ROLE OF THE MICROPHYSICS FOR A CONVECTIVE EVENT IN THE PO VALLEY: COSMO-MODEL AND MM5 HIGH RESOLUTION SIMULATIONS

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I. INTRODUCTION

Numerical weather forecast of severe weather has received an increasing attention in the hydro-meteorological community. Therefore, in order to be able to reproduce the mechanisms involved in this processes a numerical meteorological model has to be non-hydrostatic. Recent studies highlighted the main role played by the microphysical parameterization at high resolution in correctly forecasting convective structure too.

II. PRESENTATION OF RESEARCH

On 20 May 2003 a cold front, arriving from North-West and moving across the Alps, caused a deep convective event in the east side of the Po Valley (Italy). A hailstorm developed at 16.30 UTC along an ideal axis connecting the two-radar system; the storm was characterized by high values of reflectivity (50–60 dBZ), it was localized at about 55–60 km from S.Pietro Capofiume (SPC) and 30–35 km from Gattatico (GAT). The distance between the two radars is about 90 km, and a sounding station is operative close to SPC and it is used for inferring the thermodynamic structure of the observed atmosphere. The thermodynamic and dynamic processes of a hailstorm event are driven by intercept parameter of drop size distribution, density of graupel, a and b parameters included in terminal velocity described as $\mathbf{v(D)=a*D^b}$. To aim of investigating the role of graupel composition a few sensitivity tests are performed using different settings for ρ, N, a, and b (Table I) to reproduce the range from graupel to hail hydrometeors, for both COSMO-LAMI and MM5.

Setting	ρG (g/cm3)	NG0 (m-4)	a[cm(1-b)*s-1]	b
1	0.2	4*104	442	0.89
2	0.2	4*105	442	0.89
3	0.2	4*106	442	0.89
4	0.4	4*104	93.35	0.50
5	0.4	4*105	93.35	0.50
6	0.4	4*106	93.35	0.50
7	0.9	4*104	140.03	0.50
8	0.9	4*105	140.03	0.50
9	0.9	4*106	140.03	0.50

TABLE I: Different settings for ρ, N, a, and b .

MM5 is the nonhydrostatic limited area model developed by Pennsylvania State University and National Center for Atmospheric Research (PSU/NCAR) (Grell et al., 1994, Dudhia, 1993). It has been run in the following configuration: 33 vertical levels, 100 mbar of top pressure, four nested domains with a grid resolution of 27, 9, 3 and 1 km respectively, Kain-Fritsch for cumulus parameterization, MRF scheme for planetary boundary layer and Reisner 2 microphysical parameterization which adds supercooled water to liquid water, rain, ice, graupel and snow allowing slow melting of snow [Reisner et al. 1998].

Similarly the COSMO-LAMI, operationally managed by ARPA–SIM (the regional HydroMeteorological Service of Emilia-Romagna) since 2001 (in the framework of an agreement among UGM (Ufficio Generale di Meteorologia), ARPA–SIM and ARPA–Piemonte), is formulated using the primitive hydro-thermodynamic equations describing compressible nonhydrostatic flow in a moist atmosphere without any scale approximation (Elementi et al., 2005; Diomede et al., 2006). The prognostic model variables are the wind vector, temperature, pressure perturbation, specific humidity, cloud water, cloud ice, rain, snow and graupel sedimentation fluxes. For the comparison among models output, radar and rain gauge network, the high resolution domain (1 km) has been used.

The models have been run in the same configuration, with a special attention to boundary conditions and microphysical parameterizations.

III. RESULTS AND CONCLUSIONS

The 3 hours accumulated precipitation for the chosen configuration (setting 7) is compared with radar and rain gauge data for two different periods: 15-18 UTC (P1) and 18-21 UTC (P2). The results clearly show an underestimation of rainfall for MM5 during P1 with respect to both the pluviometer and radar observations, whereas COSMO-LAMI clearly overestimates the observations. On the following time interval (18-21 UTC) a good agreement is found between MM5 and the pluviometers especially in the south side, but it barely reproduces the two rain bands observed by radars. COSMO-LAMI still overestimates the rainfall but clearly identifies the two rain bands observed by the radars, even if they are misplaced. The previous results clearly indicate shortcomings for both models in the timing of the events. The delay can be better investigated by analyzing the hail content as will be shown next, and rain rate as will be done in a future work. This comparison clearly shows models failure in reproducing the rainfall, but if the comparison is performed using the hail distribution, beside the time delay, both models clearly show a good ability in reproducing the hail storm for both location and amount. Moreover, good models ability is found in reproducing either the structure of the convective cells and the different hydrometeors distribution. The hail models production at 18.00UTC is now analyzed to better identify the time delay. The models hail content at the surface, beside the time delay, clearly shows a good ability in reproducing the hail storm for both location and amount. The comparison between the hail content as estimated by the radar at 16.34 UTC and the models clearly shows that MM5 and COSMO-LAMI are both able to reproduce the hail storm with a delay of 1.5 hour for MM5 and for COSMO-LAMI. Moreover, the MM5 maximum amount of graupel and its location agree perfectly with the radar, whereas COSMO-LAMI produces a more widespread distribution and an overestimation of the graupel amount.

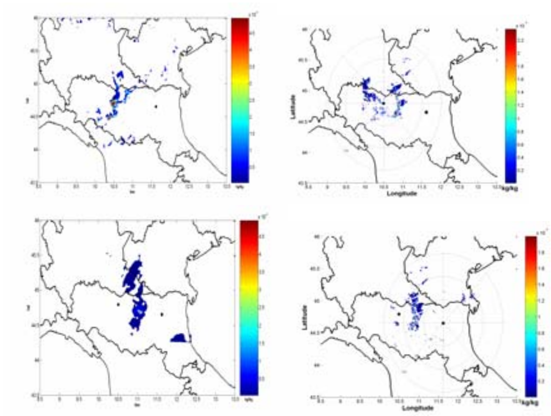

FIG. 1: ground level graupel mixing ratio from MM5 and COSMO-LAMI at 1 km (left), 18 UTC, 20 may 2003, and PPI map at the elevation of 0.5° at 16.34 UTC for GAT and SPC (right) :Estimated water content for each hydrometeor class.

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