Analysis of an Extreme Precipitation Episode over the Central Subtropical Andes using the Eta-PRM Regional Model

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1. INTRODUCTION

The Andes Cordillera runs meridionally from 55ºS to 10ºN with a mean width of 200-300 km. The height varies with latitude, from the most southern latitudes till 35ºS, the mean height does not exceed 2500 m.s.l. allowing the westerly winds to pass over the mountains without much blocking. But northward of 35ºS, the cordillera rises rapidly, achieving a mean altitude of 4500 m.a.s.l., with many peaks over 6000 m.s.l. Here the mountain range is a great barrier for the wet winds and precipitation coming from the Pacific Ocean.

The most significant precipitation event over the Central Andes mountain and windward low land took place on 26-29 August 2005. This work addresses several key questions concerning this episode in particular:

- What is the synoptic evolution accompanying the episode?
- How does the ability of the Eta-PRM 15-km resolution to simulate the episode?
- What is the spatial variability in model precipitation and the accuracy across the region?

2. DATA AND METHODOLOGY

The model grid values were bilinearly interpolated at the station locations in order to compare with observation (Fig.1). In addition, the numeric experiment with the 15km Eta-PRM regional model was used to estimate the spatial structure of the precipitation event. This was because the scarcity of regional meteorological stations that do not allow to establish it with precision. The ETA-PRM model is a regional version of 40-km ETA-Centro de Previsao de Tempo e Estudos Climáticos (CPTEC-Brazil) South American continent. The model integrations began at 1200 UTC 25 Aug 2005 and ended at 1200 UTC 29 Aug 2005 (96-h forecast).

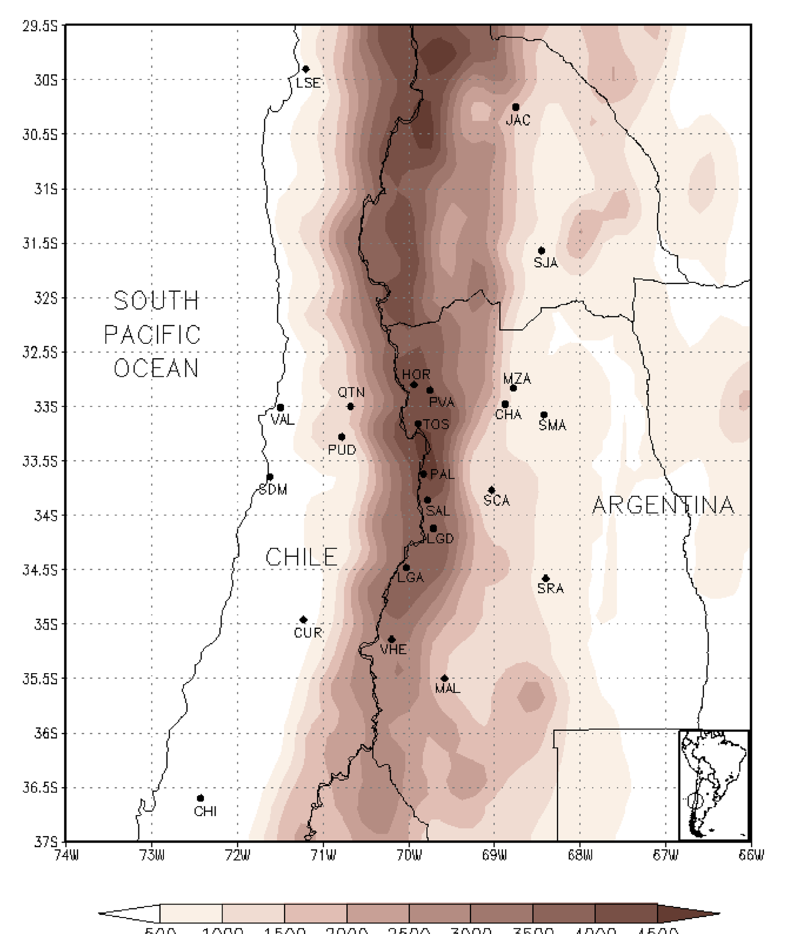

Figure 1: locations of stations used and the model region and orography (m, elevation higher than 500m are shaded).

3. BRIEF SYNOPTIC OVERVIEW

The synoptic situation was characterized by a clear baroclinic zone (polar frontal zone) between 30ºS and 40ºS denoted in 1000/500 hPa thickness and linked with an intense westerly flow at 500 hPa (see extended abstract). And at surface level, a low pressure belt with a typically surface cyclones family (Bjkernes system) to the south of this frontal zone was noted (Fig. 2).

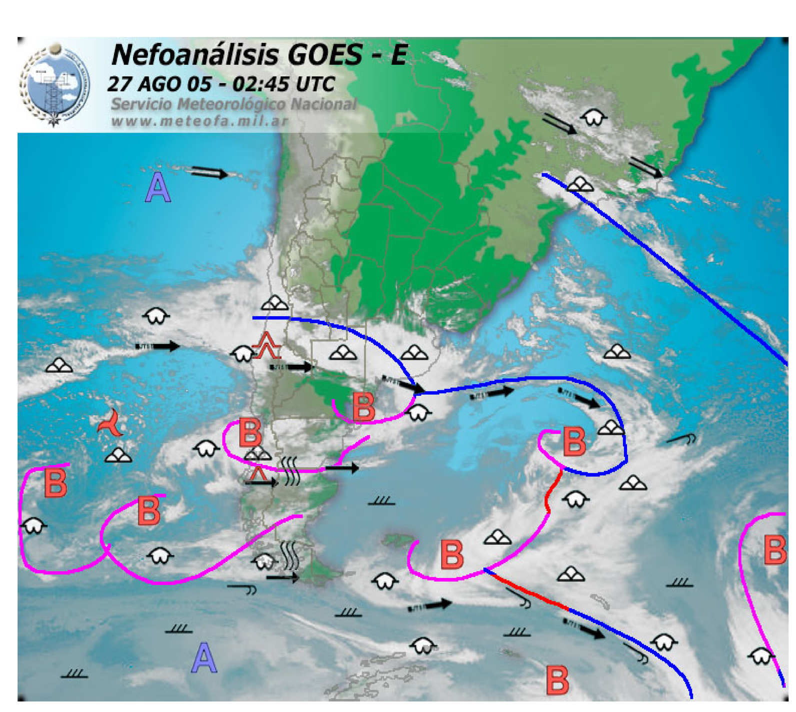

Figure 2: Nephoanalysis at 0245 UTC 27 Aug 2005. The letters B and A correspond to the low-pressure center and high-pressure center, respectively.

4. SIMULATION OF 26-29 AUGUST 2005 EVENT

4a. Windward surface time series

The main characteristics registered at Pudahel (PUD, Santiago de Chile airport) and at Santo Domingo (SDM, see Fig.1) were the principal and secondary maximums precipitation and the two SLP minimums, decreasing temperature and veering winds entailed with the Princiapal Cold Front (PCF) and the Cold Front (CF) passages (Fig. 3). The rain was realistically simulated by the model, but the initial time was forecasted nearly six-hour later. Also the model had some difficulty capturing lower magnitude of 10-m wind, 2-m dew point temperature and larger 2-m temperature daily range (Fig. 3).

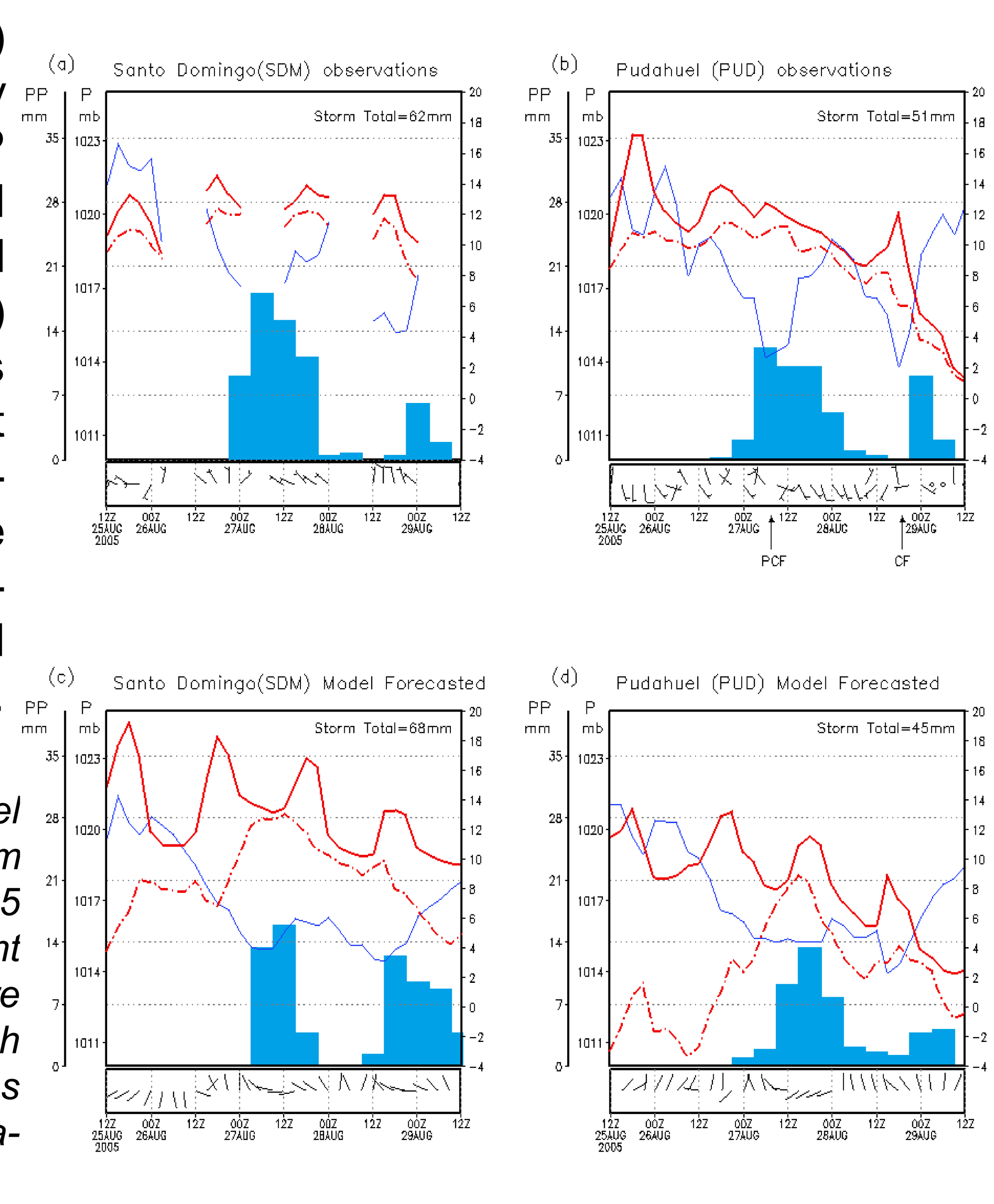

Figure 3: (a) Santo Domingo(SDM), and (b) Pudahel Aero(PUD), observations plotted every 3h from 1200 UTC 25 Aug to 1200 UTC 29 Aug 2005 showing temperature (ºC, red solid), dewpoint temperture (ºC, red dot dashed), sea level pressure (mb, blue solid), winds (full barb=10 kts), and 6-h precipitation (shaded in mm). (c) and (d) same as (a) and (b), respectively, except for the 15km Eta-PRM simulation.

4b. Leeward surface time series

The more important signal at same latitude leeward of the Andes linked to cold front passages, was the downslope wind situation (Zonda wind, Norte 1988) and the spillover rainshadowing (about all at MAL, more southern station, where the mountains ranges are lower so the bloking effect is diminished, Fig 4.d). The 15-km Eta-PRM under predicted the rain at MAL and MZA (Fig 4). This coincided with 10-km Eta-NCEP cold season evaluation that generates not enough rain on the lee of major barrier in NW U.S.A founded by Colle et al. (1999) (Fig. 4e-4f). Nevertheless, the model was able to forecast several aspects of the Zonda wind, such as wind strength, temperature, and dew point changes (Fig 4d-4f). This results are consistent with founded by Seluchi et al. (2003).

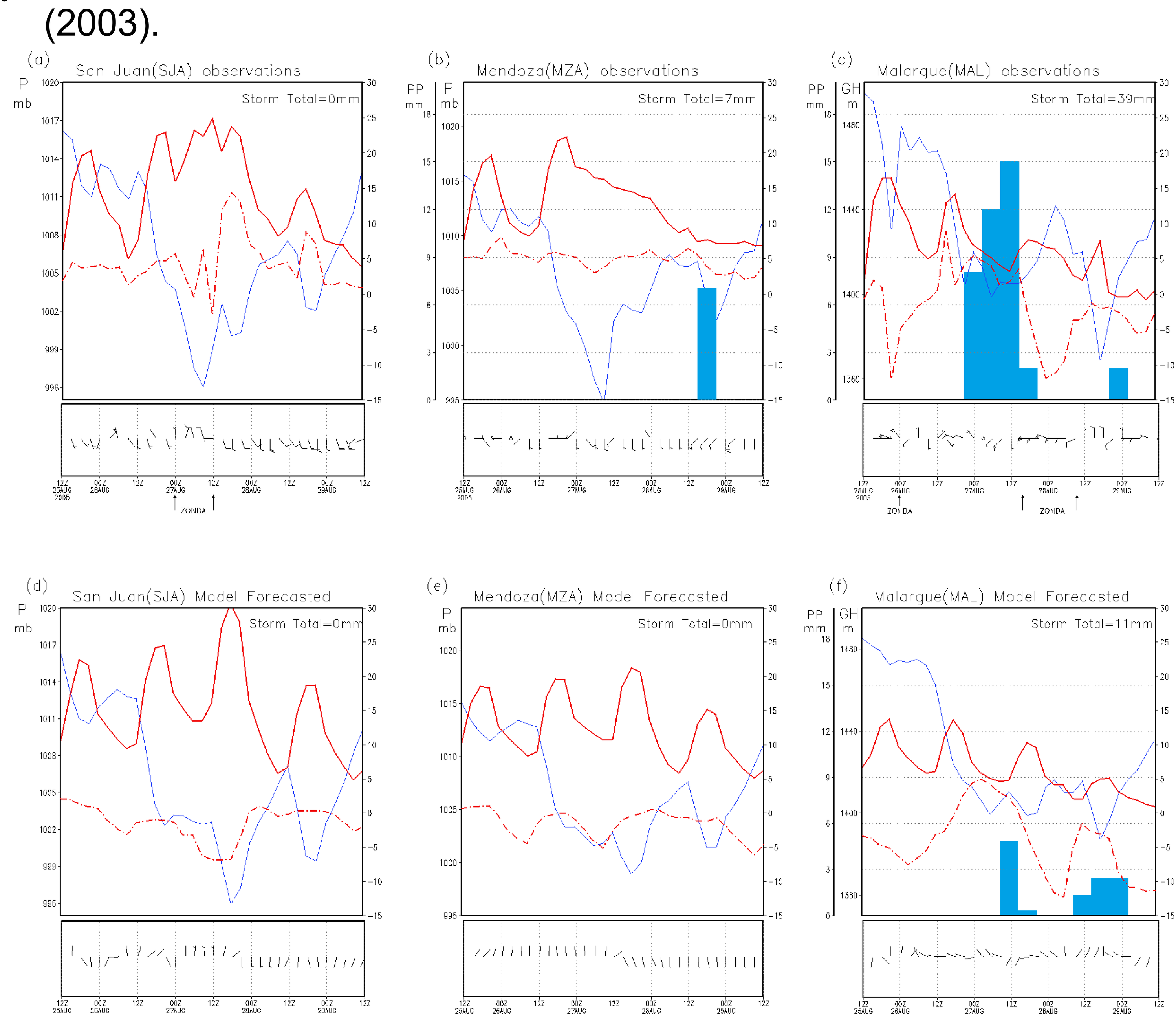

Figure 4: Same as Fig.3 but for stations at leeward in Argentina, (a) San Juan (SJA), (b) Mendoza (MZA), and (c) Malargue (MAL) observations (see, Fig.1); (d), (e), and (f) are showed the Eta-PRM simulation, respectively. The sea level pressure at MAL are remplaced for the 850mb geopotencial height (GH) because its altitude is about 1500 m.

4c. Percents of Observed Precipitation (POP) and Model Spatial Precipitation Distribution

This POP is defined as forecast divided by observed (*F/O*) precipitation, and then multiplied by 100. In Figure 5, the better bias scores (70%-130%) are situated over the lowlands of Central Chile and to the northward 34ºS on downstream of Andes crest (near the Chile-Argentina border). In contrast, the model predicted less than 70% at most stations on leeside. The maximum precipitation (200-300 mm) was observed upstream of the high Andes crest. Similar results founded Colle and Mass (2000) when simulated a flooding event over Cascades ranges in NW U.S.A. And also, a very large zonal precipitation gradient was simulated downstream showing the great barrier blocking effect.

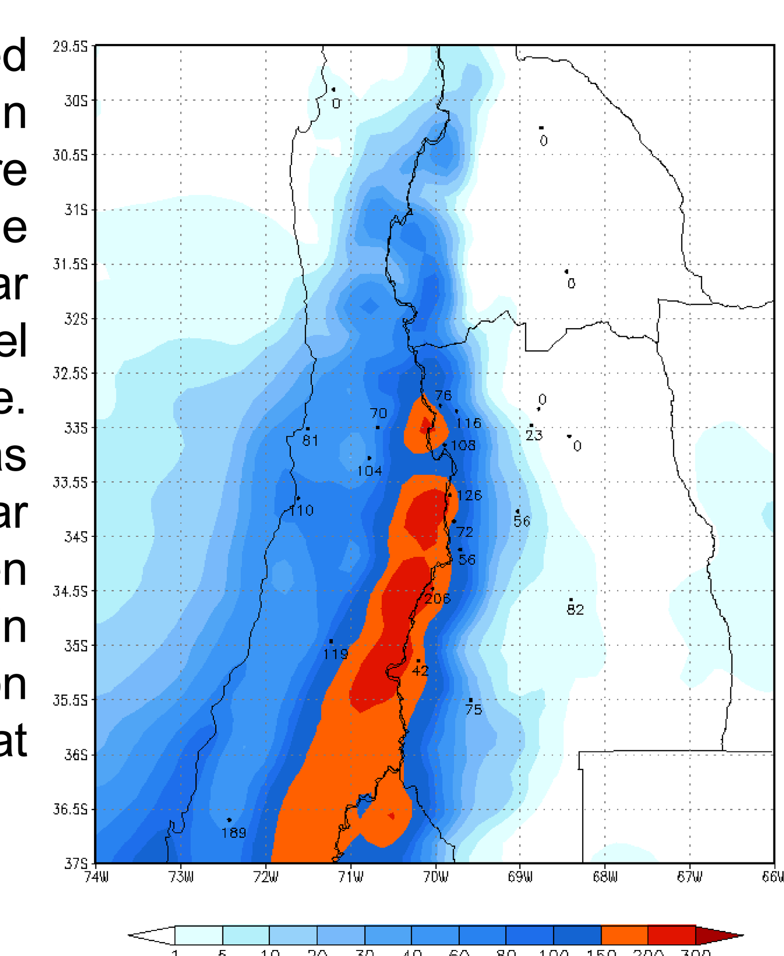

Figure 5: Storm-Total precipitation 96-h forecasted (shaded in mm) for the Eta/PRM model from 1200 UTC 25 Aug through 1200 UTC 29 Aug 2005. The numbers at the • locations indicate the percent of observed precipitations.

5. CONCLUDING REMARKS

The precipitation windward of the Andes was realistically simulated by 15-km Eta-PRM and was able to forecast Zonda wind on leeward. Nevertheless, this had some difficulties over both sides of the Andes capturing lower magnitude of 10-m wind and 2-m dewpoint temperature, larger 2-m temperature daily range, and the cold fronts passages nearly six-hour later. The spatial model precipitation simulated has maximum upstream of the high crest and a very large zonal precipitation gradient downstream showing the great barrier blocking effect.

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