Proceedings of 8 ICSHMO, Foz do Iguaçu, Brazil, April 24-28, 2006, INPE, p. 1171-1173.

A SACZ EVENT SIMULATION USING MM5 MESOSCALE MODEL

Isimar de Azevedo Santos[1]
Maria Gertrudes Alvarez Justi da Silva
Claudine Pereira Dereczinsky
David Garrana Coelho
Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

1. INTRODUCTION

South Atlantic Convergence Zone (SACZ) are meteorological systems that bring great accumulation of rain in southeast and western regions of Brazil. The use of mesoscale model as a downscaling tool allows to aggregate essential information as topography, vegetation cover and SST with high resolution. The SACZ event occurred in the period of January 22 to 27, 2004, was chosen to analyze the great quantity of precipitation that falls over an interesting basin in *cerrado* region of Brazil, the Manso River Basin, using the MM5 mesoscale model.

The rain occurred in January of 2004 in Brazil (figure 1) affected great part of the country, with massive destruction, lost of around 161 lives and about 230,000 of homeless. In central part of Brazil, in Mato Grosso state, the monthly rainfall anomaly was about 50 % over the normal, reaching 350 to 500 mm per month.

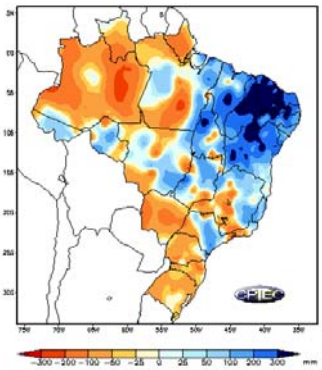

Figure 1 – Anomaly of precipitation over Brazil during January 2004.

2. METODOLOGY

The present study is based on an event of SACZ that occurred from 21 to 26 January 2004. The MM5 mesoscale model ran with three grids, the first one covering the Brazilian area with 27-km spacing. The second grid with 9 km and the third one with 3 km, were centered on the Manso Basin. The 24 hours total precipitation simulated by the model was compared with the totals of rainfall observed in the Brazilian rain gauge network.

[1] *Corresponding author address*: Isimar A. Santos, Universidade Federal do Rio de Janeiro, Departament de Meteorologia, 21949-900 Rio de Janeiro, RJ, Brazil. E-mail: isimar@acd.ufrj.br

3. RESULTS

SACZ normally actuates during summer in Southeast region of Brazil and in January 2004 reached latitudes northern then normal. Also, during this period actuated over South America the 30-60 days oscillation in its positive phase, bringing substantial convective activity especially in the second half of the month. According to CPTEC/INPE, three SACZ events occurred in Central Brazil, and the present study analyses the third one (figure 2).

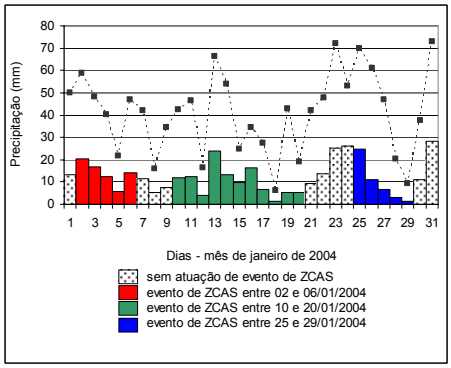

Figure 2 – Observed daily precipitation in Manso River basin. Lines indicate the higher rainfall observed in several gauge stations. Bars represent mean rainfall in the basin.

Figure 3 represents the cloudiness simulated by the MM5 model and the correspondent visible satellite image for 26 January 2004 at 12 UTC. As the simulation was made in the 27 km resolution grid, the good accordance between cloudiness simulation and satellite observation was possible because the SACZ is a large scale phenomenon.

Figure 4 represents the 24-hour total rainfall observed over Brazilian area in confrontation with the MM5 simulation, for 26 January 2004. Again, due to the large scale characteristic of the SACZ, the 27-km grid was enough to simulate with accordance the precipitation over all the system including over the Manso River basin area.

(a)

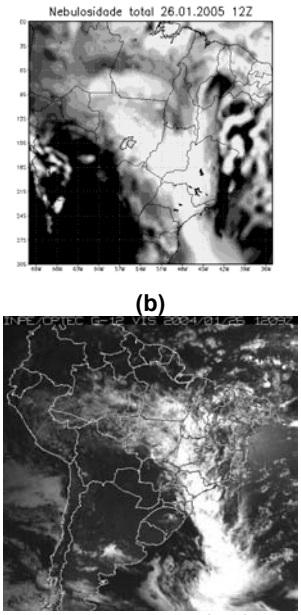

Figure 3 – Cloudiness at 12 UTC of 26 January 2004. (a) Total cloudiness simulated by the MM5; (b) satellite visible image.

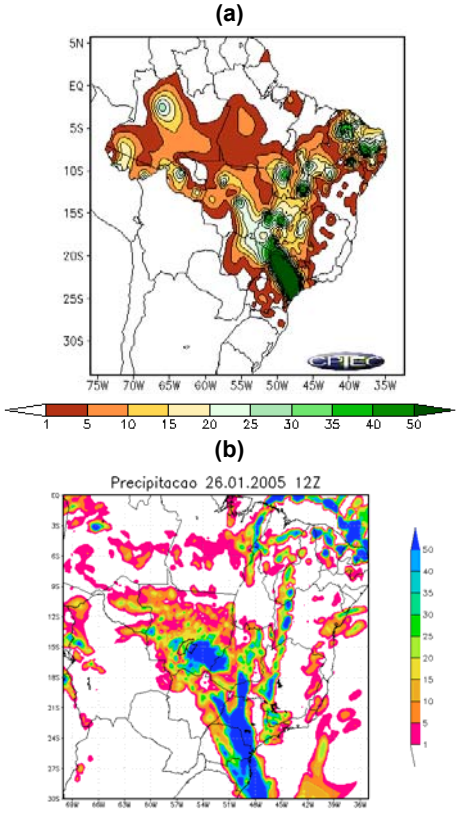

Figure 4 – Daily total rainfall at 12 UTC of 26 January 2004. (a) Integrated observations from Brazilian rain gauge stations network, as interpolated by CPTEC/INPE; (b) 24-hour accumulation for 26 January 2004 as simulated by MM5 model.

Next it will be shown two statistical analyses that prove the ability of the MM5 mesoscale model to simulate a SACZ event occurring on January 2004. The BIAS and the Root Mean Square Error (RMSE) were calculated for temperature and relative humidity at 2 m, wind intensity at 10 m and precipitation. The hourly values observed of each meteorological variable at the local station, was compared with predicted values by the model for each integration grid. The table 1 summarizes the results obtained, making evident the good quality of the simulations made in this period by the MM5 model.

Table 1 – Statistics referring to validation of the case simulation (T=temperature; RH=relative humidity; P=precipitation=wind speed).

	Grid 1		Grid 2		Grid 3	
	BIAS	RMSE	BIAS	RMSE	BIAS	RMSE
T	0,6	3,0	0,5	3,1	0,5	3,0
RH	-12,2	15,6	-12,9	16,3	-12,5	16,0
P	0,1	4,0	0,1	4,2	0,2	4,3
V	3,9	4,6	4,0	4,7	4,1	4,8

The graphics presented in figure 5 show comparisons between time series of observations and MM5 simulation for temperature and precipitation in the period of 22 to 27 January 2004. In these graphics is evident the good performance of the model.

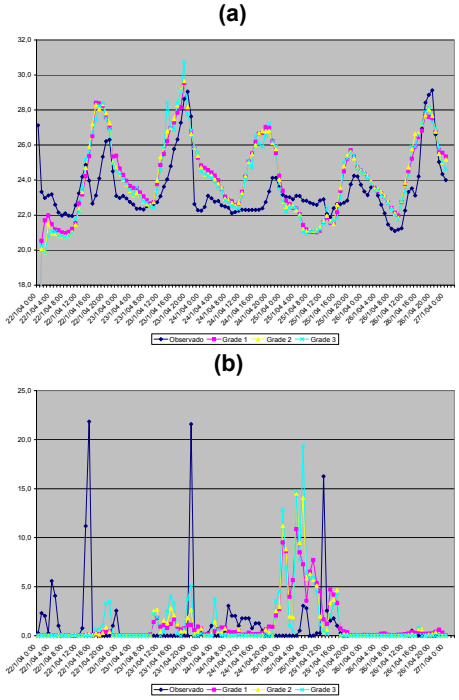

Figure 5 – Comparison between temperature and rain observations with the 3-grids simulation of MM5 from 22 to 27 January 2004.

Although it is still under discussion the best way to evaluate the performance of simulations (past) and predictions (future) of the rainfall by numerical models, in the present verification it was calculated the 5-day rainfall accumulation in a Manso River grid point, with the results listed in table 2. These preliminary results indicate a good adjustment of this variable obtained in the present MM5 simulation.

Observed Rainfall	Predicted Rainfall		
	Grid 1	Grid 2	Grid 3
125,0	134,3	135,5	143,6

4. CONCLUSIONS

The punctual comparison between model simulation and observations shows in great details the atmospheric behavior, like temperature, relative humidity, wind speed and direction, and precipitation. Principally the cloudiness and the accumulated rainfall evaluated in a meteorological station inside the Manso River Basin demonstrated the ability of the MM5 numerical model to simulate a kind of phenomenon as SACZ with acceptable confidence.

5. REFERENCES

BENOIT, R., P. PELLERIN, N. KOUWEN et al., 2000: Toward the Use of Coupled Atmospheric and Hydrologic Models at Regional Scale. *Mon. Wea. Rev*., **128**, 1681 - 1706.

CHEN, F. and J. DUDHIA, 2001a: Coupling an Advanced Land Surface-Hydrology Model with the Penn State-NCAR MM5 Modeling System. Part I: Model Implementation and Sensitivity. *Mon. Wea. Rev*., **129**, 569 - 585.

CHEN, F. and J. DUDHIA, 2001b: Coupling an Advanced Land Surface-Hydrology Model with the Penn State-NCAR MM5 Modeling System. Part II: Preliminary Model Validation. *Mon. Wea. Rev*., **129**, 587 - 604.

CHOU, S. C. and M.G.A. JUSTI DA SILVA, 1999: Objective evaluation of Eta model precipitation forecasts over South America. *Climanálise*, **vol 14**, no 1.

COELHO, D. G., M. G. A. JUSTI DA SILVA, and I. A. SANTOS, 2000: Modelagem de mesoescala: uma alternativa de baixo custo. *XI Congresso Brasileiro de Meteorologia*. Preprints in CDROM.

COELHO, D. G., M. G. A. JUSTI DA SILVA and G. A. OLIVEIRA, 2002: Sensibilidade em relação à fonte de dados nas previsões do modelo MM5. *XII Congresso Brasileiro de Meteorologia*. Preprints in CDROM.

DROEGEMEIER, K. K.; J. D. SMITH, S. BUSINGER et al., 2000: Hydrological aspects of weather prediction and flood warnings: Report of the Ninth Prospectus Development Team of the U. S. Weather Research Program. *Bull. Amer. Meteor. Soc*., **81**, 2665-2680.

DUDHIA, J., 1993: A nonhydrostatic version of the Penn State NCAR Mesoscale Model: Validation tests and simulation of an Atlantic cyclone and cold front. *Mon. Wea. Rev*., **121**, 1493-1513.

DUDHIA, J., D. GILL, Y. GUO, K. et al., 2000: PSU/NCAR Mesoscale Modeling System - Tutorial Class Notes and User's Guide: MM5 Modeling System Version 3. Mesoscale and Microscale Meteorology Division, NCAR.

FONSECA, J. F. B., Modelos Regionais de Previsão Numérica do Tempo: Um Estudo Comparativo das Destrezas dos Modelos FSU e ETA, Sobre a América do Sul. Master Degree Thesis - INPE, 1998.

FRITSCH, J. M.; R. A. HOUZE et al., 1998: Quantitative precipitation forecasting: Report of the Eighth Prospectus Development Team of the U. S. Weather Research Program. *Bull. Amer. Meteor. Soc*., **79**, 285-299.

GRELL, G. A., J. DUDHIA and D. R. STAUFFER, 1994: A description of the Fifth-Generation Penn State/NCAR Mesoscale Model (MM5). *NCAR Technical Note* **398**.

JUSTI DA SILVA, M.G.A.; M. C. D. BARBOSA and M. C. A. XAVIER, 2000: Sistema Alerta-Rio: verificação objetiva das previsões de precipitação e temperatura. *XI Congresso Brasileiro de Meteorologia*. Preprints in CDROM.

KALNAY, E.; M. KANAMITSU; R. KISTLER et al., 1996, "The NCEP/NCAR 40-Year Reanalysis Project". *Bull. Amer. Meteor. Soc*., **77**, 437-471.

KISTLER, R.; E. KALNAY; W. COLLINS et al., 2001: The NCEP-NCAR 50-year reanalysis: monthly means CD-ROM and documentation. *Bull. Amer. Meteor. Soc*., **82**, 247-267.

LeMONE, M. A., R. L. GROSSMAN, R. L. COULTER et al., 2000: Land-atmosphere interaction research, early results, and opportunities in the Walmut River Watershed in Southeast Kansas: CASES and ABLE. *Bull. Amer. Meteor. Soc*., **81**, 757-779.

OLIVEIRA, I. C., T. R. A. PEREIRA and W. F. MENEZES, 2002: Estudo de tempestades do verão 2001/2002 no estado do Rio de Janeiro: aspectos observacionais e numéricos. *XII Congresso Brasileiro de Meteorologia*. Preprints in CDROM.

ROEBBER, P. J. and G. W. REUTER, 2002: The sensitivity of precipitation to circulation details. Part II: Mesoscale Modeling. *Mon. Wea. Rev.*, **130**, 3-23.

SANTOS, I. A. and M. G. A. JUSTI DA SILVA, 1994: Estimativa diagnóstica da precipitação orográfica na região Sudeste do Brasil. *VIII Congresso Brasileiro de Meteorologia*, vol. 3, p. 548-551.