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COMPARISONS BETWEEN OBSERVED AND MODELED PRECIPITATION AND TEMPERATURE EXTREMES IN SOUTH AMERICA DURING THE XX CENTURY (IPCC 20C3M).

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1. INTRODUCTION

[1]One of the key aspects of Climate Change is to understand the behavior of extremes. It is recognized that the changes in the frequency and intensity of extreme events are likely to have a larger impact than changes in mean climate. Because of differences among model formulation in the various IPCC AR4 global coupled models, some differences can be expected in the projection of mean climate and extremes in the present and also in the future. A trend analyses performed by Marengo et al (2006) using various indices of extremes used by Tebaldi et al (2005) have shown that even though all models simulate quite well the observed warming trends in mean and extremes temperatures for 1950-2002, the situation with rainfall indices is not as good, and basically all models show tendencies that are different that the observed trends in various regions of South America. Marengo et al (2006) analyzes the simulations of the IPCC 20C3M, where all models are run with the same forcing for present climates, and their analyses focuses on trends during 1951-2000. And Tebaldi et al (2005) analyzes future climate changes in extremes for 2071-2100 for an ensemble of IPCC AR4 model projections, and while almost all models show a common signal of warming in many regions of the planet, the common signal for rainfall anomalies in the future climate is restricted to few regions around the globe. We propose to assess the expected changes in climate extremes over southern South America through the analysis of the indices of the IPCC 4th Assessment Model Output for the present climate (IPCC20C3M). These "extreme indices" are derived data, calculated from simulated daily temperature and precipitation, in the form of

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annual indicator time series. In this paper, for the common period 1960-2000, the mean, standard deviation and mean square error between the grid point from different models and the nearest station was calculated.

2. DATA

The models calculate ten different extreme indices related to daily temperature and precipitation extremes. In this study, the indices obtained from the workshop held in Maceió, Brazil, based in the paper of Frich et al (2002). Nevertheless, there are some differences among calculation of indices that reduce the number of indices that can be used here. The indices that could be comparable are: FD: annual occurrence of frost days (days with MinT <0ºC), Tn90: percentage of days where MinT was above the 90th percentile of the 1961-90 base period. R10: number of heavy precipitation days > 10mm, CDD: consecutive dry days and R5D: maximum 5-day precipitation and R95t: fraction (%) of annual total precipitation due to events exceeding the 95th percentile. The available indices calculated by models are from NCAR CCSM3 (CCSM),USA CNRM-CM3, (CNRM), France GFDL-CM2 .0 (GFDL0) GFDL-CM2.1 (GFDL), USA, INM-CM3.0-Russia (INM), MIROC high-resolution MIROC), MIROC mid-resolution (MIRMED), Japan,, and MRI-CGCM2.3, Japan.

These indices are also evaluated in 90 stations for the countries Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay, Perú, Uruguay. All the information used in this study was supplied by the Weather National Services for the different countries, and the calculus done as explained in Vincent et al (2005) and Haylock et al (2006). More Argentina and Uruguay data were added. In these data, homogeneity testing was performed at all the information in order to check the quality of the data. Only series presenting no inhomogeneity have been retained with less than 10% of missing data for their period of record..

3. RESULTS

For the temperature indices, we have two different thresholds, one fixed and cold (FD) and the other one according to the local climate, meaning warm (Tn90), both related to minimum temperature. In general, it is necessary to think that the values of the models on the Andes cannot be evaluated by the failing of the models in interpreting the orography. For FD, if we center the analysis in the Southeast of South America, a low land region which has more dense information, one sees that the average value is well simulated, the station values has similar values over regions, and are of the same order of magnitude, as in case of the models. In some cases, as the model GFDL, FD's average values are well simulated. The interannual variability from days to weeks in average, also is in good agreement. In the Figure 1 mean 1961-2000 values from observed data are compared to the models for the other temperature extreme, a warm one, Tn90, (being an index percentile-based, is relative to the local climate), It seems to be better represented that the FD. In general, all the continent has values between 5 an 15 % (it is necessary to explain here that the values are not all 10% because the percentile-base period is 1961-1990). The models are in the same order, with the significant exception of the NCAR PCM1.0. The interannual variability of the index (Figure 2) mostly between 2.5 and 7.5 is well represented too.

To quantify these differences, the ECM was calculated. It is clear to notice that the lower values are over southeastern South America in all the models, with better performances in NCAR CCSM3 and CNRM CM3.0.

The consecutive dry days are more difficult to be simulated, since the region has a marked precipitation gradient that is not properly represented. The maximums of dryness over central Argentina Andes could not be represented for any model. On the other hand, the extensive dry season of the Amazon, is displeased and exaggerated in GFDL, whereas it does not exist for CCSM3. An index that measures the quantity of extreme rainfall, (R5d) shows in all the models that the quantity of rainfall is underestimated and there the differences of rate of rainfall are not clear. The one that better approaches the average values is the MIROC3.2. When the number of days is evaluated by extreme rainfall (R10), without considering how much it precipitated, the maps are more similar (Figure 4). The Amazon interannual variability is well simulated (Figure 5).

The observations and the ensemble means of some indices are shown in Figure 6. The models ensemble in all the indices shows a good agreement with the mean observed data, mainly in southern South America.

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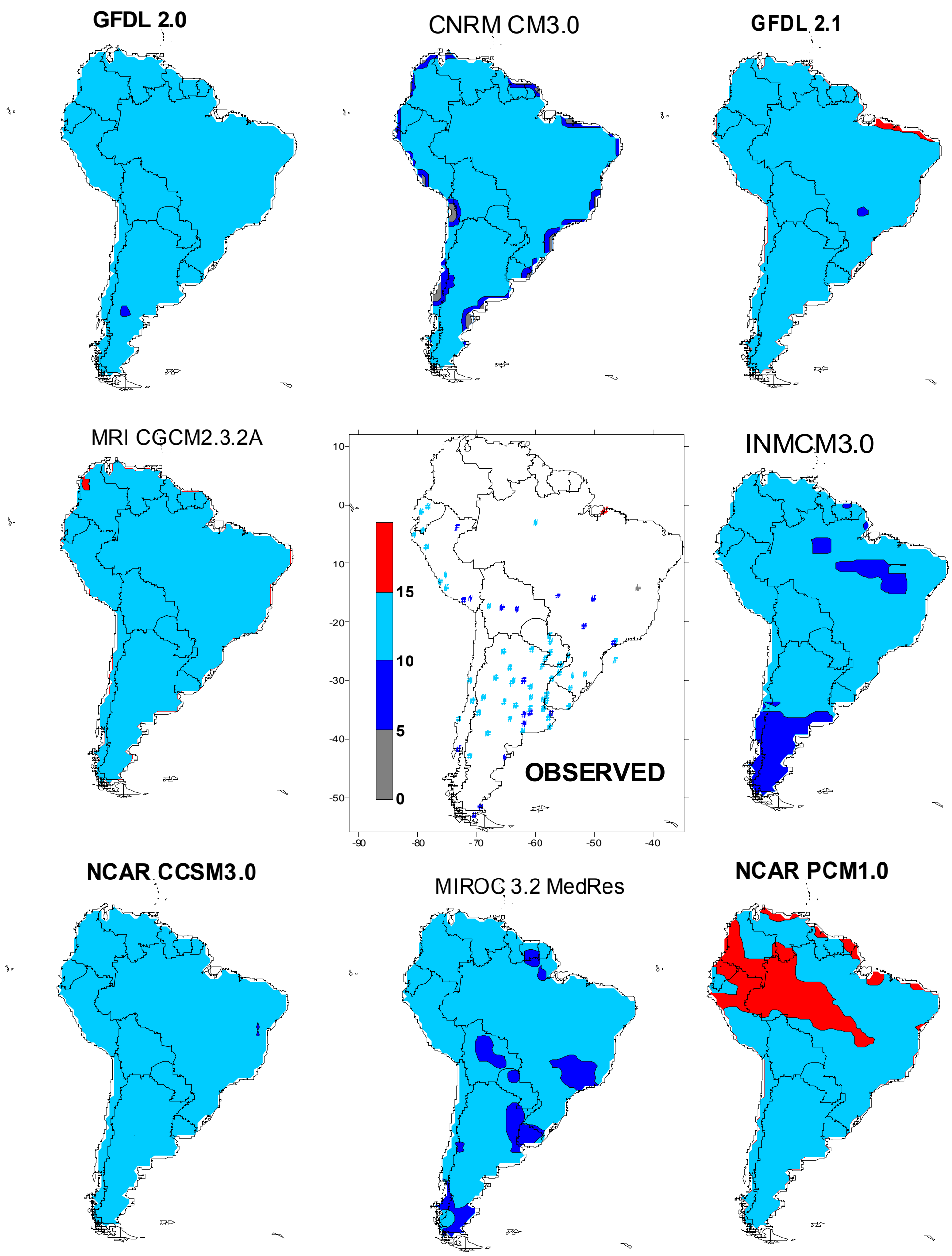


Figure 1: Tn90 1961-2000 mean values

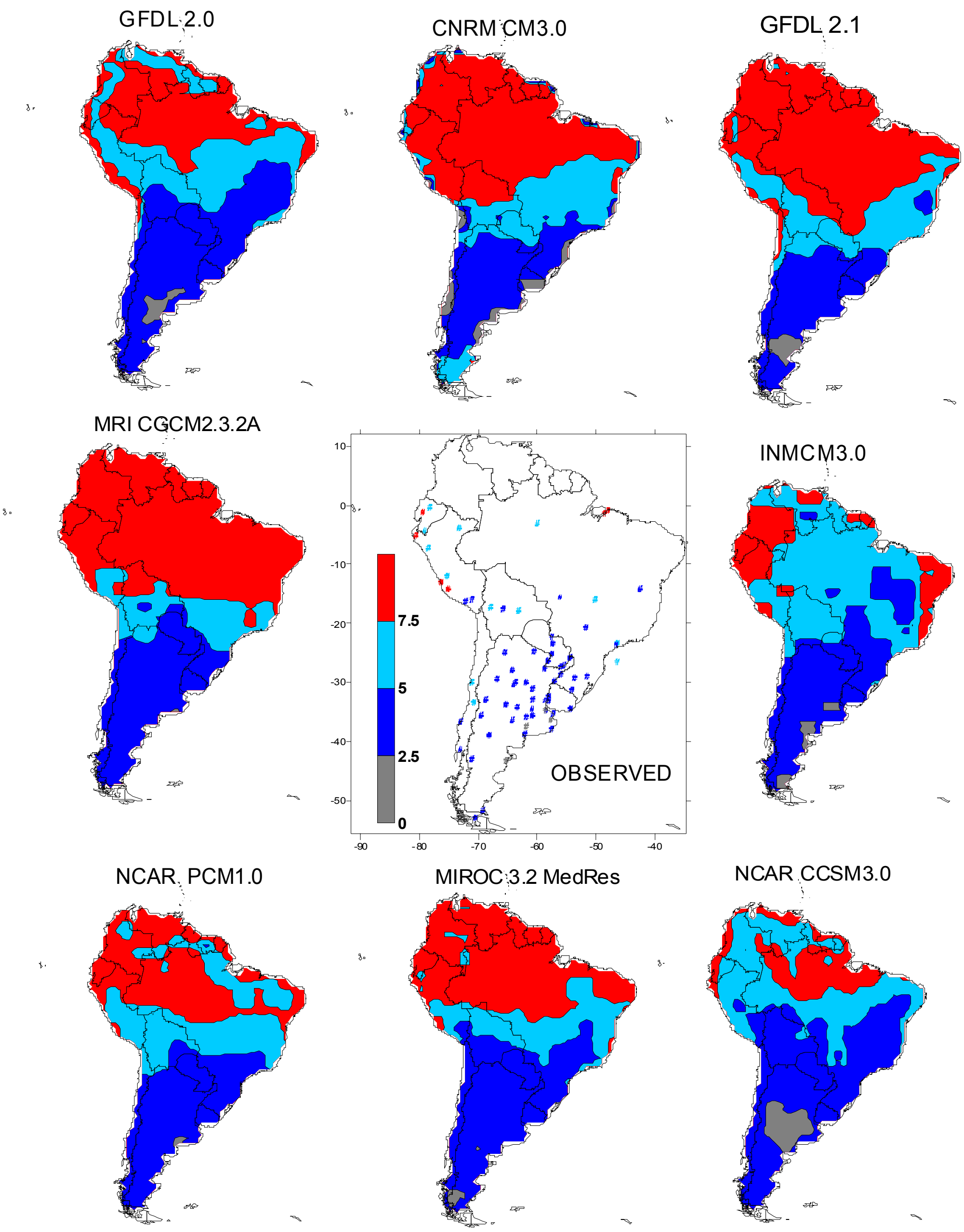


Figure 2: 1961-2000 Tn90 Standard Deviation

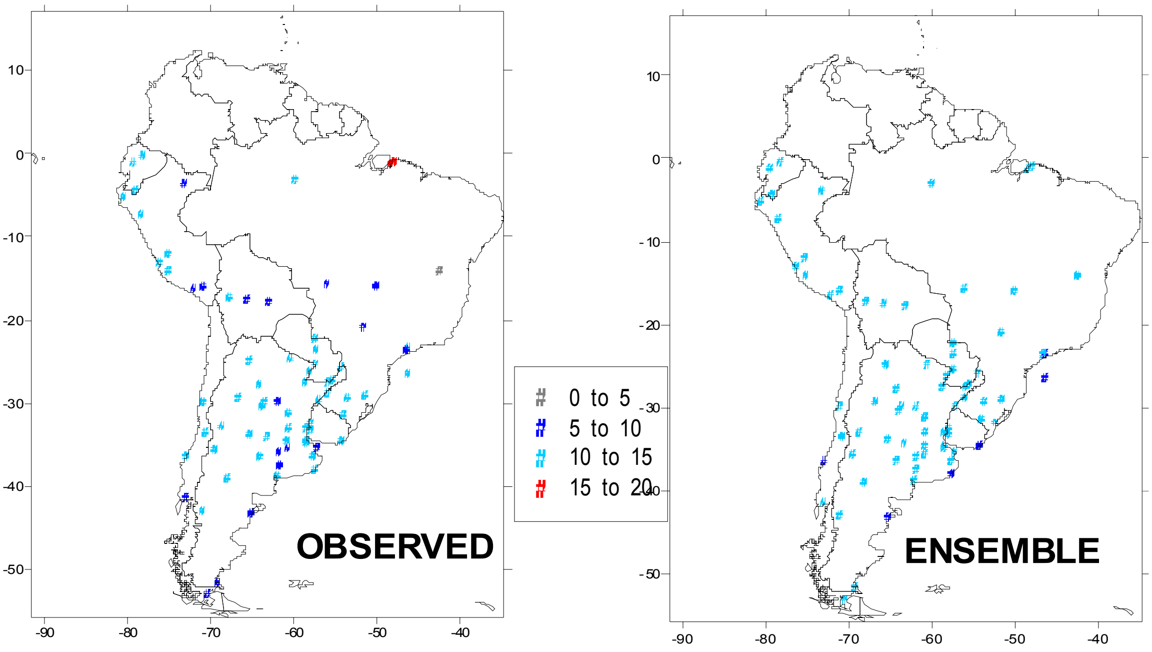


Figure 3: Tn90 mean values and models ensemble

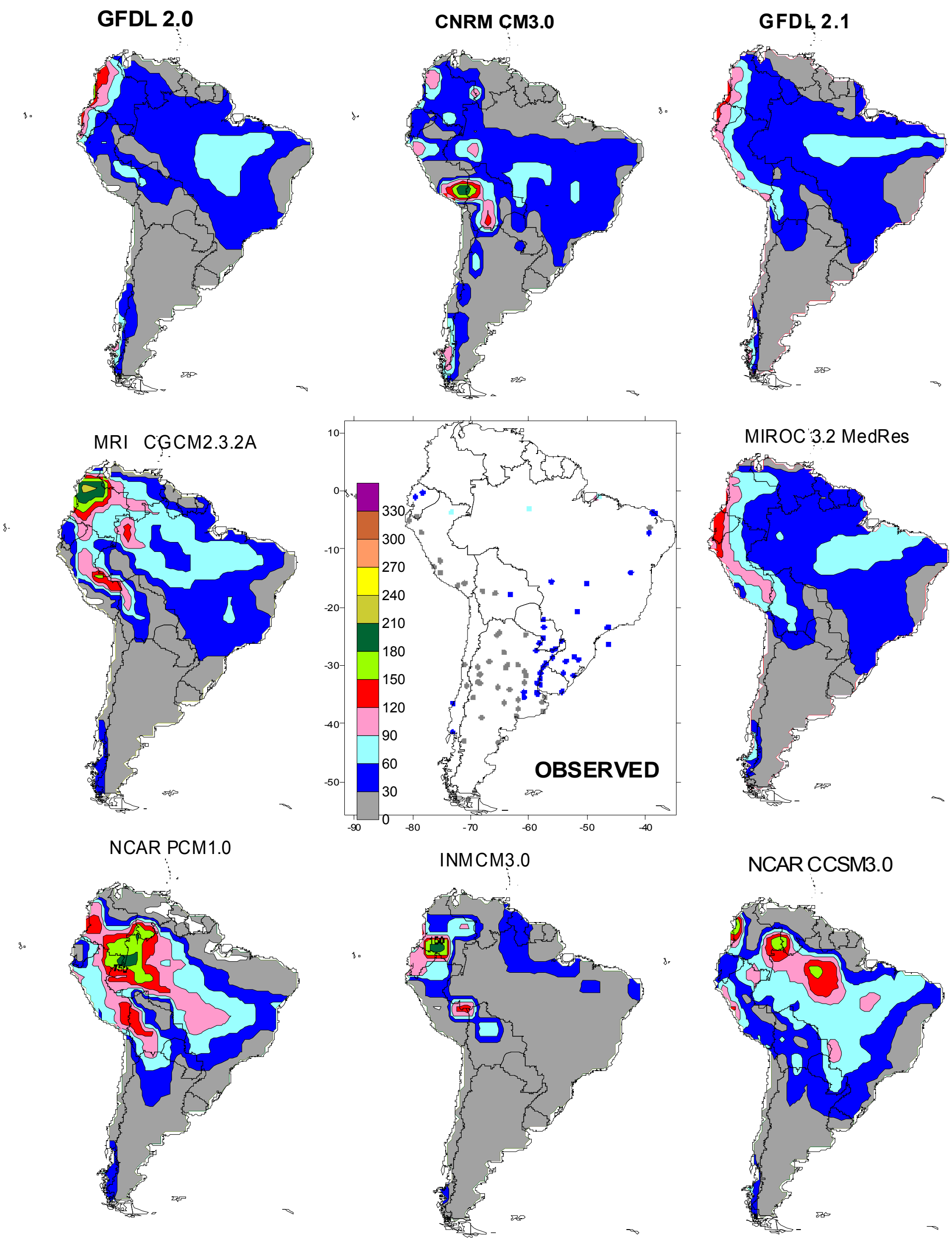


Figure 4: R10 1961-2000 mean values

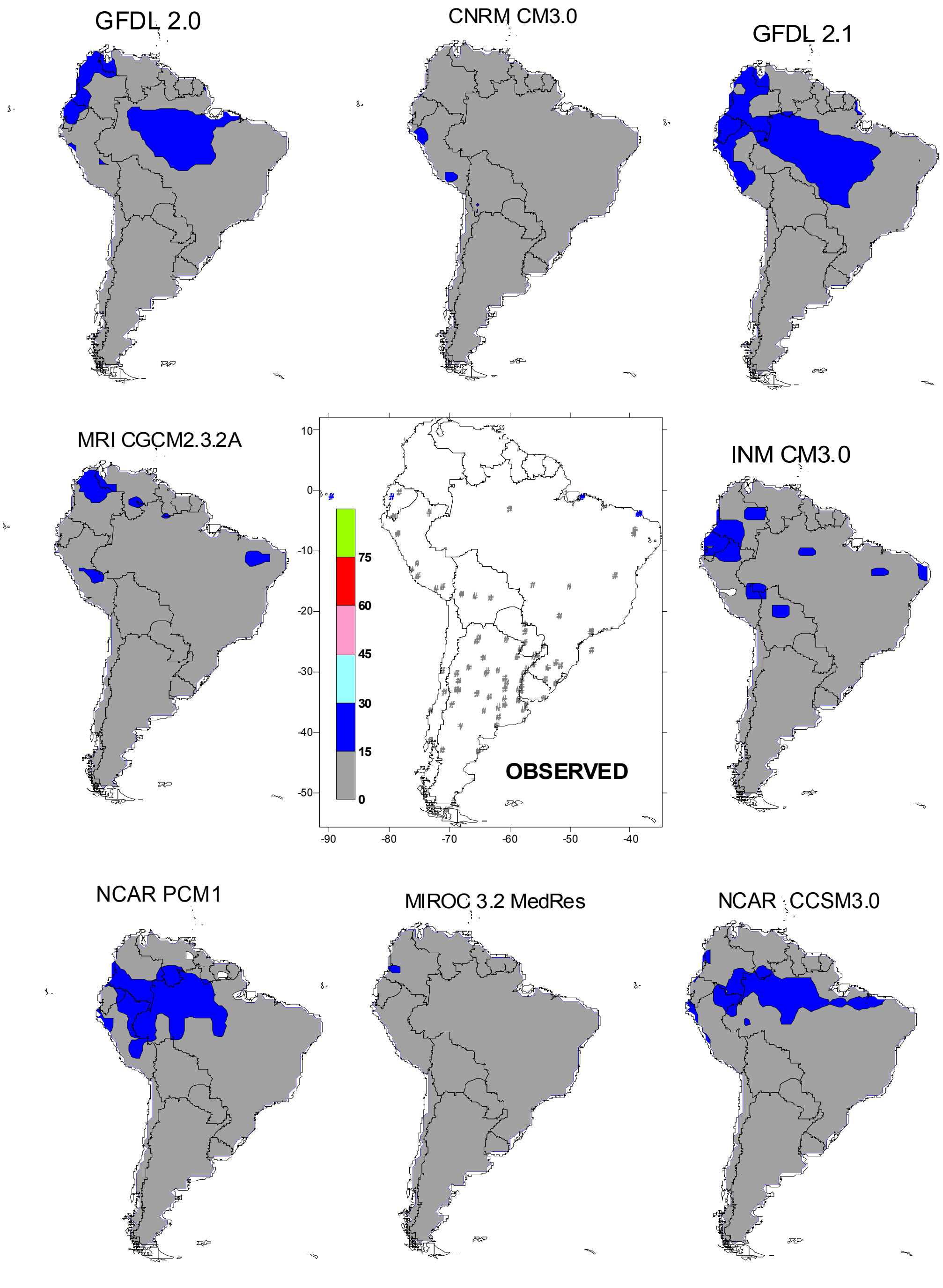
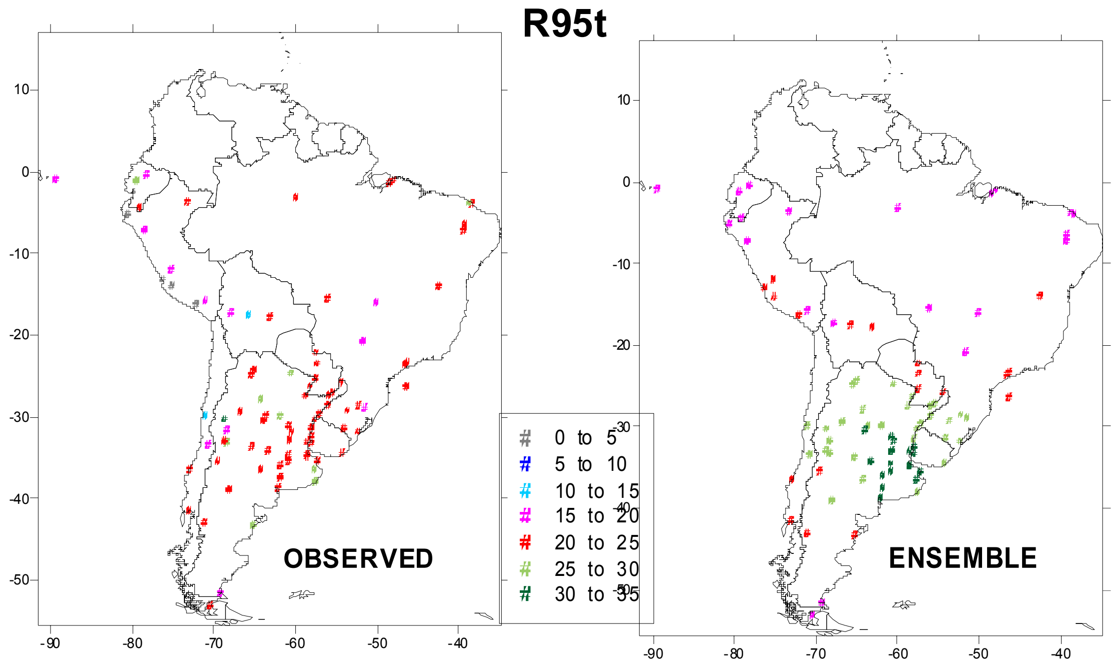


Figure 5: 1961-2000 Standard Deviation R10



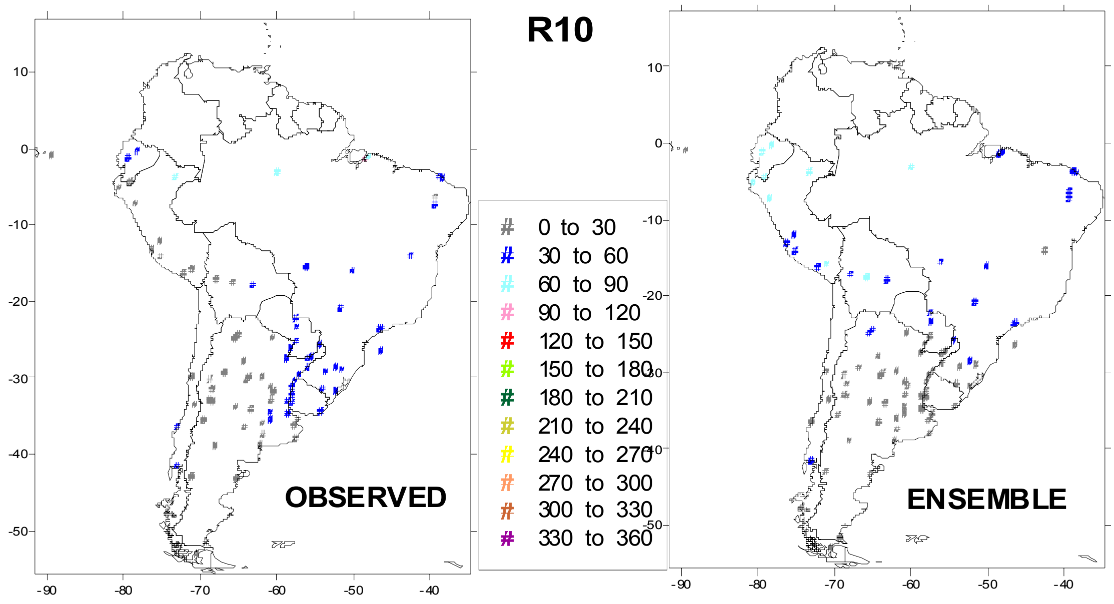


Figure 6 Observed and Models ensembles for different indices.

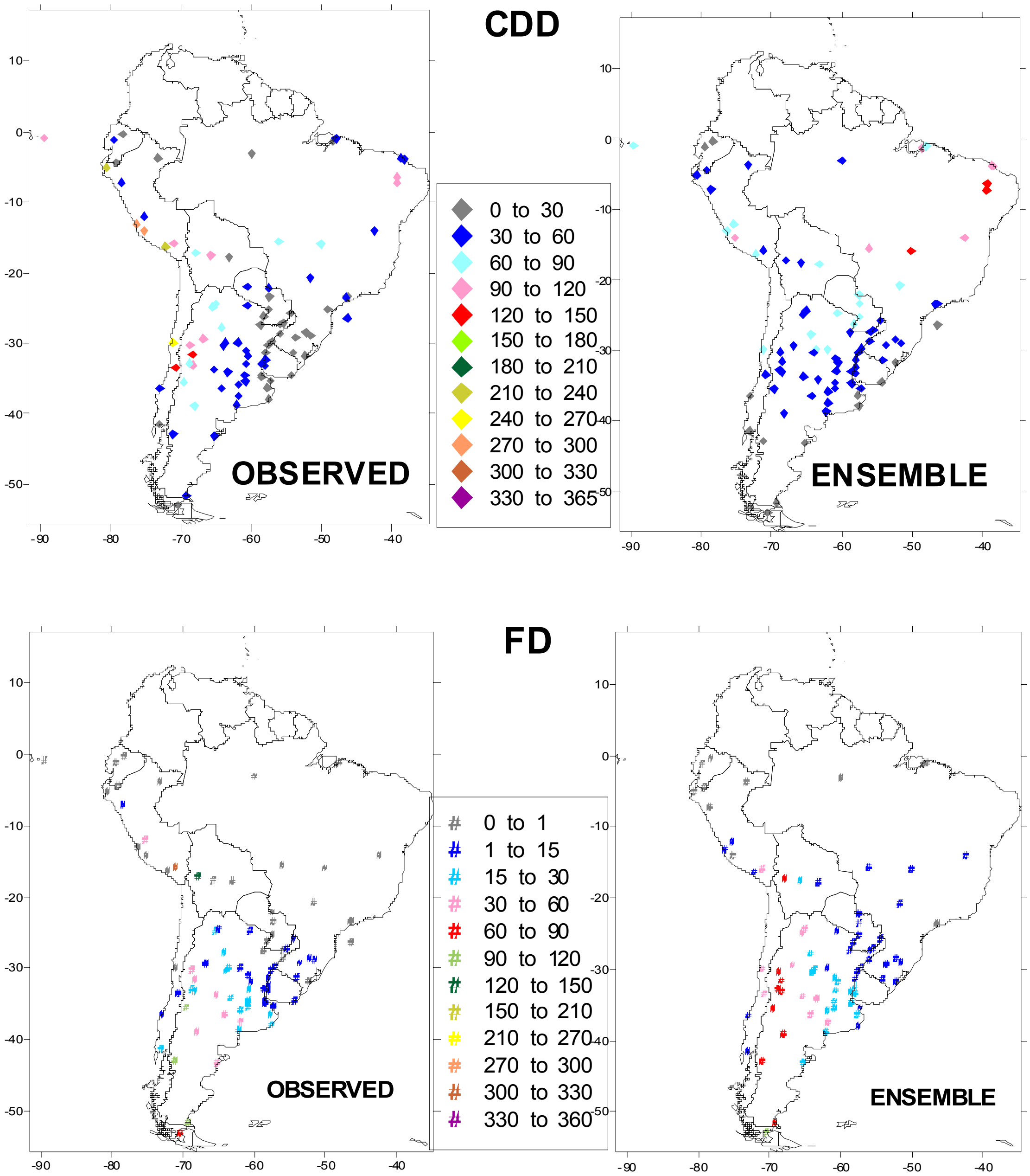


Figure 6 (cont)