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PREDICTABILITY OF HEAVY RAINFALL EVENTS OVER THE SERRA DO MAR

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1. Introduction

The Serra do Mar are mountains that run along the coast of Southeast Brazil near major cities. Frequent rains occur over these mountains that exhibit some steep slopes and erosive soil. This combination can result in major landslide events. The region also hosts the remainings of endangered native forest, the Mata Atlântica.

Mainly the quasi-stationary feature of the South Atlantic Convergence Zone (SACZ), which produces rain for about consecutive 4 or 5 days, causes heavy rainfall events. Local forcing, mostly related to the proximity to the coast and the orographic lifting, can cause frequently heavy showers.

The objective of the work is to improve forecasts of heavy rainfall by use of short-range ensemble forecasts in the Serra do Mar region in order to provide more reliable information of the civil defense and other decision makers. The forecasts of risk events are given in terms of probability forecasts. Due to the complexity of the terrain, high resolution forecast experiments are being designed.

2. Methodology

2.1 The Eta Model

The Eta model (Mesinger et. al, 1988) domain covers most of Southeast coast of Brazil. It was configured with 40-km resolution and 38 layers (Eta40) and 10 km and 50 layers (Eta10). The convection precipitation is generated by the Betts-Miller-Janjic scheme (Betts and Miller, 1986) and microphysics by Ferrier scheme (Ferrier, 2002). The land-surface processes are solved by the NOAH scheme (Chen et al, 1997). The radiation package was developed by GFDL. The initial condition were taken from NCEP analyses. The lateral boundaries of the Eta40 were updated every 6 hours from CPTEC T126L28 global model forecasts. The lateral boundaries of the Eta10 were updated using Eta40 model forecasts. The Eta Model uses the same initial monthly climatology of soil moisture and seasonal albedo.

2.2 The ensemble

The CPTEC GCM produces 15-member ensemble. The members are constructed from perturbations generated using Empirical Orthogonal Functions. The GCM ensemble is organized in 4 clusters, one member of each cluster is taken for the Eta short-range ensemble. A 5-member ensemble is constructed including the control member for each model resolution, Eta10 and Eta40.

3. Results

The local forcing case of heavy precipitation occurred on 9 December 2002, with landslides and flooding in coastal cities in the Serra do Mar. Precipitation was accumulated to values of 128 mm/day in Angra dos Reis and 80 mm/day in Ubatuba (Fig.1). After the passage of a cold front, coastal circulation toward the continent was enhanced and combined with the orographic lifting caused localized areas of maximum precipitation. The 40-km runs produced little precipitation along the coast. The increase of resolution resulted in a considerable increase of precipitation rate, although large variability among the forecast members was observed.

The large scale forcing event is illustrated by the SACZ case which occurred from 26 until 29 January 2004 with a meridional orientation. The precipitation total over southern areas of Serra do Mar accumulated over 200 mm in 4 days (Fig. 2). The 120-h forecasts of Eta10 of the 24-h accumulated precipitation showed that all members positioned correctly the maximum of precipitation in the southern part of the Serra do Mar. The major precipitation band was captured by all members.

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Some differences in the band orientation was forecasted.

The spread of mean sea level pressure (MSLP) in the domain showed increase toward 72-h forecasts, after that a decrease is observed (Fig. 3). The higher resolution version showed slightly higher spread in MSLP. The spatial distribution of the MSLP spread shows larger values in the interior of the continent and over the ocean. The consistent area of maximum rainfall over Serra do Mar exhibits smaller MSLP spread.

Figure 4 showed the short-range ensemble forecasts at different lead times. All runs showed consistently the increase of the precipitation rate on 12z 26/01/2004, however, the peak value of 65 mm/day was not reached by the ensemble means.

The added value of an ensemble forecast can be seen in Figure 5. On the 26 January, when heavier precipitation occurred, 4 members indicated precipitation rate higher that 30 mm/day, which would be translated as an 80% probability of heavy rain occurrence.

Conclusions:

The evaluation of ensemble members of Eta with 40-km and 10-km resolution showed that the increase of resolution improved the amount of precipitation forecast. Precipitation caused by local forcing showed smaller reliability in the forecasts of the heavy event due to the larger spatial and temporal spread. In the case of large scale forcing illustrated by the SACZ case, the forecasts of the heavy rainfall event showed smaller spread in MSLP in the position of maximum of precipitation, indicating a higher predictability event. Additional members are being constructed for the short-range ensemble prediction system, in order to include model physics uncertainties.

References:

Betts, A. K.; Miller, M. J., 1986: A new convective adjustment scheme. Part II: Single column tests using GATE wave, BOMEX, and arctic air-mass data sets. **Quart. J. Roy. Meteor. Soc.**, 112, 693-709.

Chen, F.; Janjic, Z.I.; Mitchell, K., 1997: Impact of atmospheric surface-layer parameterization in the new land-surface scheme of the NCEP mesoscale Eta model. **Bound. Layer Meteor.**, 85, 391-421.

Ferrier, B. S., Y. Jin, Y. Lin, T. Black, E. Rogers, and G. DiMego, 2002: Implementation of a new grid-scale cloud and precipitation scheme in the NCEP Eta Model. 1*9th Conf. on Weather Analysis and Forecasting/15th Conf. on Numerical Weather Prediction*, San Antonio, TX, Amer. Meteor. Soc., 280-283.

Mesinger, F.; Janjic, Z.I.; Nickovic, S.; Gavrilov, D.; Deaven, D.G., 1988: The step-mountain coordinate: Model description and performance for cases of Alpine lee cyclogenesis and for a case of Appalachian redevelopment. **Mon. Wea. Rev.,** 116, 1493-1518.

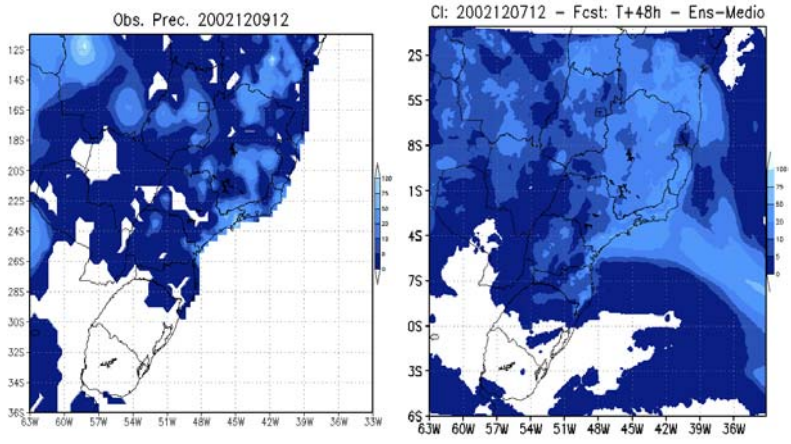

Figure 1 – Local forcing event. 24-h accumulated precipitation: observation (lhs), 48-h ensemble mean forecast (rhs). Unit is mm

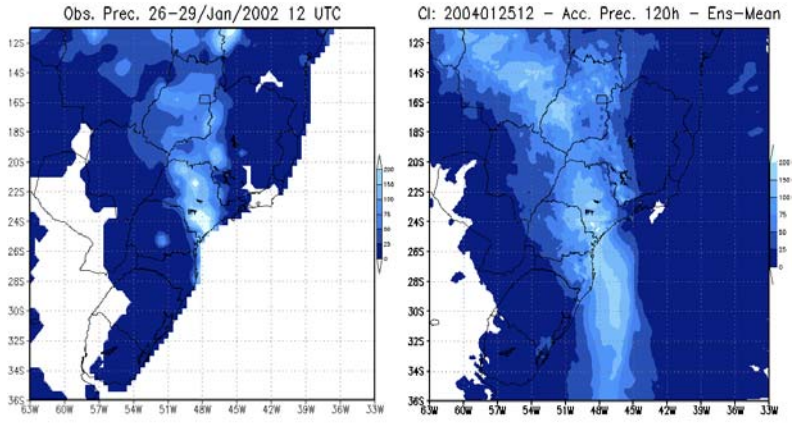

Figure 2 – SACZ event. 24-h accumulated precipitation: observation (lhs), 48-h ensemble mean forecast (rhs). Unit is mm.

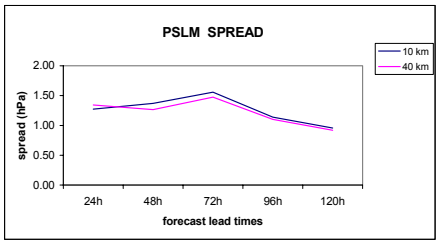

Figure 3 – Domain average spread of MSLP for the runs starting on 12z 25/01/2004..

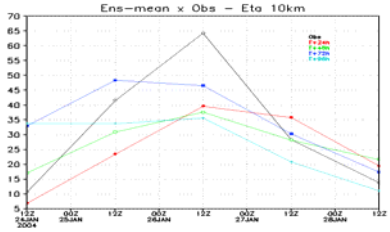

Figure 4 – 24-h accumulated precipitation from Eta10 at different forecast lead times, for the SACZ event. Unit is mm.

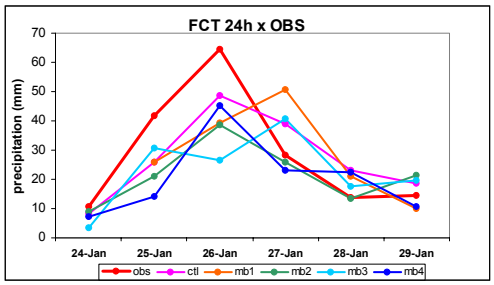

Figure 5 – 5-member forecast of 24-h accumulated precipitation (mm) at 10km resolution. Unit is mm.