Analysis of a stationary deep convective storm: detecting a V – Shape feature through GEO-LEO satellites

S. Melani[1,2], M. Pasqui[1,2], V. Levizzani[3], A Ortolani[1,2], A. Antonini[1,4]

[1] Laboratory for Meteorology and Environmental Modelling (LaMMA), via Madonna del Piano 10, Sesto Fiorentino, Florence, I-50019. E-mail: melani@lamma.rete.toscana.it
[2] Institute of Biometeorology, National Council of Research (IBIMET-CNR), via G. Caproni 5, Florence, I-50145
[3] Institute of Atmospheric Science and Climate, National Council of Research (ISAC-CNR), via Gobetti 101, Bologna, I-40129
[4] Hydrological Service of Tuscany Region, via S. Gallo 34, Florence, I-50129

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I. INTRODUCTION

Significant cloud top features, as plumes of small ice particles, have been observed (Setvák and Doswell, 1991; Levizzani and Setvák, 1996) and modelled (Melani et al. 2003a, 2003b; Wang, 2003) through polar-orbiting (NOAA-AVHRR, MODIS) instruments, taking advantage of their high spatial resolution.

Against the poor refresh time of polar satellites, the enhanced high temporal sampling, and the new spectral channels of the last generation of geostationary satellites open up new possibilities to insight into the physics of these deep convective storms, and enable the study of the evolution of their cloud top structures.

A severe deep convective storm, located between Corsica and Tuscany coasts, has been analyzed for its stationary long-lived characteristics. In its mature stage, this storm has clearly revealed on its anvil top enhanced V-shape features, whose presence is a good marker of severe weather conditions (Negri, 1982; Heymsfield et al., 1983; McCann, 1983).

Taking advantage of the high temporal repeat cycle (every 15 minutes) of the MSG satellite and the high spatial resolution (from 250 m to 1.1 km) of MODIS and NOAA-AVHRR satellites, we have investigated the storm physics and given an insight into the different stages of the cloud evolving system.

II. PRESENTATION OF RESEARCH

On December 4th, 2004, a deep stationary convective storm has token place in the Tyrrhenian sea, between Corsica and Tuscany coasts, lasting approximately from 02:00 to 23:00 UTC. Forced by flow instabilities around Corsica, the storm has produced heavy precipitation and intense gust fronts, on its anvil top forming a V-shape feature with brightness temperatures colder than -65°C (see Figure 1) and very high reflectivity values in its mature stage (see Figure 2).

The combination of GEO and LEO satellite observations presents the clear advantage of the complementarity of information, high temporal resolution from one side, high spatial resolution on the other.

In this research, we have thus investigated storm top properties, analyzing either its scattering properties by means of bidirectional reflectance factor in the visible (VIS) channels, or emission properties through brightness temperatures in the water vapour (WV) and infrared (IR) channels.

Further, we have also addressed the task to study in details the different phases of the convective storm, from the growing to the dissipating stage, through the 15 minutes cloud system sequences of MSG satellite.

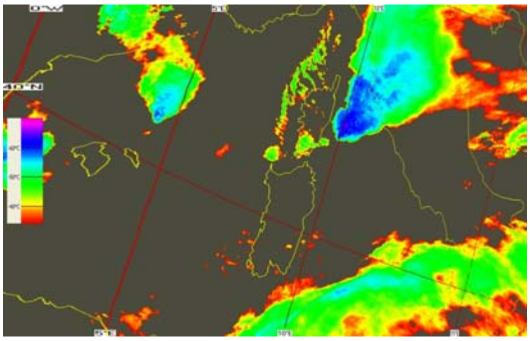

FIG. 1: 04 December 2004, 12:40 UTC. NOAA-16 AVHRR channel 4 (10.3-11.3 μm) image of cloud top temperature.

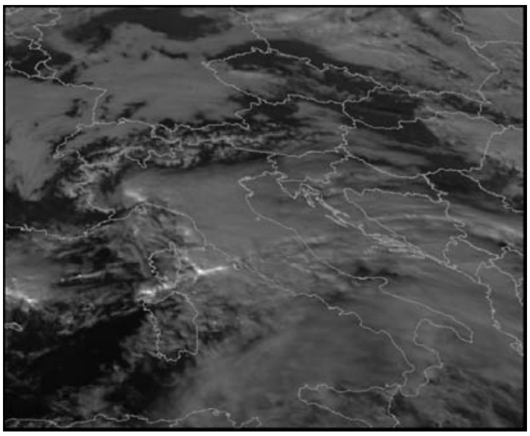

FIG. 2: 04 December 2004, 12:45 UTC. MSG-1 SEVIRI channel 2 (0.6-1.1 μm) image of cloud top reflectance.

III. RESULTS AND CONCLUSIONS

The synergy between GEO and LEO satellite observations has allowed to achieve a comprehensive insight into storm top physics, the GEO satellite resolving the lack of dynamical information of convective storm evolution, between two consecutive LEO passages.

Further investigations are needed to better understand the mechanism of plumes formation, even using a numerical modelling system, being of matter of our next research and publication.

IV. AKNOWLEDGMENTS

The archived NOAA-AVHRR overpasses have been obtained from the Satellite Active Archive (SAA), EOS MODIS AQUA and TERRA overpasses from the GODDARD Space Flight Centre (GSFC) Distributed Active Archive Centre (DAAC), and the MSG-1 overpasses from the EUMETSAT on-line Archive.

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