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OPERATIONAL RAINFALL PREDICTION OVER BRAZILIAN *CERRADO* REGION USING MM5 MESOSCALE MODEL

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1. INTRODUCTION

It is a common practice the use of mesoscale models to predict regional weather, although this methodology has not been sufficiently tested on continental tropical regions yet. In Brazil the major source of electric energy comes from hydrological plants, so it is important to forecast with accuracy the rainfall in the basin under consideration. In the present test, the MM5 model was used operationally for 5 days prediction during January 2005 over the Manso River Basin (Mato Grosso State, in *cerrado* region of Brazil) using a detailed grid of 3 km spacing.

2. METHODOLOGY

The operational mode of the atmospheric modeling for the Manso river hydrological basin was made through MM5 mesoscale model. Chen and Dudhia (2001a, 2001b) in USA and Justi da Silva et al. (2000) and Coelho et al. (2002) in Brazil demonstrated the good performance of this model for operational hydrological applications. In this work an adaptation with three grids was made. The grid number 1, with 27 km resolution, covers almost the Brazilian area. The grids 2 and 3, with 9 and 3 km of resolution respectively, are centered over the Manso River Basin. The higher resolution grid has the function of describing in details the topography, soil and vegetation coverage around the basin. The initial conditions for the operational model prediction were the global forecasts from NCEP.

3. RESULTS

Only four frontal systems actuated on Brazil area during January 2005. Although no one of them reached Cuiaba City, in the central part of the South American continent, all these fronts organized convection in several parts of this region. Furthermore, from January 17th. to 21st., a frontal system became stationary over Southeast Brazil, characterizing the unique SACZ event during this month. Figure 1 shows the total daily precipitation in several gauge stations of the region.

Comparisons between observed and forecasted rain distribution (not shown) indicate that the model well represents the meridional movements of the precipitation bands, including rain intensity. However, the model tends to concentrate the rain in nucleus of maxima precipitation, reducing the area with values between 5 and 10 mm and expanding the regions with values over 70 mm. It is important to take into account that those comparisons were made using a gauge network database with low density.

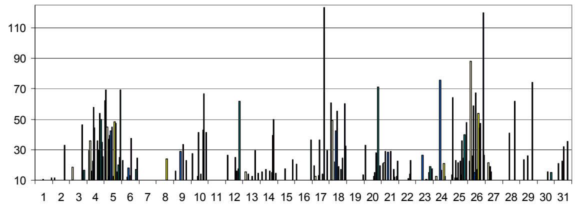

Figure 1 – Precipitation observed in several gauge stations in Manso River Basin during January 2005.

To characterize the SACZ event and its effects on the Manso River Basin precipitation, the following analysis will focus on total rain and its distribution during the period from January 17th. to 21st. Figure 2 represents the accumulated rain over the SACZ period. The MM5 model well captured the localization of the precipitation band associated with the SACZ, with maxima over São Paulo state and no precipitation northward and southward of the band line. However, the model super estimated the rain over Goiás state, different of the observations.

The Bias and the Root Mean Square Error (RMSE) are calculated for the three grids and five meteorological variables over a 5-day forecast period. The observed data point used corresponds to a meteorological station localized inside the basin.

The first fact to be mentioned is that the error does not increase very much until a 5-day prediction, which is an excellent result for this kind of application. Except for the relative humidity, the errors are small, indicating a great quality in the prediction of the analyzed variables. Eventually, lightly greater errors appear in the higher resolution grids, which can lead to an erroneous interpretation. It must be considered that the tests for the higher resolution grids are very rigorous as the target to be bitted is smaller and more specific than those of the lower resolution grids. On the other hand, the nesting of high resolution grids helps to improve the quality of the results in lower resolution grids.

Figure 3 shows a comparison day by day between 24-hour predicted and observed values of temperature and zonal and meridional wind components

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for Manso meteorological station. It was made also this kind of comparison for 48, 72, 96 and 120 hours, although not shown here. The results were excellent for predictions until 72 hours and good for 96 and 120 hours, but with discrepancies in some days which the meteorological system could not be detected by the model with so great anticipation. For this interior region in the continent, the meridional wind component was the best forecasted variable by the MM5 model, including for long periods of forecast.

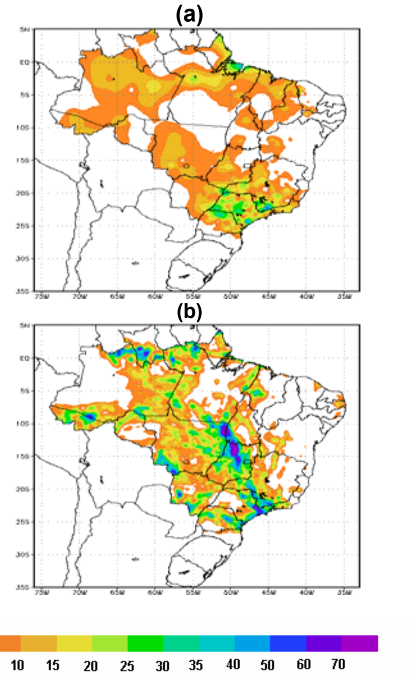

Figure 2 – Total precipitation over Brazil, during the SACZ period, (a) observed and (b) predicted by MM5 model.

Table 1 – Prediction Bias calculated for the Manso observation station.

		24h	48h	72h	96h	120h
Precipitation	Grid 1	0,09	0,36	0,44	0,04	0,16
	Grid 2	0,33	0,45	0,52	0,05	0,16
	Grid 3	0,26	0,44	0,55	-0,01	0,12
Relative Humidity	Grid 1	-4,61	-8,24	-6,33	-6,63	-10,24
	Grid 2	-5,67	-8,89	-6,99	-7,59	-10,87
	Grid 3	-5,45	-8,47	-6,40	-7,24	-10,48
Temperature	Grid 1	0,10	0,21	-0,18	-0,47	-0,27
	Grid 2	-0,03	0,06	-0,31	-0,55	-0,39
	Grid 3	-0,10	0,04	-0,36	-0,61	-0,45
Zonal wind	Grid 1	-0,47	0,11	0,19	0,78	0,87
	Grid 2	-0,37	0,12	0,21	0,72	0,80
	Grid 3	-0,33	0,19	0,29	0,83	0,90
Meridional wind	Grid 1	-0,26	-0,50	-0,40	-0,51	-0,59
	Grid 2	-0,18	-0,44	-0,35	-0,54	-0,58
	Grid 3	-0,22	-0,47	-0,38	-0,57	-0,61

4. CONCLUSIONS

The rainfall forecast showed good agreement with accumulated regional observed precipitation, important to dimension the hydrological basin outflow. In a point to point verification, all RMSE tests show that the temperature, wind components and rainfall forecasts errors are small enough to justify the proposed methodology. Even for 120 hours forecasts, the model presented good skill, although the relative humidity, being a composed parameter did not show not so a good forecast performance.

Table 2 - Prediction RMSE calculated for the Manso observation station.

		24h	48h	72h	96h	120h
Precipitation	Grid 1	3,28	3,28	3,29	2,91	3,21
	Grid 2	4,41	3,88	3,71	3,17	3,25
	Grid 3	4,68	4,27	4,51	3,22	3,40
Relative Humidity	Grid 1	11,92	13,60	12,45	12,75	15,58
	Grid 2	12,92	14,57	13,53	13,61	16,49
	Grid 3	13,12	14,62	13,55	13,70	16,43
Temperature	Grid 1	1,97	2,05	2,11	2,41	2,57
	Grid 2	2,17	2,18	2,27	2,46	2,63
	Grid 3	2,18	2,21	2,30	2,51	2,68
Zonal wind	Grid 1	1,35	1,65	1,68	1,91	2,01
	Grid 2	1,36	1,71	1,72	1,89	1,96
	Grid 3	1,41	1,82	1,85	2,02	2,09
Meridional wind	Grid 1	1,24	1,59	1,83	2,10	2,08
	Grid 2	1,35	1,74	1,96	2,20	2,14
	Grid 3	1,45	1,91	2,07	2,27	2,21

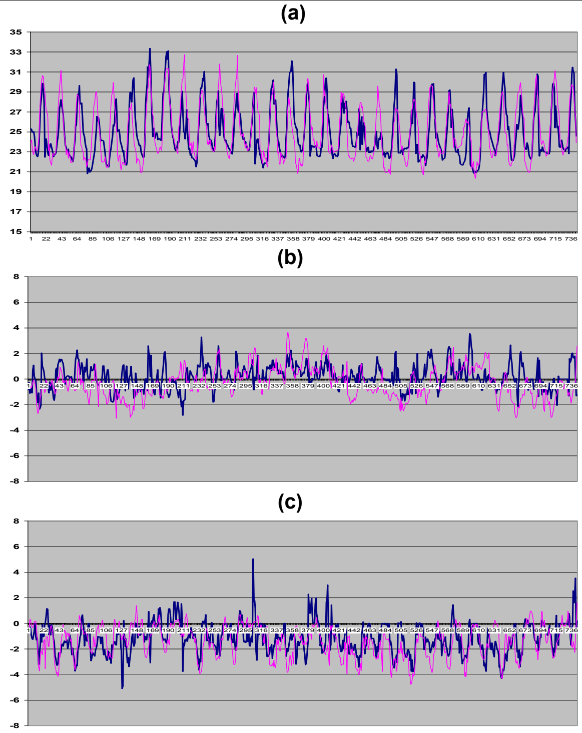

Figure 3 – Observed and 24-hour predicted values of (a) temperature and (b) zonal and (c) meridional wind components of wind in Manso meteorological station.

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