THE ROLE OF THE LOW LEVEL JET IN A FLASH FLOOD EVENT OVER CENTRAL ARGENTINA

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I. INTRODUCTION

Flash flood events occur within minutes or hours of excessive rainfall, this kind of events can destroy buildings and triggers catastrophic situations due to sudden water stream. The central region of Argentina presents a flat terrain with a weak slope to the Atlantic Ocean. March 26 to April 1, 2007 was a week characterized by the presence of successive convective systems over central Argentina that generate strong rain rates, flooding large areas and producing important damages and lost of lives.

A primary goal of the present work is to describe the synoptic and mesoscale characteristics of the environment associated to a flash flood case over the central region of Argentina, with a special emphasis in the relationship between the behaviour of convective precipitation and the evolution of the low level jet. In order to achieve this objective a numerical simulation is performed considering a version of the Brazilian Regional Atmospheric Modeling System (BRAMS), that include a microphysics scheme and explicit convection in the finest resolution grid and estimations of precipitation.

II.DATA

The evolution of the successive mesoscale convective systems (MCSs) that affect the area of interest and their impact on precipitation rain rates have been studied considering satellite images every half hour and 4km-resolution and satellite estimation every one hour and 8km-resolution.

In order to evaluate the evolution and life cycle of different convective systems that impact over central Argentina, a clusterization and tracking technique called ForTraCC (Vila et al 2008) are employed to determine the life-cycle of each system considering two temperature thresholds 235 and 218 K. 235 K was considered to determine the contour of the rain area and 218 K was considered in order to follow areas associated with deep convection.

CMORPH information is considered in order to determine stratiform and convective precipitation regions, this estimation is considered due to the lack of radar observations and hourly precipitation information over the area. 235 K contour in IR images is used as a threshold to identify the precipitation areas associated with each system. Then stratiform and convective areas are differentiated considering the threshold of 7.5 mm hour-1 suggested by Mc Annelly and Cotton (1989) using CMORPH. Areas with values higher than 7.5 mm hour-1 are considered as convective and areas with values lower than this threshold are denoted as stratiform, all precipitation regions must be contained by a 235 K contour.

This case study was simulated with BRAMS. It is a regional non-hydrostatic, primitive equation model, formulated with an interactive multi-scale grids nesting capability. A complete and general description of the model can be found at Cotton et al (2003). Version used in this experiment includes several improvements from the original one. It includes a shaved ETA vertical coordinate, making it suitable to use in steep topographies as the Andes Mountains (Tremback and Walko, 2004). It also includes a shallow cumulus parameterization (Souza and Silva 2002) that complements the Grell cumulus scheme for deep convection (Grell and Devenyi, 2002). BRAMS model was applied in the region to simulated different mesoscale phenomena and results shows that it satisfactorily represents the observed conditions (Salio et al, 2006; Saulo et al, 2007; Nicolini et al, 2005a and Nicolini et al, 2005b).

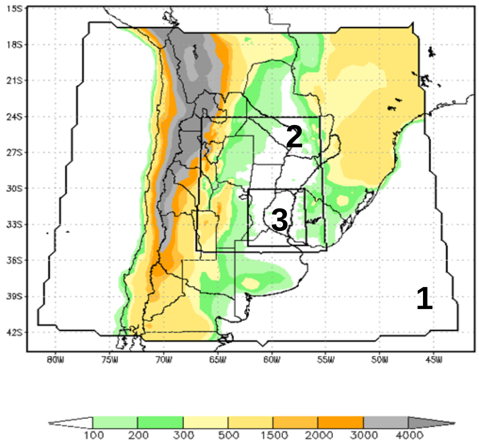

Figure 1: BRAMS nested domains considered in the simulation.

To simulate this case study a 156 hours simulation was performed starting at 12 UTC March 25, 2007. Outputs were extracted every 3 hours. Global Data Assimilation System (GDAS) analyses from National Oceanic and Atmospheric Administration/ National Center of Enviromental Prediction (NOAA/NCEP) were used as initial and boundary conditions. Numerical experiment was configured with three nested domains, with an increasing horizontal resolution of 50, 12.5 and 3.125 km. Geographical location of nested domains is shown in figure 1. Grell cumulus parameterization and shallow convection scheme were only activated in the lower resolution grid. It was used the “bulk water” scheme for the microphysical representation in all grids. Shaved eta vertical coordinate was applied and the model was configured with 30 atmospheric and 9 soil vertical levels, including topography data (1km resolution), terrain land use (1km resolution), soil types (50km resolution) and weekly sea surface temperatures.

III. RESULTS AND CONCLUSIONS

Mesoscale convective activity from March 26 shows that all systems tend to generate during the beginning of the night and decay during the day (Figure 2). The maximum extension of the systems varies from small systems to the bigger one on March 29 at 8Z that cover all area, and shows also developments over northwestern Argentina. Most extreme rainfall producer systems area detected on March 26 and 31 with maximum rates close to 12 UTC. Strong convective rates are detected at these times, these rates overpass by three times the total stratiform precipitation generated by the systems. Systems during the rest of the period present an equivalent total stratiform and convective precipitation but, in general, convective maximum precipitation occurs before the stratiform precipitation.

Convection generated before March 26 are principally associated with stratiform precipitation over the whole area, but this situation evidences potential conditions of soil saturation over the flat terrain of central Argentina.

The thermodynamic environment is characterized by strong CAPE, low CINE and the presence of a deep flow from the north that shows a low level jet (LLJ) profile. These environmental features present the ideal conditions to the formation of convection, because they establish a favorable situation associated with large-scale vertical ascent and potential instability over the area.

Preceding the clear development of convective precipitation rates the northerly ageostrophic wind tends to increase denoting an interaction between the incipient development of convection and the intensification of the circulation directed toward the storm.

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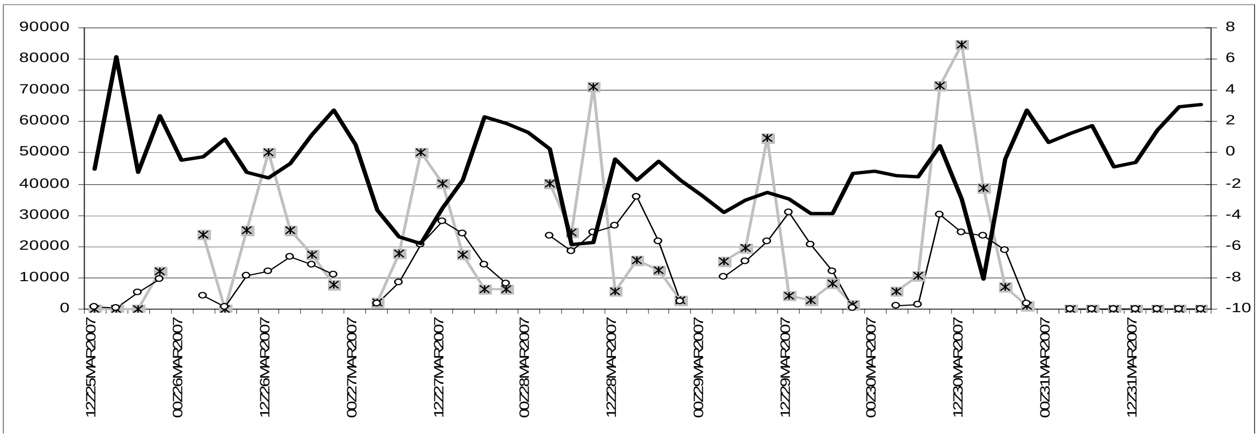

Figure 2: Evolution of ageostrophic wind at 32 ºS averaged between 58 and 62ºW (solid black line), convective precipitation (grey with black asterix) and stratiform precipitation (thin black line with open circle).

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