CONVECTIVE PARAMETERS COMPUTED WITH ALADIN AND AROME MODELS FOR THE HAUMONT (F4) TORNADO.

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I. INTRODUCTION

A F4-tornado has produced severe damages in the North of France, during the late afternoon of the 3rd of August, 2008 (FIG. 1). This severe convective event has not been explicitly forecasted in the basic fields of the suite of Météo-France nested models, neither with the hydrostatic ALADIN LAM (9.5 km) nor the AROME meso-scale and non-hydrostatic LAM (2.5 km).

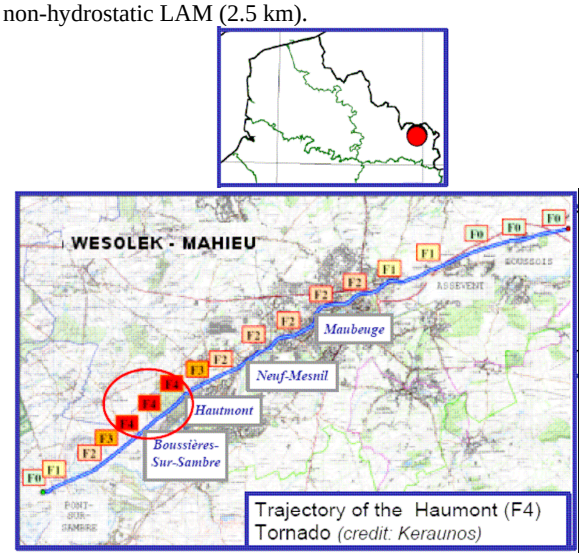


FIG. 1: The F4 event occurred between 20h25 and 21h UTC, close to the Haumont town in the North of France, and close to Belgium.

The aim of the Forecast Laboratory is to test new ideas, new products. Among the available outputs for the ALADIN model, there already exist the CAPE, the Storm Relative Helicity and a "Composite Map" which corresponds to an attempt to draw altogether different indices measuring the "availability in severe convection", with either enhancement or inhibition characteristics, such as "θ'w>14°C" and moisture convergence at 925 hPa ; ω and Q.G. forcing within 400-500 hPa ; Saturation-deficit, …

Differently to this set of moisture and dynamical properties, the approaches followed in the U.S.A. for the tracking of severe thunderstorms and tornados promote the use of special "Convective Parameters".

These Convective Parameters are all based on a CAPE information (either the Most Unstable, the Mean-Level or the Surface Based one). They also include other terms, added as product terms to the (MU, ML or SB) CAPE, like the Helicity, the vertical shear, the Lifting Condensation Level height or the MLCIN.

As an example, the "***EHI***" is the **E**nergy *(SBCAPE)* and Storm Relative **H**elicity *(SRH)* **I**ndex. It is defined by:

$$EHI = \frac{SBCAPE_{2m}}{1000\,J\,kg^{-1}} \times \frac{SRH_{3km}}{160\,m^2 s^{-2}}$$

The two terms SBCAPE and SRH are normalized in the EHI formula (Davies, 1993) with some relevant values, set to 1000 J/kg and 160 m2/s2, respectively. The aim is to provide an index varying from 0 to some units, leading to a possible increasing scale of risk for Super-cells or Tornado:

FIG. 2: The EHI scale of risk for Super-cells or Tornado.

The other Convective Parameters (see for instance Thomson et al., 2003) are: the BRN (Bulk Richarson Number) ; the SCP (Super-cell Composite Parameter) and the STP (Significant Tornado Parameter).

II. PRESENTATION OF RESEARCH

The motivation for this study is to compute with the ALADIN (9.5 km) and the AROME (2.5 km) models all the normalized USA Convective Parameters (BRN, EHI, SCP, STP). The aim is to determine the regions with higher risk of severe convection, for the now-casting or short-range forecast purposes, i.e. where the indexes reach (or go beyond) the appropriate levels in each of the "scale of risk" (like > 4 for EHI and for F4 tornados on FIG. 2).

In the present preliminary study, we have used the same thresholds and "scale of risk" than the ones determined in the USA from the climatology of RS over the Great-Plains. These values will have to be confirmed (or retuned) to be adapted to the conditions prevailing over France.

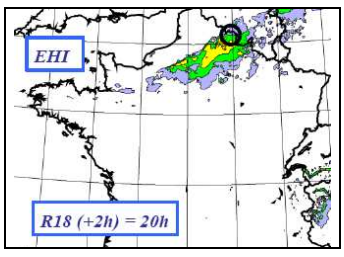
III. RESULTS

Since the Meso-scale model AROME start to resolve the convective scale, the CAPE computed from AROME outputs can be logically small (even equal to zero) in the simulated convective cores. But the CAPE is a common factor of all the Convective Parameters and it could be interesting to apply some spatial filtering to the outputs of AROME, in order to catch (may be) more relevant environmental values into the CAPE computations (with unchanged or recomputed cores).

The "Filtered EHI" is thus computed with the environment based on 100 km – Filtered data, leading to:

F-EHI with F-SBCAPE ; F-SRH (3km-30dg)

FIG. 3: The EHI computed with AROME (2h forecast from the 18 UTC analysis).



Note that the significant values for the EHI are only located close to the region of Haumont, i.e. with small level of False Alarms.

It results the following EHI maps, shown in FIGS. 3 and 4. They are based on a 18 UTC analysis, from 1 to 3 hours.

The F-EHI signal appearing in FIG. 4 is almost well localized and with the right timing. Only the intensity - from FIG. 3 - is smaller than the expected value F-EHI > 4 (with possible dark purple colours).

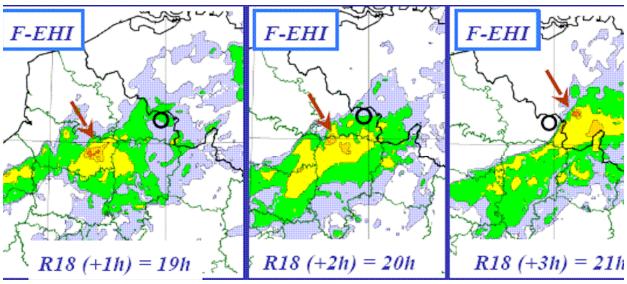


FIG. 4: The "movies" of the F-EHI for the F4 event, as simulated by the AROME (2.5 km) NH model / Zoom of FIG. 3. Forecast from the 18 UTC analysis: 1 h and 19 UTC (left) ; 2 h and 20 UTC (center) ; 3 h and 21 UTC (right).

The SCP and F-SCP are defined as follow, with the associated "scale of risk" (Marginal Super-Cells -> Non-Tornadic SC -> Weak Tornadic-SC -> Significant Tornadic-SC).

$$SCP = \frac{MUCAPE_{300hPa}}{1000\,J\,kg^{-1}} \times \frac{SRH_{3km}}{160\,m^2s^{-2}} \times \frac{0.5\,(Shear)^2_{(\overline{6km}-\overline{500m})}}{40\,m^2s^{-2}}$$

F-SCP with F-MUCAPE ; F-SRH (3km-30dg) ; F-Shear²

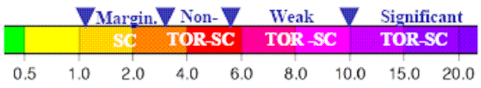


FIG. 5: The formula and the "scale of risk" for the SCP (ALADIN) and the F-SCP (AROME).

For ALADIN – on the left in FIGS. 6 and 7 - the SCP signal clearly exhibits a narrow maximum, but too North–West from the region of Haumont. The F-SCP values as seen by AROME (on the right) are more realistic, passing through the region of Haumont. The SCP and F-SCP values are smaller than the expected ones (for both ALADIN and AROME): from the FIG. 5 they should be above 10 units…

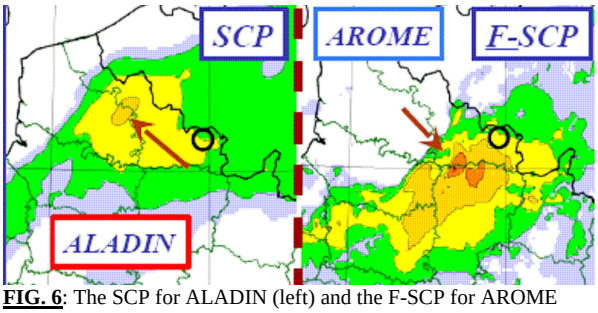


FIG. 6: The SCP for ALADIN (left) and the F-SCP for AROME (right), for 2 h forecast from the 18 UTC analysis (20 UTC).

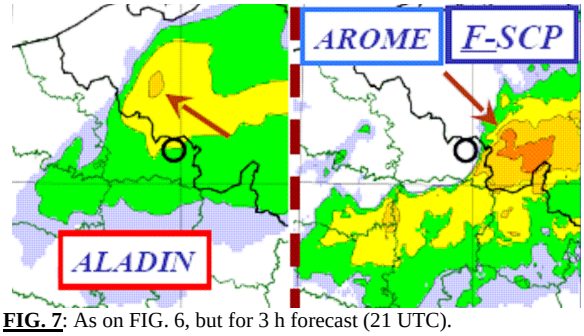


FIG. 7: As on FIG. 6, but for 3 h forecast (21 UTC).

The "STP" and the associated "scale of risk" are

$$STP = \frac{MLCAPE_{100m}}{1000\,J\,kg^{-1}} \times \frac{SRH_{1km}}{20\,m^2s^{-2}} \times \frac{Shear_{(6km-10m)}}{20\,ms^{-1}} \times \frac{2000 - MLLCL}{1500\,m}$$

FIG. 8: The formula and the "scale of risk" for the STP (AROME).

Like for the SCP values, the STP ones seen by AROME are realistic, with clear and narrow maxima passing through the region of Haumont. The STP values almost reach the relevant ones for AROME (0.8 to 0.9 red spot at 21 UTC), whereas from the FIG. 8 they should reach 1 unit, or more.

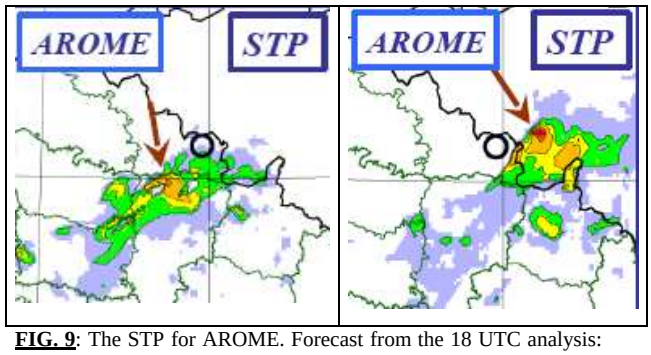


FIG. 9: The STP for AROME. Forecast from the 18 UTC analysis: 2 h and 20 UTC (left) ; 3 h and 21 UTC (right).

IV. CONCLUSIONS

It seems that the USA Convective Parameters could provide additional and interesting outputs for the ALADIN (9.5 Km) and AROME (2.5 km) hydrostatic and non-hydrostatic Météo-France models, respectively.

For the special case of this F4 tornado in the region of Haumont, the EHI, SCP and STP maps do not generate False Alarm over France, even if False Alarms and Non-Detections have been more frequent on the 2009 JJA period.

As a future development, it could be interesting to analyse the behaviour of the prognostic turbulent kinetic energy (with indeed a strong signal in the ALADIN and AROME models for this Haumont's case / not shown).

It could be also interesting to modify these Convective Parameters, in order to avoid the cancellation of the index as soon as any of the (SB/ML/MU)-CAPEs are equal to 0.

An attempt will be made to transform the Composite Map, developed at the Météo-France Forecast Laboratory, into the frame of the USA "Composite Parameter" and with the associated thresholds to be determined.

VI. REFERENCES

Davies J. N.., 1993: Hourly helicity, instability, and EHI in forecasting supercell tornadoes. *17th Conf. On Severe Local Storms*, St.Louis, MO, Amer. Meteor. Soc. 107-111.

Thomson R. L., Edwards R. and Hart J. A., 2003: Close proximity soundings within supercell environments obtained from the rapid update cycle. *Wea. Forecasting.*, 18, 1243-1261.