ATMOSPHERIC CIRCULATION PATTERNS ASSOCIATED WITH HAIL EVENTS IN LLEIDA (CATALONIA)

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I. INTRODUCTION

Although the advance of powerful computers has improved the outputs of meteorological models, a good synoptic classification (SC) can be very useful for long-range forecasting. In this way, the Meteorological Service of Catalonia is working on elaborating an accurate SC for extreme events. In this study it will be presented the atmospheric circulation patterns associated with hail events in an agricultural area of Catalonia.

One of the biggest arable lands in Catalonia (northeast of Spain) is the plain of Lleida (fig. 1) with about 200.000 hectares of crops. From 1990 the Associació de Defensa Vegetal - Terres de Ponent (ADV-TP), a local organisation for crop protection, is working to collect information of hail events and damages. In 2001 they built a hailpad network in this arable land with 170 hailpads distributed every each 16 square kilometres (Fraile et al. 1992).
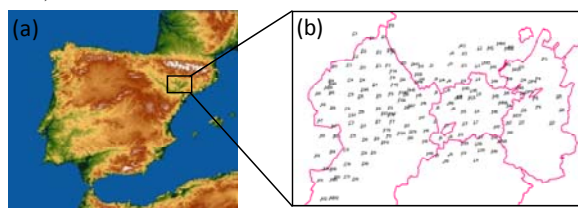

FIG. 1: (a) Iberian Peninsula (b) Hailpad network in the plain of Lleida.

In the second section it is presented the methodology used. The hail event database is detailed in section three. In the fourth section it is presented the results obtained with this methodology. Also it will be included a comparative study with a subjective synoptic classification (Pascual, 2002). Finally, in the fifth section some discussions are presented.

II. METHODOLOGY

In this section it is presented the different objective methodologies tested. As a first approach, the principal component (PCA) analysis is used as a classification technique. The data matrix is in T-mode (Huth 1996, 2000), where the date is the variable and the grid points are the cases. This semi-objective classification was applied to the sea level pressure (SLP) of the NCEP-NCAR reanalysis (2,5º resolution). However, a disadvantage of this method is that can only be used at one atmospheric level. For this reason, it was designed a methodology where the classification was structured using at the same time PCA in S-mode and cluster analysis (CA) (Yarnal, 1993; Esteban et al., 2006). This method allows working with different levels (Houssos et al. 2008): SLP, temperature at 850 hPa and geopotential height at 500 hPa. Furthermore, it was used a precipitation matrix (data from automatic weather stations of

the National Service of Catalonia) to take into account mesoscale aspects. Figure 2 shows the scheme of the methodology that is based on three steps: PCA to reduce the dimension of the variables, CA to classify and, finally, discriminant analysis to verify and reclassify the classification obtained by means of CA.
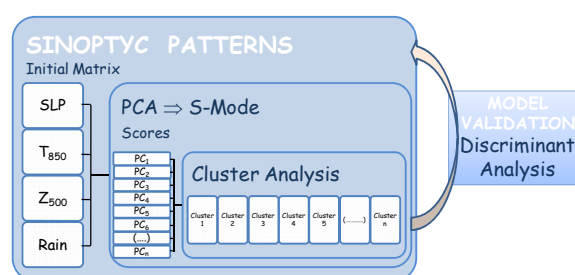

FIG. 2: Scheme of the methodology used.

III. DATABASE

From 2001 to 2007, 83 hail events were detected in the area covered by the hailpad network. These events were used to test different techniques. However, the definitive methodology was only applied to the events with more impact. So, a new database was built using a risk index estimated with the total number of dents and the maximum diameter recorded for each day. A threshold for this index to discriminate a high-moderate event was defined according to the description of each event done by the local association for crop protection in the plain of Lleida (ADV-TP). As a result, only 42 hail events were defined as a moderate to high risk events.

IV. RESULTS

The methodology shown in figure 2 was applied to the 42 hail events. At first, ten groups were obtained after CA analysis. But, verifying this first classification with the discriminant analysis only seven groups were significant.

Figure 3 shows that the clusters 2, 3 and 4 explain the 70% of all the hail events.
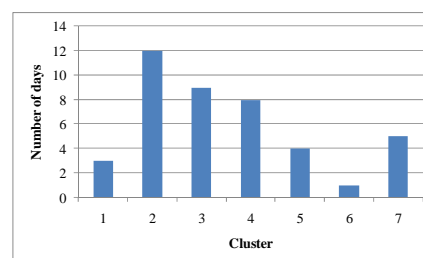

FIG. 3: Number of hail events for each cluster.

These three clusters are characterized by the presence of a trough at medium atmospheric levels, but in cluster 3 and 4 the trough is deeper and over west of Iberian Peninsula (fig.4). This result is in concordance with previous subjective classification done by Pascual (2002). In both studies this synoptic configuration accounts for nearly 40% of the events.
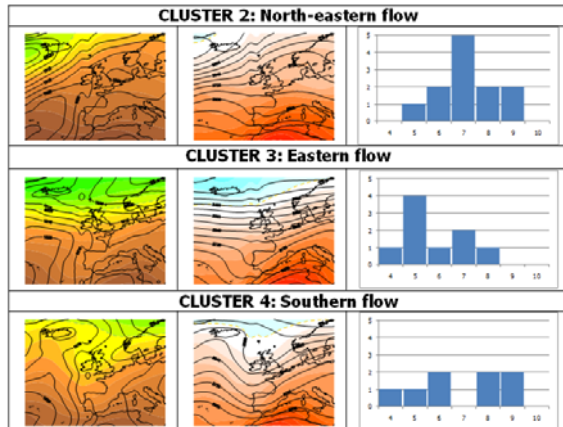

FIG. 4: Clusters accounting for 70 % of the hail events. In column 1 surface level pressure (hPa); column 2 geopotential height (mgp) at 500 hPa and in colour temperature (ºC) at 850 hPa; column 3 monthly distribution of the hail events.

V. DISCUSSION

Although the results have been suitable for our aim, we intend to go on with different trials. A first attempt has been done applying this methodology with ECMWF Interim re-analysis at a 1.5º resolution. The first result doesn't show a significant improvement.

We are carrying out a feasibility study to decide if this methodology can be applied to obtain an analogous method. It would be necessary to use the component matrix obtained by PCA of each variable and the classification function coefficients obtained by cluster analysis.

VI. ACKNOWLEGMENTS

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