CLM coupled in the RegCM3 model: Preliminary results over South America

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1. Introduction

The biosphere has a great impact in the South American climate (e.g., Silva Dias et al., 2002). Over the Amazon, the mean evapotranspiration adds from 3.3 to 5.2 mm H_2O day^{-1} to the atmosphere, and the continental fraction of precipitation coming from evapotranspiration (ET/P) varies from 54% to 86% (Marengo, 2006). At same time, many studies have shown the impact of the moisture transport from the Amazon to the La Plata Basin. A unified vision of the monsoons system in Americas was proposed by Vera et al. (2006). They pointed that the soil-vegetation-atmosphere interactions process can control the establishment of monsoons and its interannual variability and intensity. Fu and Li (2004) stressed the importance of latent heat fluxes for the onset of wet season in the Amazon. The land surface scheme used to describe the soil-plant-atmosphere is one of the main components in the climate models, and it has a particular huge relevance in the climatic simulations over South America (hereafter SA). A common problem found in the regional climate simulations over SA using the RegCM3 (Pal et al., 2007) is a deficit of rainfall and sometimes a double peak in the rainy season in the Amazon (Seth et al., 2007). The present paper compares two simulations using different land surface models coupled in the RegCM3. We compare the impact upon the Amazon and La Plata Basin precipitation annual cycle reproduced by the RegCM3 coupled with the BATS (Biosphere-Atmosphere Transfer Scheme; Dickinson et al. 1993) and the CLM (Common Land Model version 3.0; Dai et al., 2003).

2. Methodology

The RegCM3 model is a primitive equation model, compressible in the sigma-pressure vertical coordinate (*Pal et al.* 2007). Several physical parameterizations are available in RegCM3. This work utilizes the boundary layer scheme of Holtslag et al. (1990), the convective prameterization of Emanuel (1991), the Zeng scheme to solve the turbulent fluxes over the ocean and the CLM or BATS as surface model. We used a large domain (Figure 1) with 214 by 148 grid points in the east-west and north-south direction, respectively, and with 60 km of horizontal resolution and 18 vertical levels. The simulation period is from June 1, 2002 to February 1, 2005. For these same grid and period, the RegCM3 was run first using BATS (hereafter RegBATS) and second using CLM (hereafter RegCLM) land surface models. Details about the differences between CLM and BATS surface schemes are given by *Steiner et al.* (2005). The atmospheric initial and boundary conditions are from R2 NCEP reanalysis (*Kanamitsu et al*., 2002) and the sea surface temperature (SST) monthly mean is from the optimum Interpolation SST - OISST V2 of the NOAA (*Reynolds et al.,* 2002).

The simulation results were compared with the analyses known as CMAP (Xie and Arkin, 1996) and WM (Willmott, Matsuura: climate.geog.udel.edu/~climate/).

3. Results

The mean precipitation for DJF (austral summer) of 2003-2004 is shown in Figure 2. The CMAP (Fig. 2a) depicts two main oriented precipitation bands, the Inter-tropical Convergence Zone (ITCZ) and the South Atlantic Convergence Zone (SACZ), and both were simulated by the experiments RegCLM and RegBATS (Fig. 2b-c). Compared with CMAP, the RegBATS overestimates the rainfall intensity in the SA monsoon core and in the continental branch of SACZ (Figure 2c). In these areas, the RegCLM presents a considerable reduction of the RegBATS wet bias. Specifically over the northwestern of Amazon basin, RegCLM shows a better representation of the CMAP rainfall.

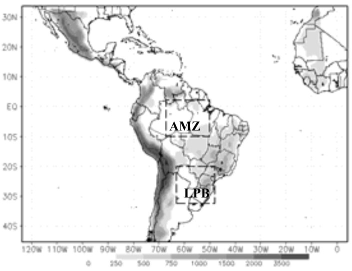

Figure 1. Simulation domain, topography (shaded), and localization of two boxes (AMZ and LPB) referred in the text.

The time series of mean monthly rainfall for Amazon (AMZ) and La Plata Basin (LPB), see Figure 1, areas are presented in the Figure 3. In general the CMAP and WM show good agreement, except for the 2004 dry season over AMZ. Over the AMZ during the peak of the rainy season the RegCLM reduces considerably the RegBATS overestimation of the rainfall and improves agreement with observations. Despite this improvement in the magnitude of precipitation, the RegCLM simulates a rainy season that is about 15-30 days shorter in length than WM or CMAP. While RegBATS overestimates the rainfall in the rainy season over the AMZ, the RegCLM underestimates the rainfall during the dry season. However, in general, the RegCLM more accurately simulates the annual cycle of precipitation compared with observations. The drier dry season simulated by RegCLM could be related with the soil water content, a known deficiency of CLM3.0 (Oleson et al., 2008). This produces an increase of air temperature (Fig. not shown), resulting in a warm bias up to 4^{o}C. As result, the RegCLM simulated temperature annual cycle is controlled by the precipitation, while the observed annual cycle is flat and mainly controlled by solar radiation (colder and warmer in the austral winter and summer, respectively).

As anticipated by figure 2, the differences decrease between RegCLM and RegBATS in the subtropics and extratropics of South America. This is very clear in the time series for LPB area (Figure 3b), where RegCLM presents a dry bias in the austral cold season while RegBATS shows a moist bias during the rainy season. The air temperature annual cycle (Figure not shown) is well reproduced by RegCLM and RegBATS.

3. Conclusions

Comparisons of the performance of RegCM3 coupled with the BATS and CLM schemes over South America were conducted. The main improvement of the CLM is obtained in the Amazon where the simulated rainfall annual cycle reproduces the observed seasonal maxima in precipitation. However, during the dry season RegCLM produces an excessive decrease of rainfall in this area, resulting in drier soils and warmer air temperature. On the other hand, the BATS scheme produces excessive precipitation, and a smaller temperature bias. Over the subtropics (LPB area), the agreement between RegBATS and RegCLM improves. Improved representation of CLM hydrology (CLM3.5) is included in a recent RegCM3 version, and this version will be used to evaluate its impact on the dry season precipitation and temperature biases.

4. Acknowledgments

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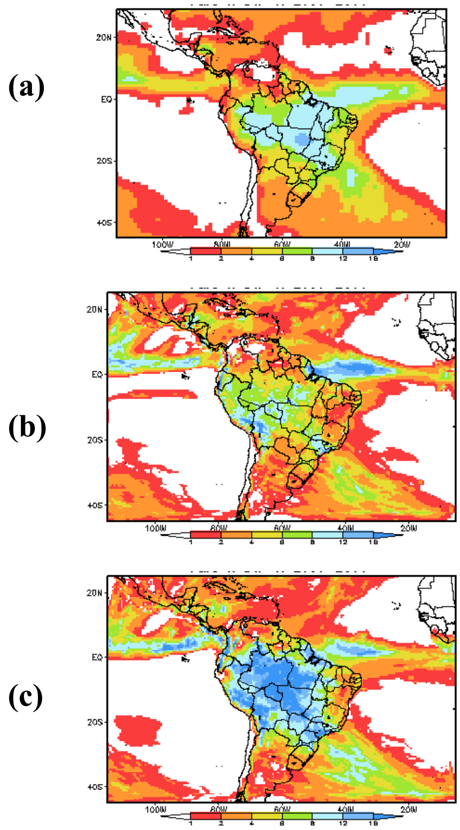

Figure 2. DJF 2003-2004 mean precipitation (mm day^{-1}) from (a) CMAP, (b) RegCLM and (c) RegBATS.

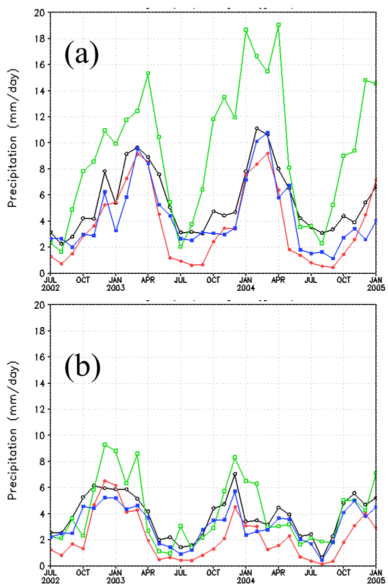

Figure 3. – Time series of the RegCLM (red), RegBATS (green) and from CMAP (black) and WM (blue) monthly mean over the (a) AMZ (b) LPB boxes.