EVALUATION OF DIFFERENT OPERATIONAL NOWCASTING METHODOLOGIES: APPLICATION TO THE SEVERE EVENT OF 25 AUGUST 2006 IN CATALONIA

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I. INTRODUCTION

Thunderstorm distribution in Catalonia (NE Spain) has its maximum in summertime. July and August together gather more lightning CG flashes than the rest of months of the annual CG flash total (Pineda et al., 2007). The case presented could be considered *a priori* as a typical thunderstorm event. However different features such as the number of flashes (2% of the total activity or approximately 3000 CG flashes in only one hour), the velocity of the thunderstorm, or the flash flood registered, made it an anomalous thunderstorm and very difficult to forecast at very short range. The aim of this paper is to evaluate different nowcasting methodologies used at the Meteorological Service of Catalonia (hereafter, SMC) applied to this event.

II. METEOROLOGICAL FEATURES

The synoptic situation at 12 UTC shows at 300 hPa a wind maximum over the NE of the Iberian Peninsula, which favoured the formation of convection on the Northern part of the region (Fig. 1). At mid-levels (500 hPa) existed a North-Western flow, that had the same direction than at high levels (not shown). At this level, it can be observed a low centred on Central Europe and also the anticyclone placed over the Atlantic. This situation favoured the high wind gradient that affected Catalonia. At surface the affected area was between the Atlantic anticyclone and a low placed over Italy. The event finished when a cold front crossed the area, dissipating the convection.

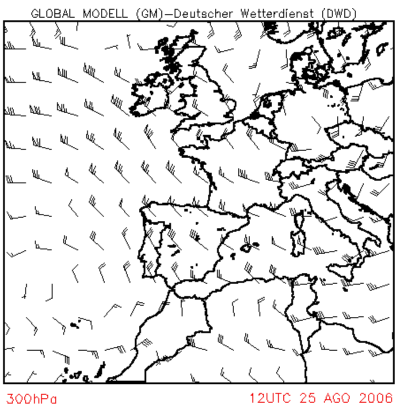

FIG. 1: Global Modell (GM) analysis for 300 hPa winds valid at 12 UTC of 25 August 2006.

III. NOWCASTING METHODOLOGIES

Three different types of methods are applied at SMC: advection of reflectivity radar fields (S-PROG), identification, tracking and nowcasting of convective structures (SCIT), and numerical weather prediction (NWP). In this section, all of the methods are briefly described.

The S-PROG technique is based on the advection of weather radar fields considering the motion field, which is derived with an algorithm based on tracking radar echoes by correlation (Berenguer *et al*., 2005).

The SCIT algorithm applies different reflectivity thresholds in order to identify convective cell contours and centroids including characteristics such as area extension and echo top heights (Johnson *et al*., 1998, Rigo and Llasat, 2004, Rigo *et al*., 2006). The tracking and 1-h nowcasting of the 3-D structures is made considering cross-correlation between consecutive images and also NWP-model derived mid-level winds (700 hPa). Moreover, the evolution stage of convective cells (initiation, maturity and dissipation) in the 3-D product is also determined and forecasted.

Two different mesoscale models are used in the study in order to compare different assimilation systems and to know their performance in short-range forecasting (Sairouni *et al*., 2007): the Mesoscale Atmospheric Simulation System (MASS), and the NCAR/PSU Mesoscale Model 5 (MM5). On one hand, an Incremental Analysis Update (IAU) technique is applied for a hot start initialisation of MASS model, and a synthetic relative humidity scheme (SynRH) is also used to allow for an enhancement of the relative humidity analysis from radar and satellite imagery. On the other hand, observational data in MM5 are processed with the Local Analysis and Prediction System (LAPS). In addition, this technique is also combined with a four-dimensional data assimilation (4DDA) grid analysis nudging for a warm initialisation of MM5.

IV. RESULTS

Heavy rainfall in a very short time period occurred in this episode producing local flash-floods. Isolated storms affected an area smaller than 30 km^2.

The application of the Threat Score (TS) has allowed analysing the results for the S-PROG technique (Fig. 2). This methodology yielded the best scores when the precipitation field increased in size (16 UTC). Precipitation forecast areas exceeding 1 mm matched substantially the observations, especially when it took place the heavy rainfall that caused the flash flood. However, quantitative forecast values underestimated considerably the radar observations (not shown).

Regarding the nowcasting of the structure's position using the SCIT method, it should be said that during the development stage -particularly the first 18’-, due to the apparently chaotic movement of the track, the results were very limited. However, in the last part of the development and maturity stages, the track became much more linear and predictable (some locations where very well forecasted 36’ in advance). In general, the distances between the positions of the observed and forecasted centroids of the convective structures were less than 5 km for time periods that not exceeded 30’ in advance (Fig. 3).

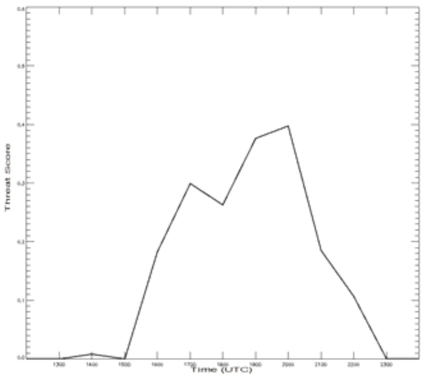

FIG. 2: TS for hourly accumulated precipitation in excess of 1 mm for S-PROG technique.

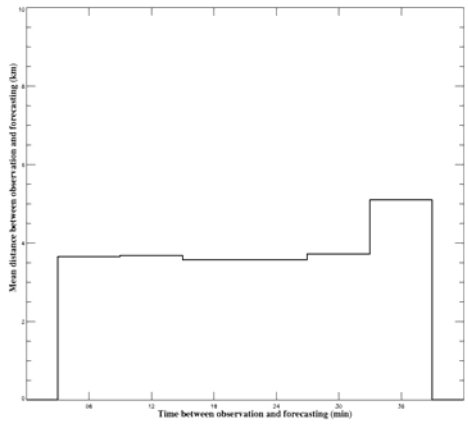

FIG. 3: Mean distance between observed and nowcasted (using SCIT) centroid positions of convective structures.

As the model did not capture properly the small scale convective event that occurred across this area at this time, worse scores are obtained in comparison with general events. In the first 4-hour period the score shows an improvement when using LAPS. After this period the threat score decreases to 0 for all members indicating their inability to represent this local storm (not shown). However, the MASS-IAU experiment demonstrates an interesting improvement in the last 2 hours (Fig. 4), because the IAU technique (MASS-IAU) leads to a faster production of cloud water during the cycling analysis increments (3-hours). Finally, the best results during the first 4 hours are obtained when a 4DDA technique is used (Fig. 4) with the LAPS system (MM5WARM).

V. CONCLUSIONS

Three short-range forecasting techniques applied at the SMC have been analysed with the purpose to evaluate their effectiveness in the severe event of 25 August 2006: NWP with assimilation of remote sensing data, advection of precipitation structures using radar information, and nowcasting of convective cells combining radar data and wind profiles of NWP. In particular, in the presented case were registered an elevated number of flashes and high rain rates in a small area.

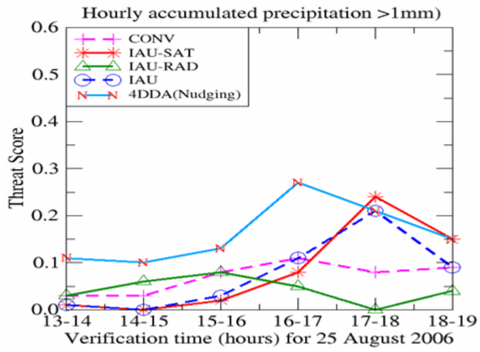

FIG. 4: TS for hourly accumulated precipitation in excess of 1mm for MASS-IAU using satellite (IAU-SAT), radar (IAU-RAD) and combination of both radar and satellite data (IAU). CONV and 4DDA(Nudging) correspond to MASS-COLD and MM5WARM experiments respectively.

In spite of the difficulty of making a good forecast for the presented event, the results show that all the techniques can provide complementary information than can improve the operational warning chain to make a decision in local flash flood cases. In particular, the NWP with assimilated radar and satellite data gives valuable information of the probable affected area and the degree of convection 3 hours in advance. Secondly, S-PROG provides a quasi-reliable hourly rainfall map 1 hour in advance, although underestimates the maximum precipitation values. Finally, SCIT allowed knowing the trajectory of the storm 30’ in advance.

VII. REFERENCES

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