Proceedings of 8 ICSHMO, Foz do Iguaçu, Brazil, April 24-28, 2006, INPE, p. 1655-1658.

PERFORMANCE OF THE WRF REGIONAL MODEL OVER SOUTHEASTERN SOUTH AMERICA DURING AN EXTREME EVENT

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1. INTRODUCTION

Despite very important improvements recently achieved, current resolution of global forecast models remain somewhat coarse to provide reliable estimates of wind speed, precipitation and other variables at the appropriate scales required in forecasting extreme weather events These have always large social concerns. One possibility to overcome this problem is to perform regional forecast simulations using limited-area models. Since July 2005, the Meteorology Unit that depends of the School of Science of University of Republic, Uruguay, had been running the Weather and Research Forecast model (WRF) (Michalakes 2001), in real time, as an earl attempt in developing numerical tools for improving national weather forecasting assets. The modeling system is based on the WRF newly developed version 2.0.2, built over two nested domains: the first one over Southeastern South-America with 2880 km north-south and 2160 km east-west extension with 36 km of grid resolution centered in a point located at 30 degrees of South latitude and 55.8 degrees of West longitude. In addition there is a nested domain over Uruguay region with 12 km of grid point resolution. Both domains run with 31 vertical levels, 84 forecast hours are calculated. The results are displayed each 3 hours and they are published in follow webpage: http://meteo.fisica.edu.uy/wrf-images. Follow parameterization scheme are used to run WRF model:

Parametrization	Scheme
Microphysics	Lin et. all
Planetary Boundary Layer	YSU scheme
Cumulus	Kain-Fritsch

Initial and boundary conditions are taken from NCEP-GFS global model (resolution of 0.5° x 0.5°) simulations over Southeastern South-America. The Model has been running just for around six months. That could result scarce for statistical testing. But evaluations on some extreme events could be achieved as sensibility tests. A recent example of an extreme weather event is the extra-tropical low that affected Province of Buenos Aires in Argentina, and Rio de la Plata and Atlantic Ocean coasts in Uruguay occurring 23-24 August 2005.

2. RESULTS

The storm was characterized by unforced rapid deepening to a near record minimum (locally) mean sea level pressure anomalously high winds and near-record rainfall in some areas. Despite this kind of event is not unusual in temperate regions of South America (Gan, M. A. 1991), the storm resulted in extensive damage due the high winds in surface (see picture of damage in figure 1) and 10 people death in Uruguay (Unidad de Meteorología, 2005).

Figure 1 FM radio tower turn upside down in Montevideo, due the high winds during the 23-24 August 2005 event.

A bulk comparison between GFS and WRF outputs for 24h forecast with observations follows. The location of low-pressure center in surface fit very close with observations, figure 2 shows the surface pressure field forecasted

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by GFS model in Southeastern South-America domain for August 24, 2005, 00Z. The mean sea level pressure field forecasted by WRF model over Uruguay domain for August 24, 2005, 00Z is showed in Figure 3.

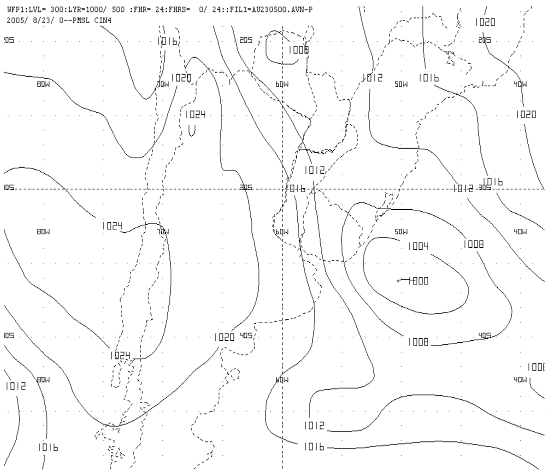

Figure 2 GFS forecast of SLP field from 23 August, 00Z GFS +24 h forecast (PCGRIDDS)

At Montevideo city (35°S and 58°W), during the event, the lowest surface (at station level) atmospheric pressure forecast by GFS was 1000 hPa and the WRF forecast a minimum of 996 hPa. Meanwhile the lowest recorded was 988 hPa.

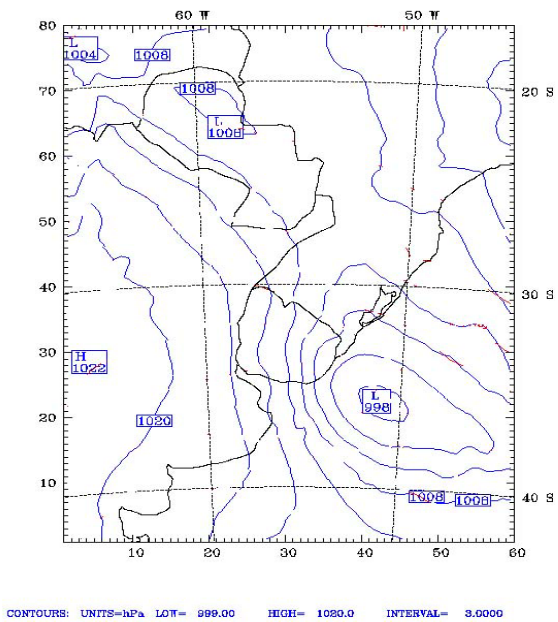

Figure 3 SLP WRF forecast output for 00 Z 24 August 2005.

The performance of the WRF mesoscale model during this extreme event was assessed comparing hourly outputs of mean wind velocity and sea level pressure with observations. The GFS model estimate for the Uruguayan coast a maximum of 35 kt mean hourly wind speed, prevailing from the South, during the peak of event (see figure 4). Meanwhile the WRF model forecast a maximum of 50 kts during the same period (see figure 5).

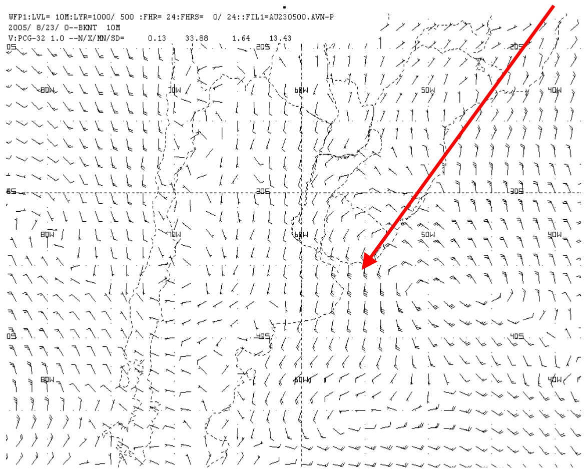

Figure 4. GFS forecast of surface (10m) wind field, for 24 August, 00Z 2005 made from 23 August, 00Z 2005, showing 30 Kts barbs along the external Rio de la Plata

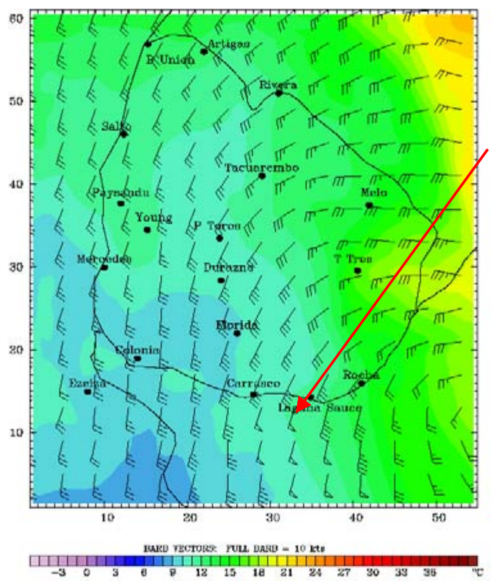

Figure 5 WRF forecast of surface temperature and wind for 00 Z 24 August 2005 showing 50 kts barbs along the external Rio de la Plata

As a primary conclusion the mean hourly wind speed is overestimated by both the GFS and WRF during the previous hours to the wind speed peak, but are underestimated around the peak (between 21Z 23 August and 03 Z 24 August), meanwhile the peak is better simulated by the WRF.

During the event, the WRF has performed performs a more suitable forecast than the global model, in terms of speed and persistence of the observed winds in Southern Uruguay, than the global GFS. (See figure 6).

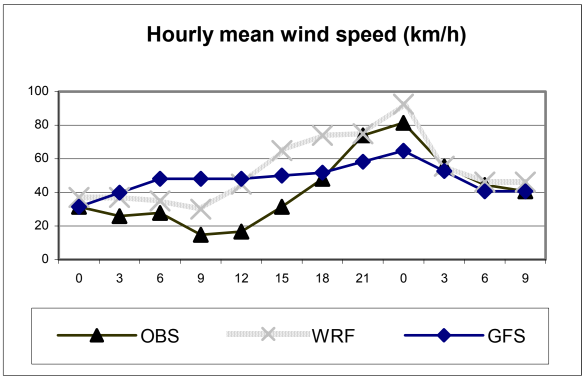

Figure 6 Observed hourly mean wind speed and models (GFS and WRF) forecast made from 00Z 23 August 2005.

The WRF Mesoscale Model performs also a suitable forecast for the evolution of atmospheric pressure fields, showing better performance than the GFS model, although having little systematic underestimation (see figure 7).

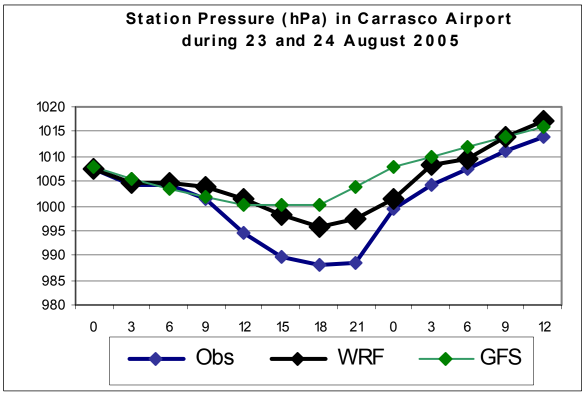

Fig 7 Station level pressure at Carrasco airport observed hourly station pressure and models (GFS and WRF) forecast between 00Z 23 August and 12Z 24 August 2005.

The WRF also seems to have performed an adequate precipitation forecast over Southeastern South America, with a center of high precipitation (over 100 mm) located over Buenos Aires province (figure 8). Observations at the Ezeiza Airport of Buenos Aires during August 22 and 23 report 138 mm. (see figures 9 and 10)

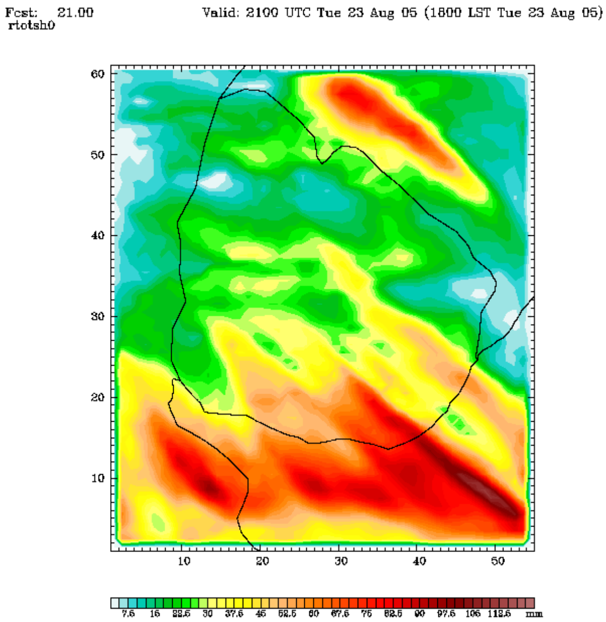

Figure 8 WRF precipitation cumulative in 24 hrs forecast during from 00Z 23 August 2005

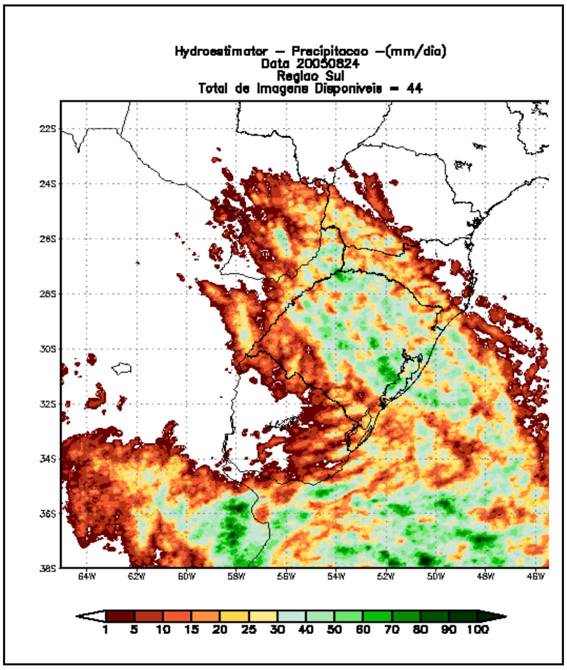

Figure 9 Satellite precipitation estimation in 24 hrs from 00Z 23 August 2005 (CPTEC-INPE)

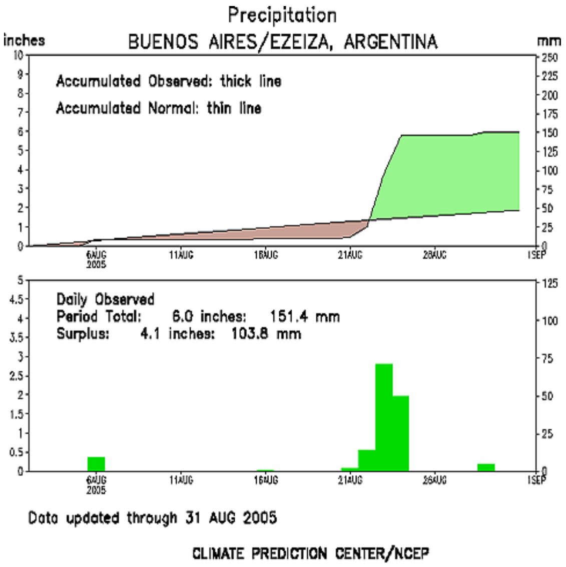

Figure 10 Observed precipitation during August 2005 in Ezeiza Airport (Buenos Aires) (CPC/NCEP)

3. CONCLUSIONS

Sea level pressure, wind field and precipitation amounts estimated by the WRF clearly illustrate the advantage in using the nesting technique vs. tough global model for representing forecasted regional features in the area. The extratropical low pressure was very well positioned in the WRF run, with close agreement with observations (spatial pattern) and with some degree of underestimation in the low-pressure core minimum. GFS forecasted coastal wind field were underestimated by nearly 40%, instead of 10% in the WRF. This pilot comparison during an extreme event introduces an initial perception over the capabilities of the WRF model for simulate weather conditions and especially extreme events in the extratropical South American region.

Preliminary results suggest that nesting technique could certainly be a computationally low-cost alternative suitable to simulate regional weather and climate features.

It's shown that improved forecasts of cyclone intensification result when the grid resolution of the forecast model is increased. However, additional simulations, parameterization tuning and further diagnose are undoubtedly needed for representing local patterns more accurately.

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Acknowledgements.

This study was largely supported by InterAmerican Institute for Global Change (IAI) – PROSUR Project CRN N° 055, and partially by SACC Project CRN Nº 061.