The Valcanale flash-flood: an event beyond the current capabilities of operational numerical models

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I. INTRODUCTION

In the afternoon of 29th August 2003 a flash flood occurred in Valcanale (Northeastern Italy, nearly on the border between Italy, Austria and Slovenia). 380 mm of rain were observed at Pontebba in four hours but even higher values were observed in the same area through radar estimates. This flash flood, produced by stationary thunderstorms, caused severe damages to the villages of Ugovizza and Pietratagliata both because of the land slides and of the rivers run-off due to the high rain rates. Two casualties occurred during this event and the viability of the area was severely compromised for several months. This event was poorly foreseen by operational numerical models (both global and local), in fact all the available runs pointed out the Prealpine area as the most interest to precipitations and the inner alpine zone, according to those runs, had to be only partially interested by rain. The vice-versa occurred. Moreover the foreseen amounts of rain, even if misplaced, were only barely comparable to the observed ones.

II. SENSITIVITY RUNS OF THE WRF NUMERICAL MODEL

The aim of this work is that of use the ARW-WRF non hydrostatic numerical model (version 2.2.x) to reproduce as correctly as possible the event, looking for: *i)* the reasons of the partial failure of the operational numerical models; *ii)* the reasons of the stationary of deep moist convection (hereafter DMC).

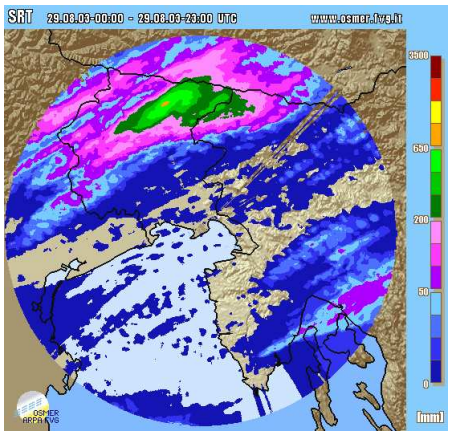

FIG. 1: Radar rain estimate of the Valcanale flash flood.

A. Parametrized convection

Several runs initialized through the ECMWF global operational model have been carried out at different resolutions (50, 10, 5 km), with different orographic representations and with different microphysical parametrizations and using the classical Kain-Fritsh convective parametrization. Even if the average rain amount produced by the numerical model increases essentially with the increasing of resolution, the precipitation peaks are always misplaced and the Prealpine area is always the most interest by precipitation. This common behaviour of all the runs is ascribed to the parametrization of DMC which has a double negative effect: 1) it produces high amounts of rain because of the particular sensitivity to the orographic lifting; 2) it dries the southerly flows damping the onset of DMC in the inner part of Alps. The best results in terms of correct positioning of rain maxima, even if not satisfactory, are those obtained with a six components microphysics and this is ascribed to the enhancement of advective effects related to the more detailed description of precipitation.

B. Explicit convection

The best results in terms of the event description are those obtained through the non hydrostatic simulations (Gladich *et al.*, 2007) carried out with a 2 km grid step and an explicit DMC. The spatial distribution of the rain amount is better represented when compared to observations even if some slight displacements remain.

A better description in terms of spatial distribution of rain amounts is obtained increasing the numerical model orography by a factor 1.2 (see figure 3). Even if correctly represented, the high amounts observed can not be reproduced neither with the resolved DMC at the 2.0 km resolution, being the reproduced rain amount lower than that observed nearly by a factor 4.

Sensitivity runs carried out looking for the reasons of stationarity of DMC show that a fundamental ingredient is a relatively dry layer (low relative humidity) near to

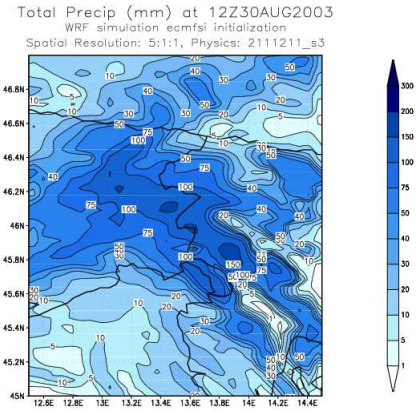

FIG. 2: Valcanale flash flood event as reproduced by the 5 km resolution run.

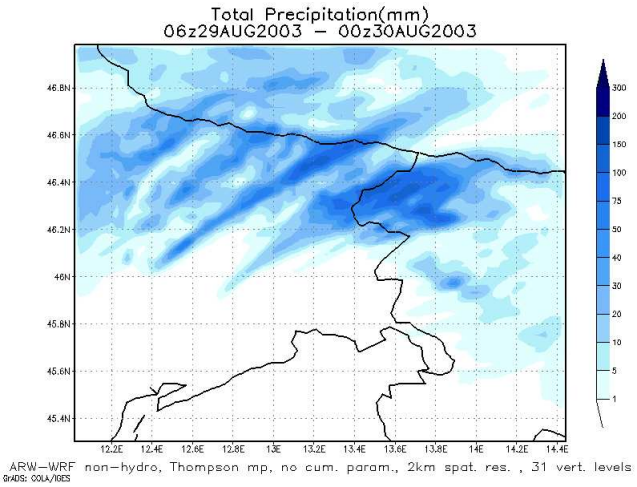

FIG. 3: Valcanale flash flood event as reproduced by the 2 km resolution run with explicit convection

the ground. Because of this dry layer the DMC onset can take place only when triggered by the relieves through their interaction with the southwesterly flow. In other words the DMC onset can take place only in the upwind side of the largest and tallest mountains, then DMC is advected toward the same direction because of the stationarity of the upper air flow. When relative humidity is increased, then even if the onset of DMC takes place on the same point of the relieves, DMC is not merely advected by the mean upper level flow but it propagates eastward interesting a wider area.

III. RESULTS AND CONCLUSIONS

Sensitivity runs of the WRF numerical model devoted to increase the comprehension of the Valcanale flash flood show that this event can not be reproduced correctly in terms of spatial distribution with a parametrized convection but it can be described only through a fully dynamical description of convection. The stationarity of DMC, strictly connected with orography, is related to the existence of a relatively dry layer near to the ground (correctly foreseen even by the available operational numerical models). The increasing of relative humidity in the lower levels induces the eastward propagation of DMC which does not insist in the same position, then distributing the impact of the flash flood on a larger area.

IV. AKNOWLEDGMENTS

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V. REFERENCES

Gladich I., Furlan G., Giaiotti D. B., Stel F., 2007: Non hydrostatic effects in the interaction between flows and topography. Submitted to J. Fluid. Mech.