ATMOSPHERIC MODELING GROUP
STUDIES FOR IMPROVEMENTS OF SEASONAL PREDICTION

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Several studies using the AGCM CPTEC/COLA have been conducted regarding the seasonal predition over southeastern South America (SSA). Seasonal climatological features simulated by the model were discussed in Cavalcanti et al (2001, 2002 a). A result concerning the region SSA is the precipitation subestimation in all seasons (Fig.1). Suggestions for the improvement of the model behaviour is related to the radiation code and the convection scheme. Analyses of radiative fluxes and discussions on the model behaviour (Fig.2) was presented in Tarasova and Cavalcanti (2002). However, even with the systematic errors, the precipitation anomalies over SSA, in ENSO years, are well represented by the model, as discussed previously (Cavalcanti et al. 2001). Analyses of model skill, in the region, during 10 years simulation, show a lower skill than in Northeast Brazil, but higher than in other regions of South America (Marengo et al. 2002). Correlations between observed and simulated precipitation anomalies for SON are displayed in Fig.3.

Results of the simulated hydrological balance over SSA, and the discussion on the behaviour of the water cycle variables were presented in Rodriguez (2002) and Rodriguez and Cavalcanti (2002). The region was divided in two sectors (north and south), and the balance was performed for each sector (Fig.4). The northern sector has an annual cycle well defined, with a maximum in the summer. The southern sector has less energy during the whole year and does not show a seasonal cycle, although the maximum precipitation was found in the spring. The humidity flux from the north was identified, converging to southeast Brazil in the summer and to northern Argentina, in the spring. The model simulates the seasonal characteristics of the water cycle variables, as well as those in extreme ENSO years, but with different intensities from the observational data. Eventhough, the precipitation differences over SSA between El Nino and La Nina years are well simulated and related to different moisture flux convergence.

Considering that precipitation over the SSA region is influenced by ENSO, and that the model has the ability of getting this signal, in strong ENSO years, studies using CPTEC/COLA AGCM were also developed to verify the role of the Atlantic and the Pacific Oceans on the precipitation anomalies over the region. The influence of Atlantic and Pacific on SSA precipitation of November is discussed in Grimm et al (2002), and the summer features is analysed in Cavalcanti et al (in preparation). November is the month of strongest impact of El Niño and La Niña events on rainfall over Southern Brazil. The role of sea surface temperature anomalies (SST) in the Pacific and the Atlantic oceans in producing rainfall and circulation anomalies during November of these events is investigated through simulations with the CPTEC/COLA atmospheric general circulation model. Three sets of integrations were performed for 1982. The first set used the observed SST over all oceans, the second one used observed SST only in Tropical East Pacific and climatological SST elsewhere, and the third one used observed SST only in South Atlantic. The results (Fig. 5) show that forcing by tropical East Pacific SST leads to circulation and rainfall patterns more similar to the observed ones for the El Niño event of 1982 than those obtained by the inclusion of the South Atlantic observed SST (Grimm et al. 2002).

Climate simulations were also performed using LMDZ AGCM, at low resolution, considering the period of 1979 to 1995 and six integrations to the ensemble mean. A new version of the model, LMDZ 3.2 with higher resolution (3^0lonX2^0 lat) was used in sensitivity tests. In this version, a stretched grid with center at 30^0 S, 60^0W was introduced, increasing the resolution over the SSA region. Climatological results show an overestimation of the wind magnitude. Several experiments have been performed, one of them, a simulation of SON 2001, a period when maximum precipitation over the region was observed. The results showed that the signal of the precipitation anomalies was well simulated, but the magnitude of the main positive anomaly over the La Plata River was subestimated (Fig. 6). Other results are documented in Menendez et al. (2001) and Carril et al. (2002).

Regional models have been applied in studies of climate modeling for the SSA region. One of these is the MM5 with resolution 60kmX60km. Changes in parameterizations are been implemented to represent seasonal features over S. America that are not simulated in the original version. The regional model is integrated during one month, and the boundary conditions are the reanalyses data, to see the model response in ideal conditions (Fig. 7). Future experiments will be performed with LMDZ boundary conditions.

Evaluation of seasonal precipitation prediction over SSA using results of the COF has been performed since 1998 (Berri, 2002). A list of where the COF took place is presented in Fig.8. Seasonal climate forecasts of precipitation are expressed in probabilistic terms. For this purpose, three equally-probable categories are identified: *above-normal*, *near-normal*, and *below-normal,* which are associated to a tercile distribution of precipitation. Homogeneous regions are identified in each case and the seasonal climate forecast is presented as the probability of occurrence of each category during the upcoming 3-month period. The COF forecast maps were used to create a database that consists of the probability of every tercile on 2.5-degree boxes coincident with the CMAP and CAMS-OPI.

Considering the CPTEC/COLA AGCM simulations and predictions, there are cases of observed extreme seasonal precipitation anomalies that are not identified in the model ensemble results. Observed precipitation over the SSA region is mainly related to synoptic systems, as cold fronts, and mesoscale systems, as convective complex (CCMs). In order to see the ability of the model to simulate the behaviour and influence of synoptic systems in the region, daily results of a climatological simulation were analysed. The model reproduces very well the characteristics of the frontal systems over SSA, in a climate simulation, when the analysis is performed for each individual integration of the ensemble (Fig.9). 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 (Cavalcanti and Coura Silva, 2002b, Cavalcanti and Coura Silva, 2003).

Due to the resolution of the AGCM ($1.89^0 \times 1.89^0$), it is not likely that the model can simulate the CCMs, but as these systems are related to the Low Level Jet, daily results of the climate simulation were also analysed to investigate the ability of the model in simulate the LLJ characteristics. The LLJ main features were identified in the model results data and compared with those identified in reanalyses data (Cavalcanti et al. 2002 c, d). The vertical structure of the LLJ and the atmospheric characteristics in cases of occurrence were very well simulated by the model.

Some of the activities in development are:

1-AGCM experiments with CPTEC/COLA AGCM to analyse the influence of the Pacific and Atlantic SSTs on the precipitation over the La Plata river basin.

2- AGCM experiments with LMDZ/CIMA AGCM.

3- Regional model experiments with MM5 and Eta.

4- The influence of teleconnections and transient systems on precipitation over the La Plata river basin, as simulated by the CPTEC/COLA AGCM.

5-Meteorological features associated with precipitation anomalies over La Plata river basin simulated/predicted by the AGCM CPTEC/COLA .

6-Evaluation of seasonal prediction over SSA.

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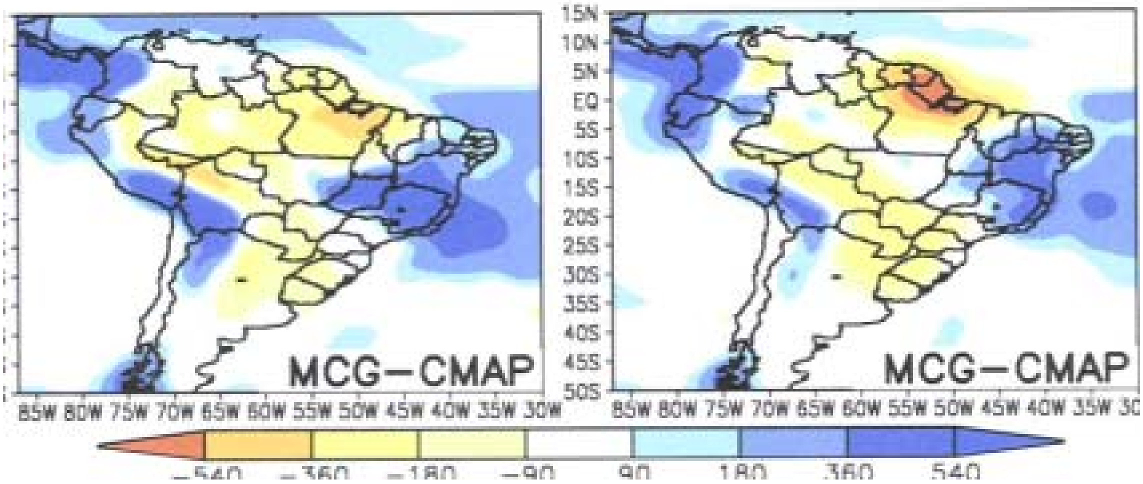


Fig.1- Precipitation difference between CPTEC/COLA AGCM climatological simulation and CMAP observational data, for DJF and MAM.

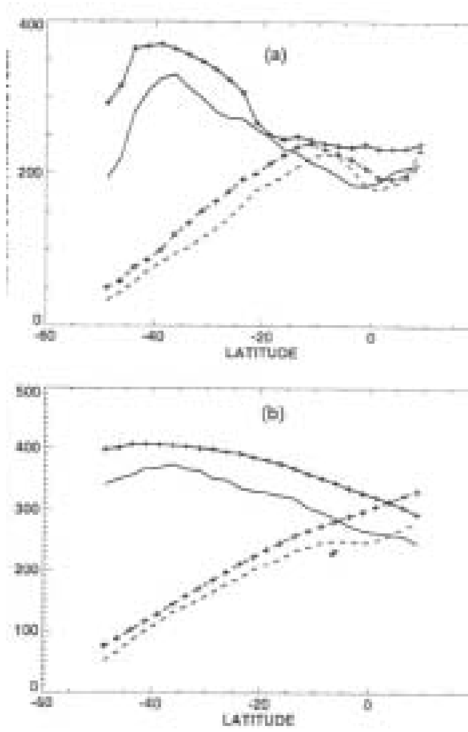


Fig.2- Monthly mean (a) all-sky and (b) clear sky solar radiative fluxes incoming at the surface in Jan (solid) and Jul (dashed). The fluxes are averaged over South America in each latitudinal zone of 2.5 and over 3 years, 1986-1988. Pluses denote the model results; curves without marks show SRB data.

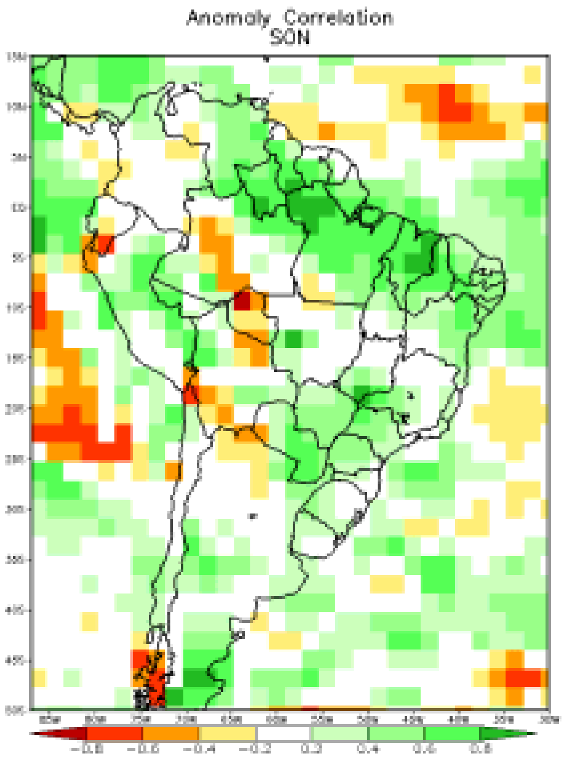
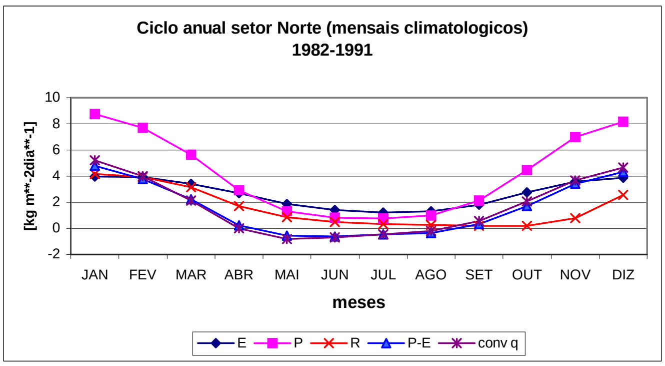
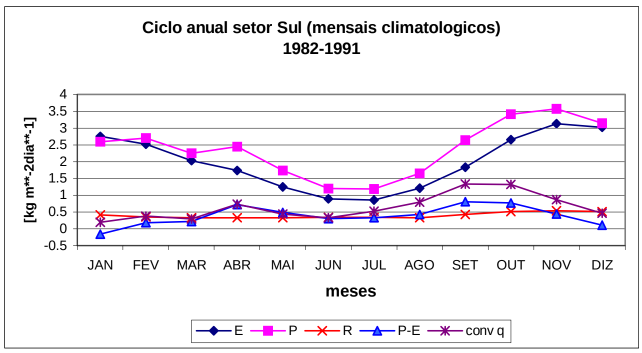


Fig.3- Correlations between the precipitation anomaly simulated and observed, in SON. Results from a climatological simulation with CPTEC/COLA AGCM.



(a)



(b)

Fig.4- Annual cycle of precipitation, evaporation, runoff, moisture convergence and P-E . (a) northern sector, (b) southern sector of the La Plata river basin.

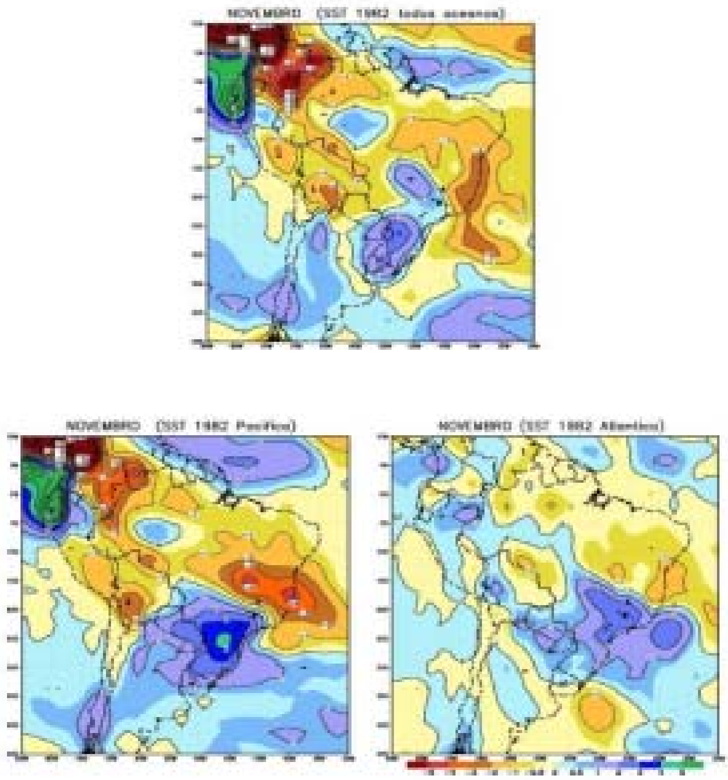


Fig.5- Precipitation anomalies simulated by CPTEC/COLA AGCM, considering, as boundary conditions, the SST anomalies in all oceans, only in the tropical Pacific, and only in the South Atlantic Ocean, in November 1982.

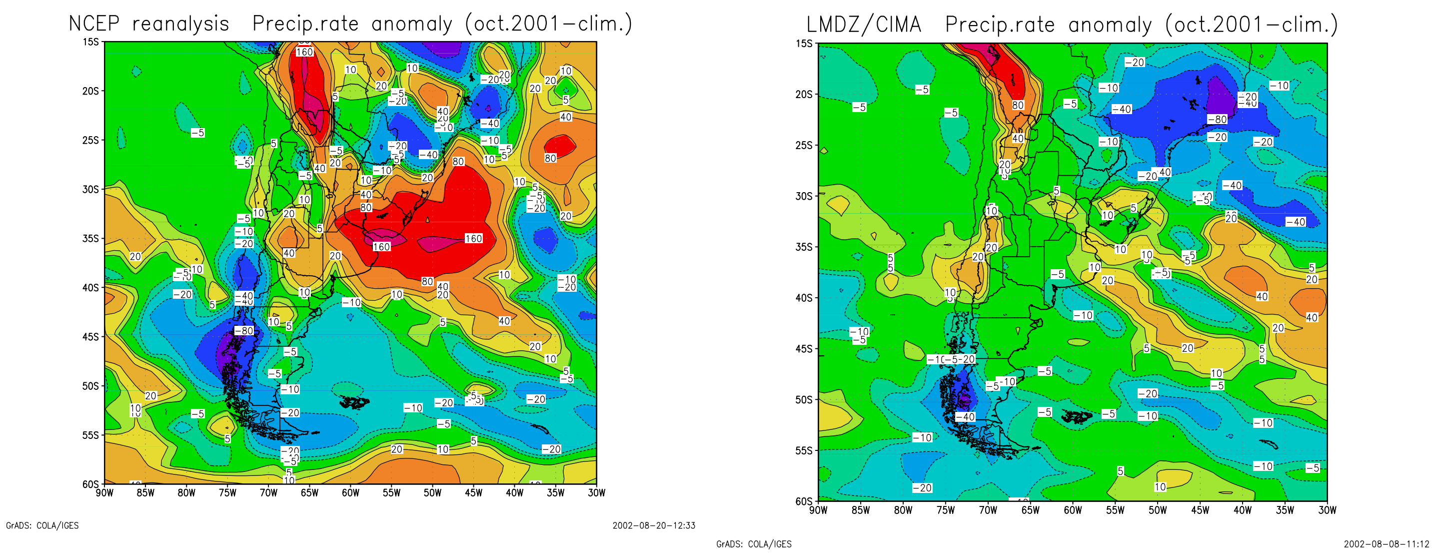


Fig.6- Precipitation anomalies for october 2001,simulated by LMDZ/CIMA and from NCEP reanalysis.

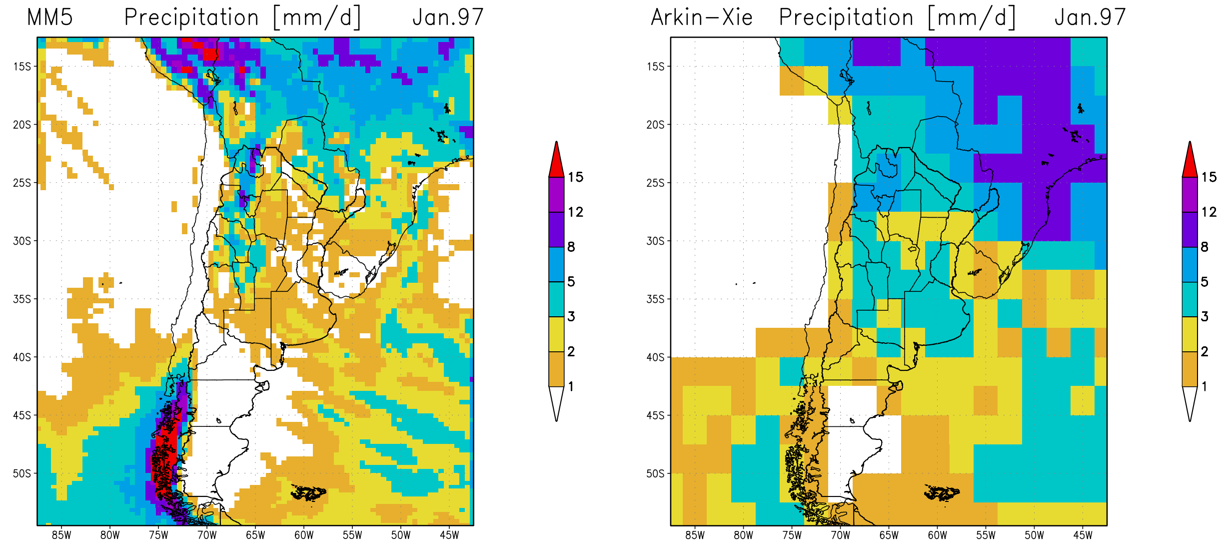


Fig.7- Precipitation simulated by the regional MM5 and observational Xie-Arkin, in Jan 1997.

COF no.	***Place and Date***	***Forecast Period***
1	Montevideo – Uruguay, December 1997	Jan-Feb-Mar 1998
2	Foz do Iguaçú – Brazil, June 1998	Jul-Aug-Sep 1998
3	Buenos Aires – Argentina, August 1998	Oct-Nov-Dec 1998
4	Salto Grande – Uruguay, December 1998	Jan-Feb-Mar 1999
5	Mariano Roque Alonso – Paraguay, April 1999	Apr-May-Jun 1999
6	Buenos Aires – Argentina, September 1999	Oct-Nov-Dec 1999
7	Montevideo – Uruguay, December 1999	Jan-Feb-Mar 2000
8	Cachoeira Paulista – Brazil, March 2000	Apr-May-Jun 2000
	Brasilia – Brazil, March 2000	Apr-May-Jun 2000
9	Mariano Roque Alonso – Paraguay, June 2000	Jul-Aug-Sep 2000
10	Buenos Aires – Argentina, September 2000	Oct-Nov-Dec 2000
11	Montevideo – Uruguay, December 2000	Jan-Feb-Mar 2001
12	Passo Fundo - Brazil, April 2001	May-Jun-Jul 2001
13	Mariano Roque Alonso – Paraguay, July 2001	Aug-Sep-Oct 2001
14	Buenos Aires - Argentina, November 2001	Nov-Dec-Jan 2002
15	Montevideo - Uruguay, May 2002	Mar-Apr-May 2002

Fig.8- List of place and date of the Climate Outlook Forum.

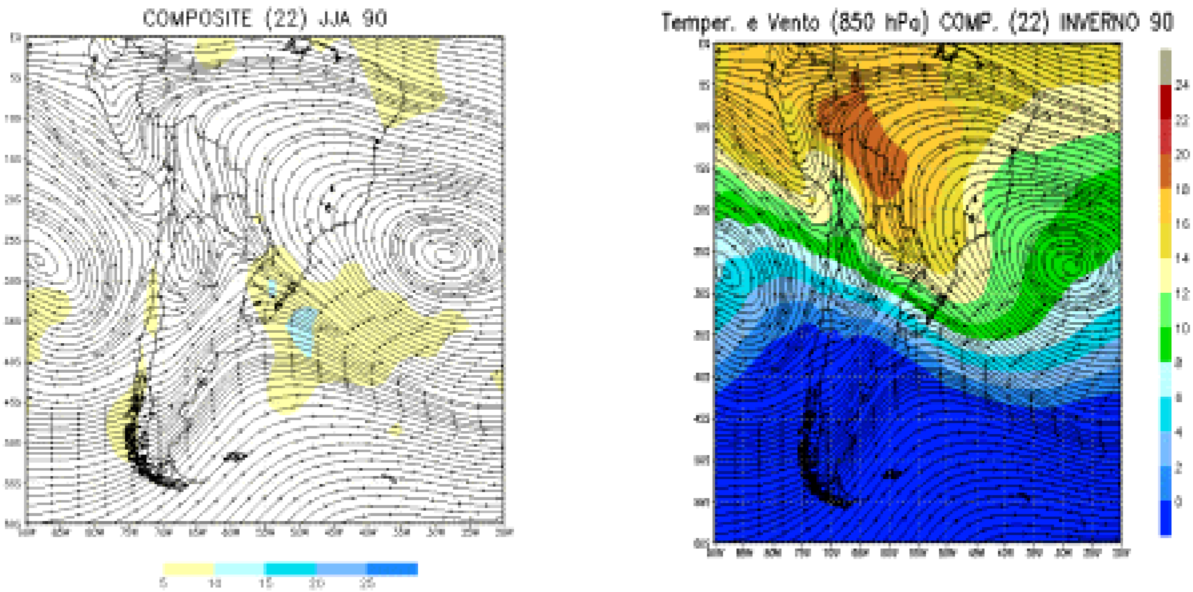
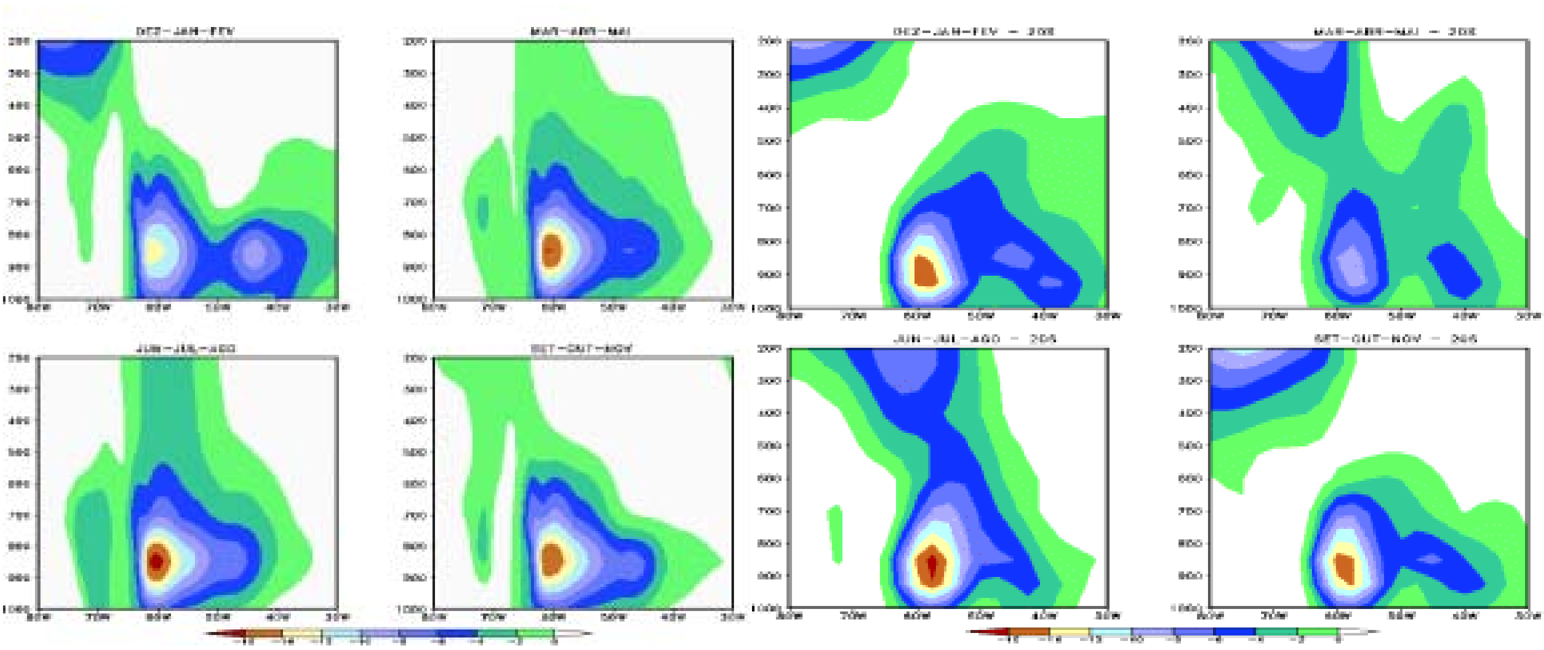


Fig.9- Average of frontal system occurrence over Southern Brazil in JJA 1990, in a climate simulation with CPTEC/COLA AGCM.



(a) (b)

Fig.10- Vertical structure of the meridional wind representing the LLJ in (a) AGCM CPTEC/COLA climate simulation and (b) reanalysis.