SENSITIVITY STUDY OF BRAMS FORECAST IN AN ORGANIZED MESOSCALE CONVECTIVE EVENT

Matilde Nicolini [1,2], Yanina García Skabar [3,4],Luciano Vidal [2,3],Paola Salio [1,2]

[1]Centro de Investigaciones del Mar y la Atmósfera, CONICET-UBA, UMI IFAECI/CNRS, [2] Departamento de Ciencias de la Atmósfera y los Océanos, Facultad de Ciencias Exactas y Naturales, UBA, Pab. 2, 2º Piso, Ciudad Universitaria, 1428 Buenos Aires, Argentina, nicolini@cima.fcen.uba.ar, salio@cima.fcen.uba.ar , [3] Servicio Meteorológico Nacional, 25 de mayo 658, C1002ABN, Buenos Aires Argentina, [4] Cátedra de Climatología y Fenología Agrícola. Facultad de Agronomía, Universidad de Buenos Aires (UBA), Argentina, yanina@smn.gov.ar, lvidal@smn.gov.ar

I. INTRODUCTION

Heavy rainfall and other severe phenomena related to deep convection and their forecast is a major problem in different geographical regions. Subtropical South America (including La Plata basin) is particularly affected by large and intense mesoscale convective systems (MCSs) within which severe events develop specially during the warm season. The objective of this work is to progress in the high resolution forecast of MCS events in order to reduce related damages and specifically to study the sensitivity to different initial conditions, vertical resolution, settings on the cloud microphysics scheme and inclusion of parameterization of convection in a pre-frontal squall line event. The evaluation is based primarily on simulated reflectivity and accumulated precipitation fields.

Currently there is a joint effort of National Meteorological Service (SMN), University of Buenos Aires and Research Center of the Sea and the Atmosphere (CIMA) to design and implement an operational high resolution forecast at SMN to contribute to improve mesoscale phenomena forecast, as convective storms, in Argentina.

II. PRESENTATION OF RESEARCH

During early morning of January 12, 2010 an extended convective line developed in association with a cold front that propagated over the central and northern part of Buenos Aires Province, Argentina (Figure 1). Related storms produced severe winds (reported gusts exceeding 30 m s–1) in different locations around the city of Buenos Aires, causing material damage and even lost of lives.

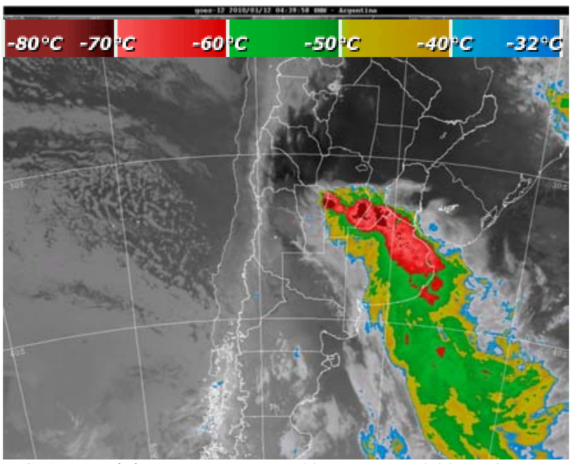

FIG. 1: IR Brightness temperature 12 January at 4:39 UTC.

This event is selected as a case study to perform a set of numerical experiments to explore high resolution forecast sensitivity as stated in the introduction.

Numerical forecasts of the case study were performed using the Brazilian model Regional Atmospheric Modeling System (BRAMS), Version 4.2, a general description of this model can be found in Freitas et al (2009) as well as online at http://www.brams.cptec.inpe.br. García Skabar and Nicolini (2010) studied the impact of assimilating SALLJEX data into initial fields on mesoscale forecasts in the region, using this model with 20km horizontal resolution and with particular emphasis on the South American Low-Level Jet (SALLJ) structure and on rainfall forecasts. Garcia Skabar et al. (2010) performed a verification for the period April 2006 to December 2008 of the forecasts performed with the same model that has been implemented in real time at the Department of Atmospheric Sciences and the Oceans.

Details of the model initialization, configurations, and parameterizations are provided for the control experiment and the sensitivity experiments in Table I and Table II respectively. Control run has the more complete configuration, higher vertical resolution, explicit convection, and more detailed microphysics.

As a focus is on the impact of the representation of the boundary layer the vertical resolution is decreased from 10 m in the control experiment to 20 m at the lower level.

Following Kain et al. (2008) discussion regarding the conceptually correct avoidance of convective parameterization in models in the range of 5–10-km grid spacing but still unrealistic model performance, sensitivity to the inclusion of parameterization in the 8 km resolution domain is tested. Also, as the precipitation and reflectivity forecast are related variables and therefore both controlled by the microphysics a comparison between the 2 moment and the one moment bulk-water representations is allowed through experimentation.

CONTROL RUN features
- Initial condition at 11 January 18UTC, 18 hours forecast
- Initial and boundary conditions provided by BRAMS 20km horizontal resolution analysis and forecasts.
- Two-way nesting, two grid of 8 and 2 km horizontal resolution
- Microphysics bulk water two moment, 8 water species
- Shallow and deep convection parameterizations were not activated
- Vertical resolution, DZ=10m, 65 vertical levels, 24 above 1500 m

TABLE I: Control run characteristics.

	Changes from CONTROL RUN
FCST01	Initial condition at 11 January 21UTC
FCST02	Microphysics bulk water one moment
FCST03	Grell and shallow cumulus parameterization activated at 8km horizontal resolution
FCST04	Coarse vertical resolution, DZ=20m, 50 vertical levels, 18 above 1500 m

TABLE II: Sensitivity experiments characteristics.

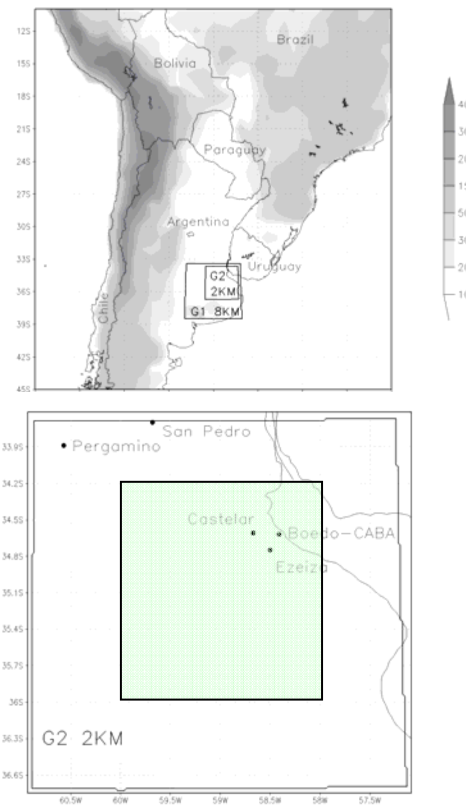

FIG. 2: Upper panel: Model integration nested domains. Topography is shaded and indicated in meters. Lower panel: 2 km resolution domain and green square denotes the area considered in figure 3.

III. RESULTS AND CONCLUSIONS

Model forecast is compared with measurements from radar, disdrometer, CMORPH estimations (8km-30min) and surface observations.

Figure 4 allows a comparison of reflectivity patterns evolution against radar data at 3 km height. All members of forecast sensitivity experiment succeeded in reproducing a convective line. Stronger sensitivity is obtained to parameterization of convection in the 8 km resolution domain. Model forecasts reproduce a more extended both along and across the line direction but similar linear and fine scale cellular system than the Ezeiza radar pattern. No closer comparison is addressed because the radar is not yet calibrated (a tendency to underestimation is detected in its operative performance) and no correction for eventual attenuation is considered. Even if higher values for the area with reflectivity exceeding 40 dbZ are predicted by the model respect to radar, the time evolution is well reproduced (Fig. 3) and the control experiment almost replicates the ensemble behaviour.

CMORPH estimated precipitation fields with 8 km and 30 min resolution depict a slightly faster progression of the line compared with the forecasts that display a narrower configuration (Fig. 5). Weaker 1 hour precipitation corresponds to 1 moment microphysical scheme.

Sensitivity to different initial conditions, vertical resolution and settings on cloud microphysics scheme were identified.

It is essential to advance on Radar calibration and improve reflectivity estimation from forecast variables, using algorithms that include mixing ratio as well as number concentration for the different microphysical species. Also to develop an objective and appropriate methodology to validate high resolution forecasts.

Some issues that require further research in the region regards mechanisms for initiation of convection as already addressed by Nicolini and García Skabar (2011) and improvements of surface data to represent these mechanisms. An important question for operational purposes is if the spacing of 2 km is small enough to resolve forcing mechanisms and if this resolution leads to greater skill of convective characteristics and of quantitative precipitation forecast respect to regional models operative in the region.

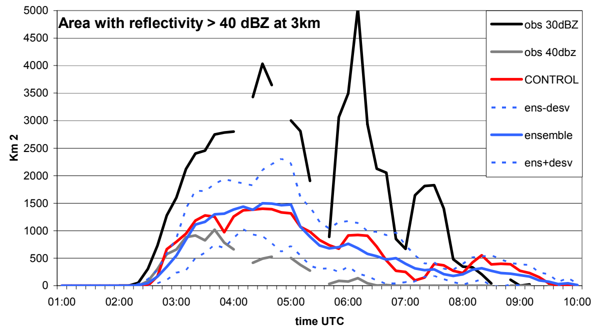

FIG. 3: Area where reflectiviy at 3km exceeds 40 dBz within green square indicated in figure 2.

IV. ACKNOWLEDGMENTS

The authors thank Centro de Previsão de Tempo e Estudos Climáticos (CPTEC) for providing BRAMS. This research was partially supported by CONICET through Project PIP 11220090100850, by ANPCYT through grant PICT 2007-355, PICT 2008-163, by MINDEF through PIDDEF 47/2010 and by the Univ. de Buenos Aires through Project X159.

V. REFERENCES

Freitas, S. R. and Coauthors, 2009: The Coupled Aerosol andTracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS). Part 1: Model description and evaluation.Atmos. *Chem. Phys.*, 9, 2843–2861.

García Skabar, Y. and M. Nicolini, 2010: Impact of data assimilation on regional numerical forecasts over southeastern South America during SALLJEX. Submitted.

Garcia Skabar, Y. P. Salio and M. Nicolini, 2009: BRAMS Forecast verification over a region of subtropical South America. *CONGREMET X - CLIMET XIII,* October 2009, Buenos Aires. Proceedings, 10 pages.

Kain, J. S., and Coauthors, 2007: Some practical considerations for the first generation of operational convection-allowing NWP: How much resolution is enough? Preprints, *22nd Conf. on Weather Analysis and Forecasting/18th Conf. on Numerical Weather Prediction*, Park City, *UT, Amer. Meteor. Soc.*,3B.5.

Nicolini, M. and Y. García Skabar, 2011: Diurnal cycle in convergence patterns in the boundary layer east of the Andes and convection. *Atmos. Res.*,100, 377-390.

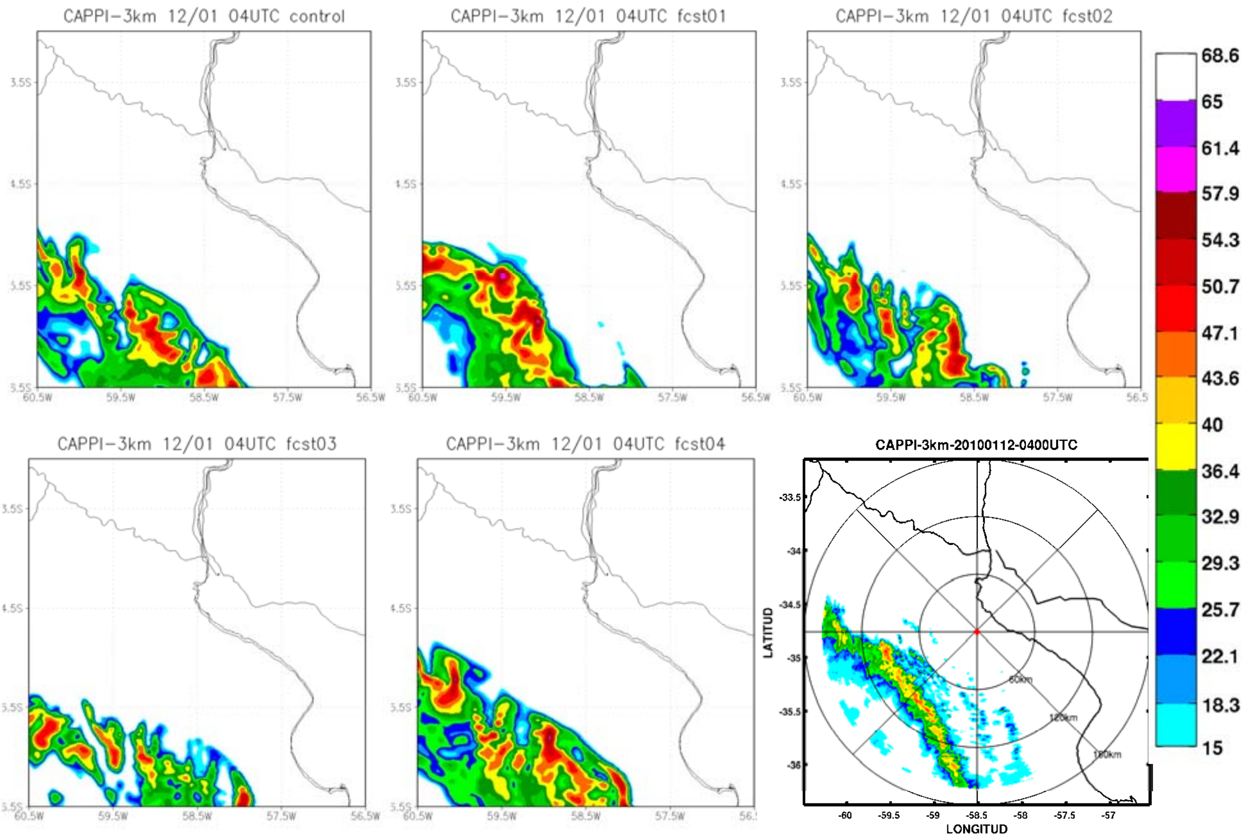

FIG. 4: Reflectivity at 4 UTC, and for 3 km level. Forecasts and radar.

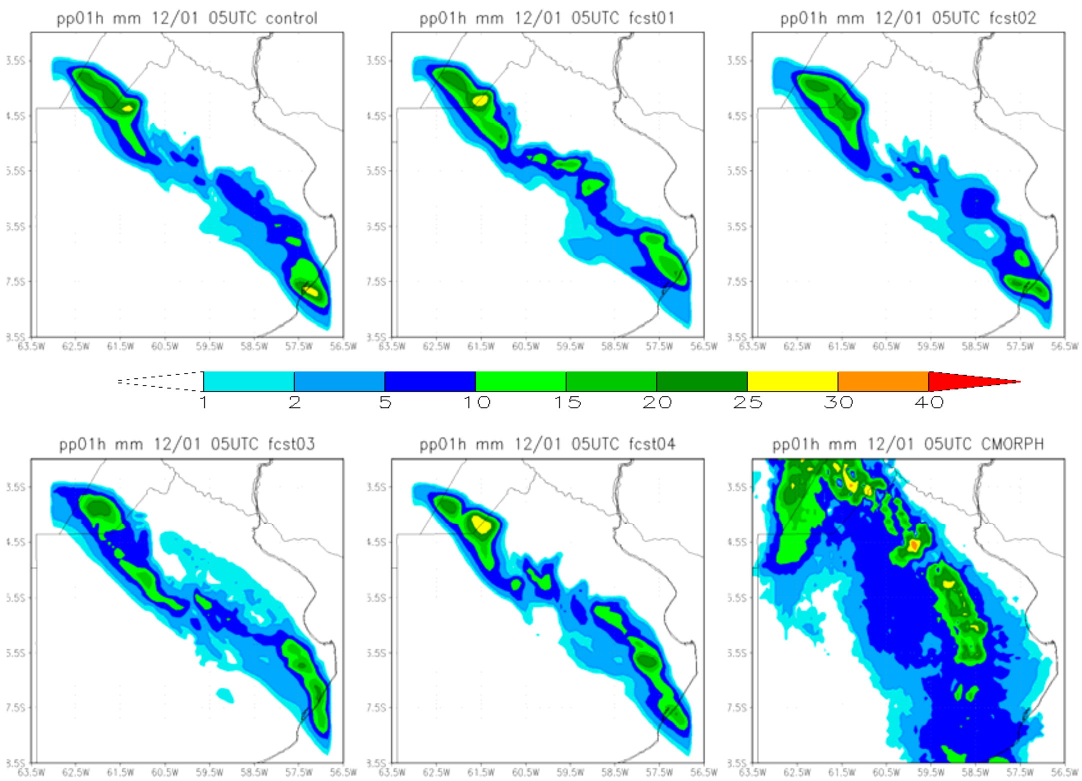

FIG.5: Accumulated precipitation between 4 and 5 UTC. Forecasts and CMORPH.