MINIMUM TEMPERATURE AS AN INDICATOR OF HAILESTORM SEVERITY IN A SCENARIO OF GLOBAL CLIMATE CHANGE

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I. INTRODUCTION

Hailstorms lead to substantial damage in numerous areas of the world. Nevertheless, the limited spatial extension of this type of precipitation, its ephemeral character, and the difficulty in obtaining measurements, limit the availability of ample data bases. Due to the importance of these events as severe atmospheric phenomena, it is important to be able to determine how Global Climate Change can affect the intensity and frequency of these events.

In order to solve the problem of the lack of databases, information about hail fall estimates gathered by agriculture insurance companies and informers are usually used. In diverse studies, this information has been used to characterize not only the events, but also their seasonal evolution (Vinnet, 2001; Dessens, 1995). The problem with employing this type of data is that in some instances the information is partial and incomplete.

Another available method for the characterization of hailstorms is the use of hailpads, which give information that is exact and objective. In the last few years, tools have been developed that allow us to identify severe phenomena via teledetection (Llasat, et al., 2003).

II. PRESENTATION OF RESEARCH

The objective of this study is to determine the existence of relationships between characteristics of hail fall and meteorological parameters that are easily available, which can be used to predict the future evolution of hailstorms.

For this study, data was used from hailpad networks in three regions with high frequency of hailstorms: the Ebro Valley in Spain, the Atlantic Area of France, and Mendoza in Argentina. Each hail event was characterized objectively using hailpads, and obtaining a high number of variables (TABLE I).

Similarly, for each of the areas of study, and for each of the hail events shown, the following temperature values were calculated: maximum daily temperature, minimum nighttime temperature for the night before a hailstorm, average daily temperature, and the temperature at dew point. From this data, we evaluated the capacity of these different temperatures to predict some of the parameters that are characteristic of the intensity of hail fall. In order to do so, we obtained correlations between the temperatures and parameters that characterize hail fall and applied the Pearson test.

III. RESULTS AND CONCLUSIONS

The analysis of results shows significant Pearson correlations between some of the hailpad variables and meteorological variables. These correlations are greater when larger databases are available, such as in the case of France and the Ebro Valley.

The results show that the minimum nocturnal temperature emerges as the greatest indicator of hail characteristics, since it is a temperature that presents the greatest number of correlations, and with a greater significance.

If we focus on the minimum temperature, the variable that presents the greatest correlation is the $D_{\text{max}}$ registered in each event. In FIG. 1, we see the distribution of $D_{\text{max}}$ in relation to the minimum temperature in the case of Bordeaux (France). Despite the dispersion that applies in some cases, a clear positive correlation is observed, and, as such, warmer nights would correspond with a greater diameter of hail precipitation.

With these results, a hypothetical future increase in minimum temperature of 1°C would produce an increase of 1.3 mm in $D_{\text{max}}$ in the case of Bordeaux (FIG. 1), which show similar results to those found in the Ebro Valley.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Acronym</th>
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<tbody>
<tr>
<td>Number of plates impacted</td>
<td>Placas</td>
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<tr>
<td>Number of total impacts</td>
<td>N\textsubscript{total}</td>
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<tr>
<td>Total hail mass</td>
<td>M\textsubscript{total}</td>
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<tr>
<td>Total kinetic energy</td>
<td>E\textsubscript{total}</td>
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<tr>
<td>Average number of impacts</td>
<td>N\textsubscript{med}</td>
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<tr>
<td>Average hail mass</td>
<td>M\textsubscript{med}</td>
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<tr>
<td>Average kinetic energy</td>
<td>E\textsubscript{med}</td>
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<tr>
<td>Average hail diameter</td>
<td>D\textsubscript{med}</td>
</tr>
<tr>
<td>Maximum number of impacts</td>
<td>N\textsubscript{máx}</td>
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<tr>
<td>Maximum ice mass</td>
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<td>Maximum kinetic energy</td>
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<td>Maximum diameter</td>
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TABLE I: Parameters that characterize hail.
The evolution of minimum nighttime temperatures was obtained for the areas of study during the last 35 years. In order to do this, we used temperature averages for various regions and analyzed the trends, as well as changes over the past few decades. These results verify the reliability of minimum temperature as a predictor of severity of hail fall, as evaluated using diameter. Thus, we can predict that if the trend of minimum temperatures is positive, as seen in the great majority of models that evaluate Climate Change (IPPC, 2007), this will be accompanied by an increase in the severity of hail fall, especially in the extreme cases. Dessens (1995) has already noted an increase in the number of severe storms as a result of Climate Change.

IV. ACKNOWLEDGMENTS

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V. REFERENCES