AN OBSERVATIONAL DESCRIPTION OF A TORNADIC SEVERE WEATHER EVENT

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I. INTRODUCTION

This study presents an analysis of a severe weather case study that took place during the early morning of the 2nd of November 2008, when intense convective activity associated to a rapidly evolving low pressure system affected the southern coast of Catalonia (NE Spain).

The synoptic framework was dominated by an extended upper level trough and an associated surface frontal system extending from Southern Spain along the Mediterranean coast of the Iberian Peninsula to SE France, which moved north-eastward. A low pressure area in the eastern coast of the Iberian Peninsula intensified from 00 to 06 UTC (Fig. 1). South-easterly winds in the north of the Balearic Islands and the coast of Catalonia favoured high values of 0-3 km storm relative helicity (about 300 m^{2}s^{-2}) which combined with moderate MLCAPE values (750-1000 J kg^{-1}) and high shear favoured the conditions for organized convection.

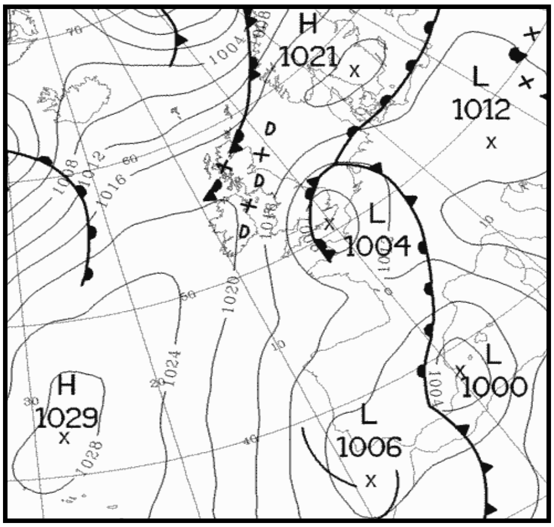

FIG. 1: UKMO sea level pressure and frontal analysis on 2nd November 2008 00 UTC showing the low pressure area over the eastern Mediterranean coast of the Iberian Peninsula.

MSG satellite images show an area of vigorous convective cloud development in the eastern coast of Spain, favoured by the surface low pressure development, the upper level trough and the presence of associated series of jets: J1, J2, J3 (as depicted in Fig. 2); J1 was about 120 kts, and J2 –which triggered convection via potential instability at mid and high levels– about 105 kts while J3 was 60 kts. Satellite images indicate the presence of several vorticity centres (marked as red encircled Xs in Fig.2). One of them moved along J2 over the coast of Catalonia, where the severe weather took place. The cold core at 500 hPa was about –25ºC at 00 UTC (–17ºC over Barcelona).

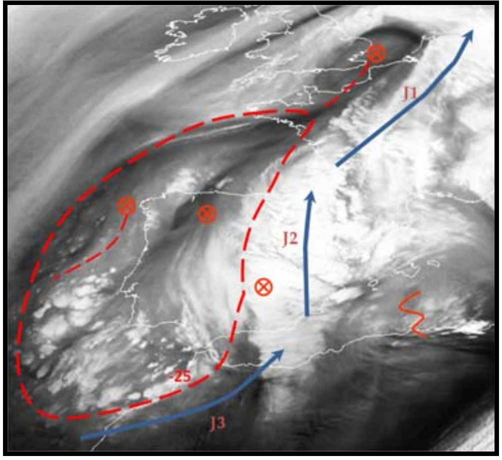

FIG. 2: 2nd November 2008 00 UTC MSG satellite water vapour image (6.2 μm) showing the convective development area in the eastern part of the Iberian Peninsula.

Between 00 and 06 UTC sea level pressure dropped about 7 hPa in the southern part of Catalonia and even more in the west of Catalonia, reaching 11.7 hPa (Raimat station), which is a value associated to rapid cyclogenesis development according to Carlson (1991). Moreover, other typical characteristics of these systems present in this case are: a). the appeareance of the low pressure system at the polar sector of a jet (in this case over Marocco pointing towards the Balearic Islands at 00 UTC); b). a strong thermal boundary, which is clearly appreciated in the analysis performed using the LAPS system (Albers et al 1996) over Catalonia (not shown here).

II. RADAR DATA AND DAMAGE SURVEY

A number of multicell storms coming from the Mediterranean -and at least one supercell, as indicated by weather radar observations- clustered later in a mesoscale convective system and moved north-easterly across Catalonia, producing ground-level strong damaging wind gusts, a tornado –which caused F2 damage– and heavy rainfall. Two thunderstorms (Fig. 3) were particularly active and most damage observed on ground was later associated to them.

Total lightning activity (intra-cloud and cloud to ground flashes) was also relevant, exhibiting several classical features such as a sudden increased rate before ground level severe damage, as discussed in a companion study (Pineda et al. 2009). Remarkable surface observations of this event include 24 h accumulations exceeding 100 mm in three different observatories and 30 minute rainfall amounts of 40 mm which caused local flash floods. As the system evolved northward later that day it also affected SE France causing large hail, ground level damaging wind gusts and heavy rainfall.

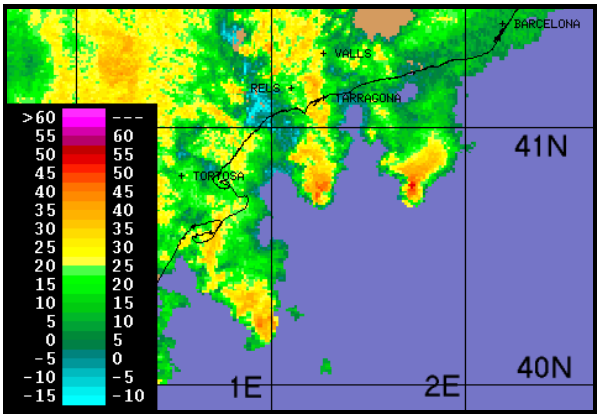

FIG. 3: Radar reflectivity 1 km CAPPI 1:42 UTC composite showing the two storms (about 41N) approaching the southern coast of Catalonia (scale in dBZ).

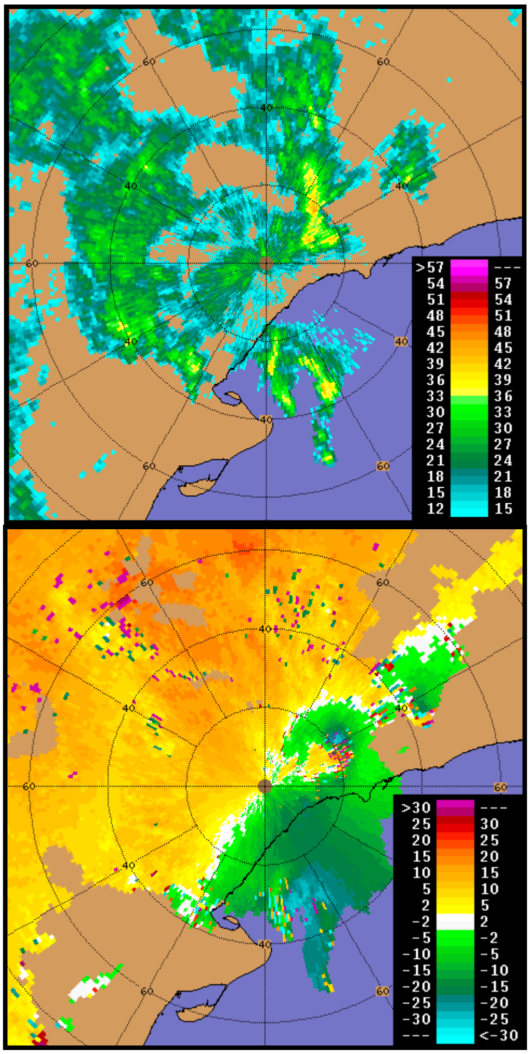

FIG. 4: LMI 0.6º PPIs showing reflectivity (in dBZ) and Doppler radial velocity fields (in m/s) at 3:18 UTC, when the F2 tornado associated to the northernmost cell (about 40 km NE from the radar) took place.

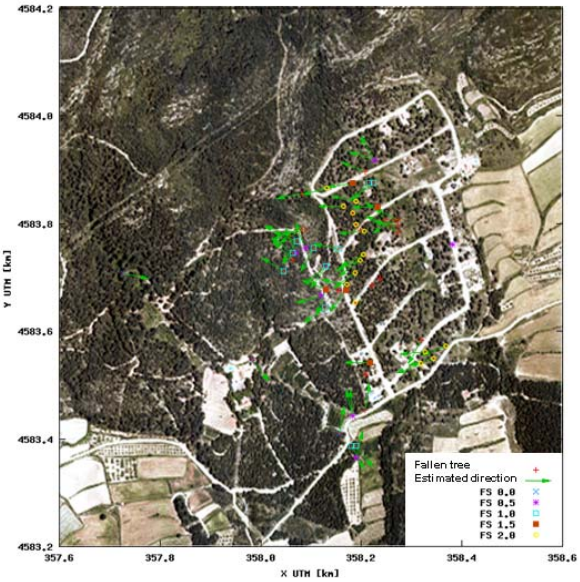

FIG. 5: Depiction of the damage survey performed over the Miralcamp village, affected by F2 damage. Four towers of high voltage power lines (NW of the picture) were knocked down during the event.

III. RESULTS AND CONCLUSIONS

Similarly as in the study of Bech et al. (2007) the passage of the thunderstorms in the proximity of a radar allowed recording clear signs of radial shear and signs of rotation (Fig. 4), which in other circumstances would have been undetected. In some cases they could be associated to the convective cells that caused strong surface winds and substantial damage by comparing the locations of the survey (as in Fig. 5) with radar data, which helped clarifying the tornadic origin of the damage in a case where no visual evidence of a tornado was available, as in the case of the Castellcir tornado (Aran et al. 2009, Bech et al. 2009).

IV. REFERENCES

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