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# UEF2023
# Using ensemble models to provide a deterministic forecast in an operational context : methodology used at Météo-France

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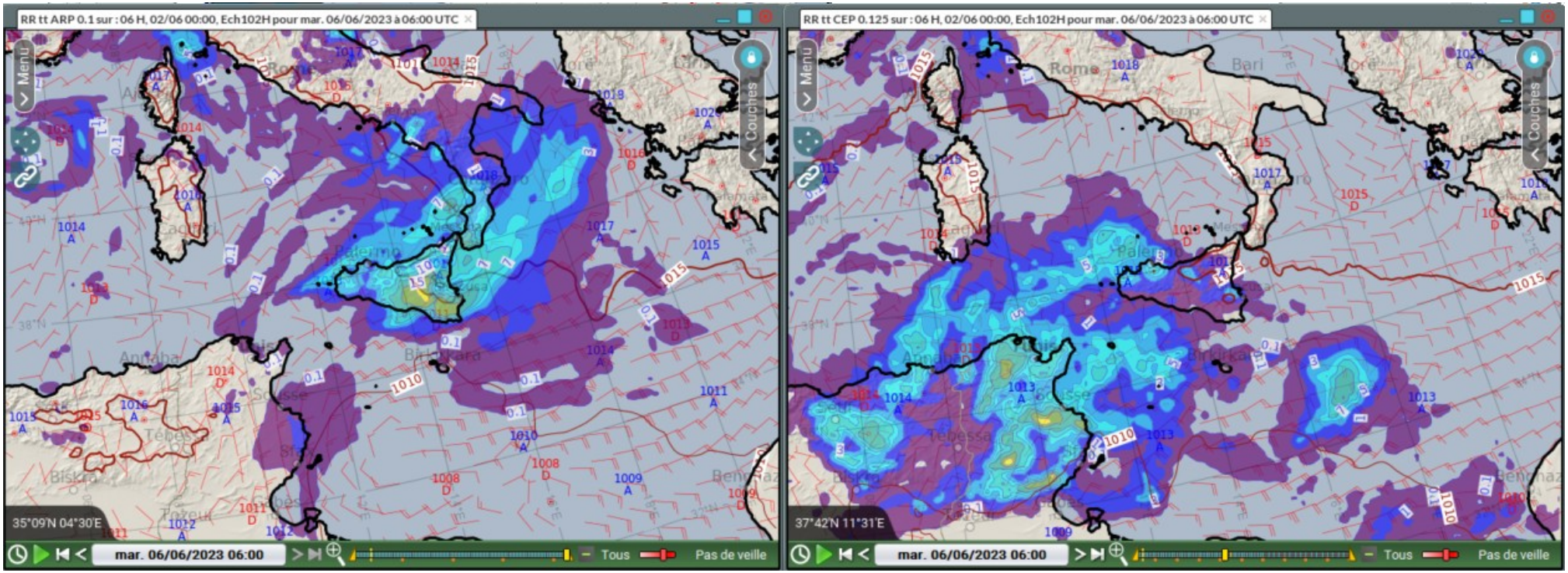
Reading, 6th June 2023

# From multi-models to Ensemble models

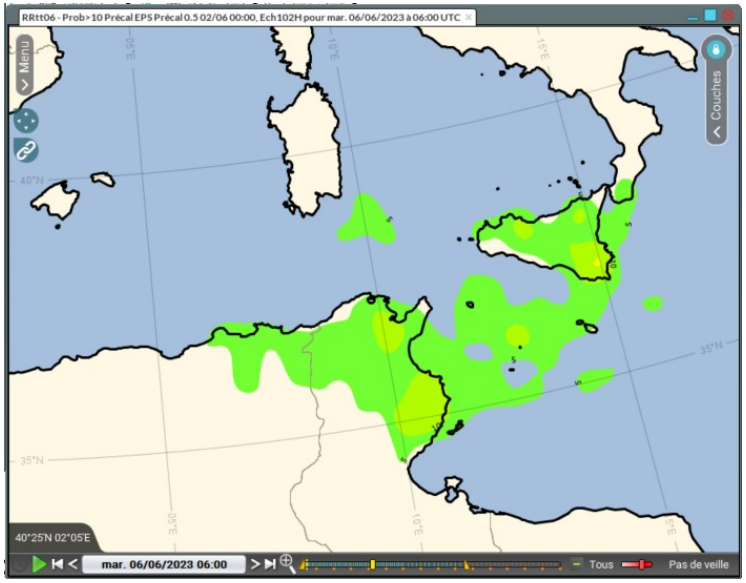
We are used for decades to comparing several runs of several deterministic models for assessing uncertainty.

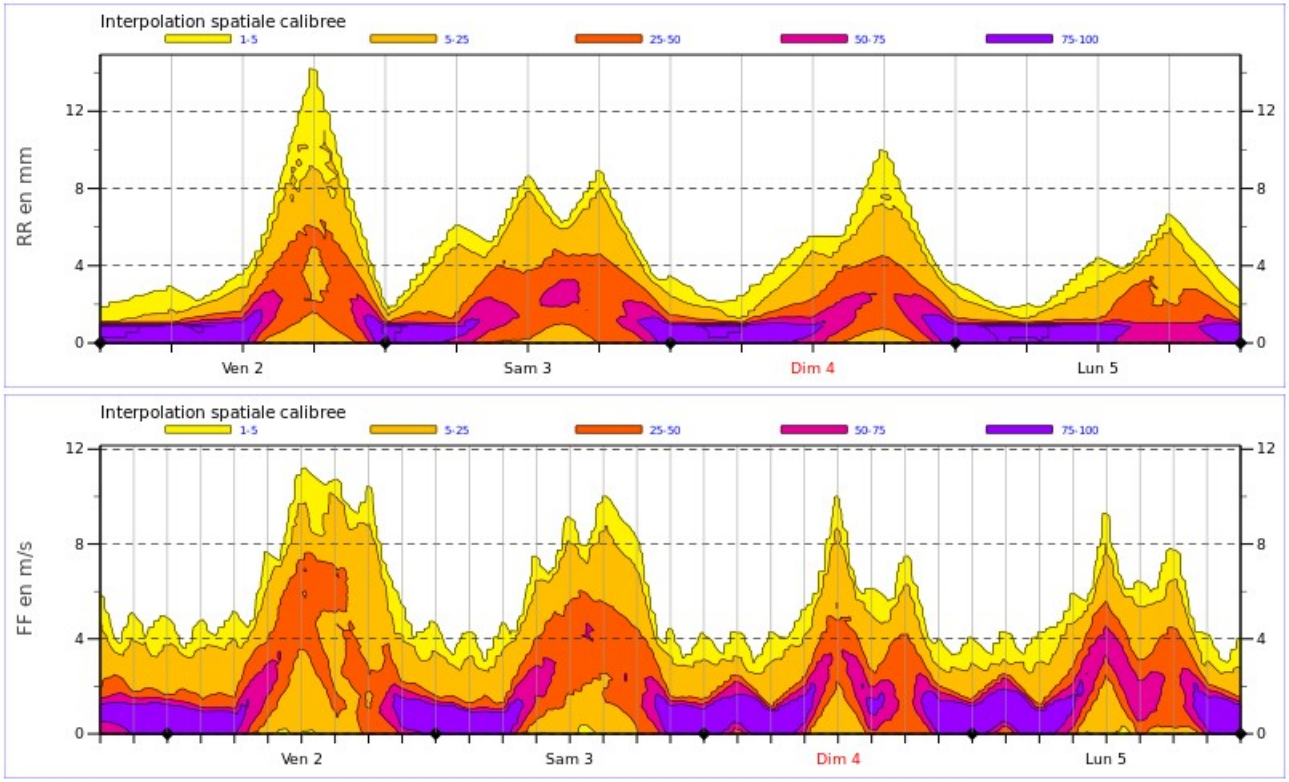
Arpège, IFS, Arome-ARP, Arôme-IFS, ICON, ICON-D2, UKMO, GFS, etc. : « the poor's man ensemble prediction» → 4 models x 4 runs = 16 propositions



# From multi-models to Ensemble models

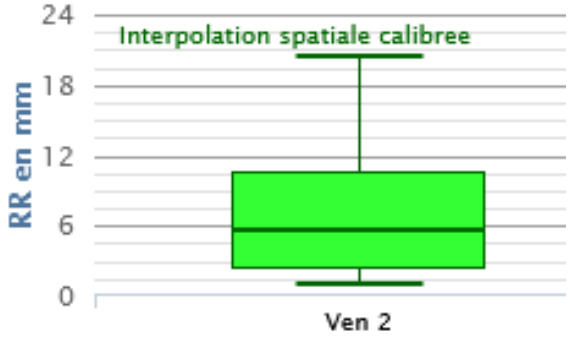
Then came the Ensemble models : EPS, PEARP, Arome-EPS, and others.




Probabilities, statistics, percentiles, mustache boxes don't help most of end-users to make their decision.

They need a deterministic scenario to apply an « on / off » or « go / no go » procedure.



# Arome-EPS : from forecast uncertainty to forcasting uncertainty

Arome-EPS offers since 2016 new possibilities to handle and reduce uncertainty, and then provide an uncertain scenario with more confidence.

ARO-EPS :

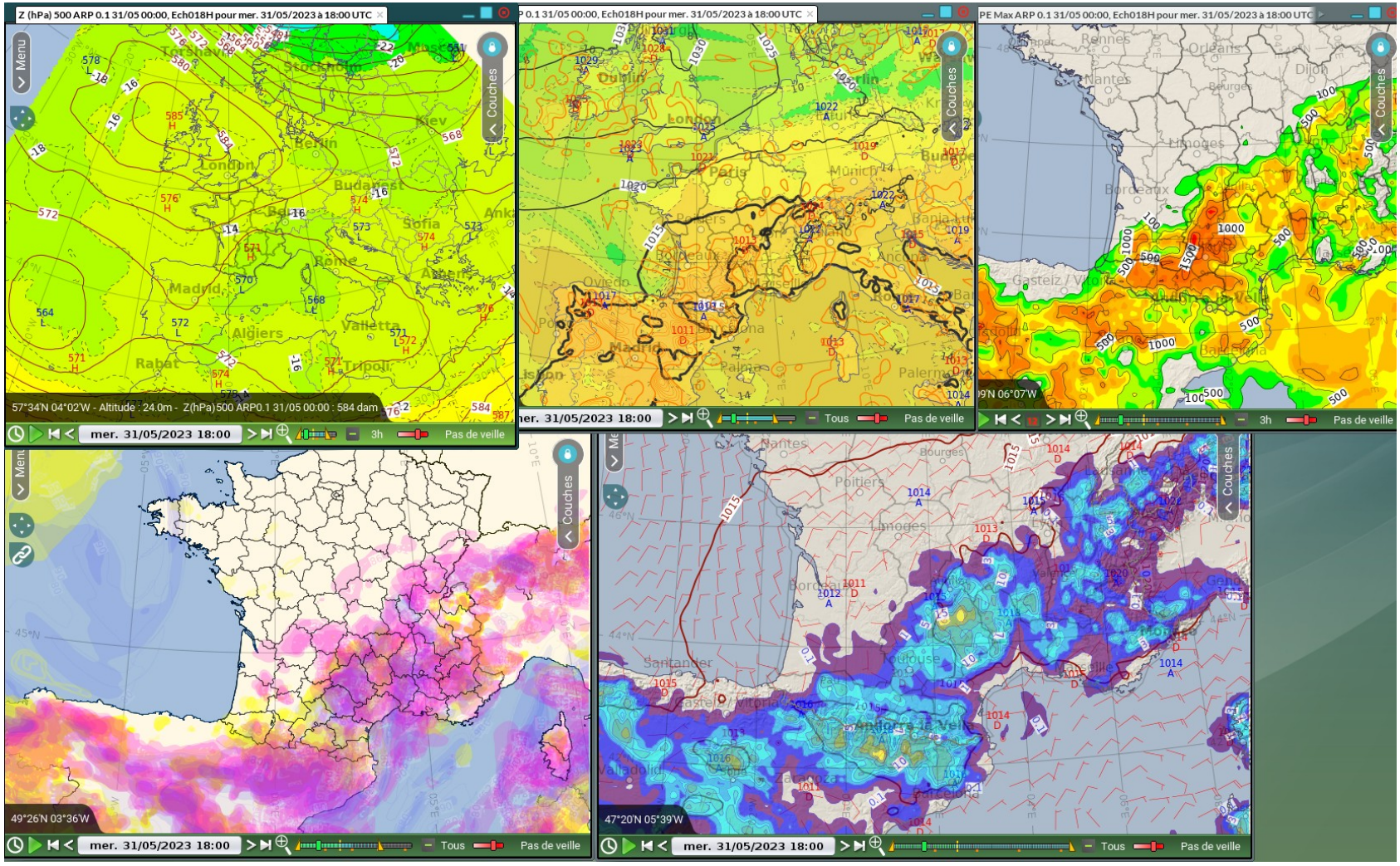
- Arpège boundary conditions
- 16 members
- 2,5 km resolution and 90 vertical levels
- 45 hours lead-time
- 4 runs per day.

It provides percentiles, probability to have phenomena or reach thresholds, thumbnails views, spaghetti.

Forecasters have been shaping methods to use them.

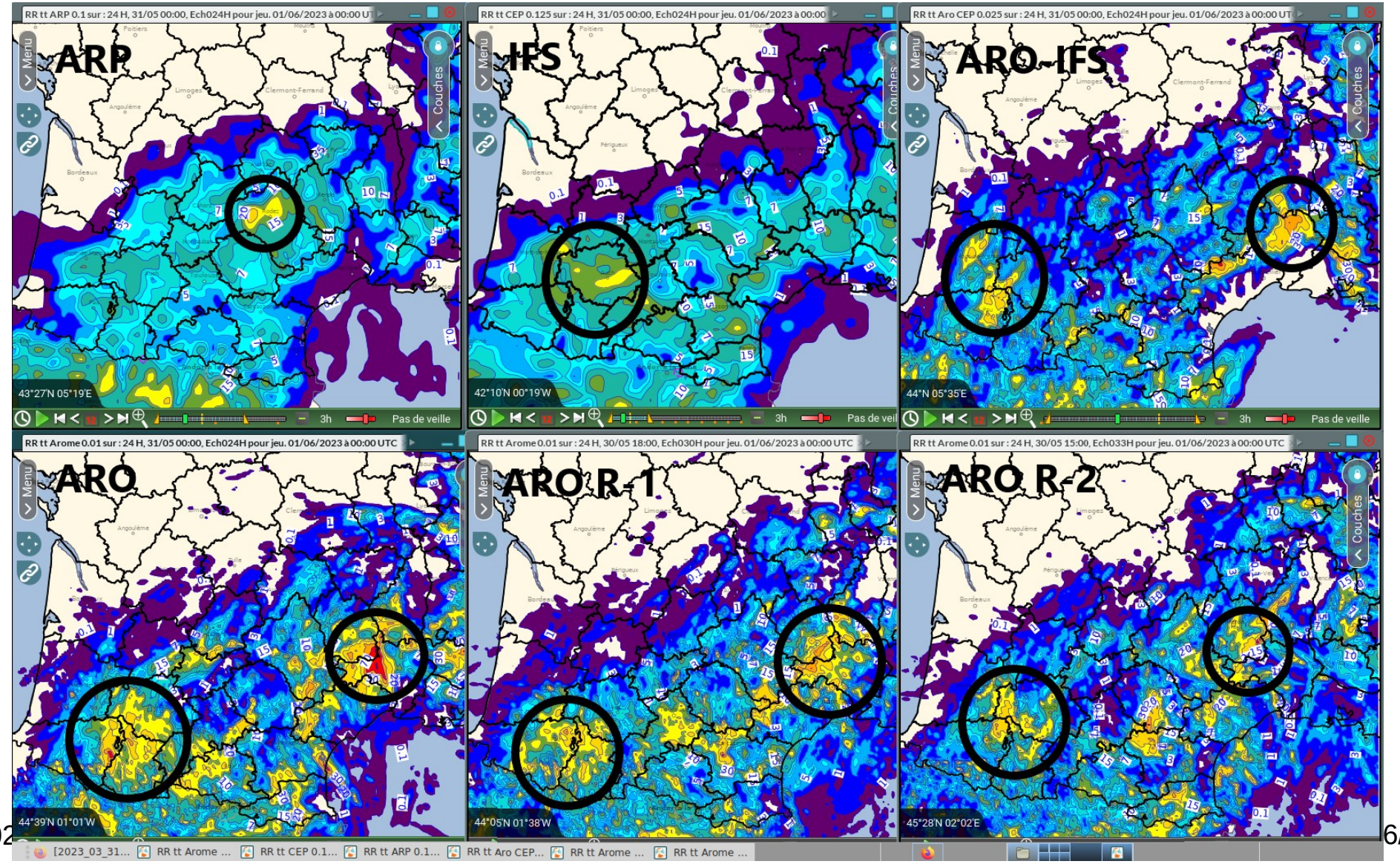
# Arome-EPS : methods to handle uncertainty

We begin by studding the deterministic models to make the big lines of the story based on a phenomenological approach : unstable warm sector, organized convection, MCS, medicane, snow from easterly returns, narrow band of cold front, sting jet, etc...



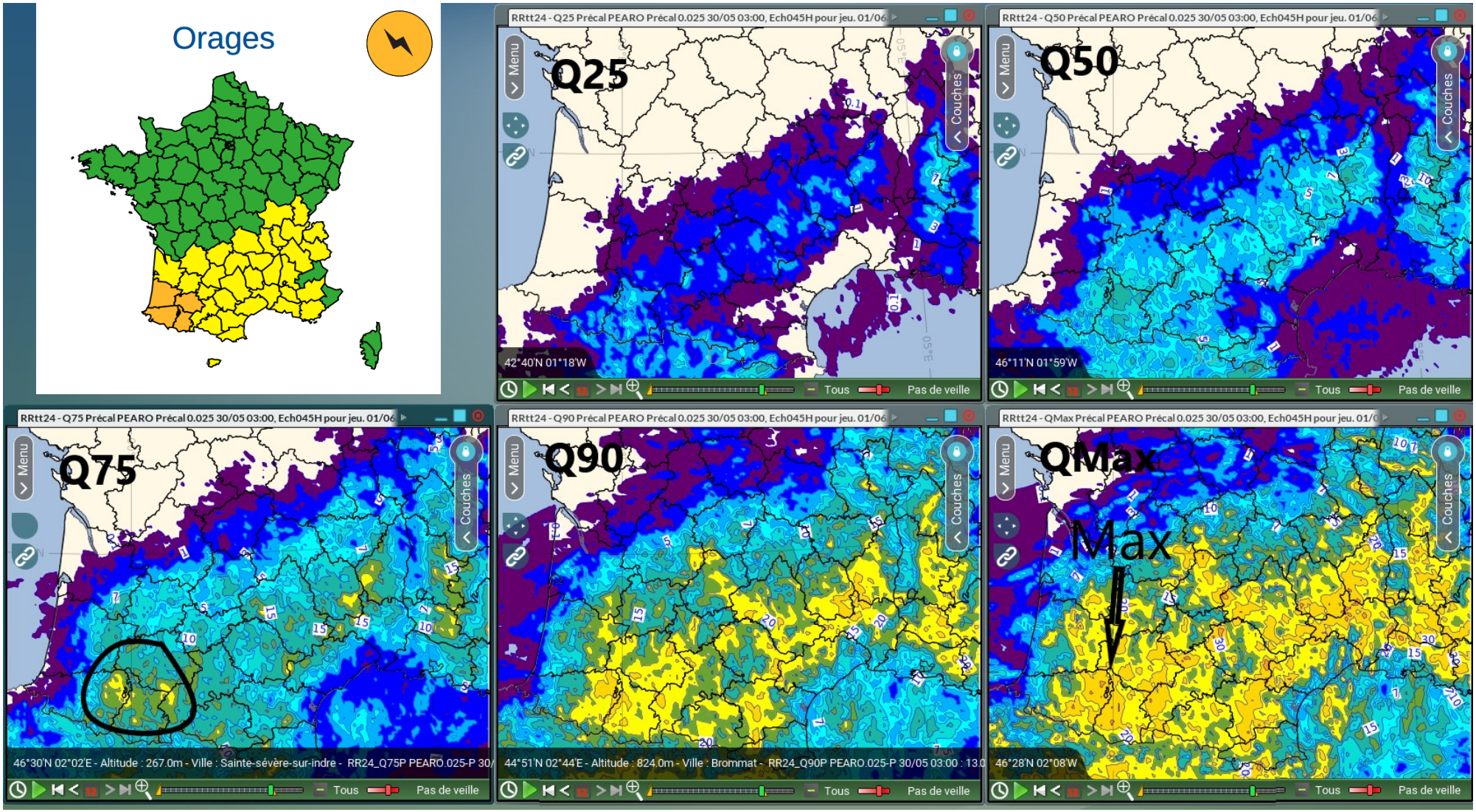
# Arome-EPS : methods to handle uncertainty

Deterministic models are suggesting an issue with heavy rain under thunderstorms, but where does one trigger a warning?



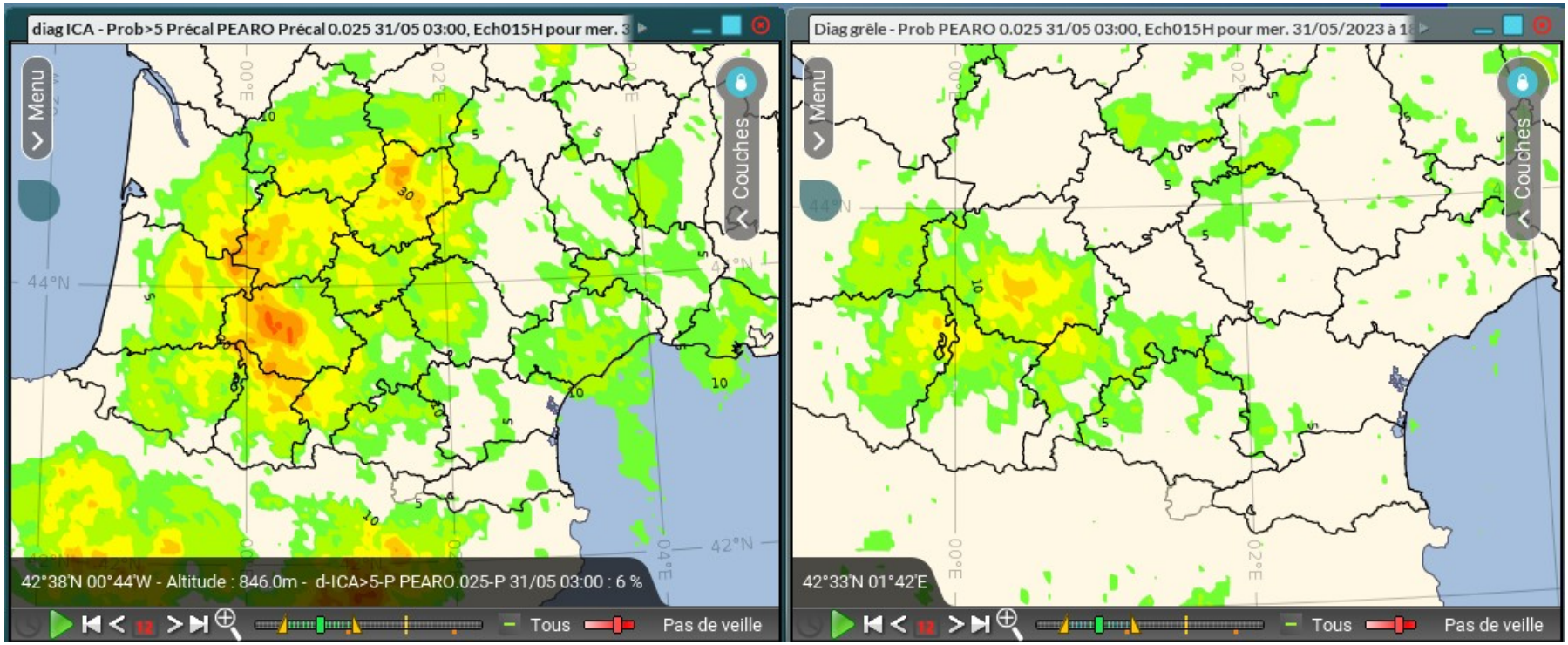
# Arome-EPS : methods to handle uncertainty

The percentiles allow the forecaster to zone out the most risk area (Q75) and to set the maximum amount of rain (Q90/Qmax).



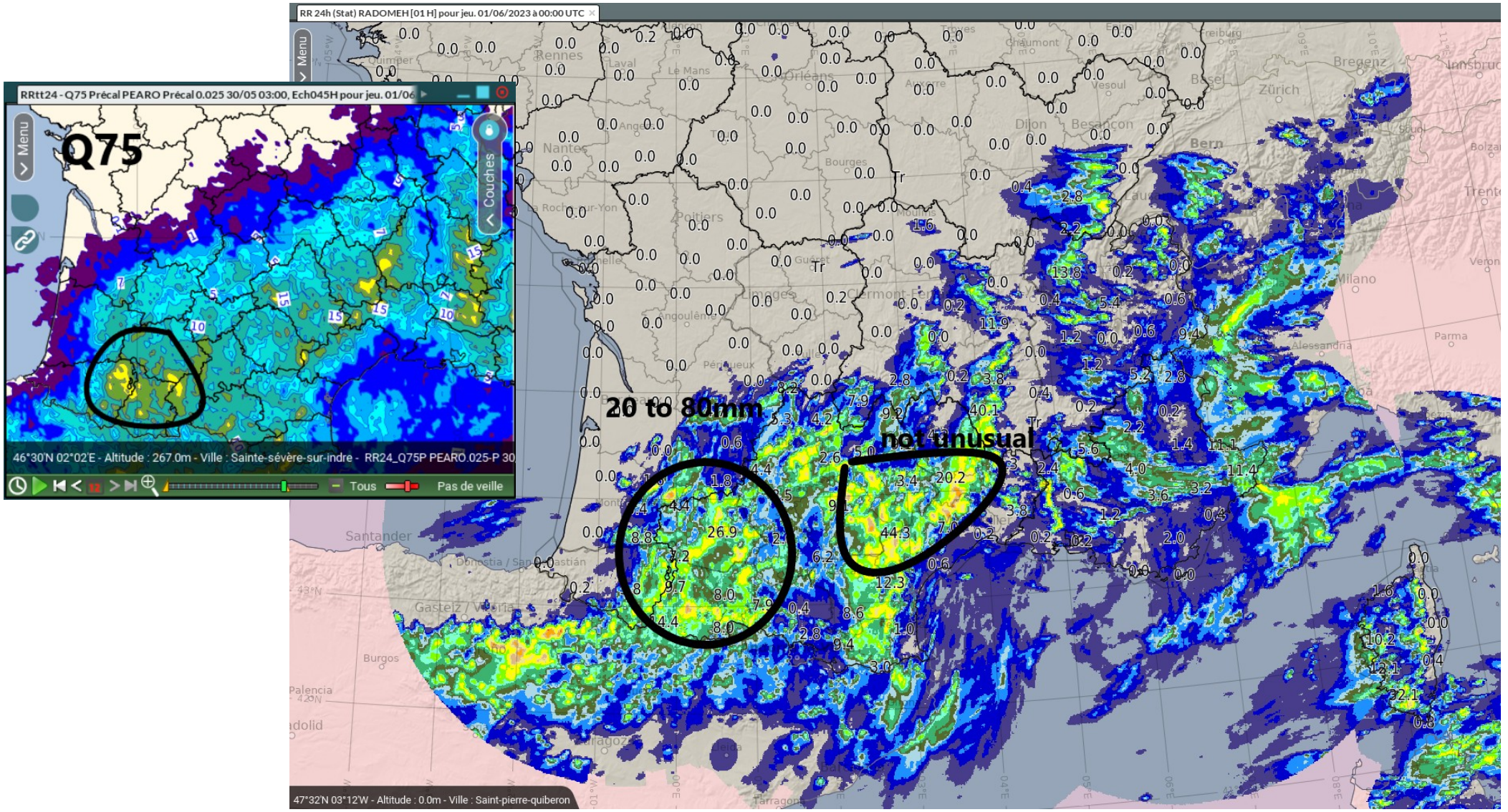
# Arome-EPS : methods to handle uncertainty

The probabilities to have Hail and a strong convection index gave a good signal too.



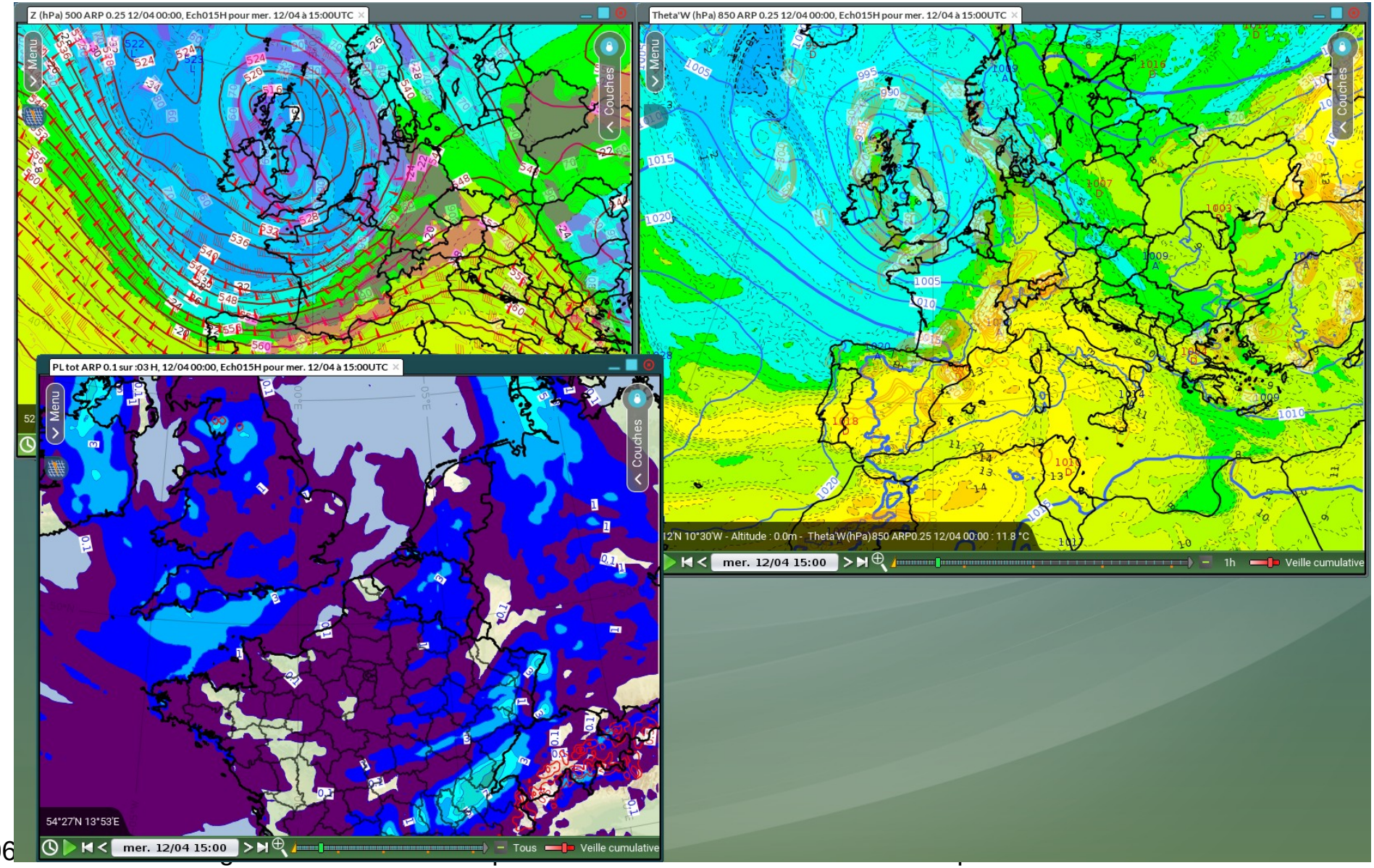
# Arome-EPS : methods to handle uncertainty

The result :



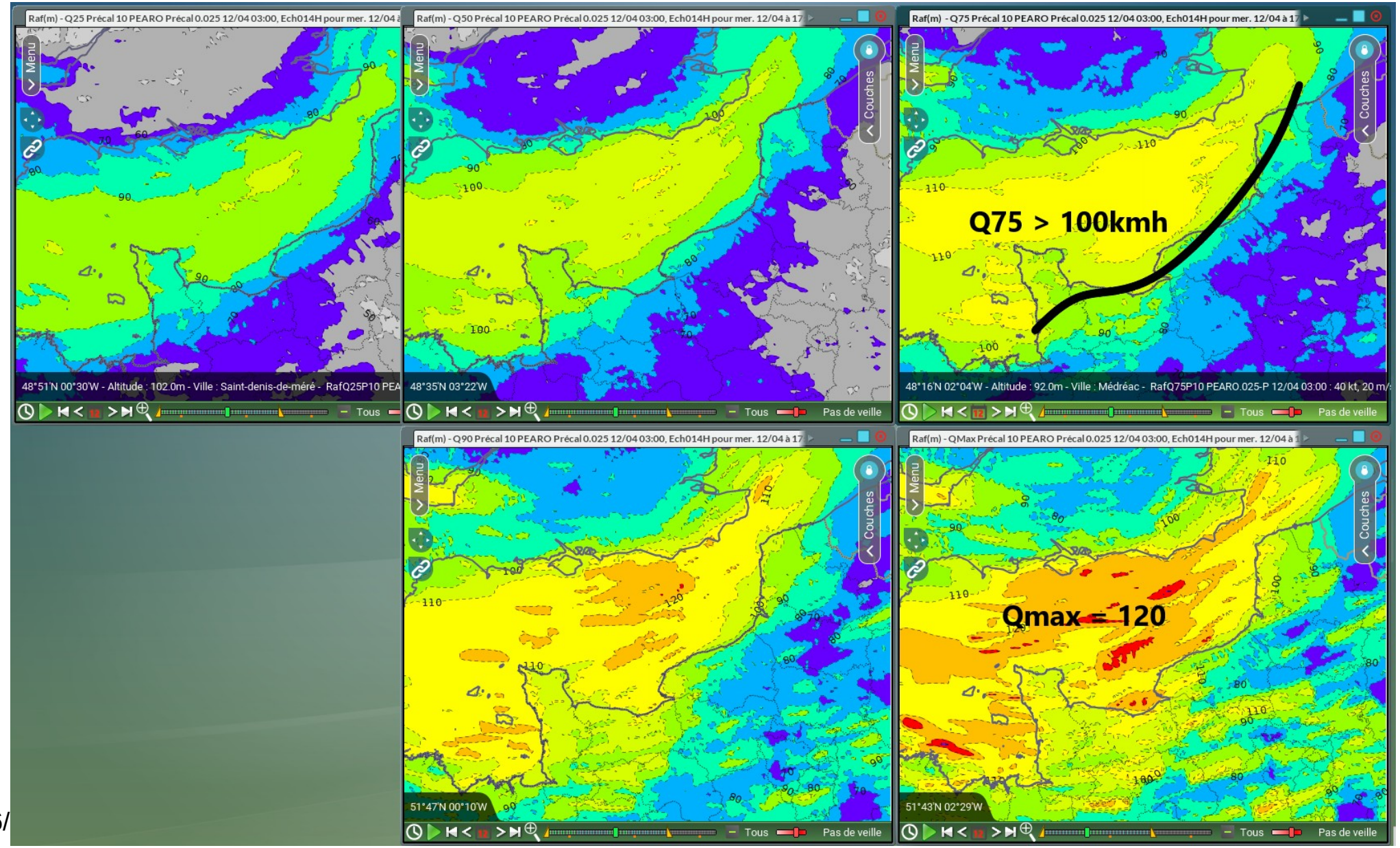
# Arome-EPS : methods to handle uncertainty

An other exemple with the Atlantic storm Noa (windy secondary cold front) :



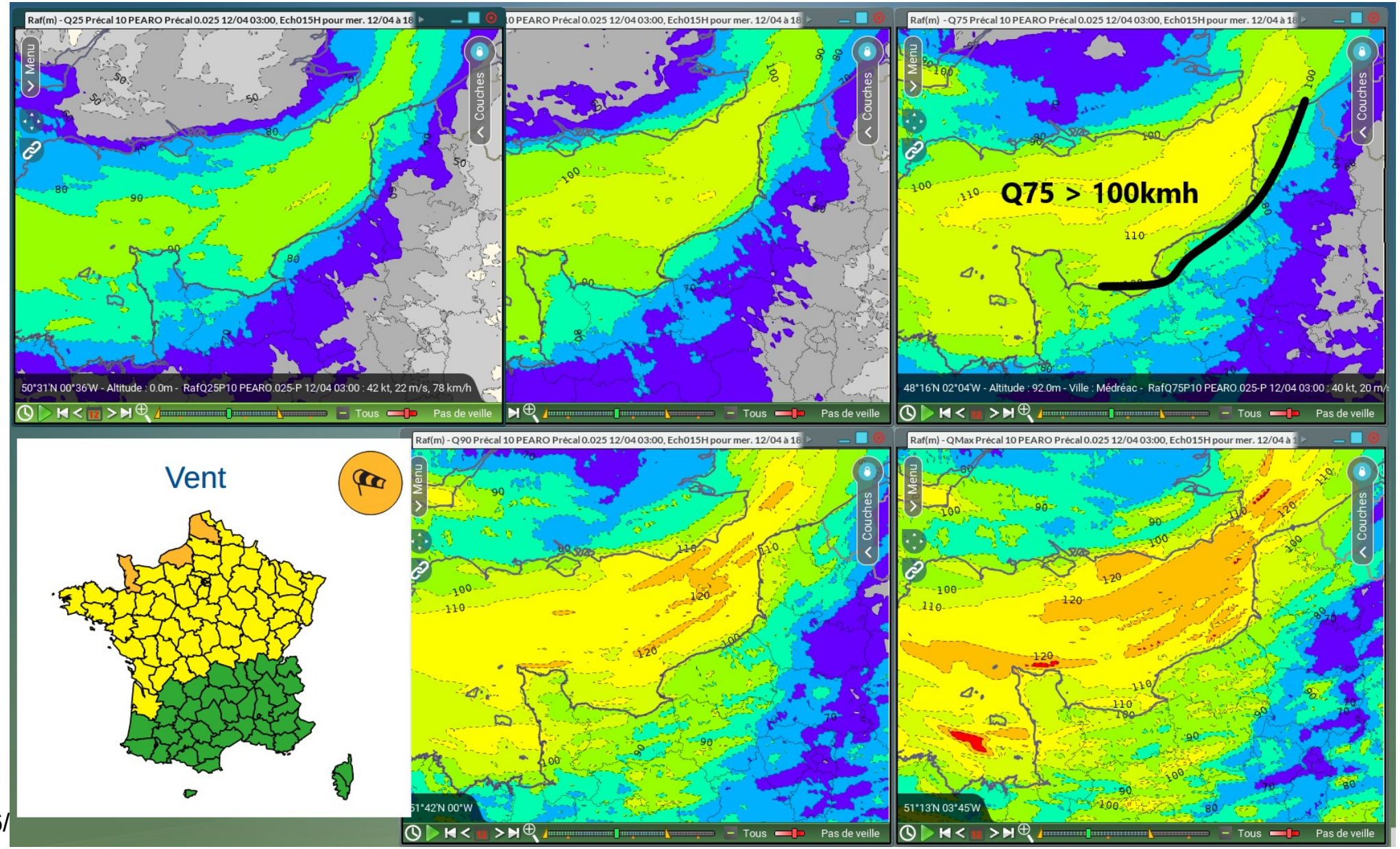
# Arome-EPS : methods to handle uncertainty

## The percentiles for max gust at 5pm



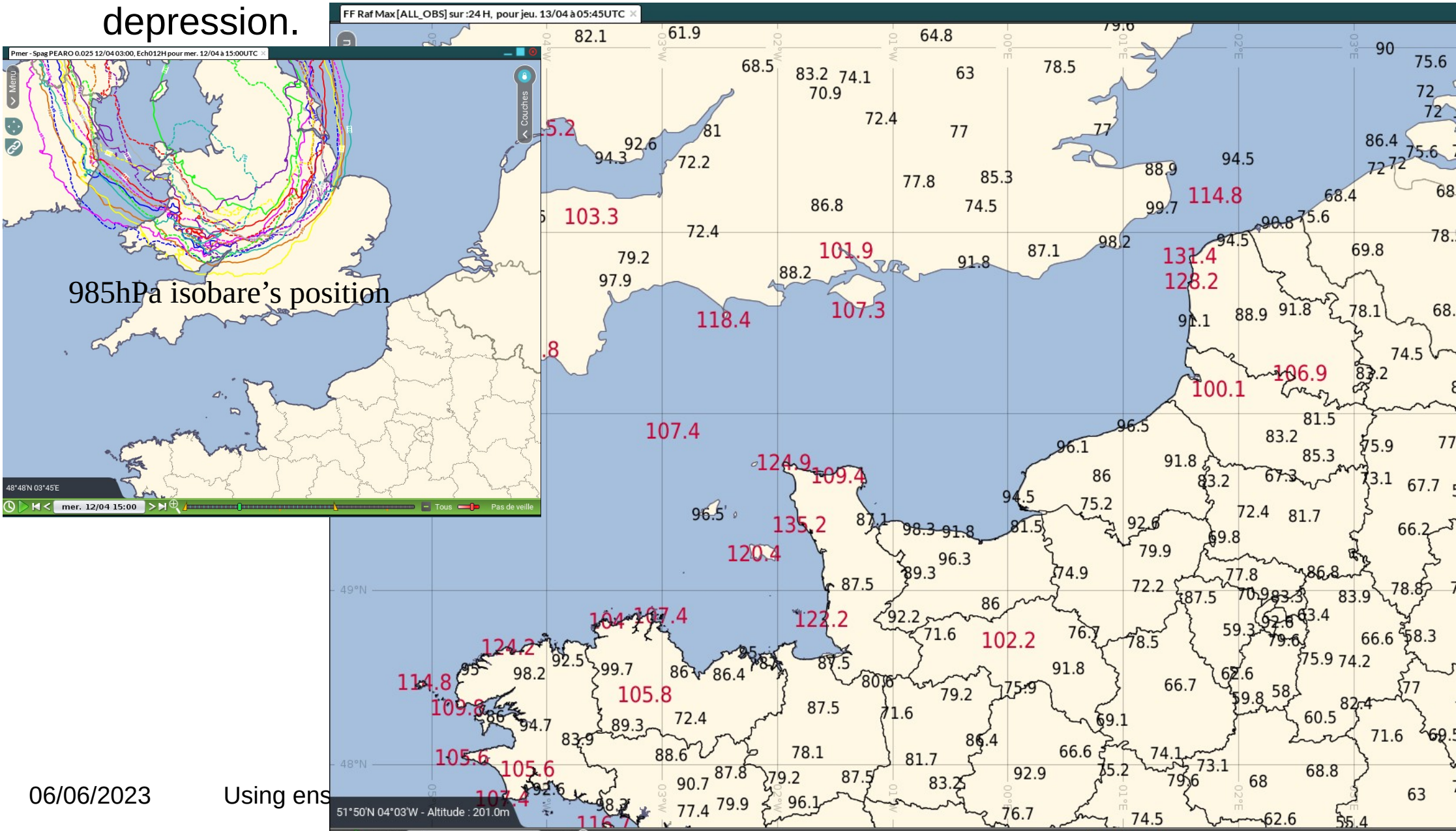
# Arome-EPS : methods to handle uncertainty

## The percentiles for max gust at 8pm



# Arome-EPS : methods to handle uncertainty

Spaghetti are showing that uncertainty comes from the deepening depression.



# Arome-EPS : methods to handle uncertainty

Thumbnails view gives an idea if a phenomenon is going to happen : sting jet

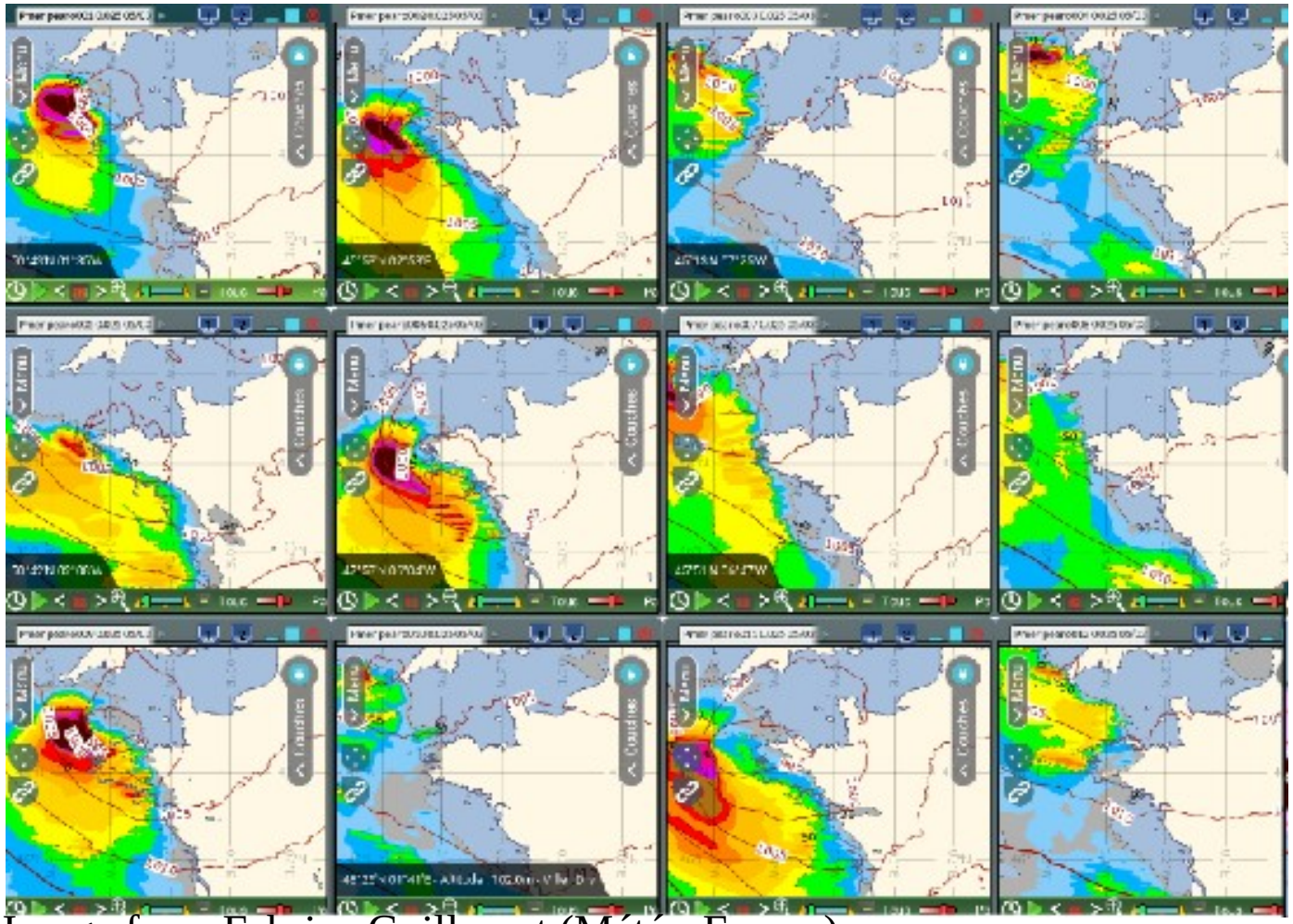
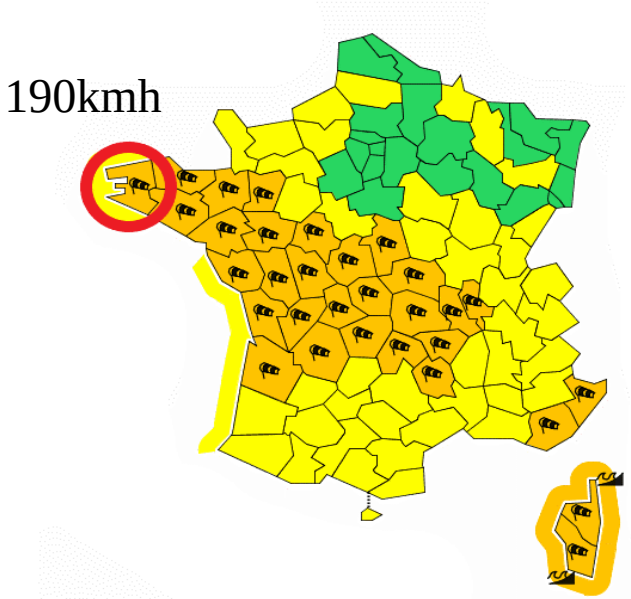


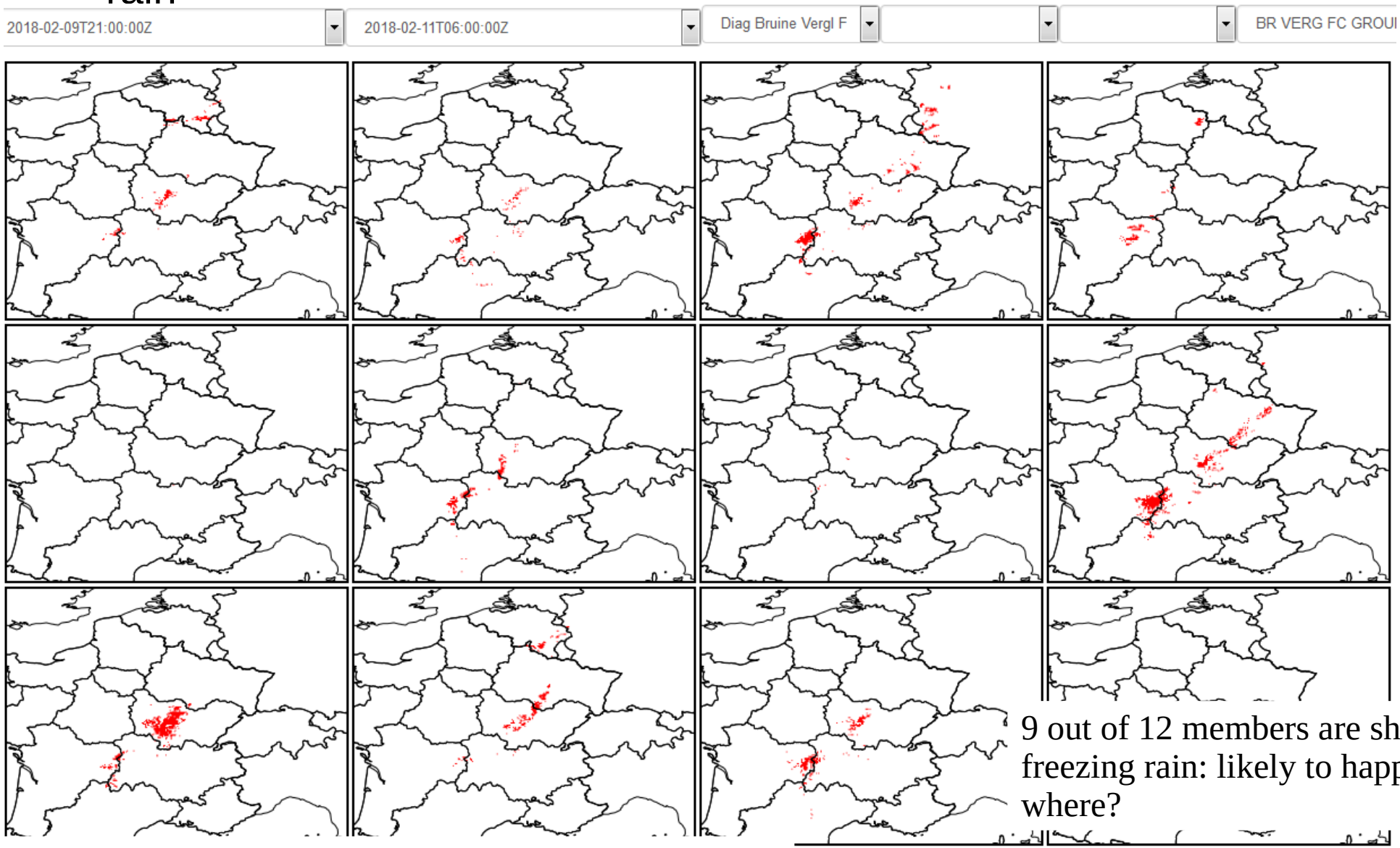
Image from Fabrice Guillemot (Météo-France)

Zeus storm. Half of members are creating a sting jet : likely to happen, but where?



# Arome-EPS : methods to handle uncertainty

Thumbnails view gives an idea if a phenomenon is going to happen : freezing rain

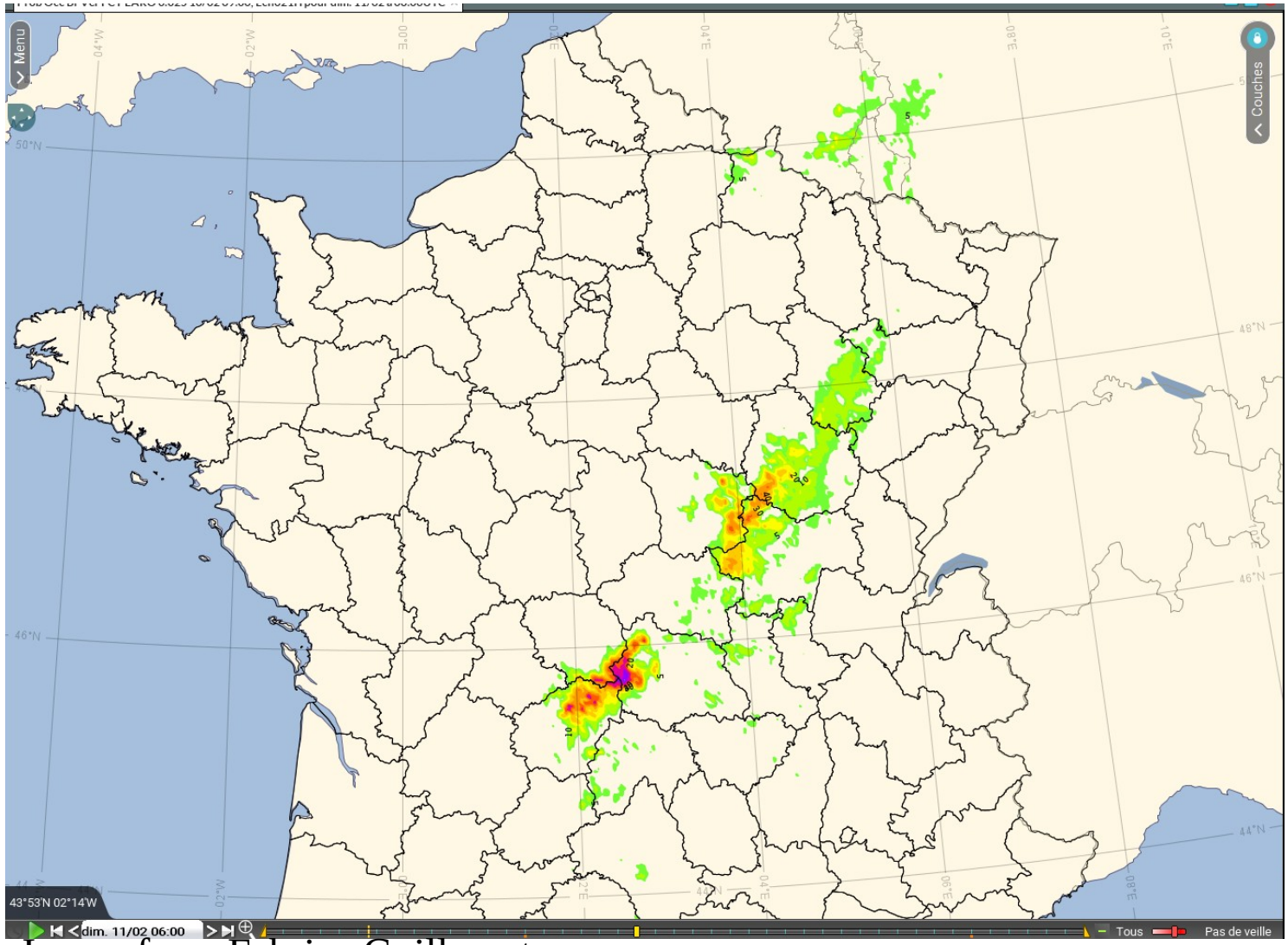



9 out of 12 members are showing freezing rain: likely to happen, but where?

Image from Fabrice Guillemot (Météo-France)

# Arome-EPS : methods to handle uncertainty

Probabilities help to pinpoint the risk, and trigger a warning where it is max :



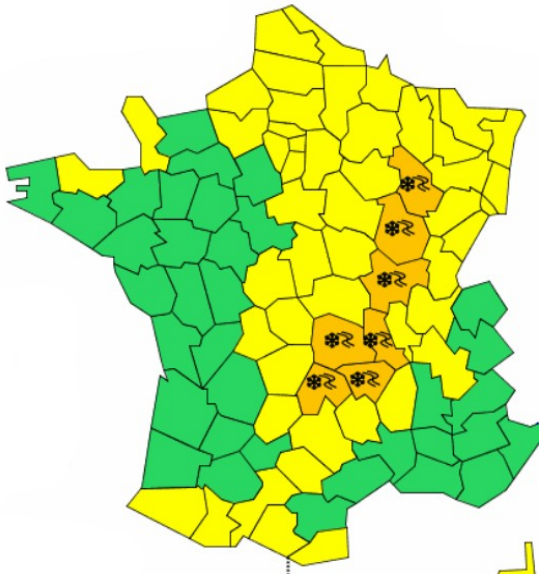



Image from Fabrice Guillemot

# Hi-Res and EPS work together

Hi-Res models :

- make the main story
- assess the uncertainty.

EPS models :

- sketch the most likely story
- wrap it with other possible items one can communicate
    - → range of values
    - → possible change in the risk zone
    - → alternative scenario.

Those methods come from a collective work between forecasters and researchers. They are still improving by experiencing new case studies, and depending on services' specificity (region, marine, avalanches, air traffic…).

# Some cooking recipes

Percentiles :

P75 for zoning out the risk, P90/Pmax for the max possible value in that zone.

Thumbnails view :

If a phenomenon appears on most of half of thumbnails, it is likely.

Probabilities :

Useful to zone out a phenomenon (thunderstorm, hail, freezing rain) or a threshold overrun.
It could come with percentiles to precise the range of values reached.

Spaghetti :

Point out where the uncertainty comes from : low position or deepening, tropopause anomaly position, chronology...

# Thank you for your attention.

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