Weather Radar Data Assimilation Impact in Very Short Range forecasting

A squall line case study in Brazil

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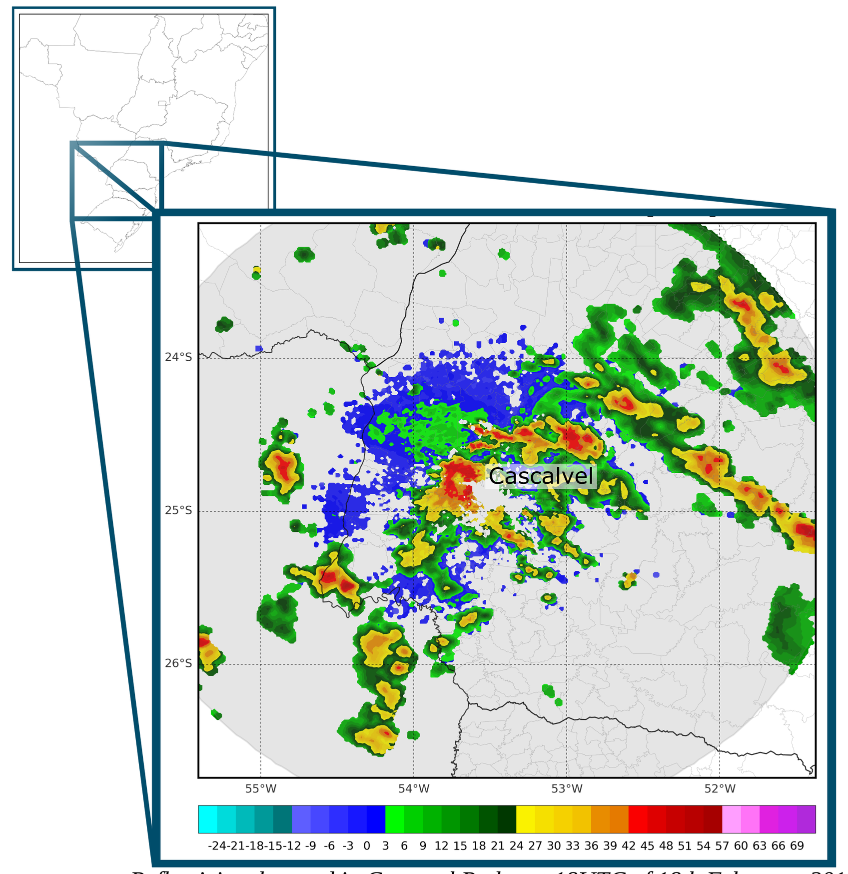
Introduction

One of the areas with frequent occurrence of severe storms in Brazil is located in the west of Paraná State, southern Brazil, due to the influences of low level jets that bring humidity mainly from tropical regions. Paraná Meteorological System (SIMEPAR) operates a dual polarization S-Band weather radar in the region. The objective of this study is to improve model skill in short-range forecasts (from 1 to 3 hours) by assimilation of radar reflectivity and radial velocity, along with automatic surface meteorological stations included as part of a project detailed in another paper in this conference (Calvetti et al, 2016).

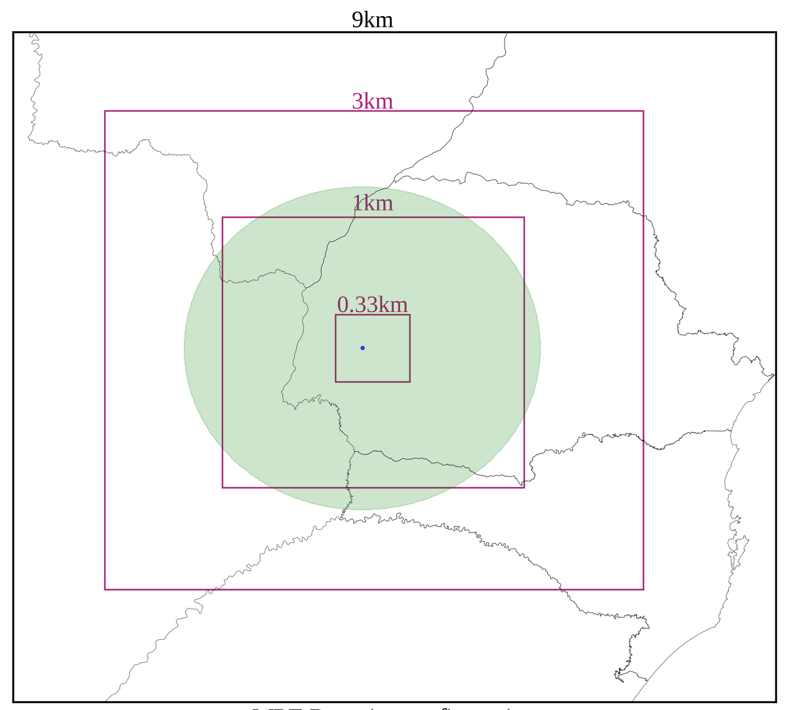
Since December 2015, a set of anemometers were installed in four energy tranmission towers within the radar range to study the wind behaviour around and in these structures. Although the time series is too short and no extreme events were observed, a case was chosen to validate the proposed methodology. On February 18th, 2016 at 18UTC a gust of 27m/s was recorded in a sonic anemometer at 28m height, associated with a convective cell embedded within a squall line.



Reflectivity observed in Cascavel Radar at 18UTC of 18th February, 2016

Methodology

This study used WRF3 model version 3.7.1 (Skamarok et al, 2008) and WRF3DVAR (Sun, 2010) with three nested grids with 9km, 3km and 1km horizontal resolution centered near the radar site. The boundary conditions used were obtained from Global Forecast System (GFS) model with a horizontal resolution of 0.25 degrees.



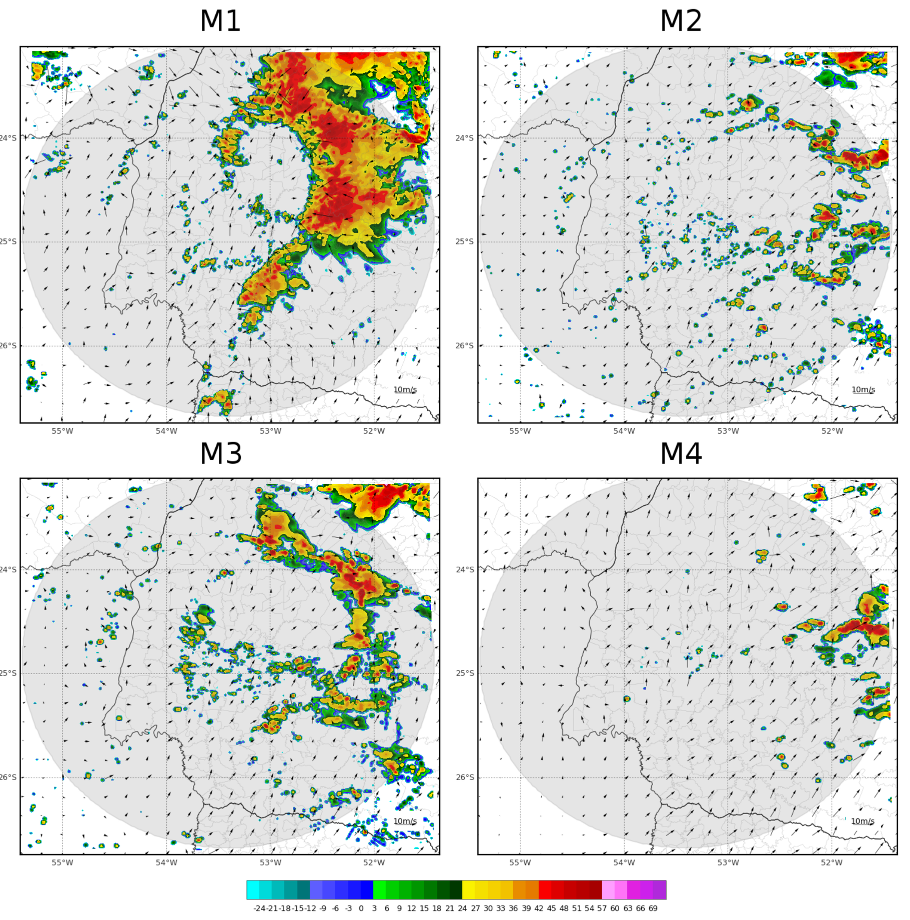
WRF Domains configurations

Two sets of experiments were performed: first initializing the model at 12UTC with four different sets of physics parameterizations, without data assimilation to identify the best configuration for that location; and the second set of experiments used the model output at 17UTC as first guess to the assimilation, which was over the 1km grid. Nested feedback carried out information throughout the domains.

Results

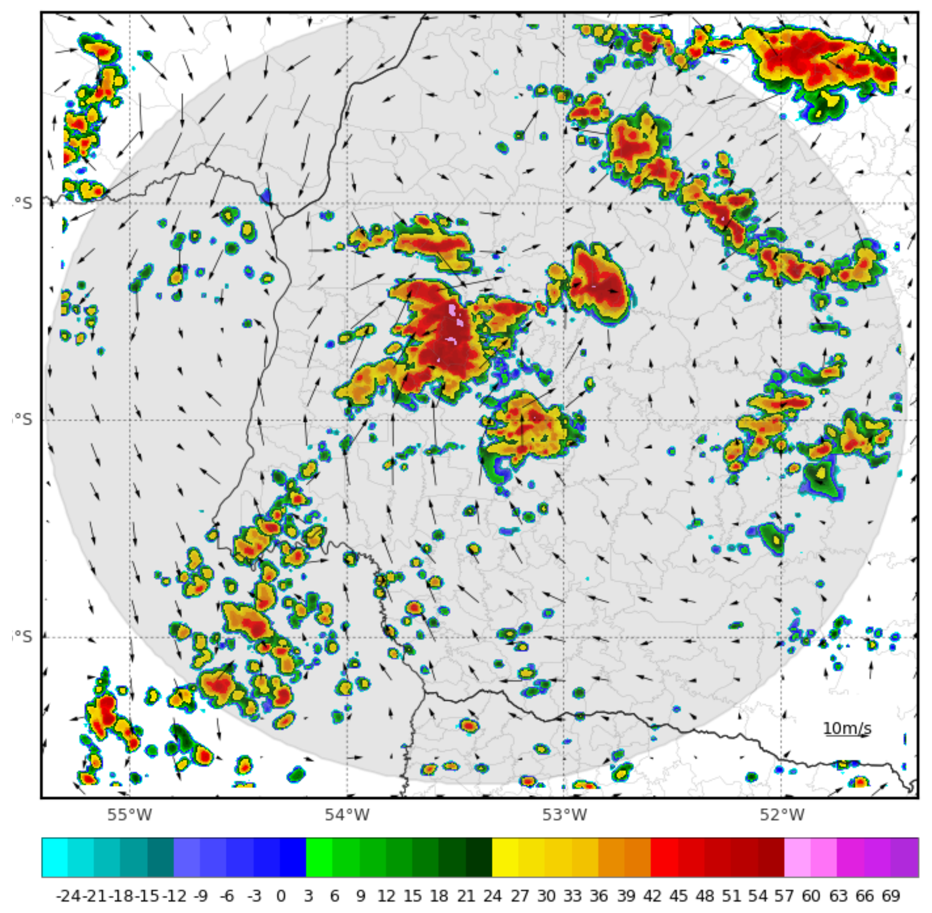
	M1	M2	M3	M3
mp_physics	Ferrier	Lin	Goddard	Lin
ra_lw	GFDL	RRTM	RRTM	RRTM
ra_sw	GFDL	Dudhia	Dudhia	Dudhia
sf_sfclay_physics	Janjic Eta	Monin-Obukhov	Monin-Obukhov	Monin-Obukhov
sf_surface_physics	Noah	Noah	Noah	Thermal Diffusion
bl_pbl_physics	MYJ	YSU	YSU	ACM2
cu_physics	BMJ	KF	MKF	KF

The model using Lin et al. microphysics (experiment M2) showed a better representation of the atmosphere state when compared to ETA microphysics (experiment M1) and Goddard microphysics (experiment M3). On the other hand, changing PBL scheme to ACM2 in M2 (experiment M4) generated less convection when compared to observations and the other experiments.



Comparation among different sets of physics

A routine in Python was used to read the raw radar data, perform quality control and output in ASCII for WRFDA4. This routine uses the Python ARM Radar Toolkit, PyART (Helmus and Collis, 2016), a Python module with radar algorithms and utilities. There is two main quality controls used, the first is the attenuation correction (using PyART for attenuation function), the second is the removal of data where the spectrum width is near zero. Radar beams where reflectivity was too high (more than 72dBZ) or low (less than 12dBZ) were also removed.


Reflectivity Field at 18UTC (1h forecast) ater Data Assimilation

The second experiment used the M2 forecast at 17UTC as background for radar data assimilation. The side figure shows the reflectivity at 18UTC. While the model without assimilation was not able to generate the convection as observed with radar data, the high-resolution simulation with assimilation yields a development of the convection cells compared to the observations, although in some areas the simulated reflectivity were overestimated.

Conclusions

These preliminary results encourage further investigations in radar data assimilation for short-range forecast. Quality control is a major issue that should be investigated thoroughly, and in particular when regarding radial velocity. Using polarimetric variables can improve the quality control and is already in the process of analysis in this project.

References

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COPEL Geração e Transmissão
ANEEL Agência Nacional de Energia Elétrica

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