Evaluation of 3 operational severe convective parameters on historical storms that have hit France

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INTRODUCTION

Although most of the severe convective events, such as tornados, mainly occur in the Central United States, such extreme events also occur over Europe. In France, it is thought that the average number of tornados each year could be estimated at 50. Typically, in the summertime in France, large hail stones associated with supercell thunderstorms are responsible for damaging aircraft, homes, cars and crops, and can be deadly to livestock and people. Improving the early detection of such severe convective weather events is of primary importance for operational centers.

Therefore, at Météo-France, severe convective parameters have been produced every day at 0000, 0300, 0600, 1200 and 1800 UTC for two french operational models (AROME and ARPEGE). Since 2016, they are also operational for AROME-Pi (real-time forecasts) and PE-AROME model (ensemble forecasts).

Those parameters consist in combining the ingredients for severe convection such as strong CAPE, Storm Relative Helicity (SRH), and wind shear (Fig. 1).

Typically, a severe convective event is characterized by those phenomena (Johns 1992):

- tornados
- damaging winds, or gust > 26 m/s
- hail diameter ≥ 1.9 cm

OBJECTIVE

Evaluate the operational severe convective parameters of Météo-France.

DATA

1. SEVERE CONVECTIVE PARAMETERS:

   - Formulations (used at Météo-France since 2009 and inspired from Thompson et al. (2003)):

     \[
     \text{POD FAR} = \frac{\text{TP}}{\text{TP + FP}} \quad \text{and} \quad \frac{\text{FP}}{\text{TP + FP}}
     \]

     \[
     \text{SUBJECTIVE EVALUATION}
     \]

     \[
     \text{OBJECTIVE EVALUATION}
     \]

     - For this study, those parameters are shown using the two following french operational models:

       - AROME (Global Numerical Weather Prediction model (horizontal resolution : 7 km over France)
       - AROME (Mesoscale and non-hydrostatic high-resolution model (horizontal resolution : 1.5 km)

     2. OBSERVATIONS:

       - Radar reflectivity + lightning impacts (1h)
       - Hail occurrences from HYDRE (french observational product)

       * Based on radar data (polarimetry and reflectivity) that allows to determine ground precipitation type (e.g. hail)

       * Real-time, every 5 minutes, kilometic spatial resolution

       * 2 hail sizes: small (< 0.5mm), medium (0.5mm - < 2cm), large (>2cm)

     METHODOLOGY

     1. SUBJECTIVE EVALUATION (two case studies)

     2. OBJECTIVE EVALUATION (ongoing work)

     - Observations: against hail occurrences from HYDRE. Only the large size hail (≥ 2 cm) is taken into account (see HYDRE-TC-CDR)

     - over 7 cases: 06/27/2017 at 17UTC, 07/07/2017 at 17UTC, 07/10/2017 at 15UTC, 08/08/2017 at 15UTC, 07/22/2017 at 10UTC, 06/15/2017 at 15UTC.

     - Domain: France

     - Model: AROME

     - Scores: Probability Of Detection (POD), False Alarm Ratio (FAR)

     - More details :

       * for each case, the max of SCP and HYDRE over 1h is used

       * the scores are calculated at the grid point but also within a neighborhood of about 25 km

     RESULTS

     1. SUBJECTIVE EVALUATION

     - For SCP ≥ 1 (low risk):

     - For SCP ≥ 2 (moderate risk):

     CONCLUSIONS

     1. SUBJECTIVE EVALUATION (based on the 2 case studies shown in this study):

     - POD is too weak

     - SCP is able to capture the areas affected by severe convection (values ≥ 2). However, this parameter is too spread out.

     - TP shows a risk of tornado (i.e. > 1) in the Hérault department where a tornado was observed.

     2. OBJECTIVE EVALUATION:

     - Recall that, in this study, scores are calculated for the SCP parameter from AROME outputs only

     - Scores for SCP show a high false alarm ratio and a low probability of detection.

     PERSPECTIVES

     - Continue adjusting the formulations of those parameters (originally developed for USA territory) to the french territory specificities.

     - Calculate the scores over a longer period (about 3 months)

     - Calculate scores for the SCP parameter using an observed tornades database.

REFERENCES


Johns, R. 1992

2. OBJECTIVE EVALUATION:

   - Formulations

   - Model:

   - Scores:

   - More details:

   - for each case, the max of SCP and HYDRE over 1h is used

   - the scores are calculated at the grid point but also within a neighborhood of about 25 km and 40 km centered around the hail occurrence

   - the event is considered predicted/failed when at least 10% of SCP values within the neighborhood exceed a given threshold for SCP (e.g. SCP ≥ 1, ≥ 2, or ≥ 4).

   - Real time, every 5 minutes, kilometic spatial resolution

   Global Numerical Weather Prediction model (horizontal resolution : 7 km over France)

   - Employment of 3 operational severe convective parameters on historical storms that have hit France

   - Evaluation of 3 operational severe convective parameters on historical storms that have hit France

   - Objective Evaluation of 3 operational severe convective parameters on historical storms that have hit France

   - Subjective Evaluation of 3 operational severe convective parameters on historical storms that have hit France

   - Combination of severe convective parameters (SCP), Storm Relative Helicity (SRH), and wind shear

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