A RIGHT FLANK SUPERCELL IN ROMAGNA; SPLITTING STORM SYSTEM CASE STUDY

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I. INTRODUCTION

During the afternoon of July 21, 2008, most of the foothills, flatlands, and coast of the region of Romagna were subjected to particularly intense severe weather conditions with at least four heavy hailstorms of which at least two were of the highest level with large hailstones (more than 5 centimeters in diameter).

Furthermore, two supercell systems developed - one over the Ravenna area during the early afternoon and a second one over the Rimini area a few hours later - giving rise to one ofthemost significant severe weather outbreaks to have occurred over the past 5 years. The objective of this case-study was to seek the main triggering factors of such atmospheric violence through the-analysis of high-resolution, non-hydrostatic models with explicit calculation.

More specifically, there was the onset of a "splitting storm" from unidirectional environmental windshear during the early afternoon over the Ravenna area, with the development of a right flank supercell system over the eastern plains and coastline (where the maximum damage was recorded). The mesoscale interactions between mid-high troposphere atlantic trough, dry katabatic flows of orographic origins (Apennine and Alpine), very hot and, above all, humid maritime currents entering the Adriatic basin (Adriatic LLJ), and very hot inert air present in the Po River Valley, gave rise, in a pre-frontal or frontal setting, to several episodes of notable violence, very often triggered in the context of an orographic dry-line, as punctually occurred under these circumstances.

II. ANALYSIS OF ENVIRONMENTAL CONDITIONS AND OPERATIONAL MODEL OUTPUT

We consider the sum of the dynamics to now in the high, mid, and low tropospheres with many model output, its seems clear that the situation was heading towards the intense production of storm activity, particularly over eastern Emilia, northern Romagna and Marche, and that it could be summarised as follows:

• Entry of the polar jet-effect wind in correspondence to the Alpine arc with high wind magnitude values in the high troposphere and a strong effective divergence on the ascending branch of the jet itself, aimed at identifying the intense vertical motions of a dynamic nature. Although the jet core does not directly involve the region, the velocity still reached between 60 and 70 knots.

• Distinctly cyclonic winds from WSW leaving a trough over France and heading ESE in mid troposphere, with a strong horizontal thermal gradient forming between the Alpine arc and regions of central Italy causing rapid cold advection and the transport of positive vorticity, especially over the Triveneto and Romagna regions.

• In mid-low troposphere (isobaric surface 700 hPa), two dry intrusions entered from the western quadrants, one of Alpine orographic origins over the Po valley and evolving ESE, and a second entering over Tuscany and the northern Apennine arc across the Ligurian Gulf with a WSW-ENE trajectory. These dry intrusions favoured the onset of dry-lines in the Apennines and south of the Po River Valley that tended to lift the existing unstable and more humid air, especially on the lower isobaric levels, over the Romagna region; making the situation a typical environmental indicator of strong storm episodes.

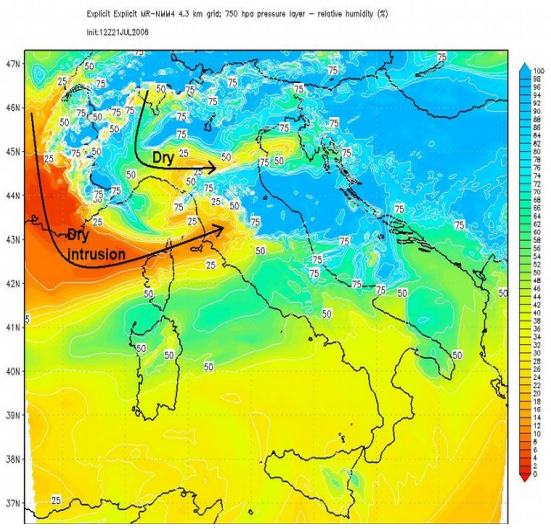

FIG. 1: Mteteocenter NMM 4km (explicit convection); 700 hpa dry intrusion

• The entry of unstable cold currents from the NE, first over the Triveneto region and then over eastern Emilia and Romagna; such currents eventually converged with warmer south-western flows arriving from Tuscany and the Apennine ridge in proximity to coastal areas and the Romagna inland, and initially with weak very humid currents rising from ESE of the mid- Adriatic to establish a somewhat favourable status of directional windshear between the low and mid troposphere (clockwise hodograph).

• Frontogenesis near the ground with ongoing undulations triggered by the closure of the baric low over the Ligurian Gulf downwind of the Alpine chain and as a consequence of the airshed of cold polar maritime air across central Europe and France. The undulation included the region of Romagna in the warm system with the cold front advancing from the W over the Ligurian Gulf, Corsica, and upper Tuscany, and

a warm active branch N of the course of the Po River.

In addition to the conditions already verified previously, other thermodynamic and convective parameters capable of justifying the escalation of events that will characterise the afternoon of the 21st were reviewed.

First of all, high CAPE (Convective Available Potential Energy) values induced by the presence of very humid air and unstable air were found at low altitudes over the Romagna sector. Somewhat significant values, well over 2000 J/kg, were recorded as soon as the early afternoon over much of the Romagna region, particularly over the belt of the inland plain, the Ravenna and Rimini coasts, and the surrounding plains as well.

During the late afternoon, the situation did not change much, and only towards sunset, with the advance of the dry intrusion even in the lower levels, did the CAPE high migrate to the confines between southern Romagna and Marche where, not by chance, other intense convective systems were developing, including a second supercell.

Other convective parameters or indexes of stability contributed to painting an overall picture that could lead to severe events in the area in question; in fact, even the correlated analyses of K values (Whiting index) and TT (Total Totals index) indicated highly favourable conditions.

Even the Lifted index and SWEAT (Severe Weather Threat) indicated conditions favourable to severe storm activity, with the LI reaching values of -5°C and the SWEAT in the 500s. In particular, the latter index denotes environmental windshear conditions highly inclined to triggering convective systems of a supercell nature and highly indicative of vortical phenomena.

Windshear values favourable to the genesis of supercell storms can also be deduced through the use of hodographic tracking according to the radiosonde planned to be carried out at 14z on the 21st via explicit model with domain at a resolution of 2 km (NNM MeteoCenter), as reported below (clockwise hodograph).

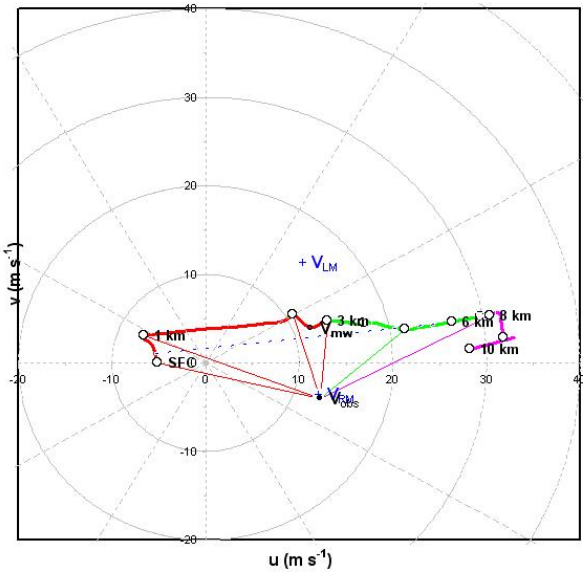

FIG. 2: Mteteocenter NMM 2km (explicit convection); derived hodograph 14z 21/7/2008

III. RESULTS AND CONCLUSIONS

The analysis by means of numerical hi-res models over a limited area (Explicit NMM model 2 and 4 km), especially by exploiting explicit resolution of the dynamics inherent in PBL and convection, has confirmed highly reliable skills in relation to the event. Even the mesocale magnitude and evolution of convective parameters (stability indexes), of environmental windshear and low level moisture convergence, which are strongly influenced by the interaction between reliefs, the Adriatic Sea and the Po River Valley according to prevailing currents in the low tropospheric layers, have provided highly interesting indications under these circumstances.

IV. AKNOWLEDGMENTS

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