A climatology of hail frequency and intensity in Italy

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The aim of the present study is to provide a climatology of hail events for the period 1971-2009 at a municipality scale over Italy, blending information from different sources and collating them with the information coming from the analysis of atmospheric precursors of hailstorm events.

Hailstorms generally interest limited areas a for very short periods of time making the record of hail episodes very difficult, however the hailstorm damages specially on the agriculture sector and on properties could be severe and related financial losses important. In addition, hail events are characterized with very high impact but rather low predictability. Only few and limited in space networks for the monitoring of hail frequency exist in Italy and long term time series of hailstorms are not available for the whole Country.

Differents sources of information about the hail events distribution have been considered and data from limited area networks, as well as from the European Severe Weather Database, have been collected for the period of interest. In addition daily occurrence of hail events at the meteorological stations of the National Weather Service recorded in the NCDC dataset has been extracted for the same period. All the information have been re-organized in a specific dataset containing not only the occurrences, but also information about the grain size obtained from hailstorm reports at several sites. The mean grain size is used in order to classify the intensity of hail events into four different classes. The information collected has been used to calculate the annual frequency of hail events, and to estimate the frequency of each size class.

The NCEP-NCAR daily reanalysis at 2.5 degrees horizontal resolution have been used in order to identify atmospheric parameters characterizing severe thunderstorms possibly leading to hail events. This study is based on a statistical approach. Aiming to eliminate the mutually correlation of the precursors, a Principal Components Analysis is performed, and a Discriminant Analysis is applied to the principal components to classify events with no available information on the grain dimension.

Each site of measurements is geo-located and the elevation and the distance from the sea are considered as well as two other indexes linked to the surface roughness, extracted from a Digital Elevation Model. The Italian territory is divided into homogeneous climatic areas for which a linear multiple regression is carried out using the parameters described above, in order to take into account the influence of the geo-morphological characteristics of the terrain. The analysis allows to identify linear equations for estimating the hail frequency on the basis of the geographical variables of each area.

Staring from the geographical coordinates of the 8100 italian municipalities, and locating each site in a re-analysis grid it is possible to link the results obtained from the different statistical analysis and to determine for each municipality the mean annual hailstorm frequencies for each of the four different size classes.