Estimation of Forecat uncertainty with graphical products
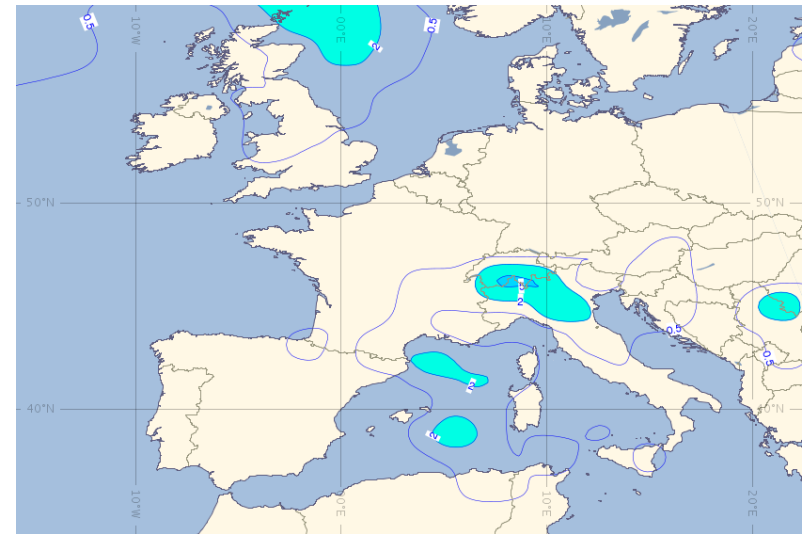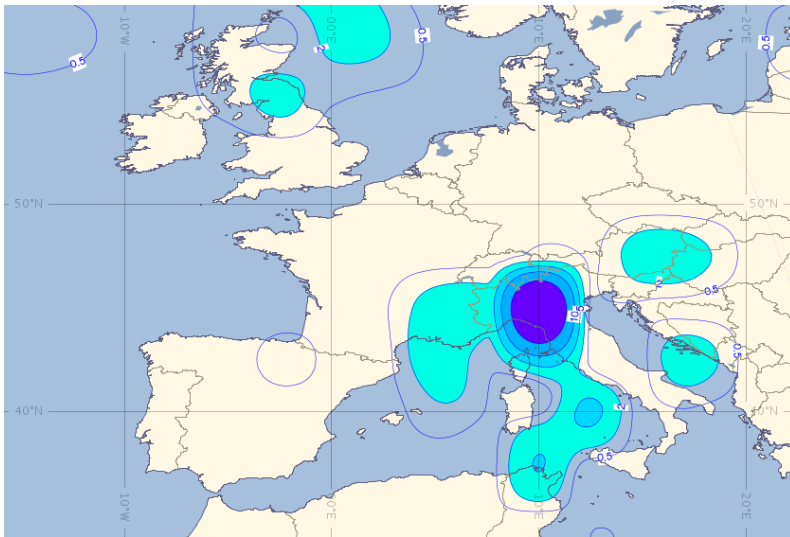
Karyne Viard, Christian Viel, François Vinit, Jacques Richon, Nicole Girardot

METEO FRANCE

- Introduction

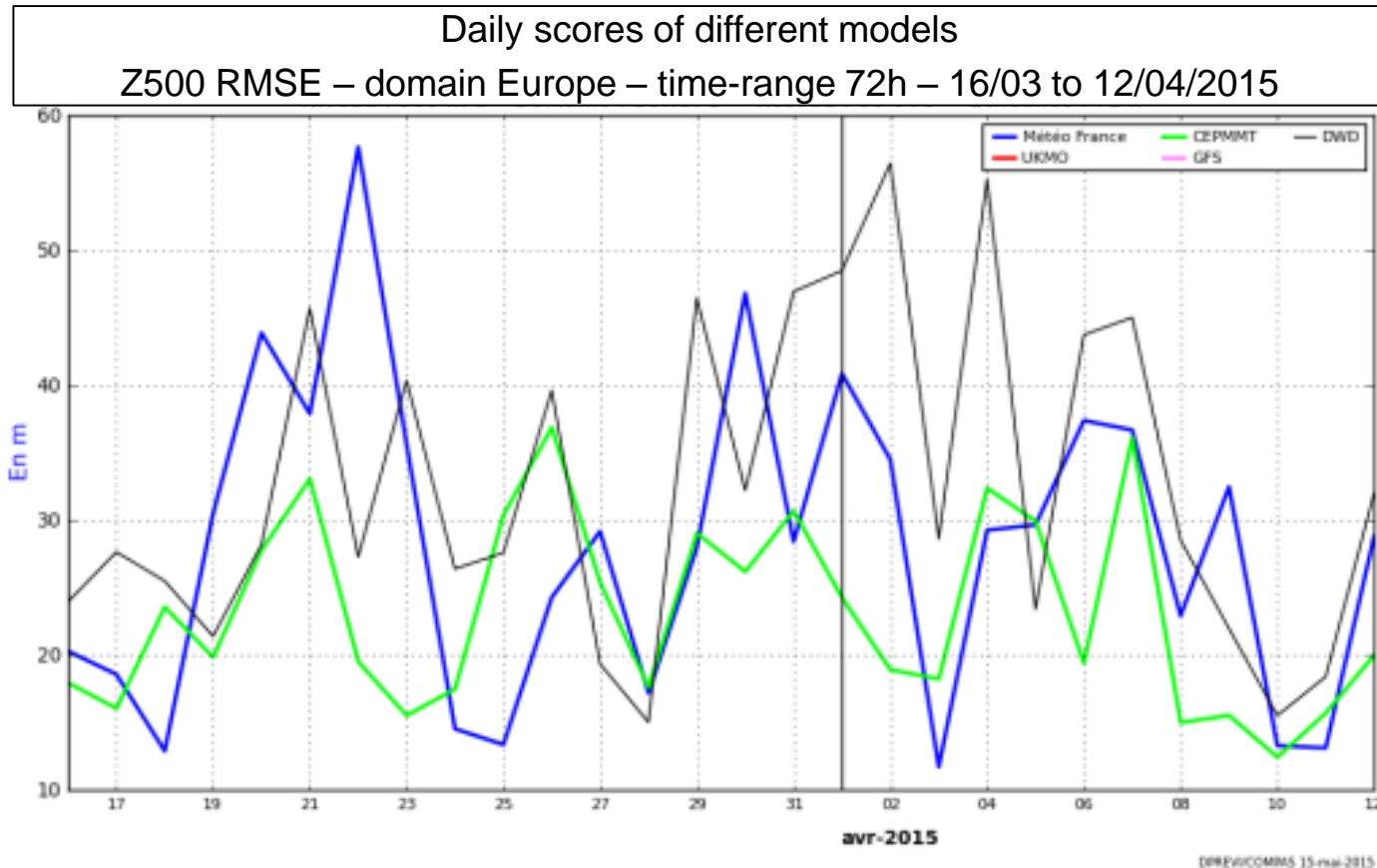- Basic graphical products… and few others

METEO FRANCE

NWP models are not perfect …

6h precipitation – time range 24h valid on 16/05/2015 0h – from two different global models X and Y

→ At least one model is wrong… maybe both…

METEO FRANCE

Does a perfect model exist ?

Daily scores of different models
Z500 RMSE – domain Europe – time-range 72h – 16/03 to 12/04/2015

→ There is some uncertainty in the forecast (it is an intrinsic attribute of the forecast)

The errors vary from day to day, from place to place

Daily scores of different models
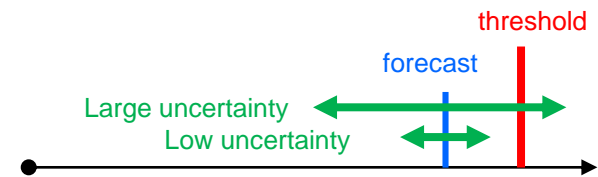Z500 RMSE – domain Europe – time-range 72h – 16/03 to 12/04/2015
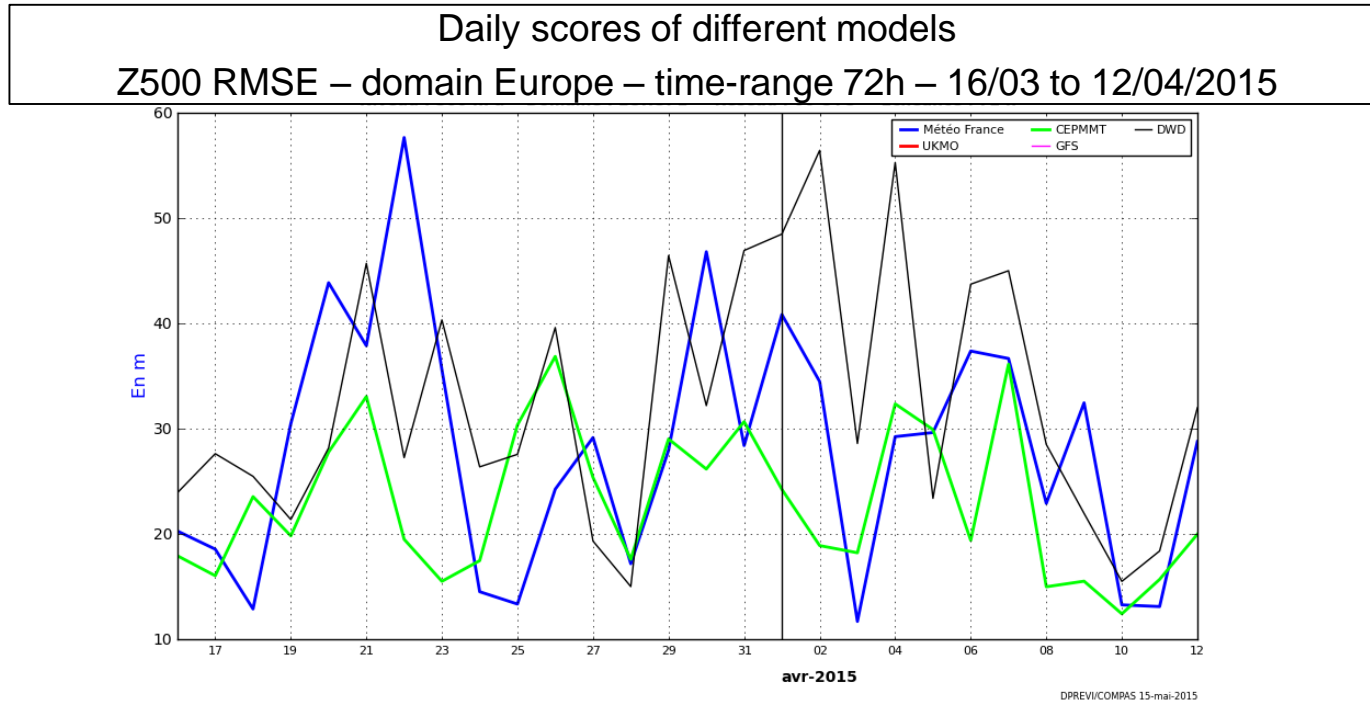
The error can be due to :
- the situation (all models do large error)
- to the model himself
→ If we can have an estimation of the error risk in advance it will be useful

What can we do with the information of uncertainty :

- End users dealing with threshold-events (windspeed and wind turbines, trains…)

- forecasters (better interpretation of models, better communication)

- numerical models : to elaborate the initial state, ponderation of observations and first guess is tuned by estimating uncertainties of each one.

→ **the uncertainty is an added value to the forecast !!!**

Nowadays, ensemble systems are the main tool to estimate uncertainty.

That means that for every grid point of the model output (in 3D), every time-step and every parameter, we don't have only one value but N values.
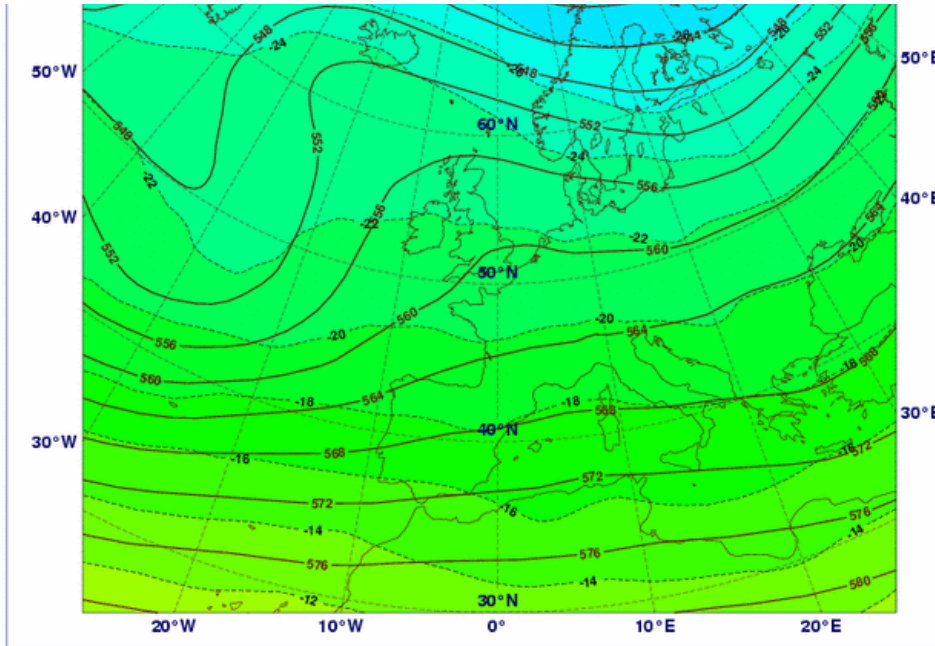
Two kinds of information can be extracted from the ensemble :

      - deterministic-like information

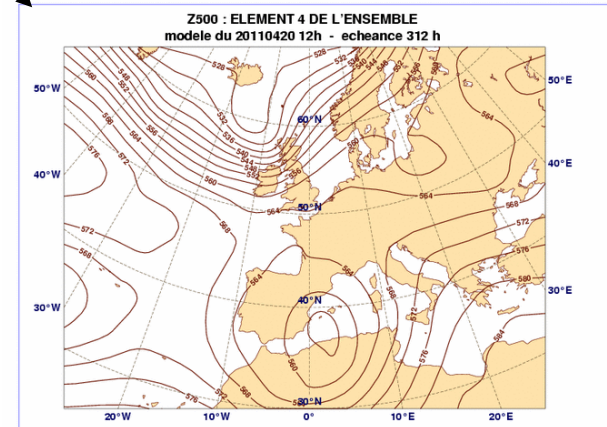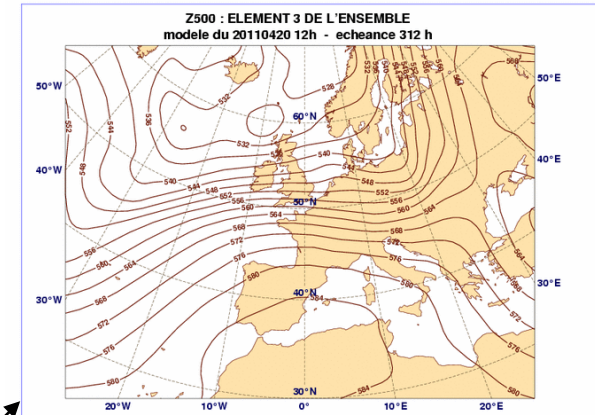   - measure of uncertainty

METEO FRANCE

Quick examples of deterministic-like information :

Ensemble means (considered as something comparable with deterministic models, but a mean is a mean and can hide many different things)

ZT500 ensemble mean from 20/04/2011-12h EPS +312h


2 different ensemble members

Z500 : ELEMENT 3 DE L'ENSEMBLE
modele du 20110420 12h - echeance 312 h

Z500 : ELEMENT 4 DE L'ENSEMBLE
modele du 20110420 12h - echeance 312 h

The products   2/23

METEO FRANCE

Products from ensemble prediction systems

Quick examples of deterministic-like information :

Quantiles are considered comparable with deterministic models, because they are measured with the same unit, but it is not a real state of the atmosphere.
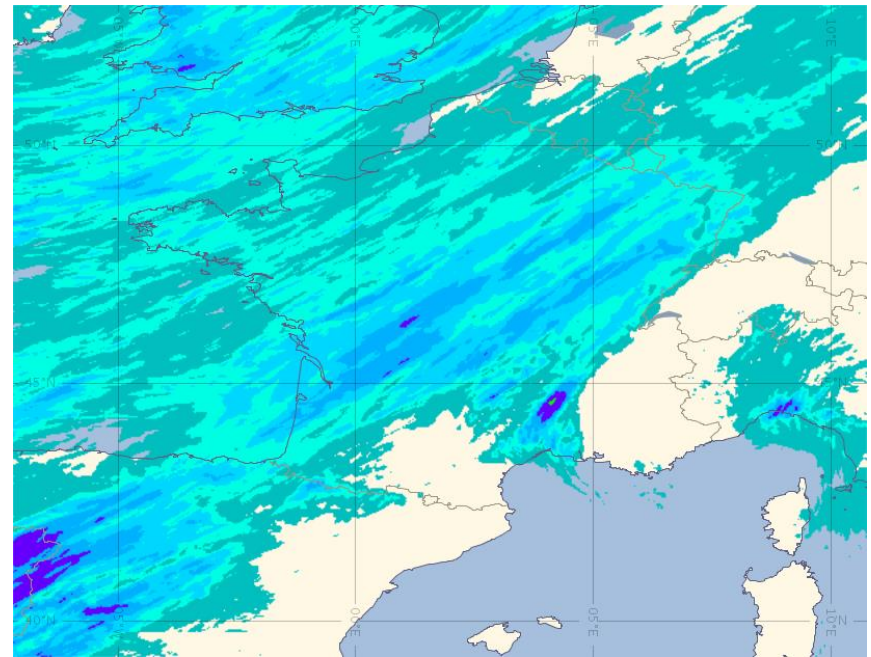
6h precipitations : one ensemble member

PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h
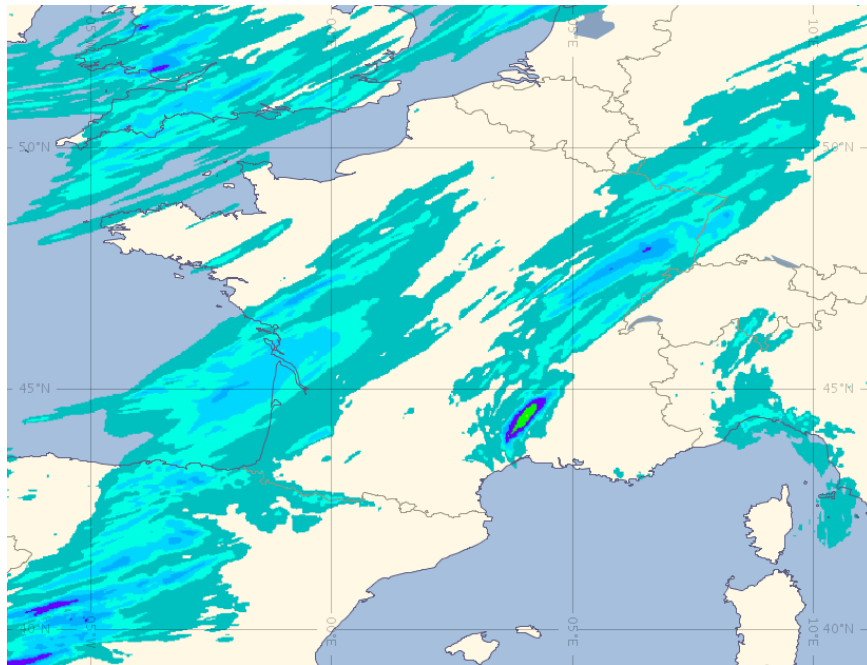
6h precipitations : quantile 90%
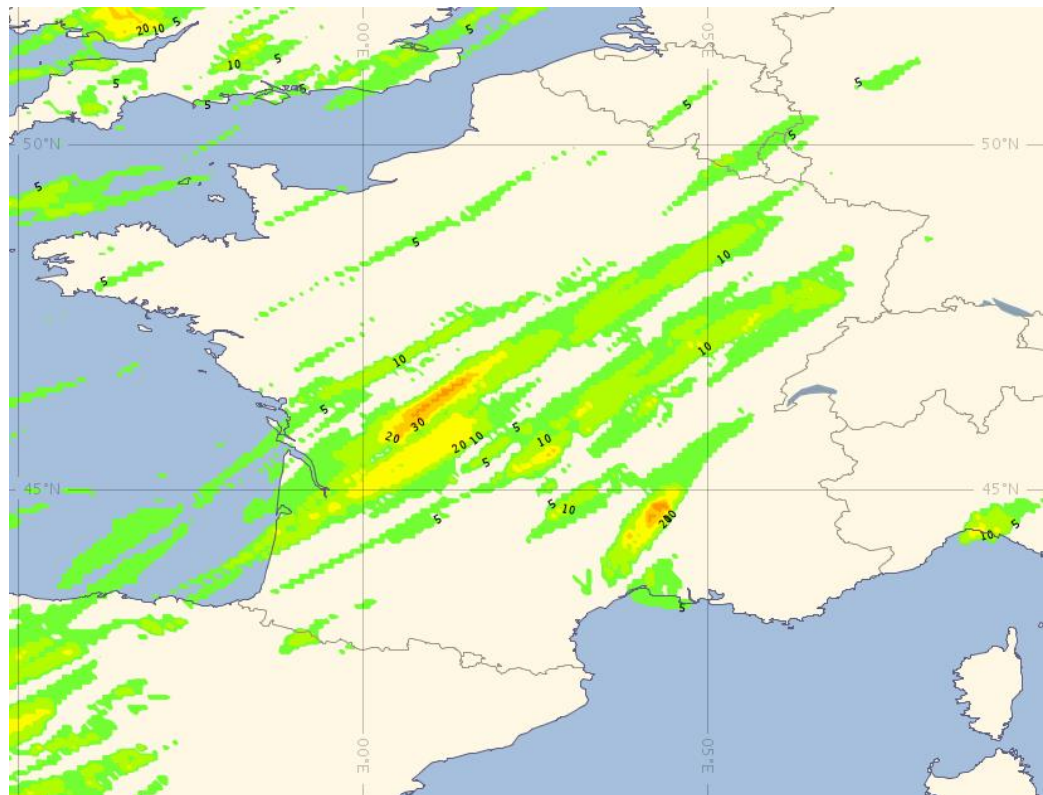
PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

METEO FRANCE

Products from ensemble prediction systems

Quick examples of deterministic-like information :

Probability maps are often used to determine a geographical area threatened with a phenomenon.
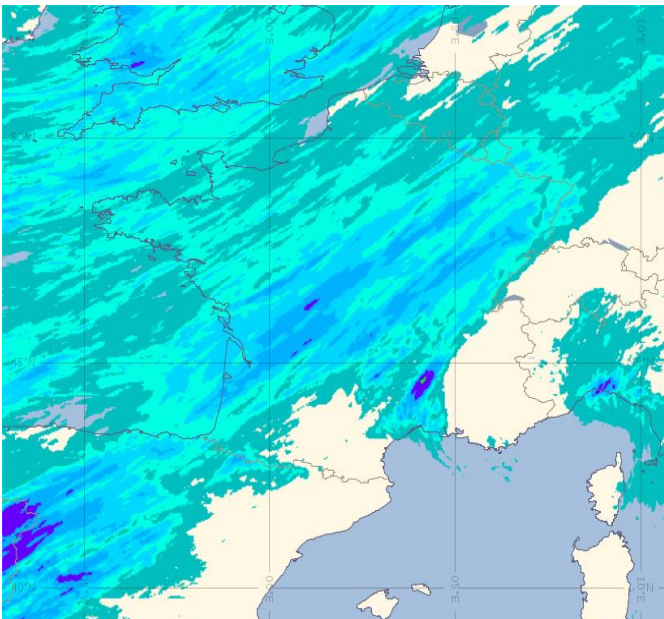
6h precipitations : quantile 90%

PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

Probability 6h-precipitations > 10mm RR

PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

METEO FRANCE

The distribution of the N values of the ensemble gives the information of uncertainty.
A simple solution to represent the distribution is to use whisker box (epsgrams).

EPS Meteogram
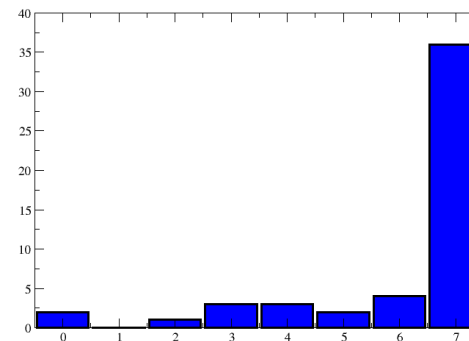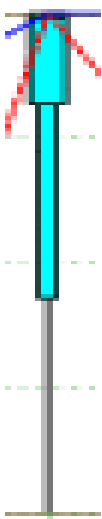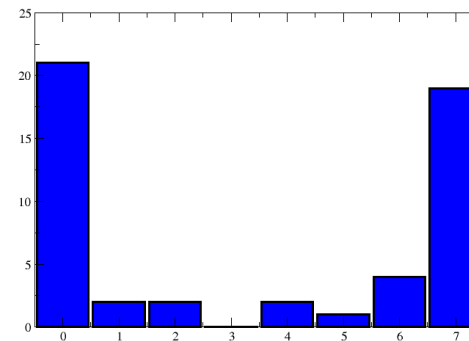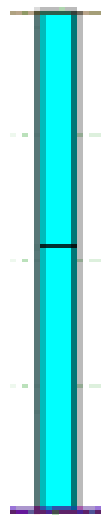Tallinn 59.44°N 24.53°E (EPS land point) 40 m
Deterministic Forecast and EPS Distribution Friday 15 May 2015 00 UTC

Total Cloud Cover (okta)
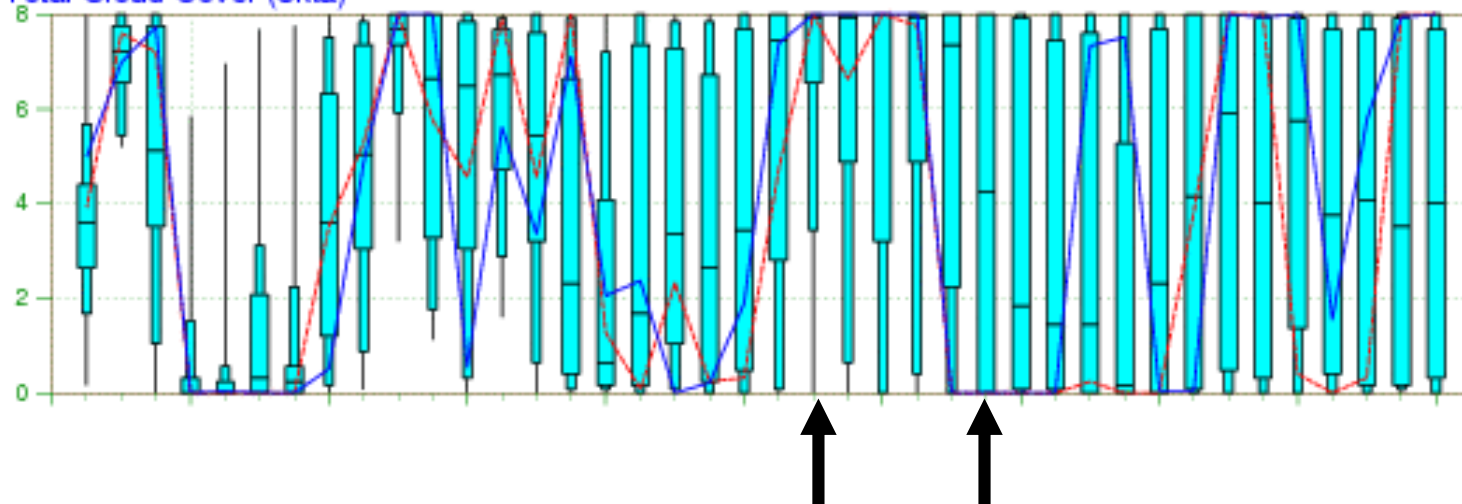
NB : if you are not fully familiar, it's difficult to imagine the shape of the distribution !

METEO FRANCE

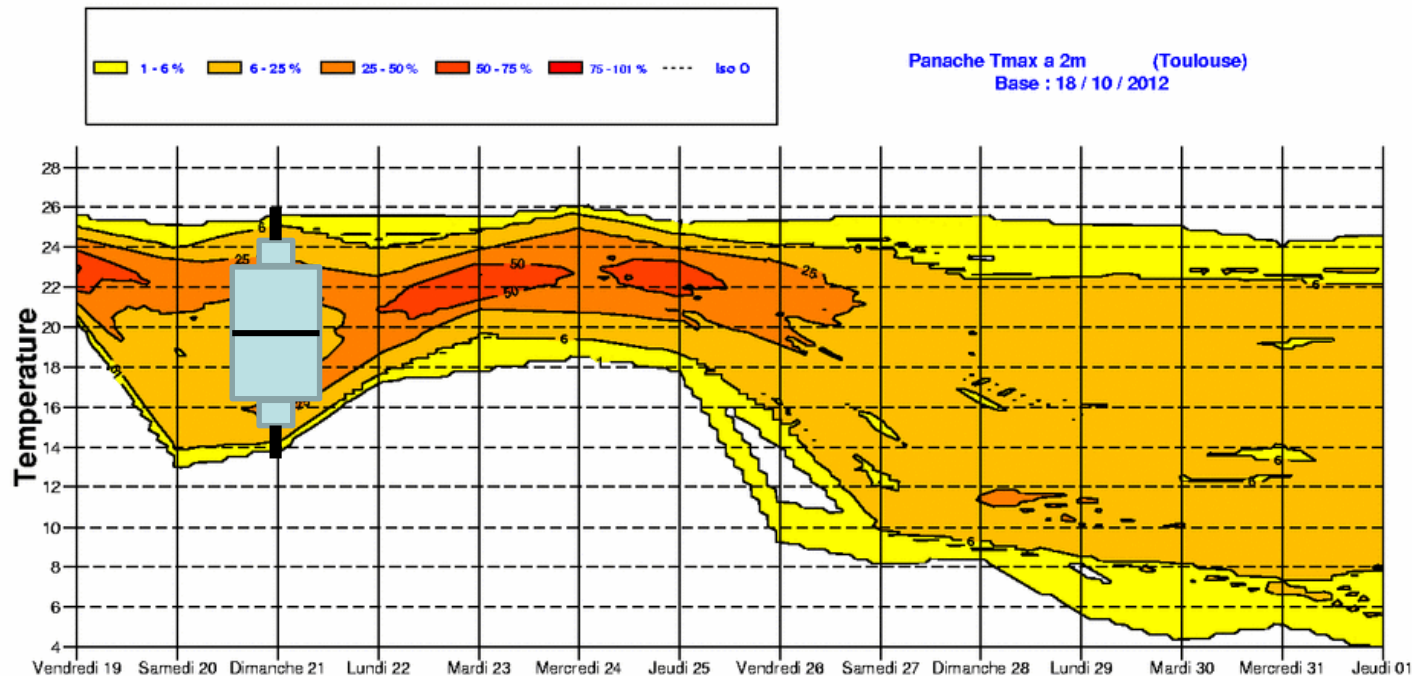Example of typical cloud cover EPSgram and the associated frequency histogram

METEO FRANCE

« Panaches » are used to figure the shape of the PDF.

For a given point of the plot, it represents the probability to be in the interval [T-1°, T+1°]

Multimodality is clear on this product.

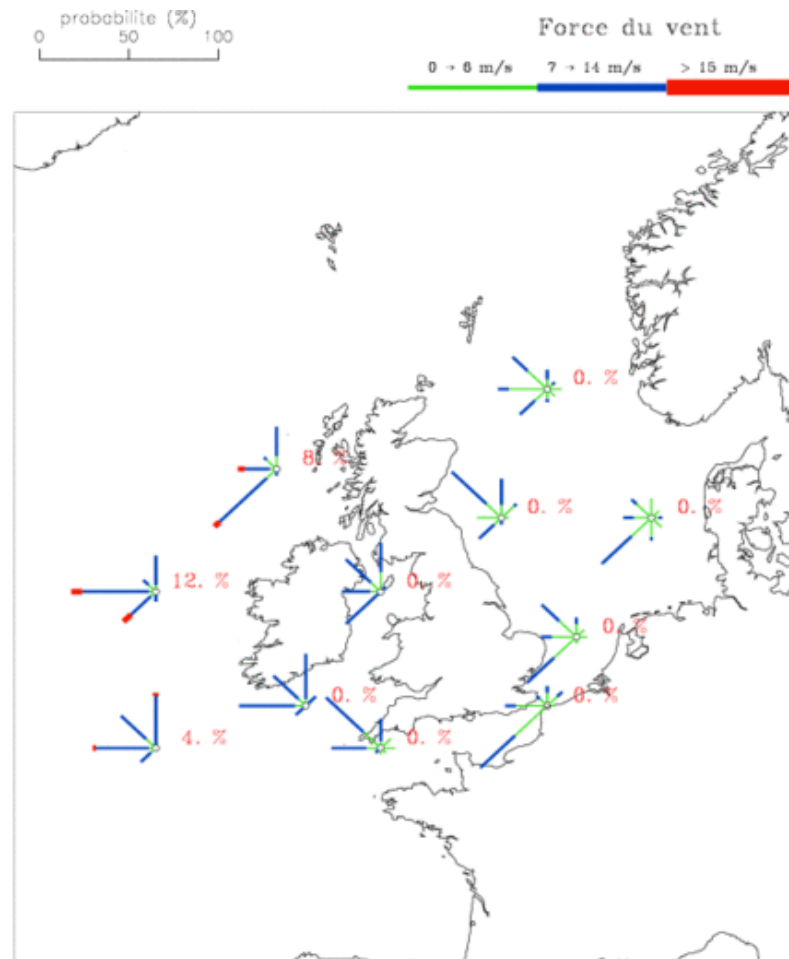Max daily 2m temperature, based on EPS from 18 october 2012 12h. (point = Toulouse)
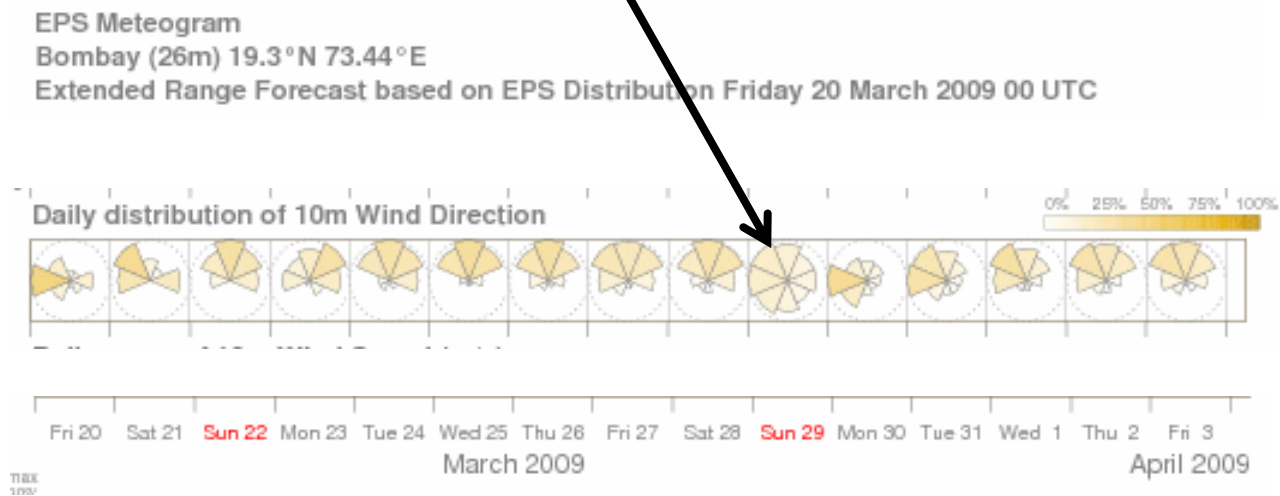
METEO FRANCE

Uncertainty for wind parameter

Wind roses are like frequency histograms for two dimensions : direction and speed

EPS from 14/05/2015 12h + 144h
Valid on 20/05/2015 12h

METEO FRANCE

Uncertainty for wind parameter

Exemple of large uncertainty in direction

EPS Meteogram
Bombay (26m) 19.3°N 73.44°E
Extended Range Forecast based on EPS Distribution Friday 20 March 2009 00 UTC

Daily distribution of 10m Wind Direction   0% 25% 50% 75% 100%

Fri 20 Sat 21 Sun 22 Mon 23 Tue 24 Wed 25 Thu 26 Fri 27 Sat 28 Sun 29 Mon 30 Tue 31 Wed 1 Thu 2 Fri 3
           March 2009   April 2009

EPS from 20/03/2009 0h

METEO FRANCE

For the forecasters, understand the meteorological situation is necessary.

→ Superposition of meteorological elements for all the ensemble members.

For example spaghettis or plums of cyclone tracks or front charts
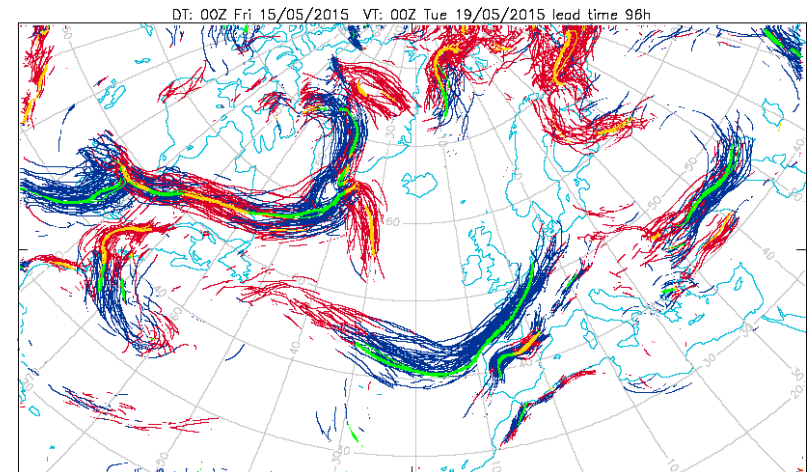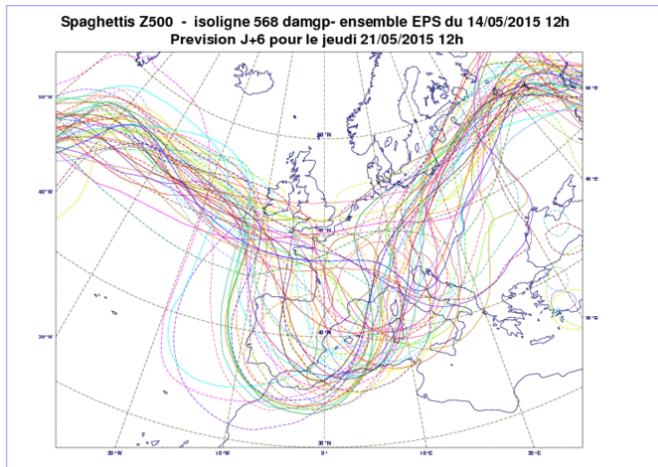
→ you have an idea of the meteorological situation (it's meteorologically coherent)

→ you can also see the accordance/divergence between ensemble members, so good idea of geographical uncertainty

→ indication of the limit of predictability

METEO FRANCE

And you can even imagine more information, for example if you plot cyclone tracks with a color indicating the intensity.

The uncertainty of intensity can be linked to the uncertainty of the position.

Tropical cyclone Bejisa (EPS from 01/01/2014 0h)

BEIJISA EPS 20140101 0h - black=...980] red=[980-990] orange=[990-1000] yellow=[1 000-1010] green=[1010...
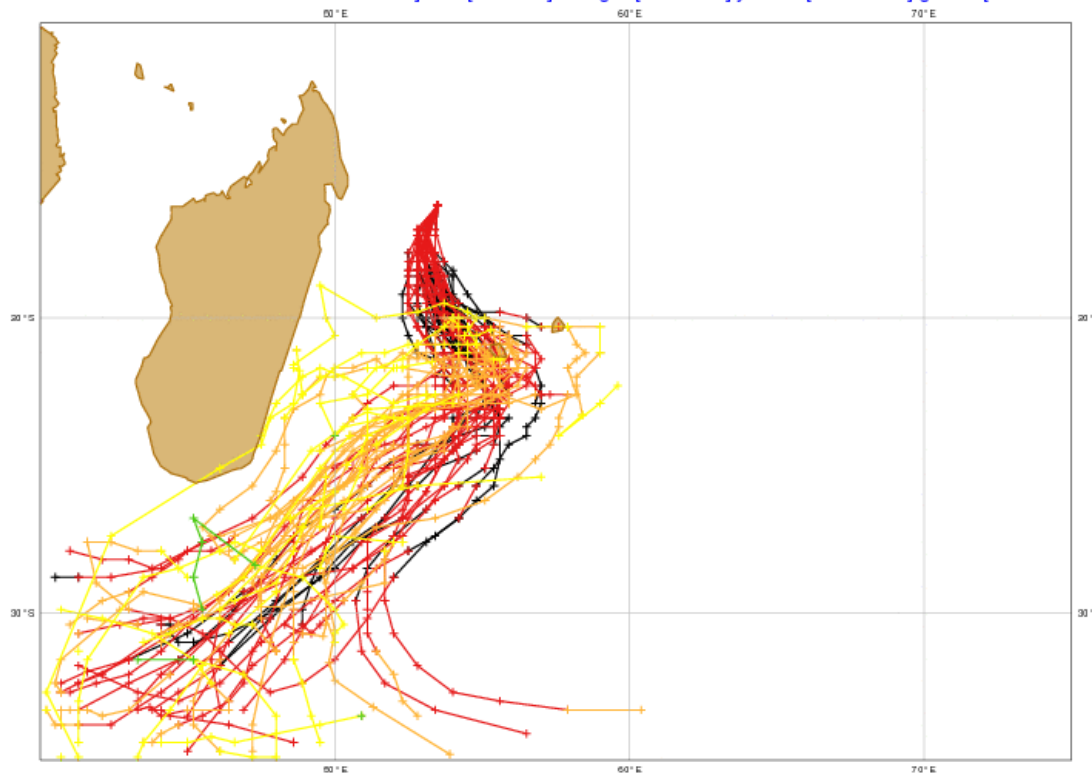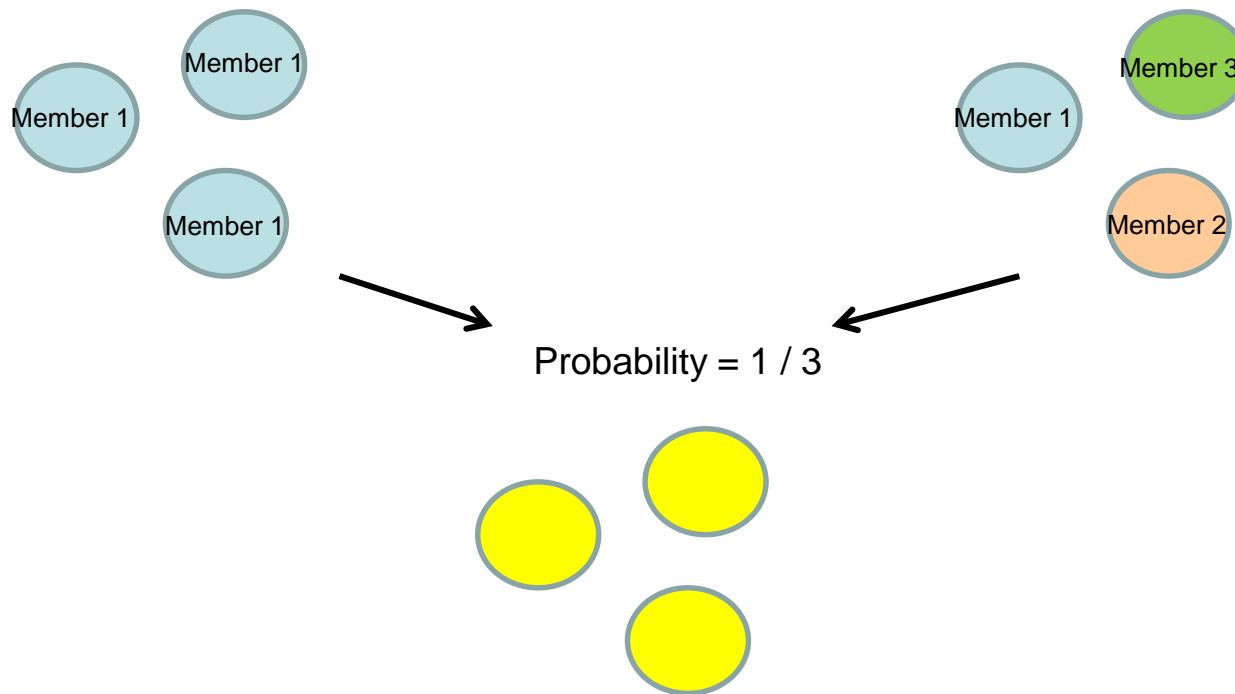
…< 980 hPa

980 – 990 hPa

990 – 1000 hPa

1000 – 1010 hPa

1010 hPa < …

METEO FRANCE

New products for Non-Hydrostatic ensemble (based on AROME model)

A probability map will not make difference between these two cases :
- one ensemble member makes rain over separated small areas
- different ensemble members make rain over small areas all differently located.

Member 1

Member 1

Member 1

Member 3

Member 1

Member 2

Probability = 1 / 3

METEO FRANCE

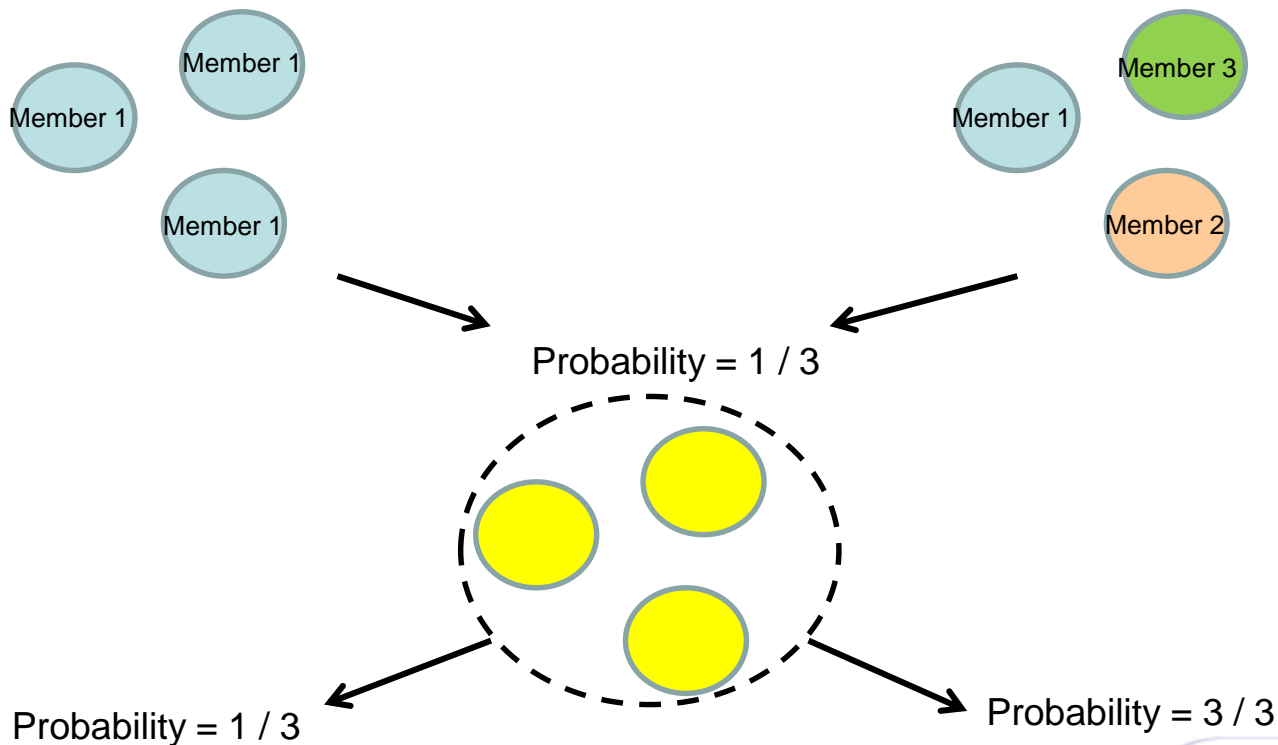First product is a kind of spaghettis plot for the precipitations and few other parameters (reflectivity, solid precipitations…).
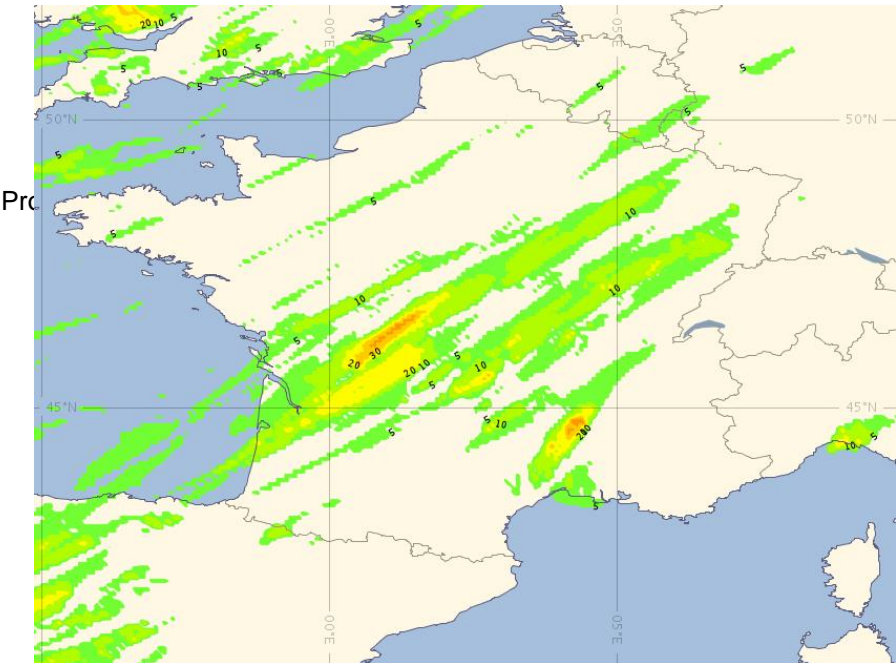
Probability 6h precipitations > 10mm
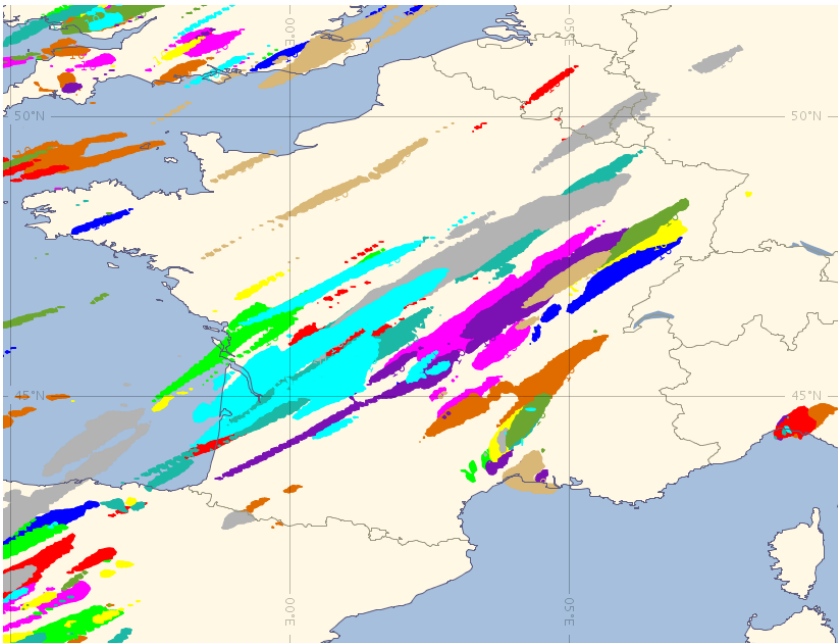
Confettis isoline 10mm

PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

« confettis » or …

Jackson Pollock's work ?
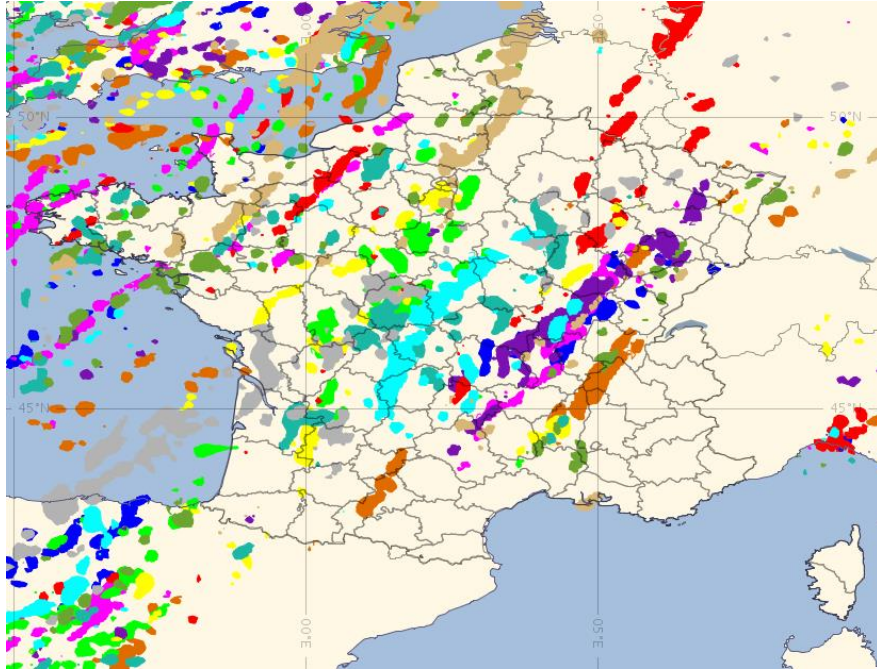
reflectivity Confettis isoline 2mm

PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

METEO FRANCE

New products for Non-Hydrostatic ensemble (based on AROME model)

A probability map will not make difference between these two cases :
- one ensemble member makes rain over separated small areas
- different ensemble members make rain over small areas all differently located.

Member 1
Member 1
Member 1

Member 3
Member 1
Member 2

Probability = 1 / 3

Probability = 1 / 3

Probability = 3 / 3

METEO FRANCE

Probability with neighbourhood takes this into account (inspired from DWD NH-ensemble)

Probabilities 6h precipitations > 10mm - PE-AROME from 08/10/2014 9h valid on 09/10/2014 13h

Raw probabilities
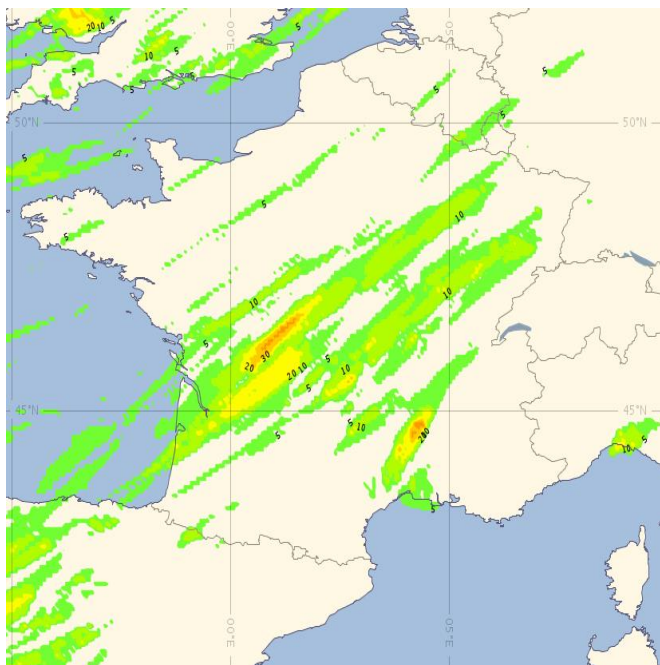
« Neighbour » probabilities

METEO FRANCE
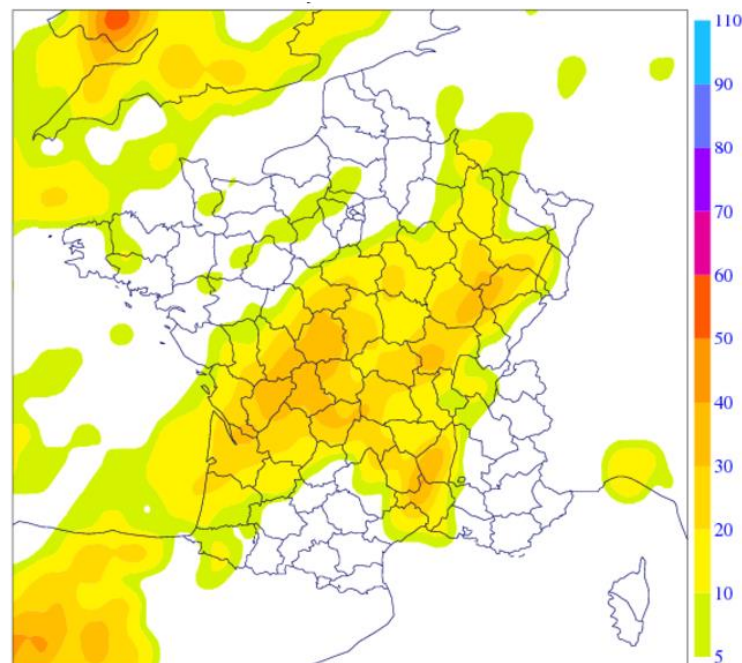
Some considerations / questions :

- There are different kinds of uncertainty : geographical, temporal, quantitative…

- We need ensembles able to estimate these uncertainties

- do we have the right scores to assess the skill of ensemble to estimate uncertainty ? (which score does tell this ?)

- graphical products are also useful for subjective assessment of uncertainty and quality of an ensemble

METEO FRANCE

Weather regimes and medium-range forecasts

Plumes of distance to every weather regime.
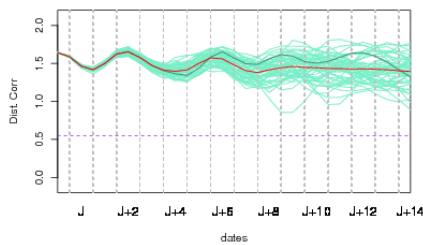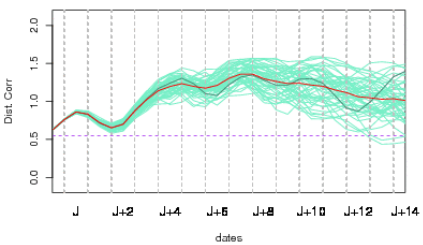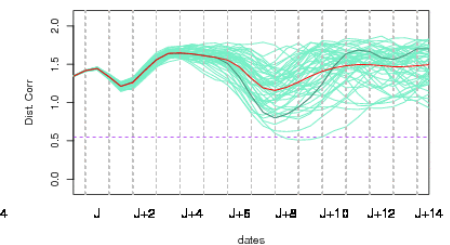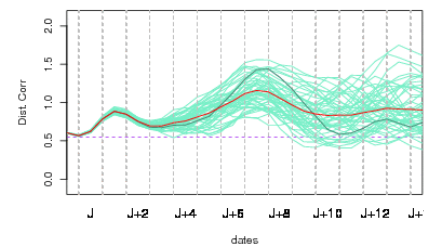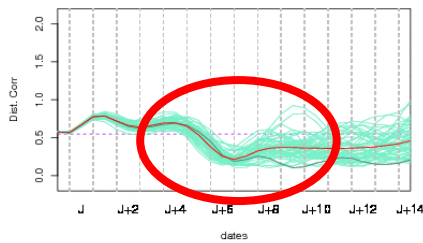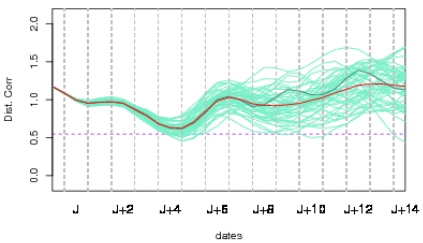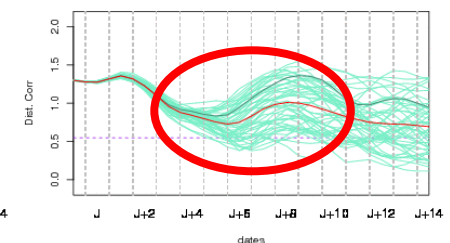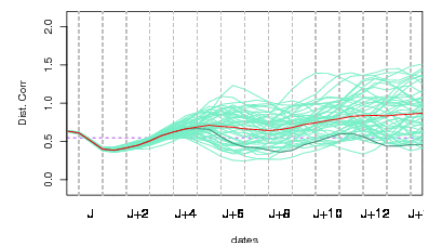
Long-range forecast of Weather regimes

Monthly Forecast from 21/05/2015
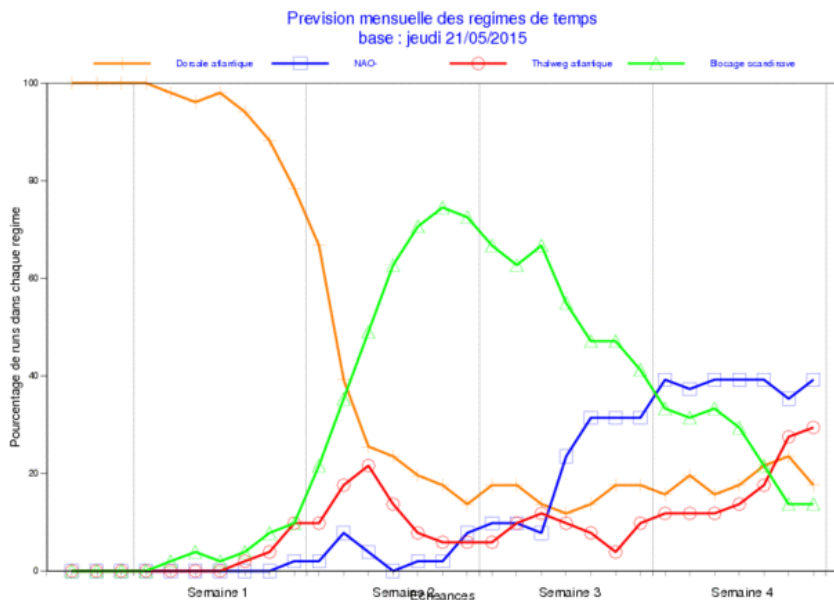
Seasonal Forecast for JJA 2015
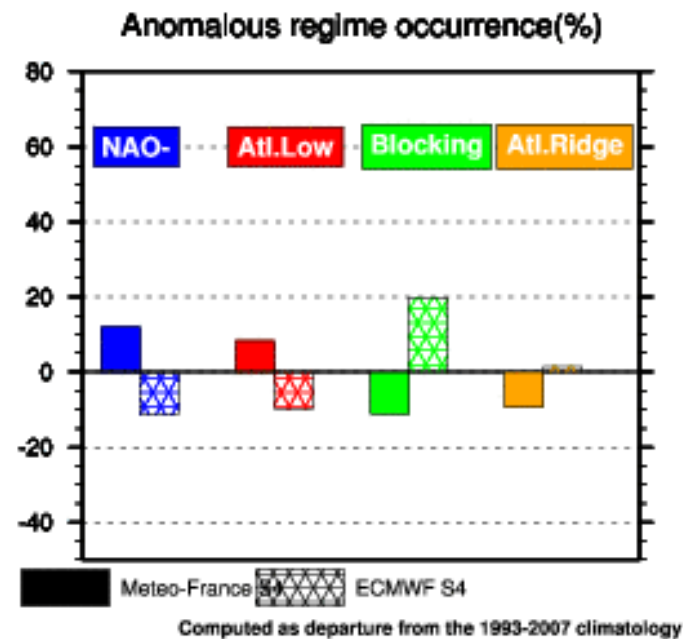
Monitoring of impact of weather regime over temperature anomalies

Regime proximity

Temperature anomaly

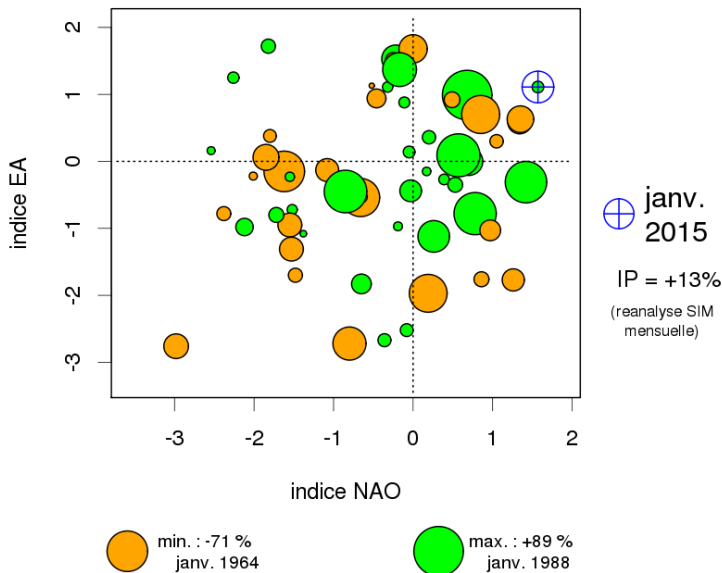These plots are available on public web page : http://elaboration.seasonal.meteo.fr/

Estimation of uncertainty : medium to long-range forecasts
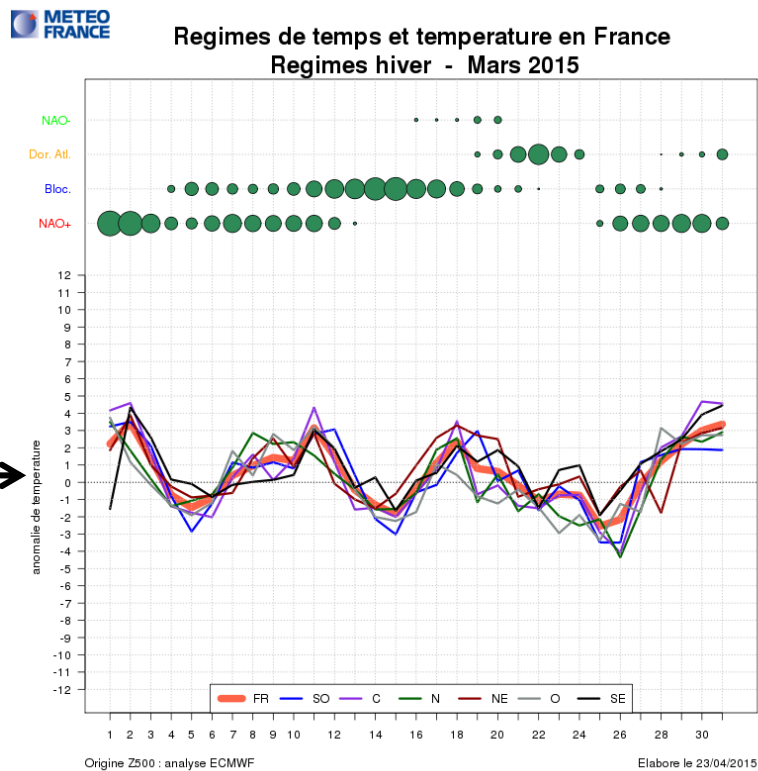
Monitoring of observed anomalies and variability modes

METEO FRANCE

Estimation of uncertainty : medium to long-range forecasts
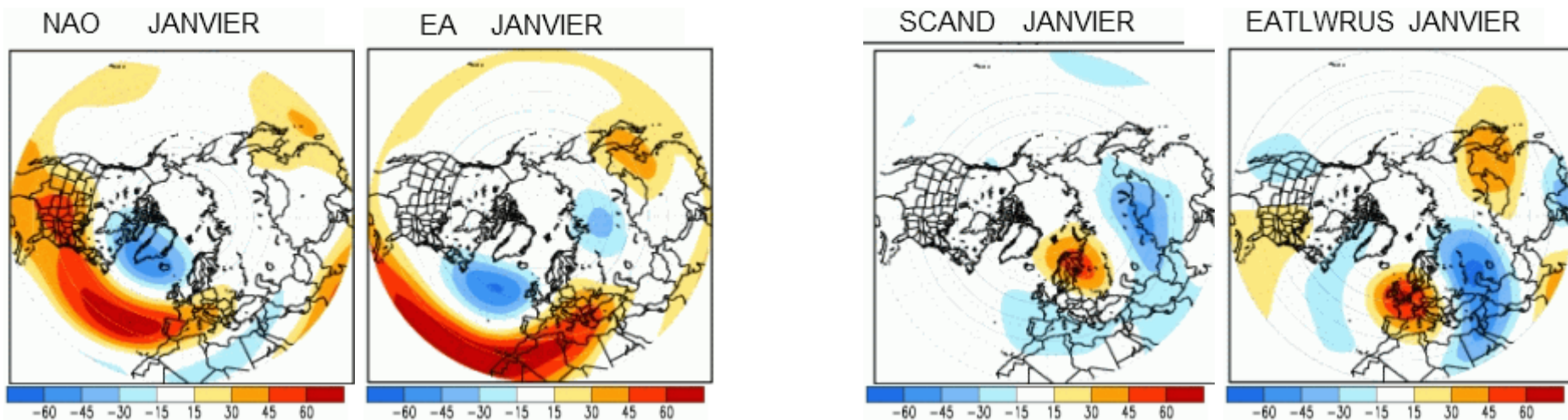
Monitoring of observed precipitation anomalies and variability modes
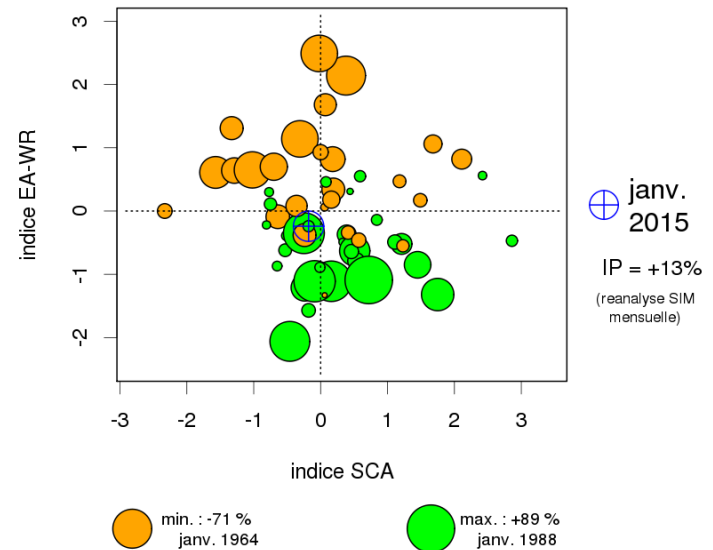
These plots are available on public web page : http://elaboration.seasonal.meteo.fr/

Plans : project the forecast onto the variability modes

(monthly and seasonal forecast)
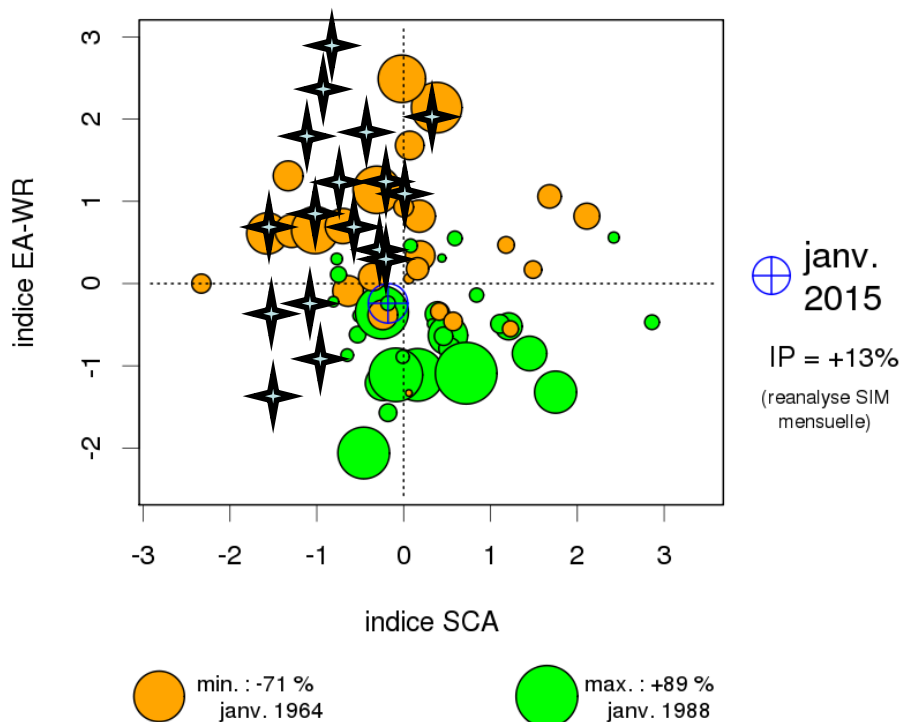
→ *Uncertainty is an added value to the forecasts*

→ *many graphical products to explore the informations given by the ensembles*

→ *products showing uncertainty are useful to give feedback to research teams*

→ *Need for « good » ensembles, so we encourage research teams*

METEO FRANCE

Thank you for your attention !

METEO FRANCE