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HIGH RESOLUTION WRF SIMULATIONS FOR WIND GUST EVENTS

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ABSTRACT

High resolution simulations were designed to investigated gust fronts and outflow in events of fall of transmission energy towers over Paraná State, Brazil. Preliminary hindcasts had a good performance to predict the gusts and outflows that blown down pylons in 19 November 2006 squall line event. Efforts in NWP have been applied to obtain more realistic wind peaks to improve nowcasting systems.

1. INTRODUCTION

Every year, wind gusts have been damage a lot of structures in several activities in Brazil. One of the biggest impacts of the gusts is the fall of energy transmission towers. So, in this paper we describe some results about the analysis of gust winds on the first meters above the ground where the towers are installed. For 17 UTC 19 November 2006 event, the strong winds blown down 5 towers of energy transmission on the central area of the Parana State in Brazil (24.96S; 50.15W). The wind gusts were generated by strong downdrafts produced by several cells along a squall line.

2. DATA AND METHODOLOGY

To simulate the gust events, the WRF (Weather Research and Forecast) 3.3.1 version (Skamarok et. Al, 2008) was used with a high resolution configuration. Data from S-band Doppler Radar located in the center of the Paraná State (Figure 1) and a network of anemometers were used for the comparisons and evaluations. The model was run at 15 km horizontal resolution with two nests in higher resolution, 5 km and 1,67 km, according to the ratio of 3 between the grids. It was used 50 vertical levels with a hyperbolic tangent stretching curve to concentrate more levels near the surface and the top of the model which helps the model to solve better the vertical fluxes of heat and mass. The timestep was set at 20 seconds and the output every 5 minutes.

The physical parameterizations were chosen so take in count the strong convective processes, including strong updrafts and downdrafts and all hydrometeors in cumulus cloud. The configuration was: the WSM 6 microphysics scheme, Yonsei University boundary layer scheme, Noah landsurface model, RRTM longwave radiation, Goddard shortwave radiation scheme and Monin-Obukhov surface model. For 15 and 5km grids a Kain Fritsch cumulus scheme was used. For 1,67 grid it is not used since convection is explicit solved by the model. For initial conditions, GFS 0.5º was used at 12 UTC 19 November 2006, five hours before the fall of the towers (17 UTC).

3. RESULTS

Since the simulations started at 12 UTC 19 November 2006, the hindcast was set for 5-6 hr until the burst winds that blown down the towers. The results indicate a phase error in the propagation of the squall line, about 40 min to 1hr late.

The simulations show a divergence resulting new cells in front of the squall line. The outflow divergence on surface triggered strong gust wind and blown down the pylons. The simulated gusts reached peaks about 17 ms^{-1} at the surface. The doppler velocity of the SIMEPAR S-Band Radar (not shown here) reached peaks from 19 to 23 ms^{-1} at 1.5 km (PPI 0.5º) at the time of the fall of the towers.

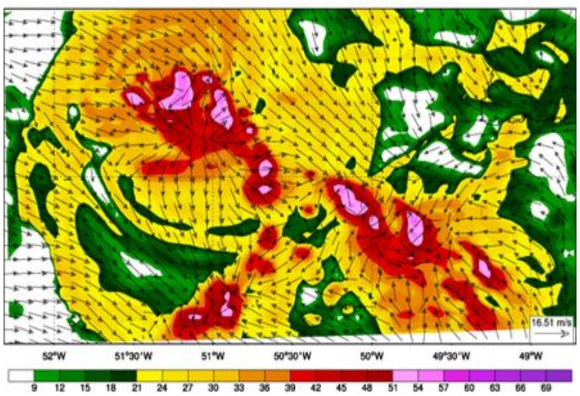

Figure1: Maximum Reflectivity (dBZ) in the troposphere and wind at 10 m, both simulated with WRF at 1,67 km resolution for 18 UTC 19 November 2006.

The maximum wind velocities near the pylons (Figure 2) were produced by the downdrafts inside the second cell of the squall line. The squall line had a length about 140 km of convection and a scattered rear stratiform area, but with a fast propagate velocity, about 15 ms^{-1} eastward.

Beside the outflow, the wind gusts received some acceleration due the irregularity of the terrain because there is a chain of mountain eastward of the line transmission. Despite the phase error and the bias of the gusts, the WRF has proven its potential in resolving the complex system down to the scale of outflow and front gusts. Another sophisticated microphysical and higher timesteps will be tested to approximate the values at the peaks gusts that blow down the towers

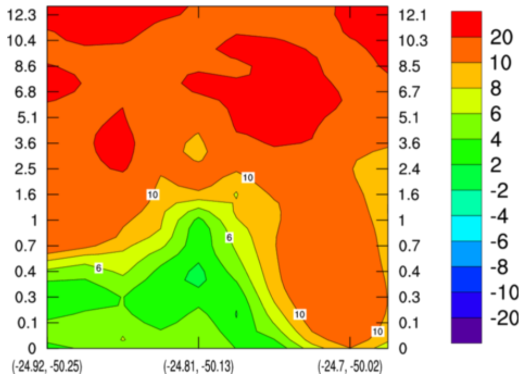

Figure 2: Vertical cross section of the wind of the Squall Line at 18 UTC 19 November 2006 over Carambeí City.

4. CONCLUSIONS

High resolution simulations of wind gusts in a fall of energy transmission towers event was run with a WRF model. The simulations proven the NWP potential for the prediction of severe weather as outflows and wind gusts in a few hours. These are important results to fill the gap between nowcasting and regular NWP systems.

5. REFERENCES

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