SIMULATING A STATIONARY DEEP CONVECTIVE STORM USING AN ATMOSPHERIC REGIONAL MODEL: A V – SHAPE CASE STUDY

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I. INTRODUCTION

Among all precipitating systems in the Mediterranean basin, deep convective storms are of particular interest because of their potential damaging power. Stationary represents one of the most important dynamical characteristic as it is responsible of large rainfall amount and can produce casualties and hazards. Such specific dynamical feature is the consequence of interaction between large and local scale atmospheric circulation. Thus it is quite difficult to reproduce with numerical models as both dynamical and thermo – dynamical description must be well simulated Krichak and Levin (2000).

During December 4, 2004, over the Tyrrhenian sea, between Corsica island and Italy a stationary long live severe convective storms developed. It lasted over 8 hours, producing heavy rains even far from the convective downdraft areas and intense wind speed. Over the anvil cloud top a so called V – shape ice plumes was observed. This unusual cloud top feature is composed of very small ice particles with a very high 3.9μm reflectivity values, as observed and modelled by Melani et al. (2003a, b)

In this work we present a numerical modelling simulation for this severe storm along with its comparison with satellite observations.

II. PRESENTATION OF RESEARCH

The The Regional Atmospheric Modeling System, RAMS, has been used operationally at La.M.M.A. (http://www.lamma.rete.toscana.it) and National Research Council (http://www.ibimet.cnr.it) since 1999. The latest RAMS version, 6.0, is used for this study as modelling component Meneguzzo et al. (2004), Soderman et al. (2003), Pasqui et al. (2005)). A general description of the model can be found in Pielke et al. (1992), while a technical description can be found on the ATMET web site (http://www.atmet.com).

Today RAMS represents one of the state-of-the-art model in atmospheric science and it is continuously improved on the basis of a multi-disciplinary work. The physical package of the model describes a number of atmospheric effects: a two-way interactive nested grid structure, an atmospheric turbulent diffusion processes according with the Mellor-Yamada scheme, a cloud microphysics parameterization (Walko et al., 1995, Meyers et al., 1997), modified Kain-Fritsch type cumulus parameterization, the Harrington radiative transfer parameterization short and long wave scheme and the Land Ecosystem Atmosphere Feedback scheme (LEAF-3) for soil – vegetation – atmosphere energy and moisture exchanges, described in Walko et al. (2000).

An interesting case study is analysed in this work: a severe convective events December 4, 2004 between Corsica and Italy, over the Tyrrhenian sea. In a south – westerly flow a single convective system lived approximately from 2:00 to 23:00 UTC, forced by flow instabilities around the Corsica island. During its mature stage its anvil top reaches -67.5 °C and V – shape features appeared over the cloud top (Fig.1, Fig.2). Heavy rain and strong surface wind was observed up to 8 hours, during its stationary phase over sea. Finally, the convective storm died and the associated instabilities, now embedded in the mean south westerly flow, produced a squall line system over the Tuscany south coast causing floods and, consequently, damages as shown by the lighting map in Fig.3.

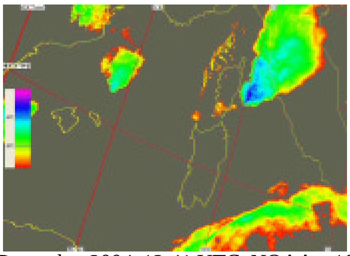

FIG. 1: 4 December 2004, 12:41 UTC. NOAA – 16 AVHRR channel 4 image of the cloud top temperature.

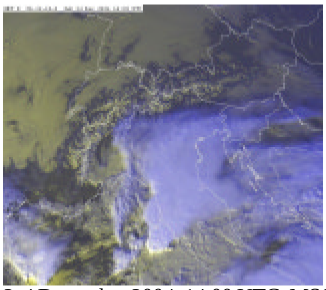

FIG. 2: 4 December 2004, 14:00 UTC. MSG – 1 SEVIRI HRV image of the cloud top reflectance.

Using the RAMS model, a simulation for this severe convective event was performed at very high horizontal and vertical resolution, 2km grid spacing and a stretched vertical spacing (from 22m, near surface, to 1200m, in the troposphere). The atmospheric forcing was provided by the NCEP – NCAR Reanalysis 6 – hours dataset. Observed sea surface temperature (SST) from MODIS was used in order to provide a good description of vapour exchanges between sea and atmosphere. A nested grid approach: a 32 – 8 – 2 horizontal resolution grids was adopted in order to guarantee the proper description of large to local scale dynamics features.

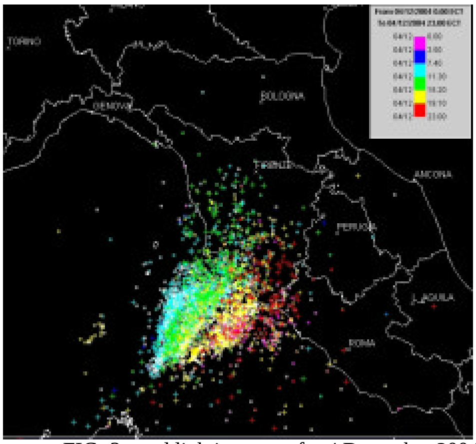

FIG. 3: total lightings map for 4 December 2004.

III. RESULTS AND CONCLUSIONS

As shown in many previous papers and study RAMS model provides a full comprehensive simulation system which is able to represent atmospheric evolution of such a severe convective systems. In particular, using the detailed parameterisation scheme for cloud microphysics dynamics, it reproduce quite accurately the main feature of this convective storm. In particular location, cloud top properties (skin temperature and shape) and rainfall amount was well represented. The stationary phase was reproduce, even if its duration was shorter than the observed one.

FIG. 5: Total cloud (blu) and ice (white) particle concentration produce by RAMS, at 14:00 UTC, December 4, 2004.

IV. AKNOWLEDGMENTS

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