Derecho-like event over France: Observation and Evaluation of the Forecast using an Automatic Verification Tool

Thibault Vallet[1], Mathieu Papazzoni[2], Gaëtan Naud[1], Alexandre Flouttard[1]

1- Direction of Meteorological Services, Aeronautical Forecast Department, Météo-France, Toulouse, France

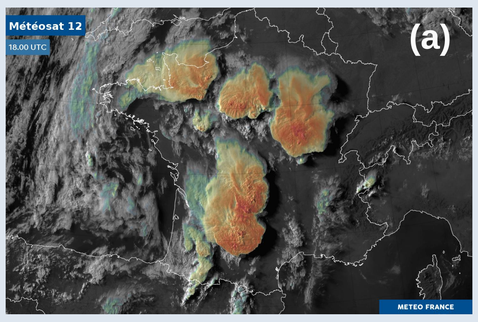
2- Direction of Meteorological Services, Research Innovation and Tools for Operational Aeronautical Forecast, Météo-France, Toulouse, France

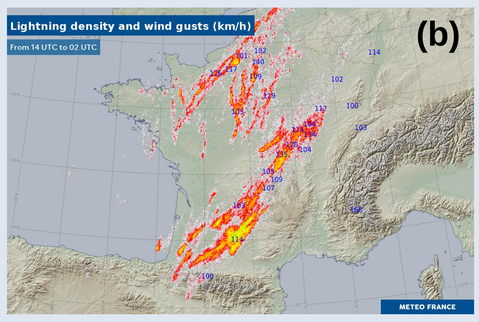
Introduction : Thunderstorms are one of the most disruptive meteorological phenomena for aviation. The impact on air traffic highly depends on their organization and its forecast is a real challenge. A feedback is needed to improve our forecasting techniques, but human evaluation could have unavoidably some bias.

Objectives : The goal of this study is to build an automatic tool, based on observations data to objectively assess the human forecast. It can help us to realize a feedback on each situation and to improve our way to do the forecast. Radars reflectivity and lightning data are mainly used to define the convective objects and their organization in order to strictly compare them with the ones drawn on the forecast bulletin.

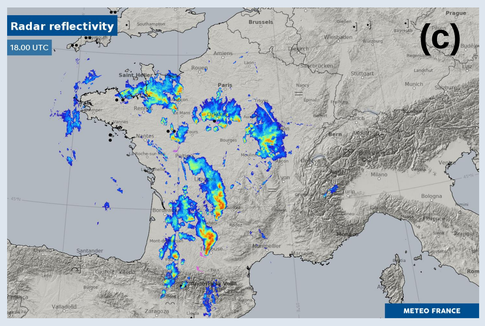
Operational Convective Forecast

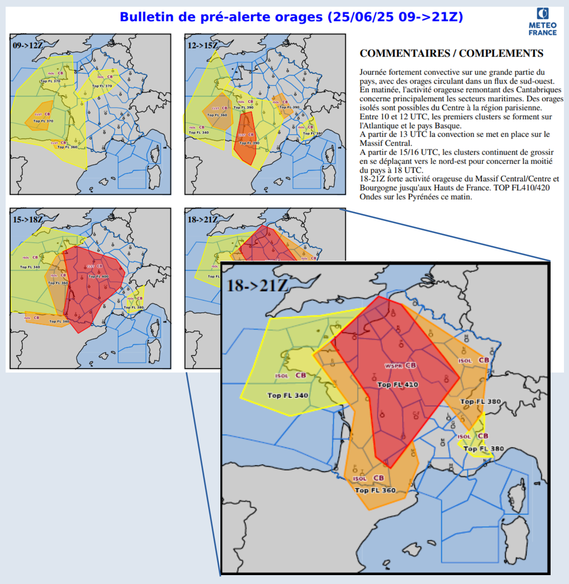
Daily Convective Forecast Bulletin : Three times a day during summer period, a four-time steps bulletin is sent to Air Traffic Control centres (ATCs), detailing the convective risk. A double input matrix depending on the convective organization and the probability of occurrence ("*Unlikely*" for a risk < 30%, "*Likely*" for a 30-70% risk and "*Very Likely*" for a >70% risk) lead to a four levels scaled forecast, defining the convective impact on aviation. This allows ATC to manage air traffic where weather conditions could be disruptive. Then preventive measures such as flights regulation or delay can be undertaken.

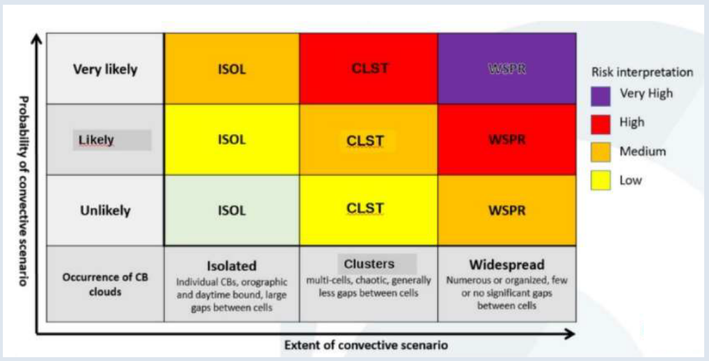




Observations charts : satellite (a), radars (b), wind gusts and lightning density (c) for the 25th of June 2025 at 18.30UTC.
South-westerly flow with high sheared environment led to deep, severe and organized convection from south-west to north-east France with several clusters of thunderstorms (some squall lines and bow echoes systems).



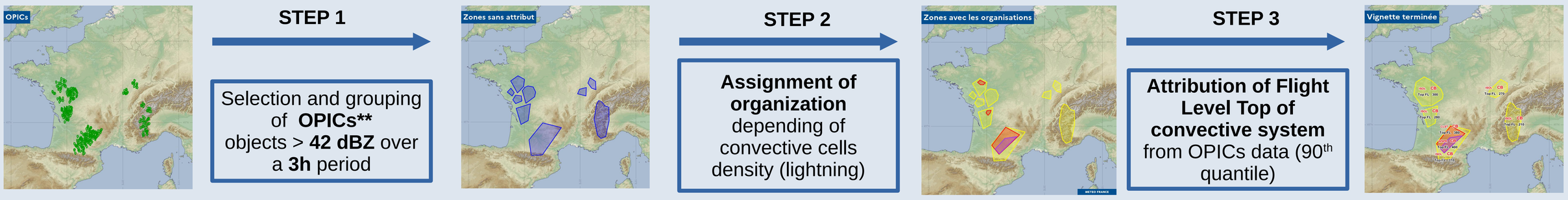




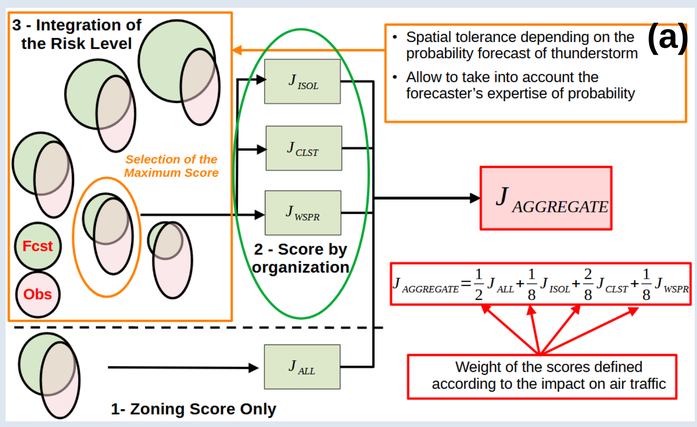
Convective Forecast Bulletin valid for the 25th of June 2025, issued at 08 UTC. Risks for aviation network only :
ISOLATED convection can be easily avoided by aircraft,
CLUSTERED convection occurs with higher instability and shear, cells can merge and the avoidance becomes more difficult.
WIDESPREAD convection (cold fronts, squall lines) represents the higher risk (larger area and lifetime).

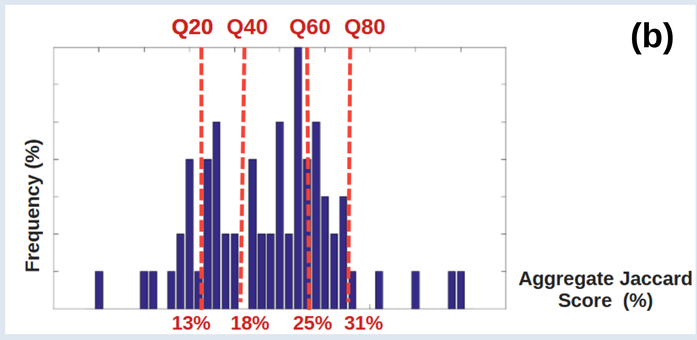
Observed Convection & Objective Assessment

Development of the "Observed Bulletin" Algorithm: Radars maximum reflectivities are first used to determine the classification between convective and non convective cells (**STEP 1**). The 42 dBZ value is selected here as a threshold for keeping cumulonimbus clouds, generating **OPICs** (***Convective Objects for Now-casting*). Then a grouping of 3h cumulated OPICs is made to build polygons, depending on the distance between each OPIC. **STEP 2** consists in assessing an organization to each polygon, depending on the cells density from lightning observations (**ISOLATED**, **CLUSTERED** convection (if cells are separated less than 40 km) or **WIDESPREAD** convection (if less than 10 km)). Finally, during **STEP 3**, Flight Level of cumulonimbus clouds are determined from a statistic method, taking into account every OPIC of the polygon (the 90th quantile value of the distribution is attributed to the convective area). The final chart lead to a similar human-made forecast bulletin that now can be compared for an objective assessment.



Scoring the Forecast – Jaccard's Method





Detailed schemes of the scoring algorithm. (a) shows the general Jaccard score definition and implementation and (b) illustrates the reference database over a whole convective season (May to October 2024) and their associated quantiles.

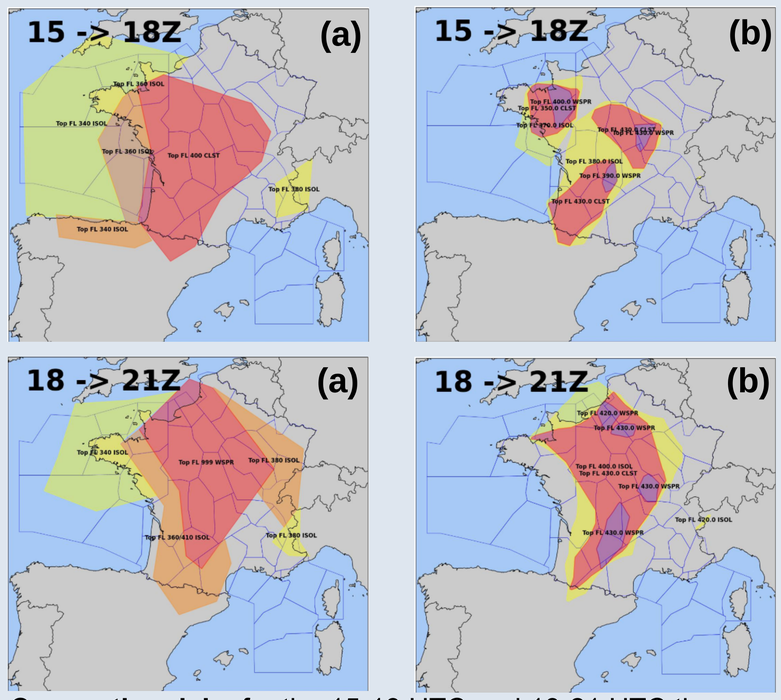
The **Jaccard Score** allows the comparison between the surfaces of the forecast and observation polygons. The more they fit, the better is the score.

As forecasters make a probabilistic bulletin, a spatial tolerance on the fitting surfaces has been applied to the score. The forecast polygon is enlarged or reduced depending on the probability class, while the observed polygon remains fixed. The best score of these various assessments is kept.

The final score is an aggregation of the different organization's scores, with different weights depending on their traffic disruptive potential.

The Jaccard score need to be considered within a reference based on human assessment to define the quality of the forecast. A quantified score (between 1/5 and 5/5) is finally attributed by replacing the aggregate Jaccard score within this reference database.

Results - Derecho-like Event of 25th of June 2025



Convective risks for the 15-18 UTC and 18-21 UTC time steps during the 25th of June 2025 event. Observed bulletin at (b) and forecast at (a).

The automatic convective detection is generally well-fitted, with polygons that correctly represent the convective organizations. Nevertheless, some discrepancies have been noted.

Widespread convection is sometimes overestimated and there are some difficulties to well discriminate clustered from widespread organizations. Isolated thunderstorms are also difficult to assess when the cells are distant.

With this automated tool, forecasters are now well equipped to rapidly monitor their production on past situations.

Further Developments and Perspectives

- Taking **others observations** into account to assess data where radars are not available (offshore / mountains)
- Trying calculations with **others statistical scores**
- Use of the algorithm to **others forecasts.**