C13

Performance Evaluation of Near-Surface Atmosphere Variables Simulations over Paraguay using a Land-Atmosphere Coupled Model

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Atmospheric-land coupled models are able to characterize more accurately the processes, interactions and feedbacks between the atmosphere and the underlying surface. Since part of the philosophy behind the design of most land surface models is to model vegetation itself in a consistent way, they can calculate the radiation, momentum, heat and mass transfer properties of the surface by considering morphological and physiological characteristics of the vegetation, which govern the fluxes between the surface and the atmosphere. Furthermore, the role of the land conditions, like soil moisture and vegetation status, can play an important role in the characterization of the behavior of the regional weather and climate variability[1), 2)].

Paraguay has experienced dramatic forest cover losses since the mid 1970s that had altered the surface conditions producing a highly fragmented landscape[3)]. Such conditions could hinder the effectiveness of climate models to accurately simulate precipitation and temperature patterns in the region.

This study is based on the analysis of simulations performed with the meso-scale numerical weather prediction model CReSiBUC, which has the advantage of linking the surface conditions with the atmosphere, and treats heterogeneity by using a mosaic approach[4)]. Three sets of simulations for the months of July and November 2006-2012 were performed using specific atmospheric and land surface settings (Table 1). The model was integrated over two different domains centered in South America at 23.5°S and 58.5°W.

Table 1. Simulation settings for each experiment

Simulation set	Exp. 1	Exp. 2	Exp. 3
Integration Time	Jul & Nov, 2006-2012	Jul & Nov, 2006-2012	Jul & Nov, 2006-2012
No. of Points *(x,y,z)*	(240, 144, 50)	(240, 144, 50)	(282, 282, 50)
Horizontal Res. *(km) (xres,yres)*	(20, 20)	(20, 20)	(5, 5)
Center *(lat, lon)*	(-23.5, -58.0)	(-23.5, -58.0)	(-23.5, -58.0)
Atm. Cond. *(freq., resol.)*	JRA (6-hours, 1.25°)	JRA (6-hours, 1.25°)	CRS (1-hour, 20km)
Land use	2000	2000	2000
NDVI	AVHRR (avg. 1991-2000)	AVHRR (avg. 1991-2000)	AVHRR (avg. 1991-2000)
Surface Process	w/ SiBUC	Normal CReSS	w/ SiBUC

Experiments 1 and 2 have the same model settings except for the surface processes involved. For the Experiment 1, land surface processes were solved using the SiBUC model, whereas Experiment 2 used the normal land and SST processes included in the standard CReSS. The horizontal grid consisted of 240x144 with a grid spacing of 20km, while the vertical was composed of 50 levels and grid resolution of 500m. The JRA (Japanese Re-Analysis) dataset form the Japanese Meteorological Agency (JMA) and the Sea Surface Temperature from the NASA's Physical Oceanography Distributed Active Archive Center (PO.DAAC) of daily output and 0.05-degree resolution were used as the atmospheric and boundary conditions. In Experiment 3, however, the CReSiBUC was integrated over a nested domain also centered at

23.5°S and 58.5°W, and the horizontal grid consisted of 282x282 with a grid resolution of 5km, keeping the vertical grid the same as the previous experiments. CReSiBUC's dump files form Experiment 1 (CRS) were used as atmospheric boundary conditions, and the remaining variables were all kept the same as in Experiment 1.

Land-use information was obtained by combining USGS's Global Land Cover Characterization data with the Paraguay Forest Change product (GLCF)[5], and were aimed at representing real land-cover distribution.

Results of the simulations over Paraguay showed to be sensitive to the different model settings used in this research. The spatial pattern of November simulated precipitation is not totally well characterized by any of the experiments, however, outcomes of Experiment 3 showed an improvement in this regard. Experiment 2, in particular, showed wetter conditions in the whole study area, with some regions of very high rainfall that are not observed in the satellite products used for comparison. In terms of average daily and monthly total accumulated rainfall (Figure 1 and Figure 2), it was observed that Experiment 3 had the best results among all the simulations performed; monthly total accumulated rainfall successfully matched the observations and daily precipitation was also well represented. July simulated precipitation from Experiment 3, on the other hand, showed better spatial distribution, however, the improvement in terms of daily and monthly total accumulated rainfall was not as satisfactory as for November.

As for the temperature, the spatial pattern was very well reproduced for both months; nevertheless, magnitudes were either over or underestimated. The model seems to overestimate averaged daily minimum temperature while considerably underestimating the daily maximum, thus widening the difference between observed and simulated daily temperature range. The underestimation of daily maximum temperature usually implies issues with the assumptions of initial values of soil moisture, and as a consequence, offline simulations of soil moisture are being considered in order to provide better initial conditions for the model.

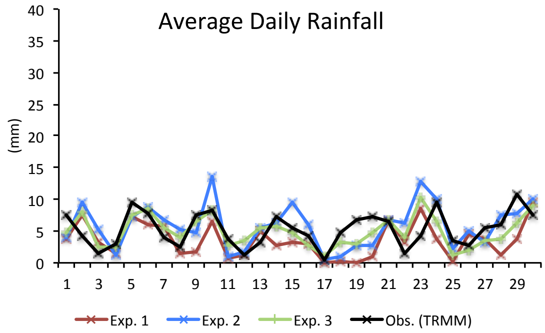

Figure 1. Averaged November Daily Rainfall over the whole Paraguay for the period 2006-2007

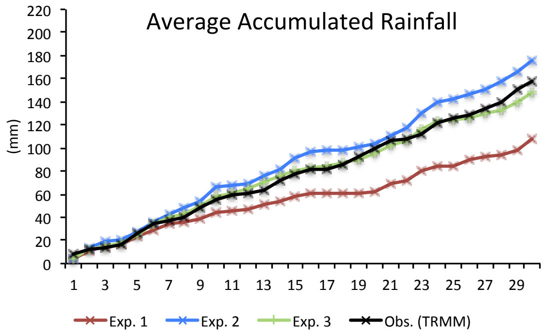

Figure 2. November Accumulated Rainfall averaged over Paraguay for the period 2006-2012

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