis of geopotential over the area 110W –30W, 70S-15S.

3. RESULTS

The preliminary results of the analysis of this large amount of data confirm the connection of the regional precipitation anomalies with a more or less stable synoptic pattern over these areas. For example, the spatial structure of the Empirical Orthogonal Function of the geopotential field at 850 hPa, the Principal Components of which have maximum correlation with precipitation in South Brazil for El Niño years, is always similar to that presented in Fig.2 for 1982.

Analysis of temporal evolution of parameters characterizing regional circulation indicate that precipitation is tightly linked with other atmospheric characteristics and correlation coefficient is sensitive to the phase of the ENSO cycle. In Fig 3 are presented

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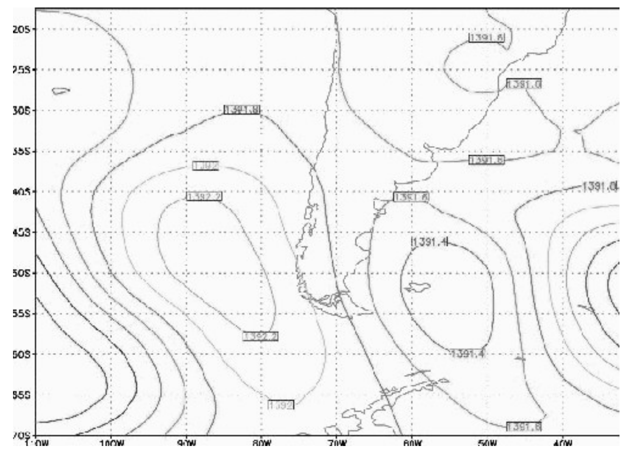

Fig. 2

the variations of the coefficient of correlation between precipitation and average vertical velocity (— solid line), precipitation and vorticity charge (... dotted line), precipitation and average divergence of humidity fluxes (--- dashed line), precipitation and average surface pressure (.-.-. dot –dashed line) for various years. One can see that 1976, 1979, 1982, 1986 (El Niño), 1984-5 (La Nina) years have some common aspects in the behavior of the correlation coefficients.

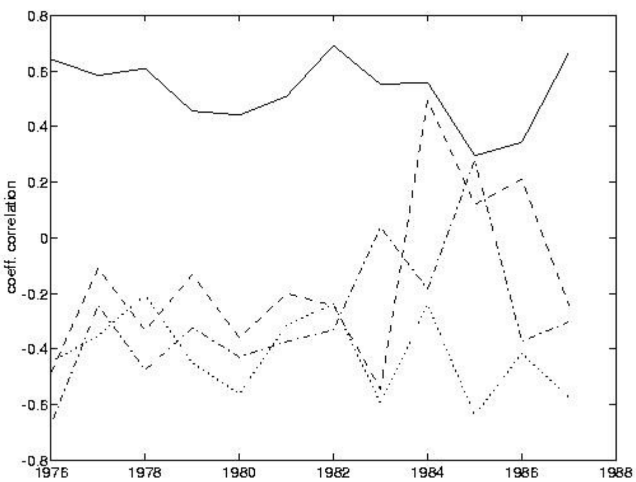

Fig. 3

A simple comparison of the time series of parameters of global circulation with the time series of regional parameters shows the following interesting relationships between them: a) during a El Niño episode most of ultra-long waves in potential vorticity field have a large quasi stationary component, and the beginning of strong rainfall in Southern Brazil is correlated with a sharp change of the phase of this component; b) most of the correlation coefficients between global and regional meteorological parameters for November have an interannual variation related to that of the monthly precipitation. In Fig.4 are shown the temporal evolution of November monthly precipitation (for South Brazil) normalized by the maximum value for this period of years (solid line) and correlation coefficients between Southern Hemisphere kinetic energy and regional (for South Brazil) vorticity charge (dashed line), SH vorticity charge and regional vorticity charge (dotted line), and SH informational entropy (which characterizes the intensity of mixing processes, consequently intensity of meridional circulation) and regional vorticity charge (dot-dash line).

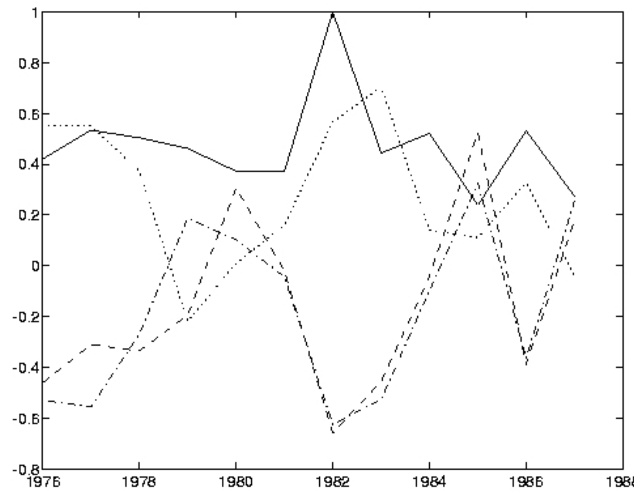

Fig.4

This investigation helps clarifying cause-consequence relationships between local weather processes and peculiarities of large-scale circulation during various phases of ENSO and can be helpful in the development of dynamic-statistical middle range weather forecast .

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