DIAGNOSIS AND SENSITIVITY STUDY OF TWO SEVERE STORM EVENTS IN THE SOUTHEASTERN ANDES

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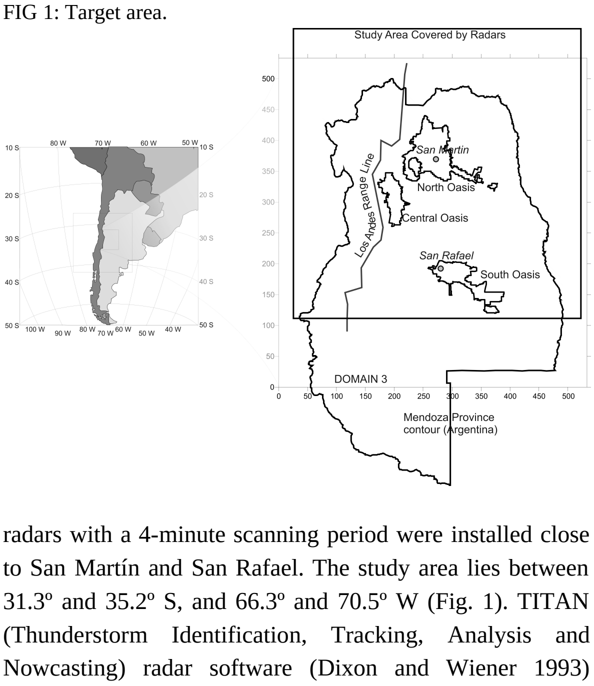
I. INTRODUCTION

Two cases of severe precipitation and hail have been studied by means of a set of mesoscale numerical simulations using the Pennsylvania State University-National Center for Atmospheric Research model. These events were caused by two convective systems developing during 23-24 December 2004 and 4-5 January 2005 over the province of Mendoza (Argentina) over the eastern Andes.

Mendoza lies approximately between 32º and 36º S, next to the highest peaks of the Andes (the Aconcagua, with 6,960 m, among them), and with the Chilean border to the west. The province of Mendoza, Argentina, is one of the parts of the world with the highest frequency of severe weather events (Zipser et al., 2006). In the past 15 years the convective activity in the region has been observed and recorded by two MRL5 S-band radars. Two MRL5 S-band radars with a 4-minute scanning period were installed close to San Martín and San Rafael. The study area lies between 31.3º and 35.2º S, and 66.3º and 70.5º W (Fig. 1). TITAN (Thunderstorm Identification, Tracking, Analysis and Nowcasting) radar software (Dixon and Wiener 1993) provided images of the storms with a spatial resolution of 1x1x1 km^3. A dense hailpad network spreads over the three oases.

FIG 1: Target area.



II. PRESENTATION OF RESEARCH

The maximum precipitation estimated by S-band radars was over 100 mm in both cases in an interval of 10 h and the hailpads in the study zone registered severe hail with a diameter of up to 3 cm.

The synoptic patterns were similar in both cases. The arrival of a trough from the west (crossing the border with Chile) and the quasi-stationary high pressures over the Pacific and the Atlantic Oceans outlined a favorable environment for the development of convection on the lee side of the Andes. The high diurnal temperatures and the topography of the area favored the formation of thermal mesolows on the lee side of the Andes

From a dynamic point of view, a favorable synoptic environment is needed so that the mesoscalar mechanisms triggering convection can sustain the storm activity. One dynamic structure that is commonly observed in periods with the most intense convective activity in the study zone is the presence of an upper-level subtropical jet stream in association with a trough entering from the Pacific with negative thermal advection. Additionally, this situation tends to co-occur with a northern low-level jet from the Amazon basin, which supplies moist air. This synoptic structure is present in most of the situations that cause intense precipitation, occasionally including severe hail phenomena, and it was also observed in the two severe convective events described in this study.

The events were numerically simulated using the non-hydrostatic version of the Pennsylvania State University-National Center for Atmospheric Research Mesoscale Model MM5v3 (Dudhia 1993; Grell et al. 1995).

The multiple-nest capability of the model, with two-way interaction between successive nesting levels (Zhang et al. 1986), has been used in order to capture the synoptic-scale evolution and the mesoscale features of the episodes with manageable computational cost.

As for the time covered by the experiments, a 30-h long simulation was performed for each case study, from 0000 UTC (case study 1: 23 December 2004; case study 2: 4 January 2005) to 0600 UTC (case study 1: 24 December 2004; case study 2: 5 January 2005) to ensure a stable behavior of the model during the convective events.

The cumulus parameterization for the two larger domains was the Kain-Fritsch 2 (Kain 2002) scheme. The parameterization scheme used to represent the planetary boundary-layer physics was the MRF scheme (Hong and Pan 1996). The explicit moisture scheme used was the Goddard microphysics scheme (Lin et al. 1983; Tao et al. 1989, Tao and Simpson 1993) including the formulation for the prediction of graupel.

On top of the two control runs, a sensitivity experiment, using the factor-separation technique (Stein and Alpert 1993), was carried out for each case study in order to determine the quantitative effect of different factors, such as topography and solar radiation on the accumulated precipitation field in the two deep convection events.

III. RESULTS AND CONCLUSIONS

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The synoptic structures were described by the control runs. In both case studies was observed the formation of thermal mesolows on the lee side of the Andes in the study area. The low-level wind from the anticyclonic circulation on the Atlantic Ocean supplied warm and moist air. This flow impinged on the mountain barrier favoring the rise of warm air. The cold advection associated with the Pacific trough enhanced the formation of areas with convective instability in the study area. The combined action of the low-level flux and the cold advection generated a convergence line in the south that further contributed to creating favorable conditions for the development of convection**.**

The results of the study reveal that the most important factor involved in the triggering mechanisms is the topography of the area, even though the precipitation induced by this factor is located in different areas from the ones that have actually been affected, according to the radars. The synergic effect of the two factors explains the spatial distribution of the precipitation, as well as the identification of the areas with maximum precipitation registered by the radars. In addition, these two factors have an inhibiting effect on a strip of land parallel to the Andes, west of the affected areas.

IV. AKNOWLEDGMENTS

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