J5.3 Seasonal Variability over Southeast Brazil related to frontal systems behaviour in a climate simulation with the AGCM CPTEC/COLA.

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1-INTRODUCTION

The Southeast Region of Brazil, which is affected by the South Atlantic Convergence Zone (SACZ) during the summer, and by frontal systems in the winter, has the lowest predictability of the country, seen in results of the AGCM CPTEC/COLA. Climatological simulation of summer precipitation over South America shows that the model overestimates precipitation in the southern part of this band and subestimates in the northern part (Cavalcanti et al. 2002). The southeastern Brazil is a transition region, between the tropical regime to the north (Nordeste), which has high predictability, and the extratropical regime to the south, which has medium predictability. The region is affected by frontal systems during the whole year (Kousky, 1979). In the summer, these systems interact with the tropical convection resulting in the SACZ. In the winter, low temperatures and cases of frost are associated with the passage of cold fronts (Fortune and Kousky, 1983). The monthly or seasonal model results, in climate simulations or predictions, indicate an average of the daily conditions during the period. Thus, it is necessary to know if the model has the ability to simulate the behaviour and the influence of synoptic systems, such as frontal systems, over the region. In this study, the number of frontal systems which affects southeastern Brazil, their behaviour and the large scale atmosphere characteristics, are analysed in a climate simulation.

2-METHODOLOGY AND DATA

Daily results of nine integrations with the CPTEC/COLA AGCM of a ten years simulation were analysed in this study. This spectral model was integrated with resolution of T62 and 28 vertical levels from 1982 to 1991. The design and results of this simulation is presented in Cavalcanti et al. 2002. From these data, the passage of frontal systems by the southeastern region of Brazil was identifyed considering the temperature, pressure and wind direction variations in a specific area of the region.

A spatial average of each variable was calculated for the area of (24ºS - 20ºS/47ºW-43ºW). A frontal system was identified when the averaged temperature was reduced, and the surface pressure was increased, during three days, more than a limit value, and there was southerly winds. Considering that the variables have different variations in each season, with the passage of a frontal system, the threshold taken for each variable was also different for each season. The analysis were performed for the ensemble mean and also for each of the nine conditions.

3-SEASONAL AND INTERANNUAL VARIABILITY

The results showed that the ensemble mean does not represent well the typical atmospheric characteristics of a frontal system, considering the southeastern region. Each condition show the system in a different position, and the ensemble average remove the atmospheric characteristics of a frontal system. However, if each condition is analysed separatelly, the typical features of a frontal system is well identified in the model simulation. Fig.1 shows one selected case, from one integration, on 12th september,1982. It is seen the wind confluence between anticyclonic flow to the north and anticyclonic/cyclonic flow to the south, associated with high/low pressure of the frontal system (Fig.1 a). Simulated precipitation associated with the frontal system is seen in Fig.1b). Negative zonal geopotential anomaly at 200 hPa associated with the upper level trough, and high/low pressure are shown in Fig.2 a, and the flow at 200 hPa, in Fig.2b, show that the trough has small amplitude.

The number of occurrences of frontal systems in each season, considering the nine conditions in ten years is presented in Fig.3. These numbers give a frequency of 3 systems for each season, considering the threshold in pressure and temperature. It is likely that only the strongest cold fronts are being identified, because this number is below of the expected frequency. It is also noticed the highest frequency of occurrence in MAM and SON, which are transitions seasons, instead of JJA, as one could expect. The minimum frequency in DJF is consistent with observations, since in this season there is not large temperature variations associated with a frontal system. There is interannual variation, and also variations among the members of the ensemble, as can be seen in the example of SON, in Fig.4. The minimum values are found in 1984 and 1988, which were La Nina years. Pós El Nino years of 1983 and 1987, had the highest number of occurrences.

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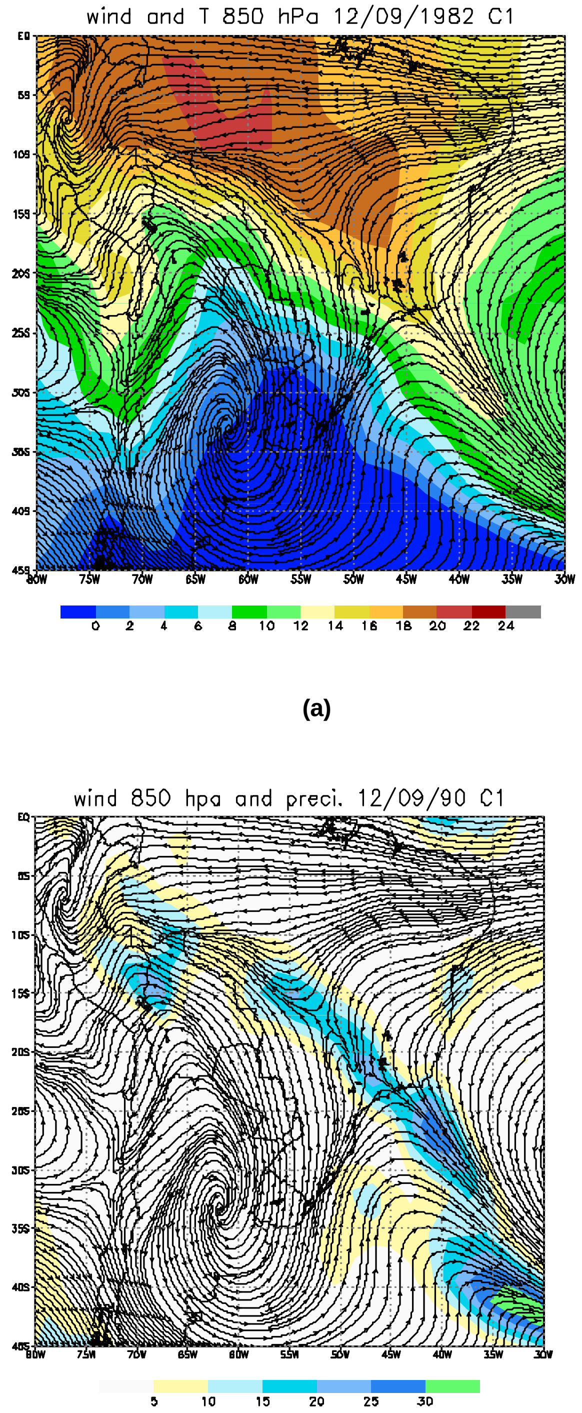
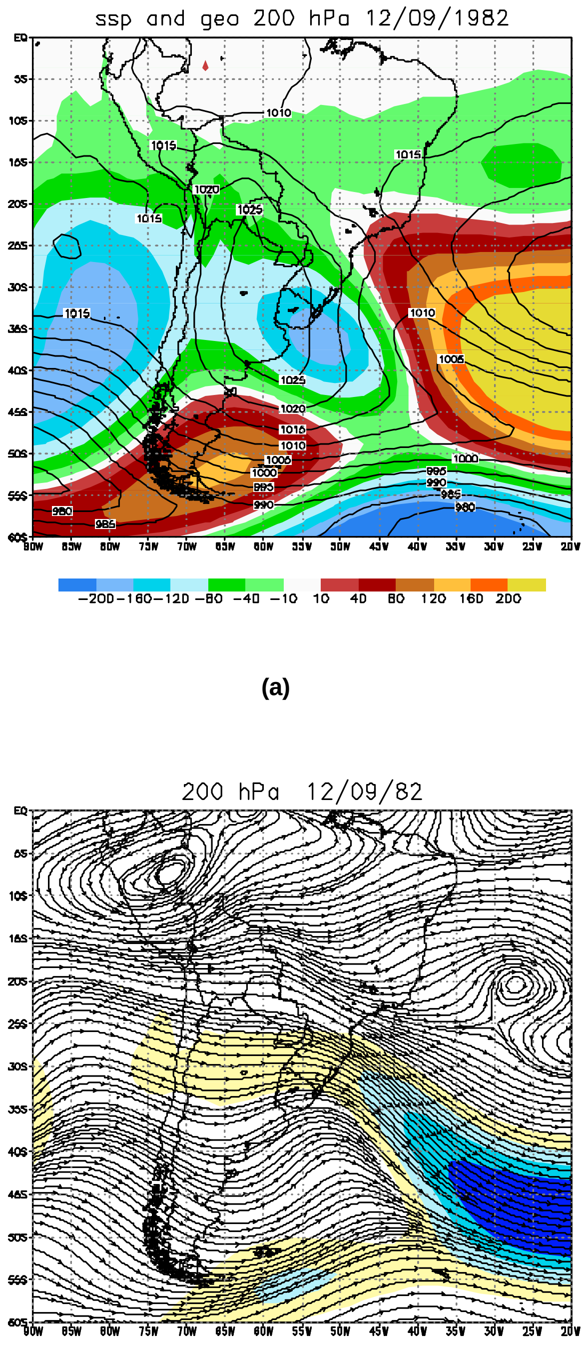


(a)

(b)

Fig.1- Occurrence of a frontal system over southeast Brazil on the model results. (a) Wind flow and Temperature at 850 hPa; (b) Wind flow at 850 hPa and precipitation.



(a)

(b)

Fig.2- (a) Sea Level Pressure (isolines) and geopotential zonal anomaly at 200 hPa (shaded); (b) Streamlines and magnitude of wind at 200 hPa, for one selected case of frontal system occurrence

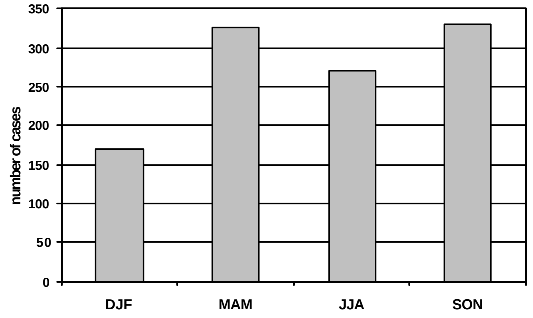


Fig.3- Number of cases in summer, autunm, winter and spring in ten years, considering the nine integrations.

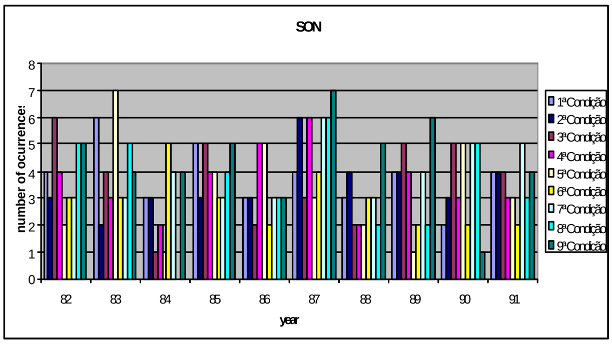


Fig.4- Number of frontal systems in SON for each integration, in each year from 1982 to 1991, simulated by the model.

4-SEASONAL CHARACTERISTICS IN CASES OF OCCURRENCE OF FRONTAL SYSTEMS

Averaging the cases of occurrence for each season and each year (1982 to 1991), the main features associated with a frontal system are well reproduced. As an example, the average of cases for all seasons of 1990 are displayed in fig.5-8. The average represents similar characteristics in the selected cases, and the typical frontal system characteristics are seen in all seasons. The intrusion of cold air, associated with the passage of a frontal system, is well simulated. The flow from the anticyclonic circulation, to the south of the system, is directed from the south to lower latitudes, bringing cold air over the continent. In the summer, the characteristics are typical of the SACZ occurrences. The precipitation in all seasons is close to the low level confluence, and it is more intense in the summer and spring seasons, consistent with observed features. It is clear the difference of the flow to the north of the system, from the Atlantic Ocean, turning toward southeastern over the continent, in the summer and spring seasons, in contrast with the flow from the ocean towards central South America, in the winter and autunm.

6-CONCLUSION

It is noticed that the model reproduces the characteristics of the frontal systems over southeast Brazil, in a climate simulation, when the analysis is performed for each individual integration. The average fields of cases for each season reproduce the low level wind confluence, anticyclonic circulation to the rear of the front, which brings the cold air, troughs at upper level and typical pressure and geopotential fields.

The seasonal atmospheric characteristics related to intensity of precipitation is also very well reproduced. However, when the ensemble mean is analysed, the typical features are not displayed, because of the large dispersion among members. It is suggested that analysis of model results for Southeastern Brazil in seasonal simulations/predictions should be performed considering each individual member, rather than the ensemble mean.

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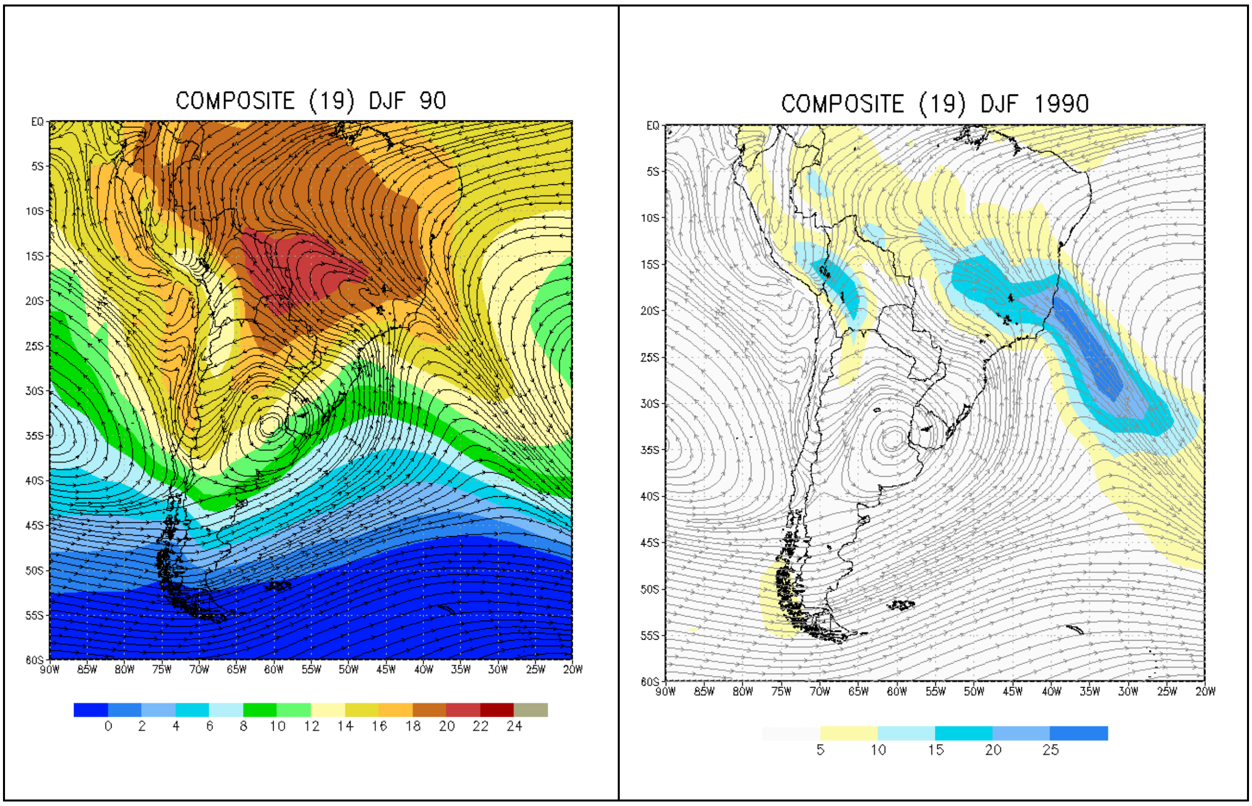
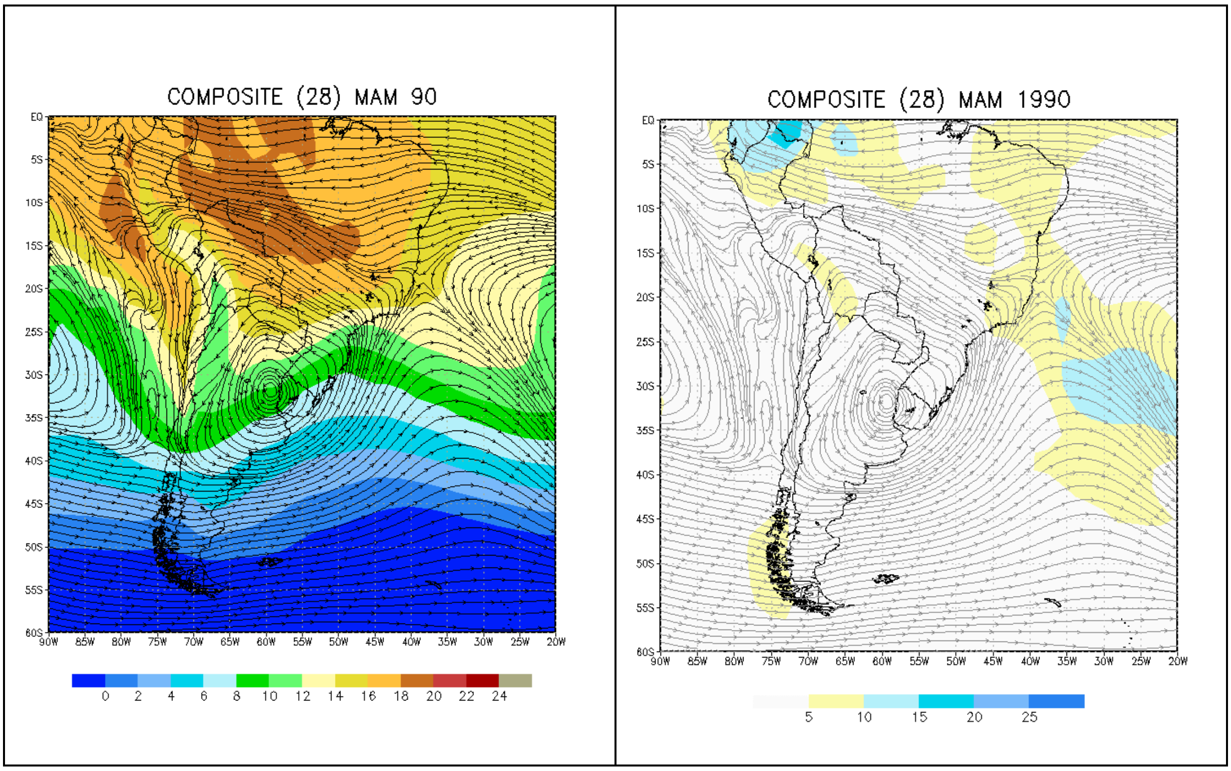


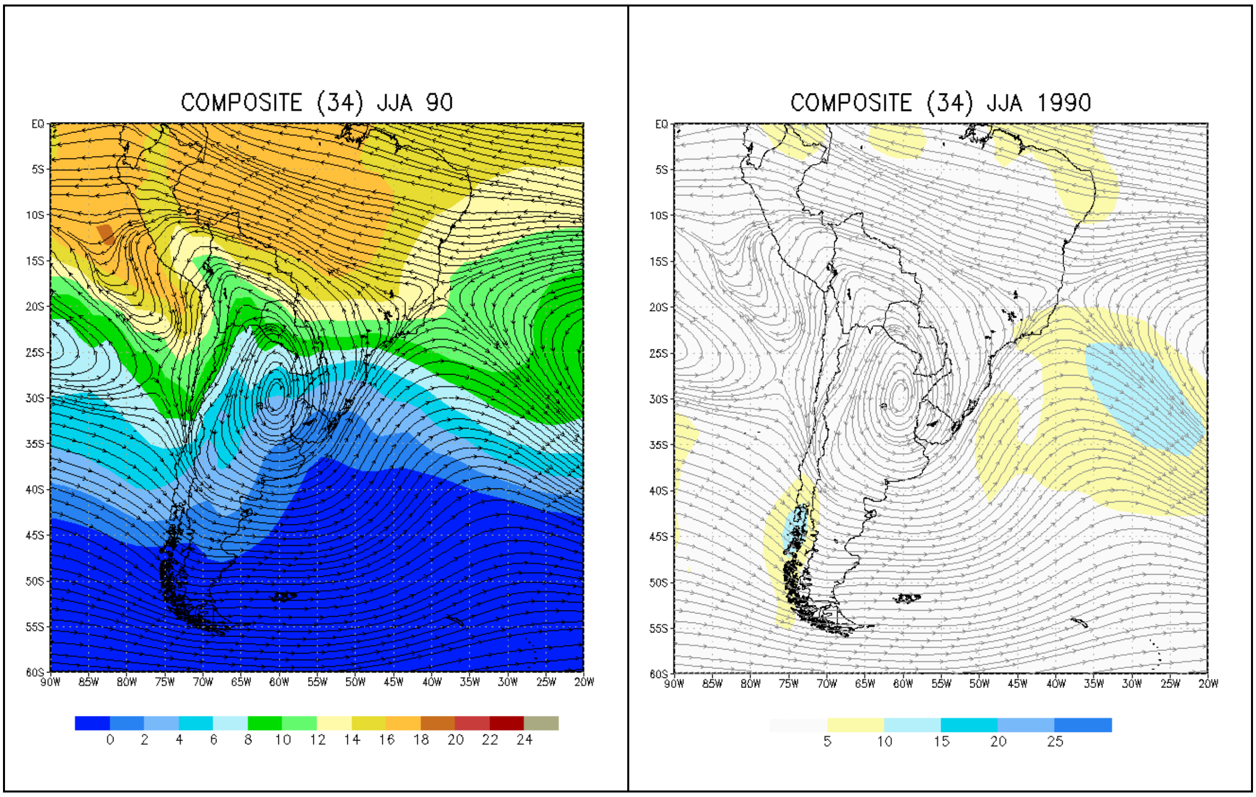
(a) **(b)**

Fig.5 (a) Wind flow and temperature at 850 hPa for the average of frontal systems occurrences; (b) precipitation for the average of cases simulated. The numbers refer to the number of cases in the summer (DJF)1990/1991.



(a) **(b)**

Fig.6- (a) Wind flow and temperature at 850 hPa for the average of frontal systems occurrences; (b) precipitation for the average of cases simulated. The numbers refer to the number of cases in autunm (MAM) 1990



(a) **(b)**

Fig.7- (a) Wind flow and temperature at 850 hPa for the average of frontal systems occurrences; (b) precipitation for the average of cases simulated. The numbers refer to the number of cases in winter (JJA) 1990

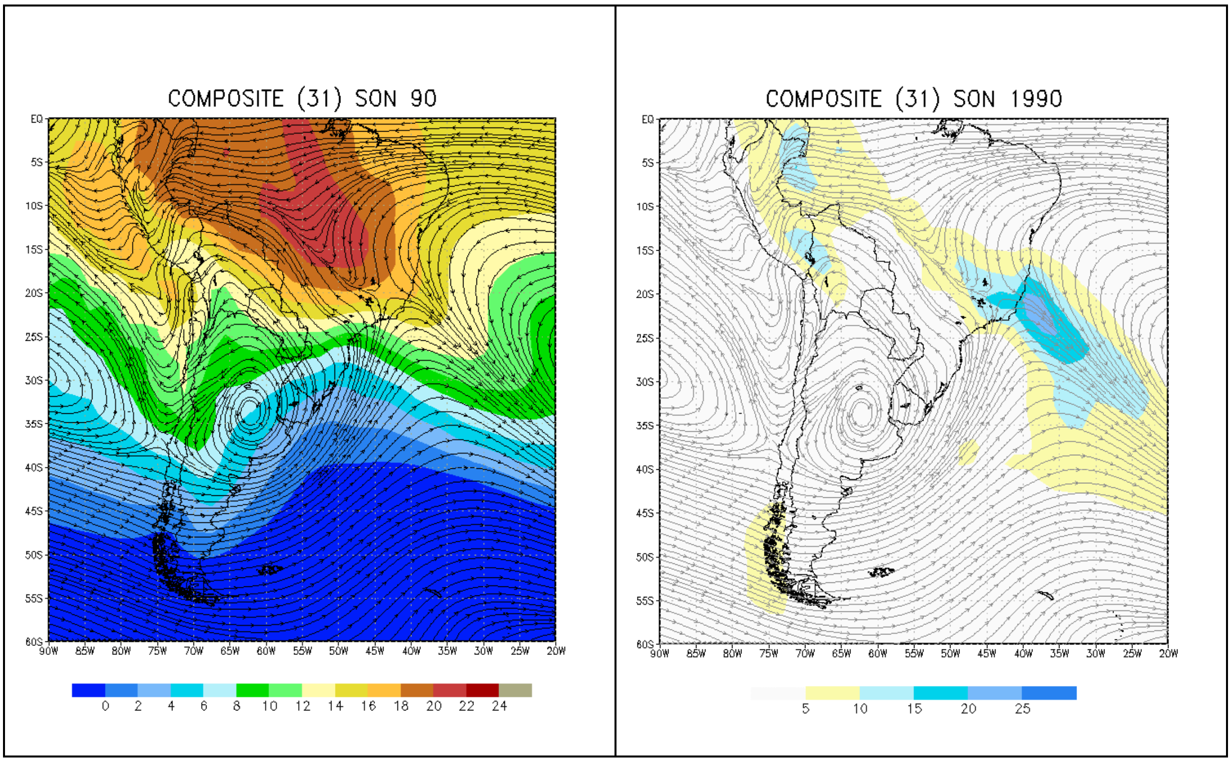


Fig.8- (a) Wind flow and temperature at 850 hPa for the average of frontal systems occurrences; (b) precipitation for the average of cases simulated. The numbers refer to the number of cases in spring (SON) 1990.