Geophysical Research Abstracts
Vol. 15, EGU2013-12920-1, 2013
EGU General Assembly 2013

Analysis of mesoscale factors at the onset of deep convection on hailstorm days in Southern France and their relation to the synoptic patterns

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Storms and the weather phenomena associated to intense precipitation, lightning, strong winds or hail, are among the most common and dangerous weather risks in many European countries. To get a reliable forecast of their occurrence is remaining an open problem. The question is: how is possible to improve the reliability of forecast? Southwestern France is frequently affected by hailstorms, producing severe damages on crops and properties. Considerable efforts were made to improve the forecast of hailfall in this area.
First of all, if we want to improve this type of forecast, it is necessary to have a good "ground truth" of the hail days and zones affected by hailfall. Fortunately, ANELFA has deployed thousands of hailpad stations in Southern France. The ANELFA processed the point hailfall data recorded during each hail season at these stations.
The focus of this paper presents a methodology to improve the forecast of the occurrence of hailfall according to the synoptic environment and mesoscale factors in the study area. One hundred of hail days were selected, following spatial and severity criteria, occurred in the period 2000-2010.
The mesoscale model WRF was applied for all cases to study the synoptic environment of mean geopotential and temperature fields at 500 hPa. Three nested domains have been defined following a two-way nesting strategy, with a horizontal spatial resolution of 36, 12 and 4 km, and 30 vertical terrains— following σ-levels. Then, using the Principal Component Analysis in T-Mode, 4 mesoscale configurations were defined for the fields of convective instability (CI), water vapor flux divergence and wind flow and humidity at low layer (850hPa), and several clusters were classified followed by using the K-means Clustering. Finally, we calculated several characteristic values of four hail forecast parameters: Convective Available Potential Energy (CAPE), Storm Relative Helicity between 0 and 3 km (SRH0–3), Energy–Helicity Index (EHI) and Showalter Index (SI) provided by WRF simulations for each hail grid point, which is very conducive to predicting the occurrence of hail in each one of the mesoscale configurations.
This mesoscale analysis and its relation to the synoptic anomalies is discussed and the contribution to improve the numerical model applied to the forecast of hailfall in this area.

Acknowledgments: This study was supported by the Plan Nacional de I+D of Spain, through the grants CGL2010-15930, Micrometeo IPT-310000-2010-022 and the Junta de Castilla y León through the grant LE220A11-2