Use of ECMWF products at Météo-France

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Deputy Head of General Forecast Department

Thanks to Bruno Gillet-Chaulet, Nicole Girardot, Fabrice Guillemot, Olivier Hamelin, Jean-Marc Jacquin and Bruno Mornet

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Outline

Use of ECMWF products at Météo-France :

- Operational forecasting at Météo-France
- Severe weather forecast for D+2 and D+3
- Medium range forecast
- Monthly weather forecast

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Operational forecasting at Météo-France (MF)

- **1 National Forecast Centre (Toulouse)**
- **7 Regional Directions**
- **95 Local Centres**

Total : 840 people, almost 25% of Météo-France staff without counting overseas services

– **Forecasting activities are defined by the Head of Forecast**

- *Ex: changing the production schedule*

- Decisions affecting the local life have to be also approved by the local director.

The Head of Forecast

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The National Forecast Centre

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The General Forecast Department (1)

- 30 forecasters - 4 working positions 24h/7d
- Forecasters appraise all available numerical weather products in order to choose the synoptic scenario for France → they issue technical guidelines for regional and local forecasters
- Chief forecaster :
  - Responsible for the coherence of the forecast from Day (D) to Day+7 (D+7) → phone conference with the 7 regional forecasters twice a day
  - Supervisor of the whole National Forecast Centre
  - Technical guidelines for D and D+1
  - Safety responsibilities for D and D+1 : the vigilance severe weather watch system, environmental emergency response (WMO RSMC)
- Forecaster 1 :
  - Atmospheric watch with observations (surface, upper air, satellites, radar)
  - Monitoring of the coherence between models and observations
  - Production of ANASYG charts (every 6 hour), PREISO/PRESYG charts

The General Forecast Department (2)

- Forecaster 2 (short range forecast) :
  - Choice of the synoptic scenario over France for D+2 and D+3
  - Technical guidelines for regional and local forecast centres
  - Production of PREISO/PRESYG charts
- Forecaster 3 (medium and extended range forecast) :
  - Choice of the scenario + confidence over France and Europe for medium and extended range
  - Technical guidelines + weather charts for D+4 to D+9
  - National media bulletin for D+4 to D+7
  - Temperature forecast for Electricity and Gas Board, for D+3 to D+5 (on a fixed list of towns)
  - Monthly weather forecast every Friday
  - During night : watch in aeronautic, marine … between 00h00 and 03h30 (local hour).

Outline

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- Operational forecasting at Météo-France
- **Severe weather forecast for D+2 and D+3**
- Medium range forecast
- Monthly weather forecast

Severe weather forecast at Météo-France

- The French « Vigilance » watch map
  - 4 watch levels (colours), for 7 dangerous phenomena, for each administrative unit (department)
  - Operational since 2001, this system is well known (86%) and has proved generally successfull

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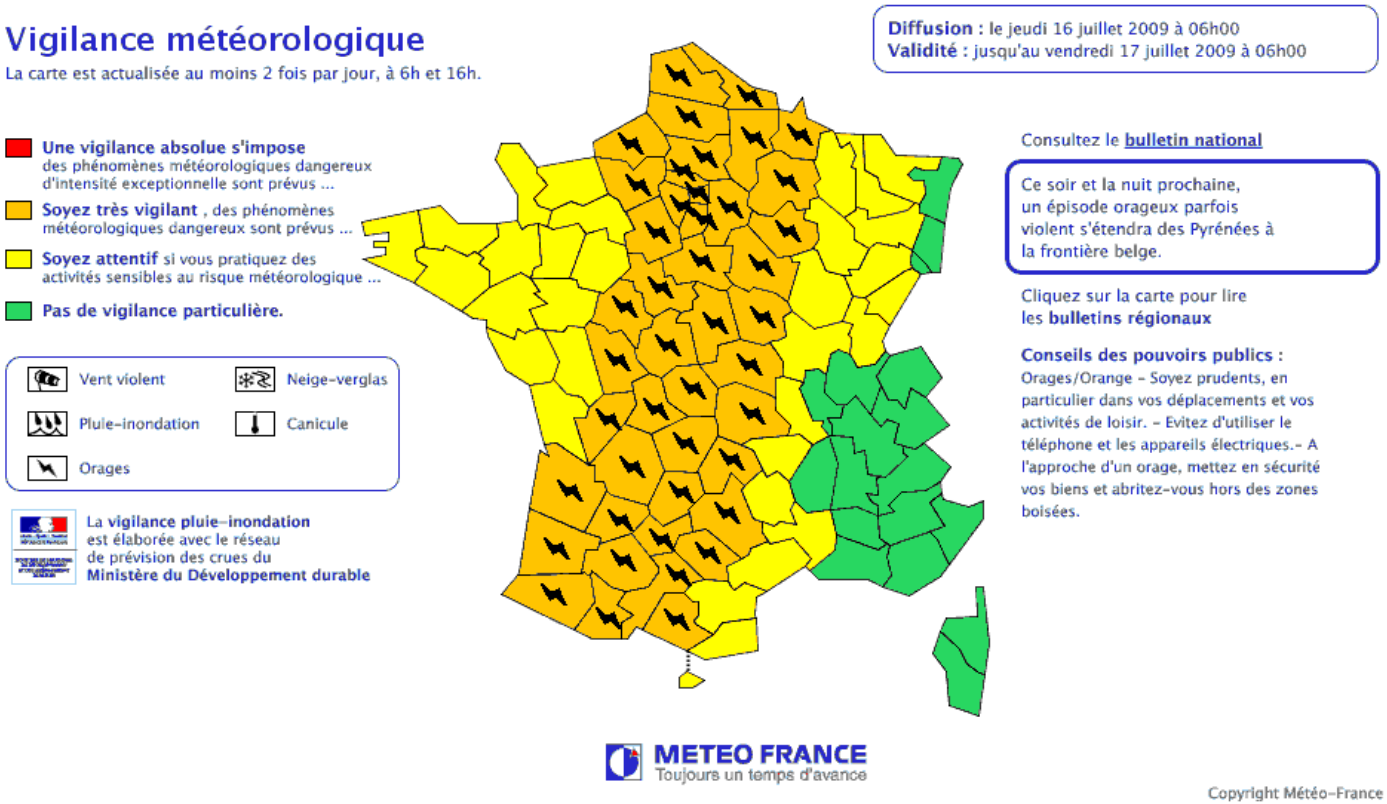

- **Watch map as a routine production :**
  - **Published twice a day,**
  - **Exceptional production may be initiated outside these hours**
- **A process involving national and regional levels**
- **In case of an orange or red level on at least one department, follow-up bulletins until the end of event**
- **MF Management « on call » 7d/24h**

Severe weather forecast at Météo-France

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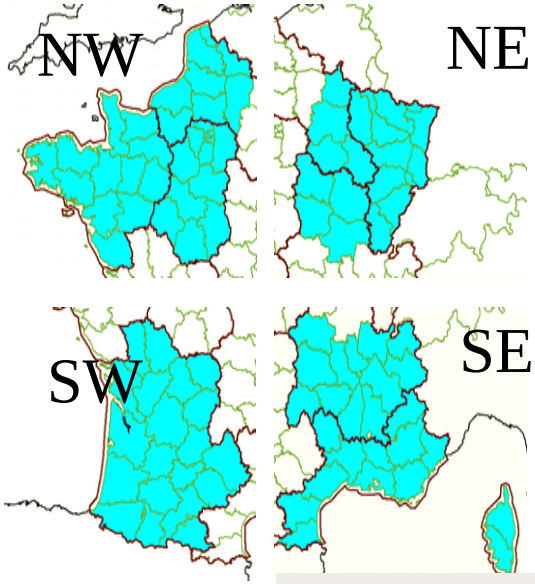
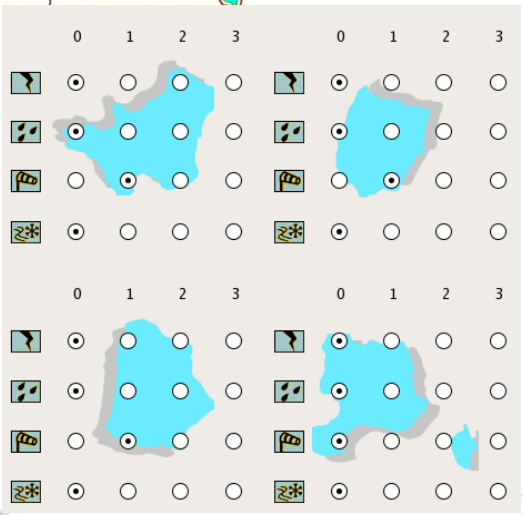
- Forecasting severe weather more than 24 hours ahead :
  - Improvements in numerical weather prediction during recent years
  - In 2002-2003, subjective verification by forecasters of the Extrem Forecast Index (EFI) products, for D+2 to D+4 : interesting results
  - During 3 years, 2005-2007, experiment of severe weather forescast over quarters of France, for D+2, D+3, D+4

Method for D+2 to D+4

- Zoning : France divided into 4 parts
- Estimation of the risk of dangerous phenomenon occurrence :
  - For each day, from D+2 to D+4
- 4 dangerous phenomena :
  - Violent winds
  - Heavy rain
  - Violent thunderstorms
  - Snow/ice
- For each zone and phenomenon, a risk index is selected from :
  - No risk (0)
  - Unlikely (1)
  - Likely (2)
  - Certain (3)





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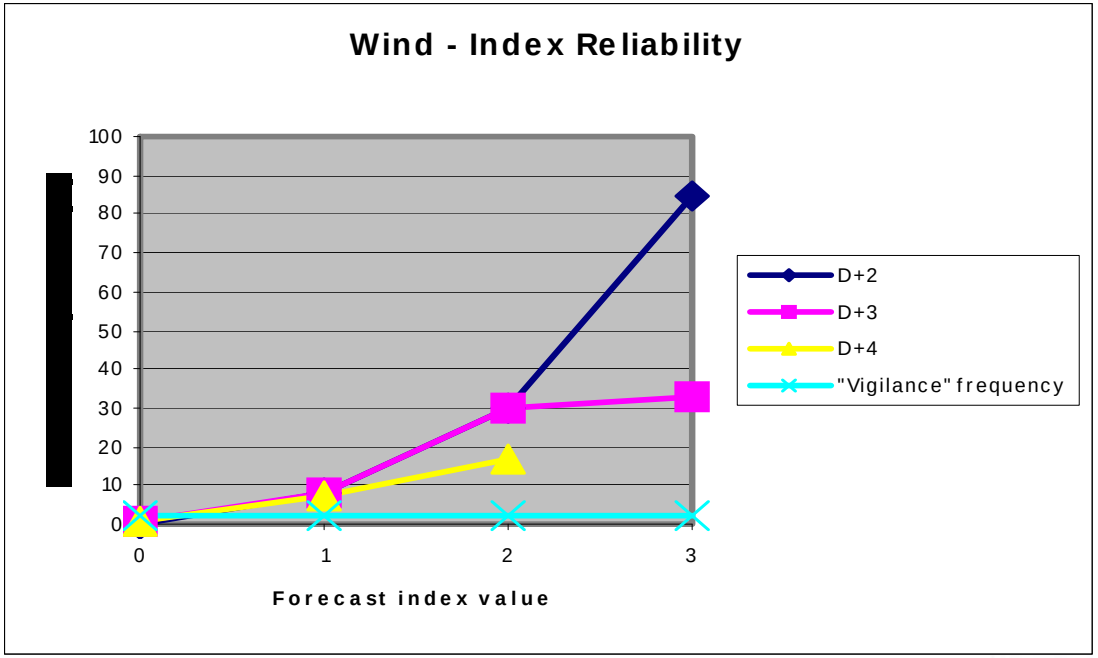
Use and limits

- The most important question for the forecasters :
  - For each risk index level, what was the outcome ?
  - What percentage of forecasts for each index actually corresponds to severe weather events ?
- The key issue for users :
  - For the observed conditions, what was the forecast ?
  - Is the forecast able to discriminate between events and non-events ?



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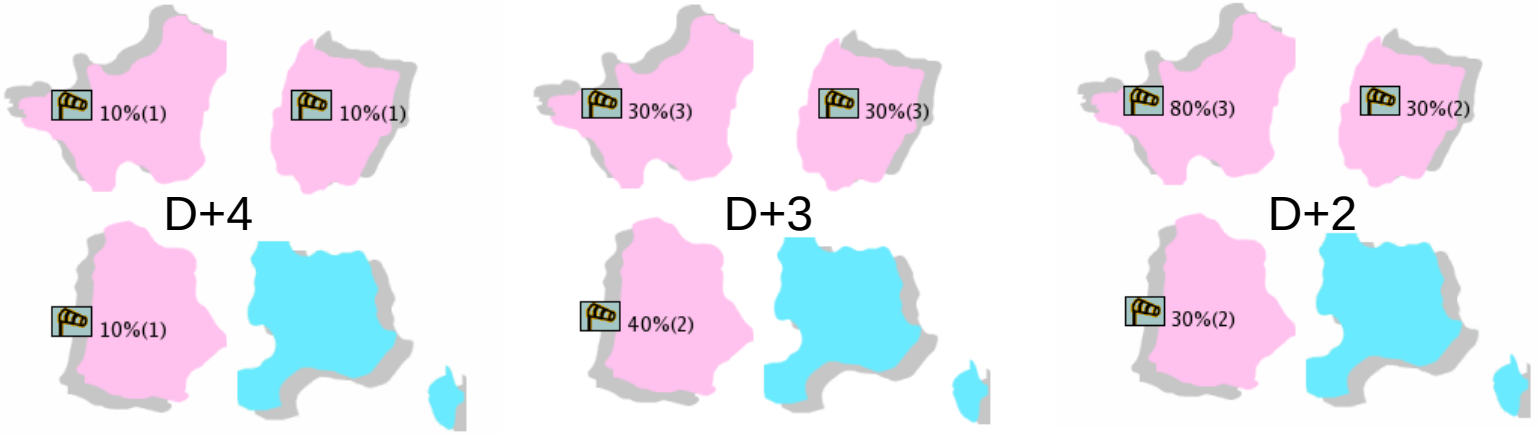
Final product

- The idea is to provide, in real time, the probabilities corresponding to the reliability of the chosen index for each parameter, taking in account :
  - The sample representativeness (reliability is calculated at the regional or national scale, depending on the sample size)
  - The discrimination between indexes (for D+3, indexes 2-3 together for wind and snow-ice)
- These charts are available on an internal Webpage.



Severe weather forecast at Météo-France

- The French « Vigilance » watch map
  - 4 watch levels (colours), for 7 dangerous phenomena, for each administrative unit (department)
  - Operational since 2001, this system is well known (86%) and has proved generally successfull
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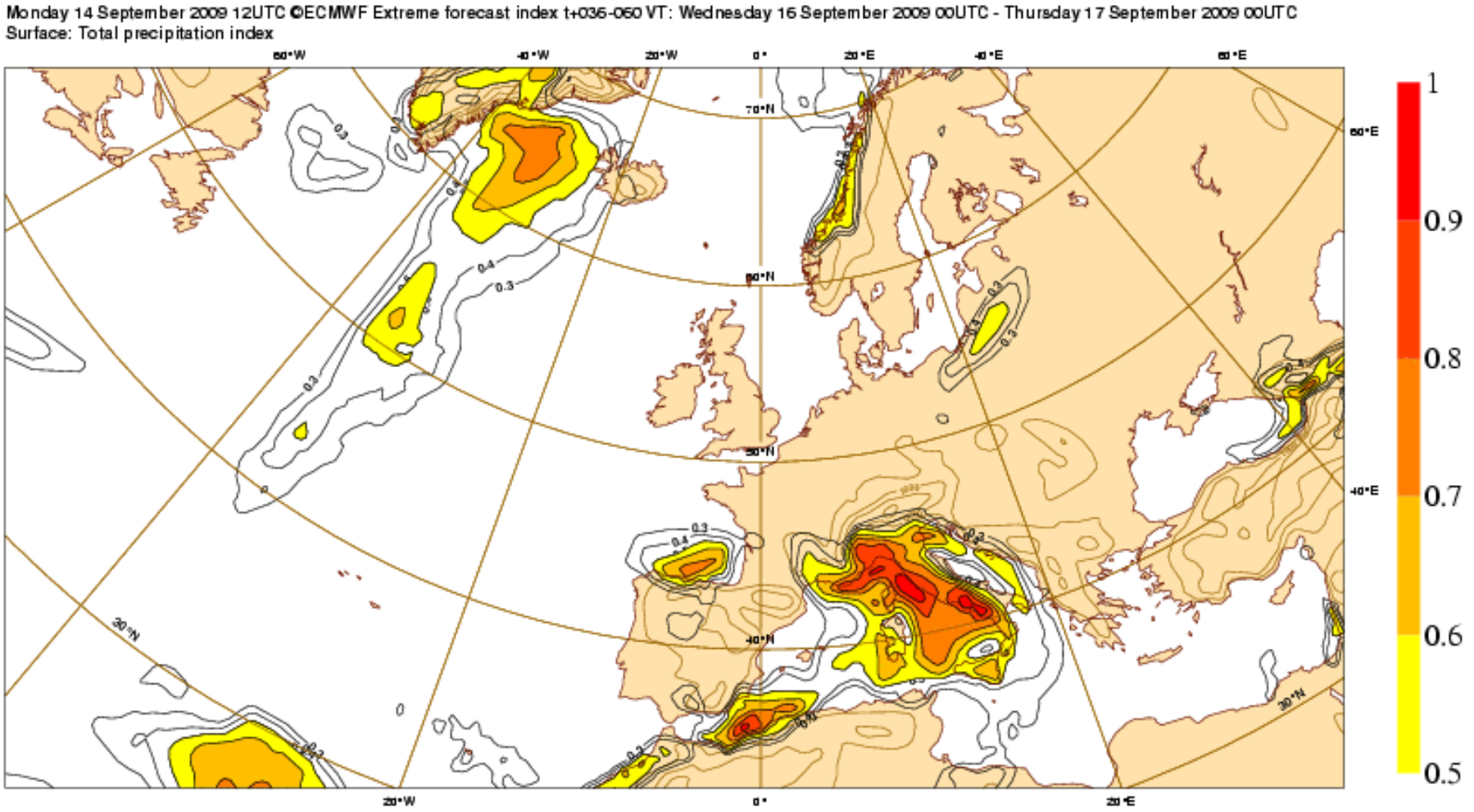
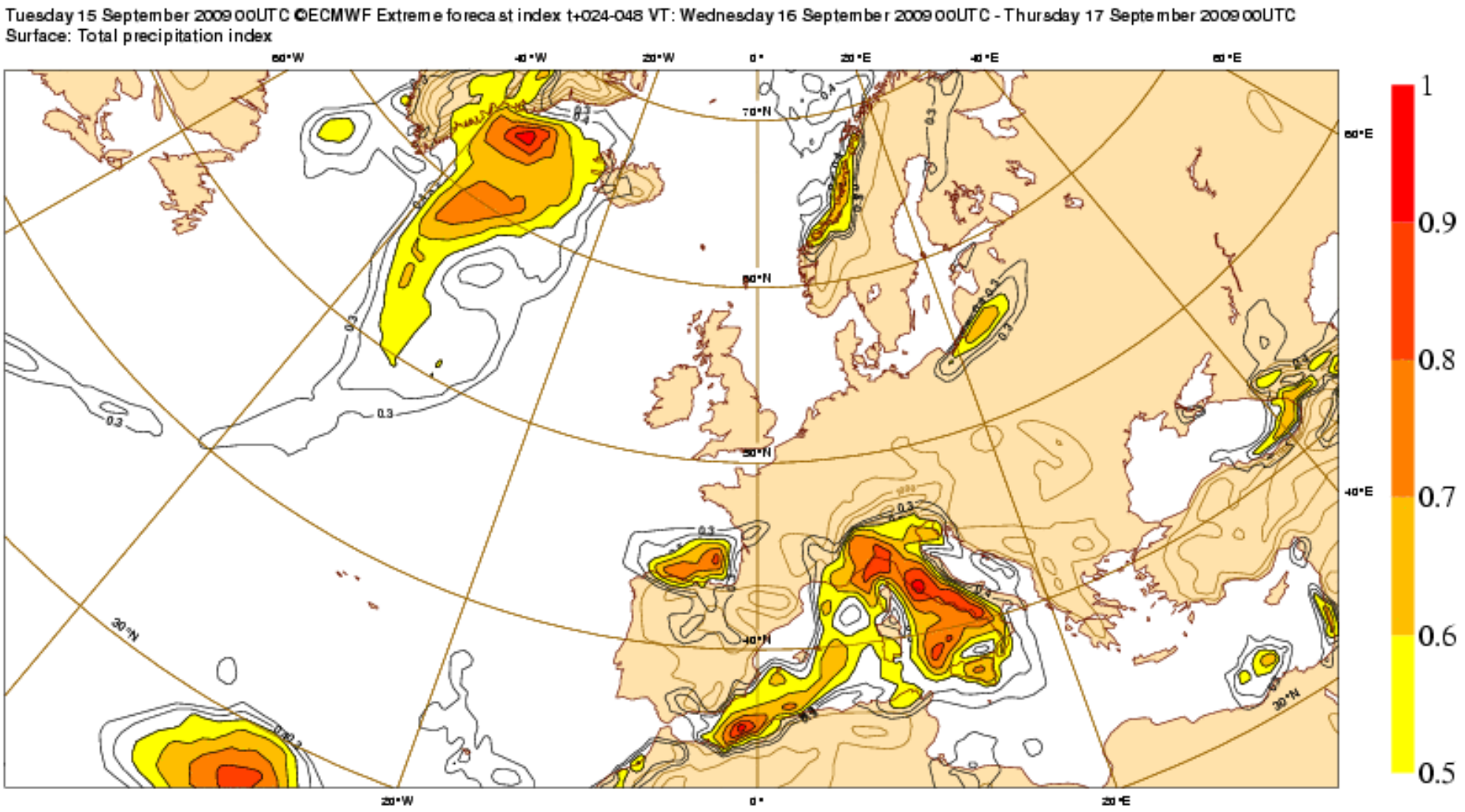
  - In 2002-2003, subjective verification by forecasters of the Extrem Forecast Index (EFI) products, for D+2 to D+4 : interesting results
  - During 3 years, 2005-2007, experiment of severe weather forescast over quarters of France, for D+2, D+3, D+4
  - Since January 2007, severe weather forecast for D+5 (at regional level) and for D+6/D+7 (at national level)
  - Since November 2007, operational severe weather forecast for D+2, D+3 : discussion on risk index between national and regional forecasters

Extrem Forecast Index charts



- EFI must draw the attention
- EFI doesn't give absolute values, nor probabilities
- It is necessary to validate with other plots

Extrem Forecast Index charts



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Multi-model early warning (1)

- An experimental tool developed at Météo-France, on an internal Website
- Comparison between deterministic and ensemble prediction models : EPS, PEARP, ARP, IFS, UKMO, GFS, GENS
- Coloured presentation of percentages of points reaching defined thresholds for each parameter, over a quarter of France :
  - 10 m wind
  - 925 hPa wind
  - Maximum temperature
  - Rainfall in 12 hours
  - Heavy rainfall in 12 hours
  - Moderate rainfall in 12 hours

Multi-model early warning (2)

NW

NE

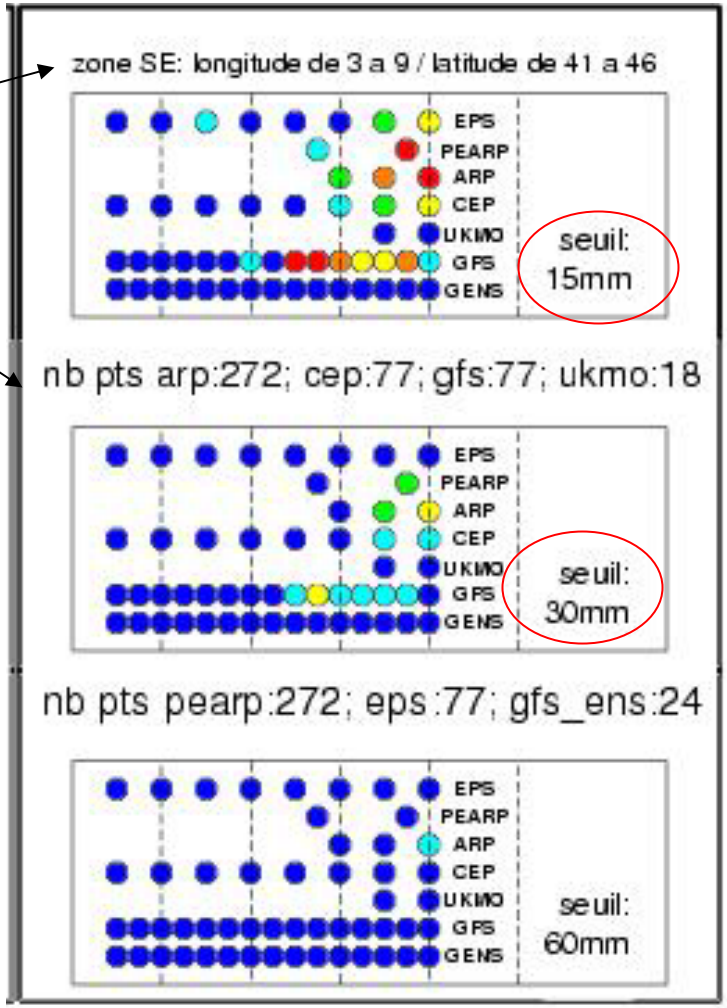
SW

SE

Example : heavy rain in 12 hours overland

Multi-model forecast of heavy rainfall at D+2

Heavy rainfall in 12 hours
over southeastern part of France



Area

Number of grid points

0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 100

Percentage of points overland reaching a threshold for 2009/09/16 12UTC

Computed on 2009/09/14 at 00 UTC

Comparison beetwen models : EPS (51 members), PEARP (21 members), ARP, CEP, UKMO, GFS, GENS (21 members)

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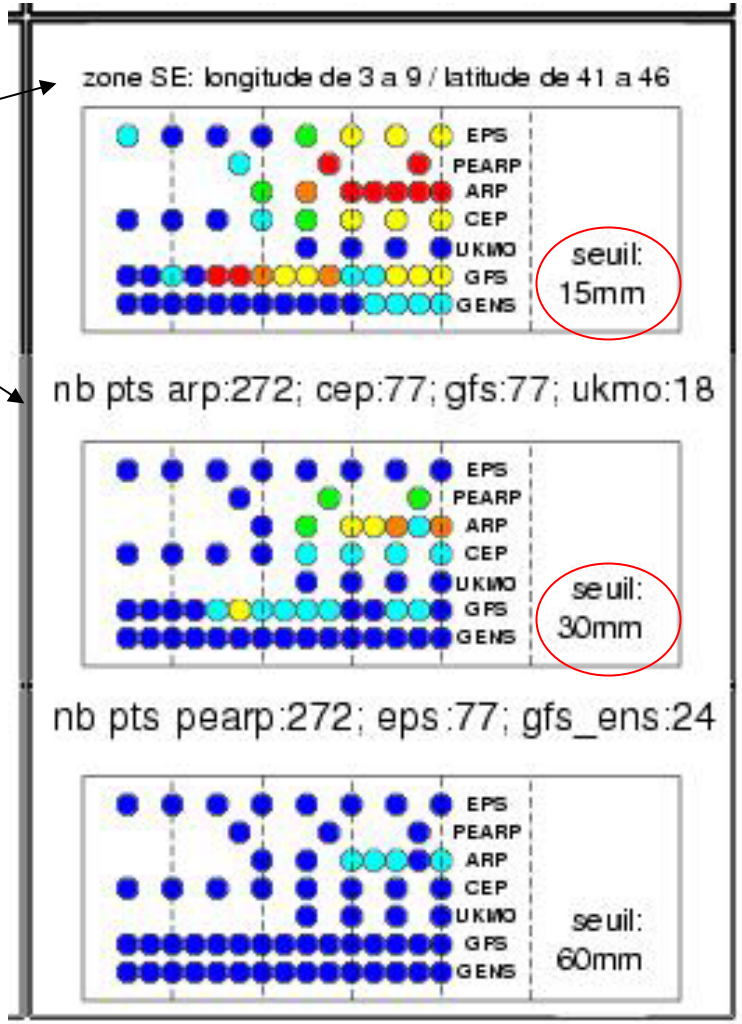
Multi-model forecast of heavy rainfall at D+1

Heavy rainfall in 12 hours
over southeastern part of France



Area

Number of grid points

0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 100

Percentage of points overland reaching a threshold for 2009/09/16 12UTC

Computed on 2009/09/15 at 00 UTC

Comparison beetwen models : EPS (51 members), PEARP (21 members), ARP, CEP, UKMO, GFS, GENS (21 members)

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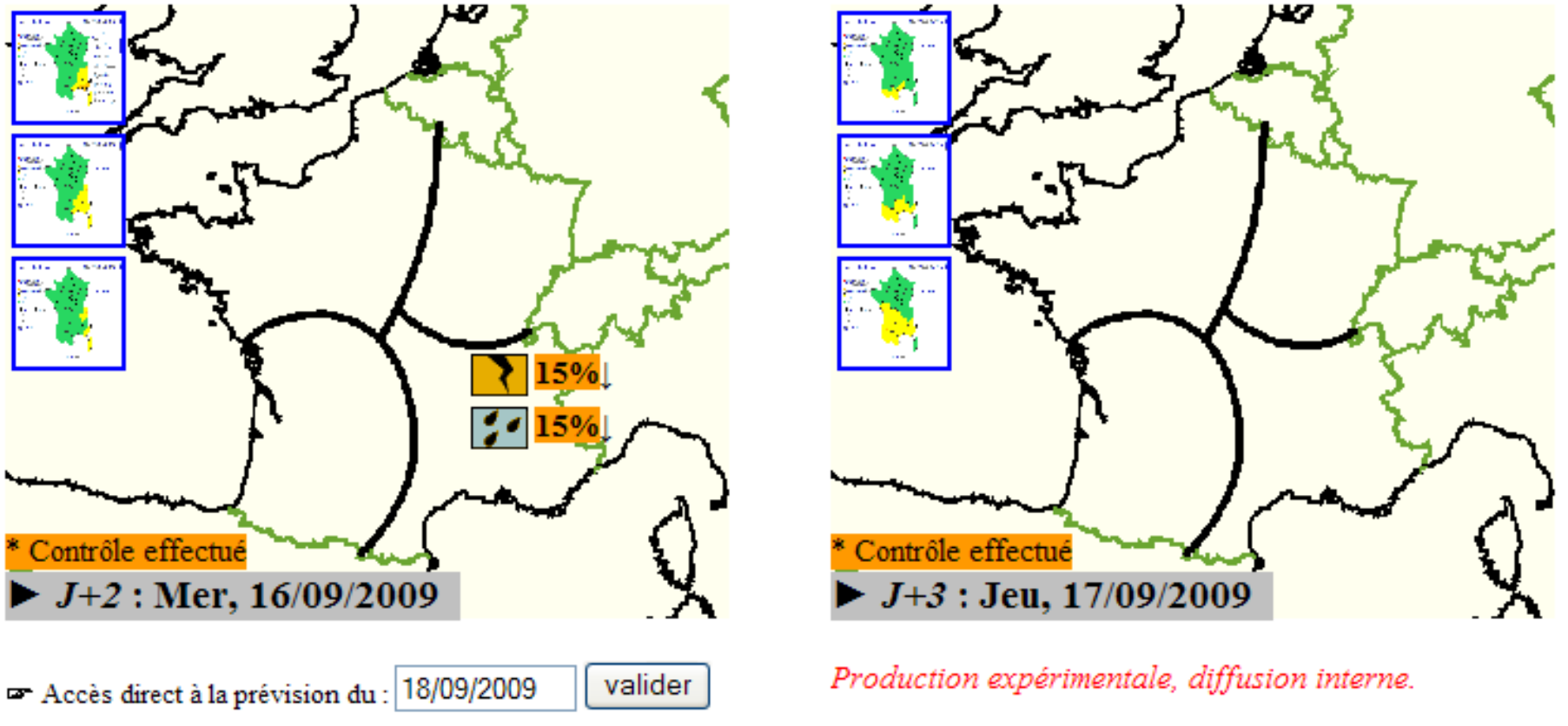
Severe weather forecast at D+2/D+3



Experimental production, for internal use

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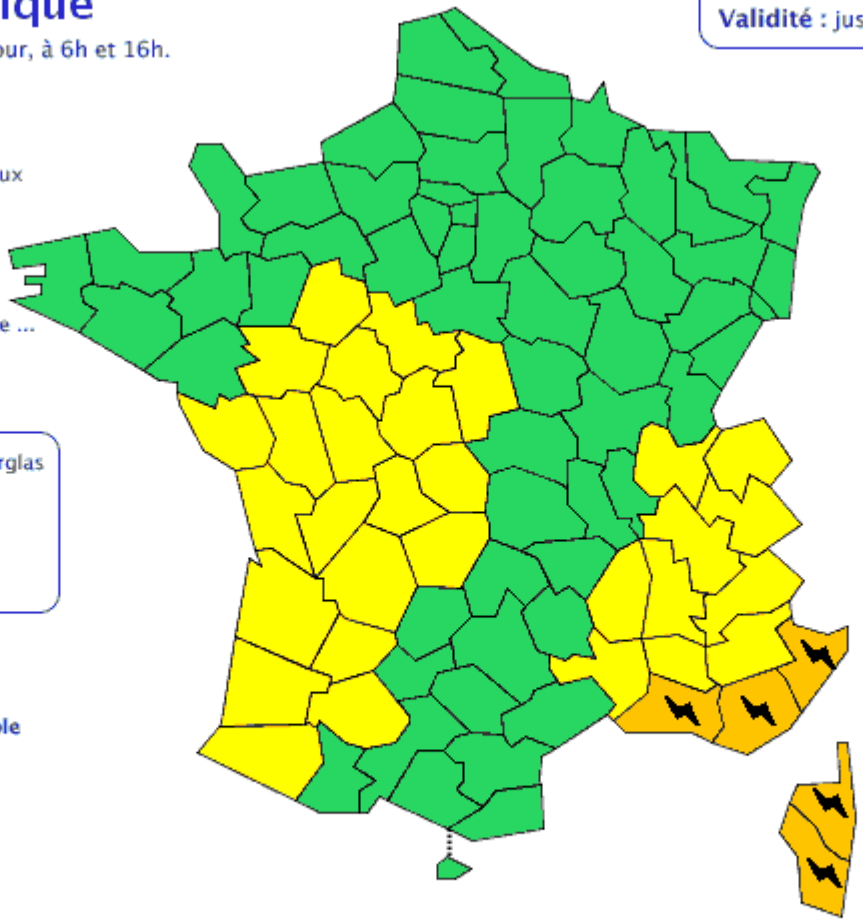
Vigilance watch map on 2009/09/15 at 16h

Vigilance météorologique

La carte est actualisée au moins 2 fois par jour, à 6h et 16h.

Diffusion : le mardi 15 septembre 2009 à 16h00
Validité : jusqu'au mercredi 16 septembre 2009 à 16h00

- **Une vigilance absolue s'impose** des phénomènes météorologiques dangereux d'intensité exceptionnelle sont prévus ...
- **Soyez très vigilant** , des phénomènes météorologiques dangereux sont prévus ...
- **Soyez attentif** si vous pratiquez des activités sensibles au risque météorologique ...
- **Pas de vigilance particulière.**



- Vent violent
- Neige-verglas
- Pluie-inondation
- Orages

La **vigilance pluie-inondation** est élaborée avec le réseau de prévision des crues du **Ministère du Développement durable**

Consultez le **bulletin national**

De fortes pluies accompagnées d'orages violents et parfois de vents forts se produiront durant la soirée et la nuit entre Marseille et la frontière italienne ainsi qu'en Corse.

Cliquez sur la carte pour lire les **bulletins régionaux**

Conseils des pouvoirs publics :
Précipitations/Orange - Renseignez-vous avant d'entreprendre un déplacement et soyez vigilants. Evitez le réseau routier secondaire.- Soyez prudents face aux conditions de circulation pouvant être difficiles.- Si vous habitez en zone habituellement inondable, prenez les précautions d'usage. Orages/Orange - Soyez prudents, en particulier dans vos déplacements et vos activités de loisir. - Evitez d'utiliser le téléphone et les appareils électriques.- A l'approche d'un orage, mettez en sécurité vos biens et abritez-vous hors des zones boisées.

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Conclusion

- Results show the capacity to produce relevant information about severe weather events more than 24 hours ahead
- The forecast reliability is established and will obviously improve day by day
- Forecasters are now used to systematically discussing the risk index after looking at the numerous EPS products and deterministic models
- Opportunity to communicate in terms of probabilities, but needs explanations for the users
- Criticism concerning the zoning of France into four parts : can be adjusted to the users' needs, but the scale must remain relevant
- A test production should be held next year with a few governmental services in order to evaluate the potential usefulness of this type of forecast.

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- **Medium range forecast**
- Monthly weather forecast

Medium range forecast for D+4 to D+9

- Synoptic elements are unpredictable at medium range => Forecast at supra-synoptic scale
- Medium range forecast is based mainly on EPS products (T399) :
  - Ensemble mean, probabilities (precip, wind, humidity…) ⟶ to define the most likely trend
  - Spaghettis Z500 ⟶ spread (dispersion)
  - EFI charts ⟶ risk of severe weather for D+4
  - Other products : EPSplumes and EPSgrams (local products)
- Comparison between different models & runs :
  - EPS 12 & EPS 00 (T399, T255)
  - IFS (T799) for D+4 and D+5
  - NCEP 12 & NCEP 00
  - EPS monthly forecast (T255) once a week
- Mixing different kind of information, with the experience of the forecaster

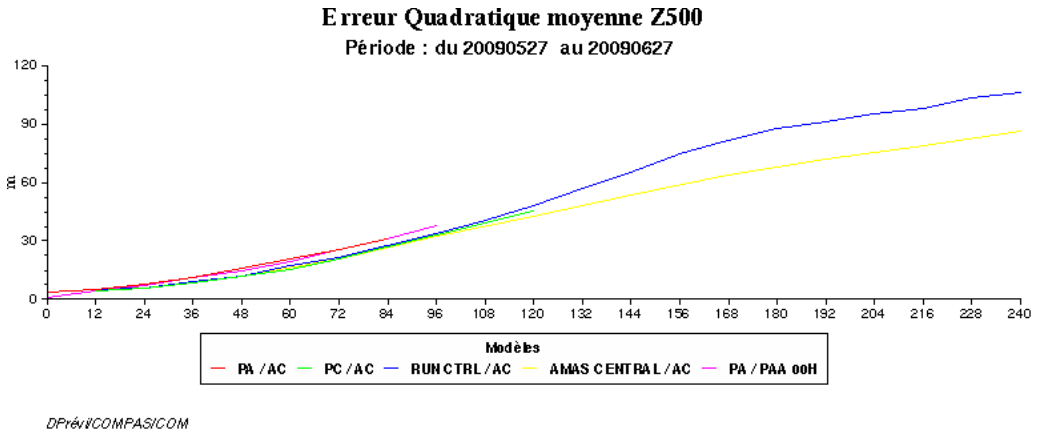
  => synthesis of the most likely scenario and confidence

  => use of weather symbols, risk symbols and confidence index.

Use of EPS ensemble mean

The average of the members:

- The ensemble mean automatically filters out the small scale features (less predictable). Agreement among the members
- Better than the deterministic Ctrl Forecast (best estimate)



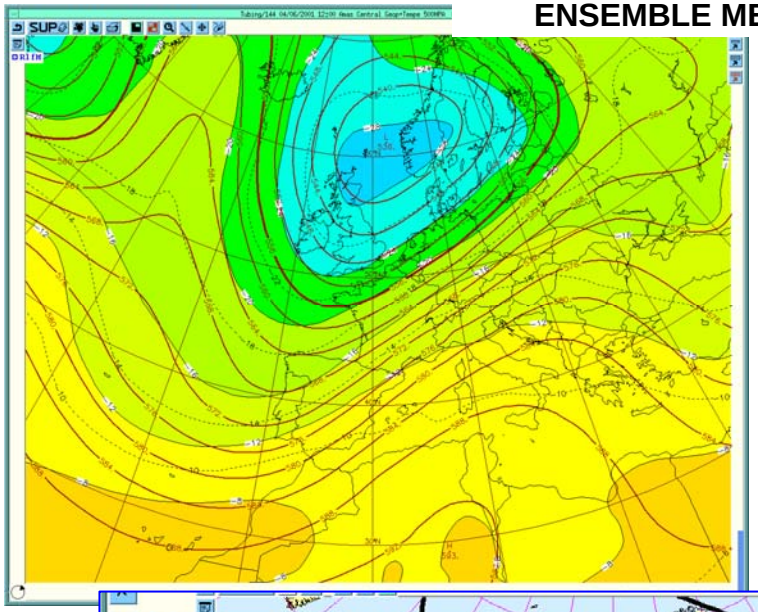
- Reduced forecast « jumpiness » (day-to-day forecast inconsistency)
- The most likely scenario. But fields are not « realistic » !

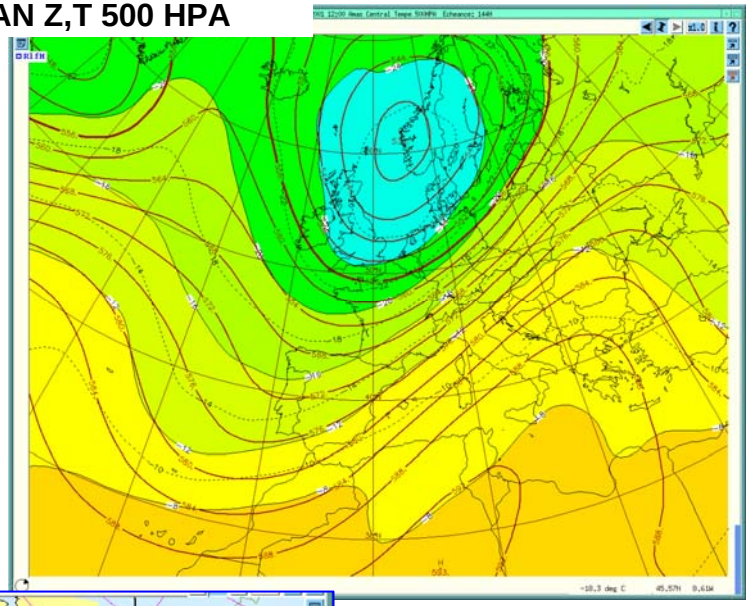
  Smoothing, weakening systems ! Resolution – Spread.

Example of a technical product at D+4/D+5

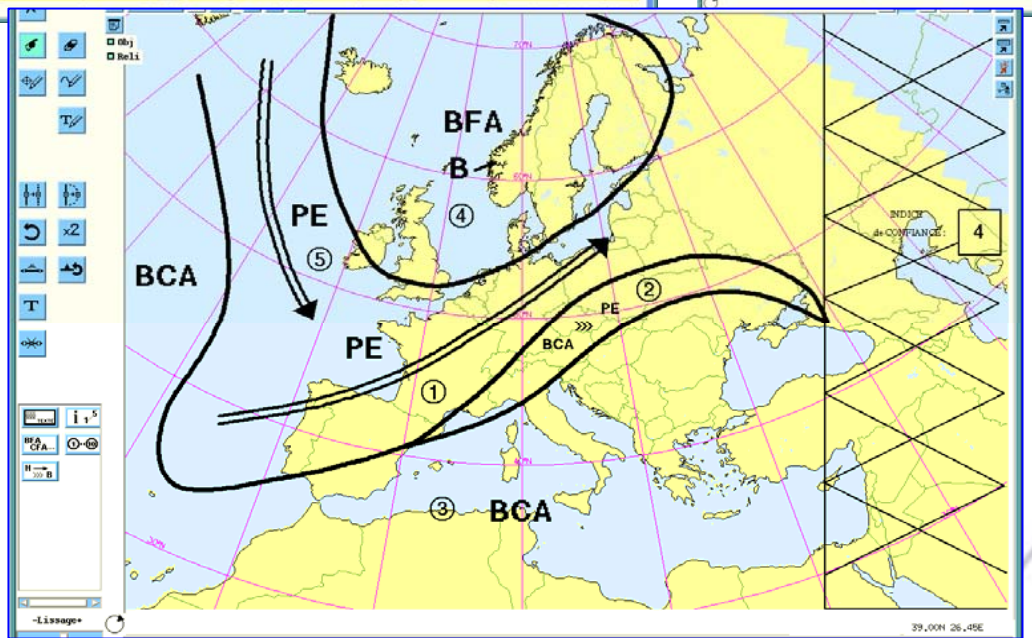
ENSEMBLE MEAN Z,T 500 HPA

120h
(D+4)





144h
(D+5)



PRESSYME D+4/D+5 :
2001/06/09 and 2001/06/10

Supra-synoptic medium range forecast

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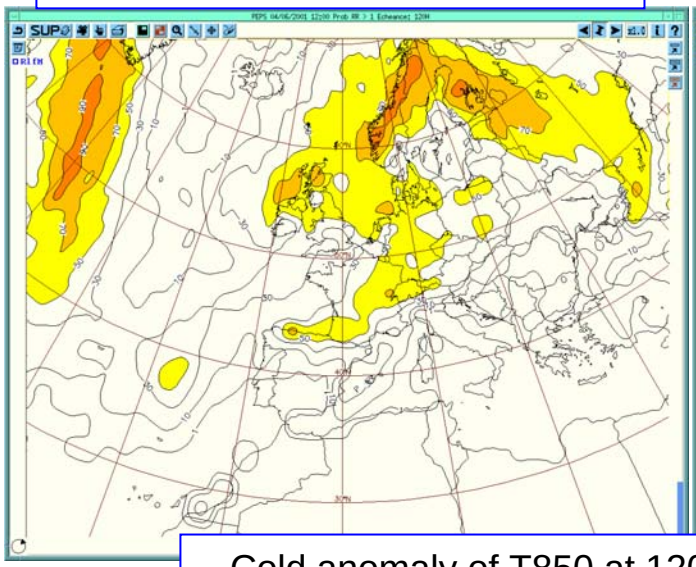
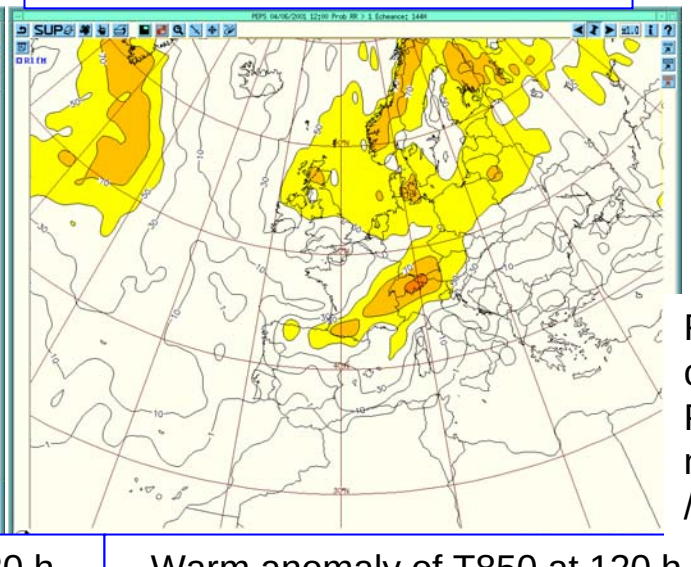
Use of probabilistic products

That kind of probabilistic product shows the evolution of the risk of precipitations (step of 24 hours, thresholds of 1mm here, with also 5mm, 10mm and 20mm per day).

Probability of RR>1mm at 120 h



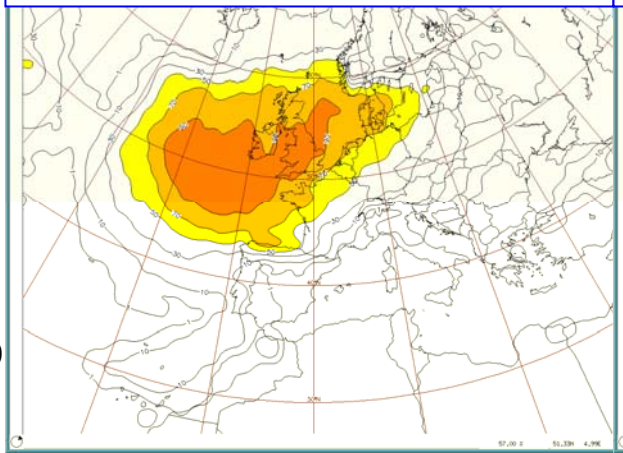
Probability of RR>1mm at 144 h



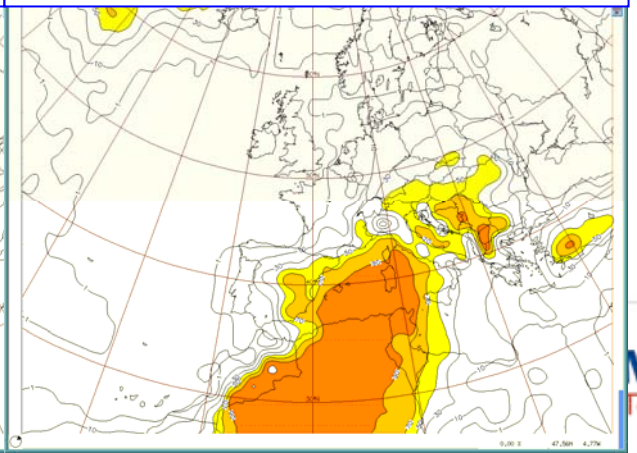
The activity of weather disturbances can be estimated by probabilistic products of rain risk.

Raw probabilities are calculated as follow :
Proba 24h (precip.>1mm) = nb members (precip>1mm) / total nb members

Cold anomaly of T850 at 120 h

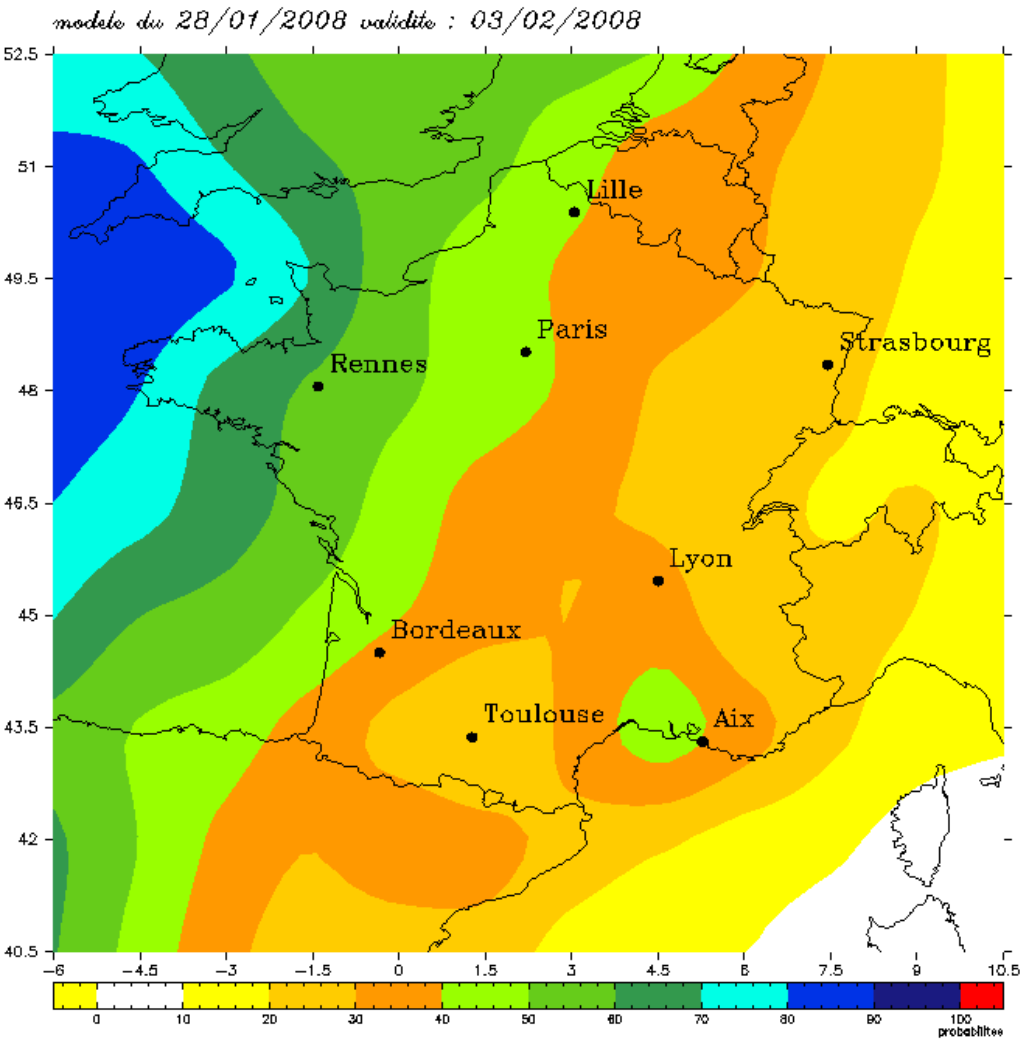


Warm anomaly of T850 at 120 h

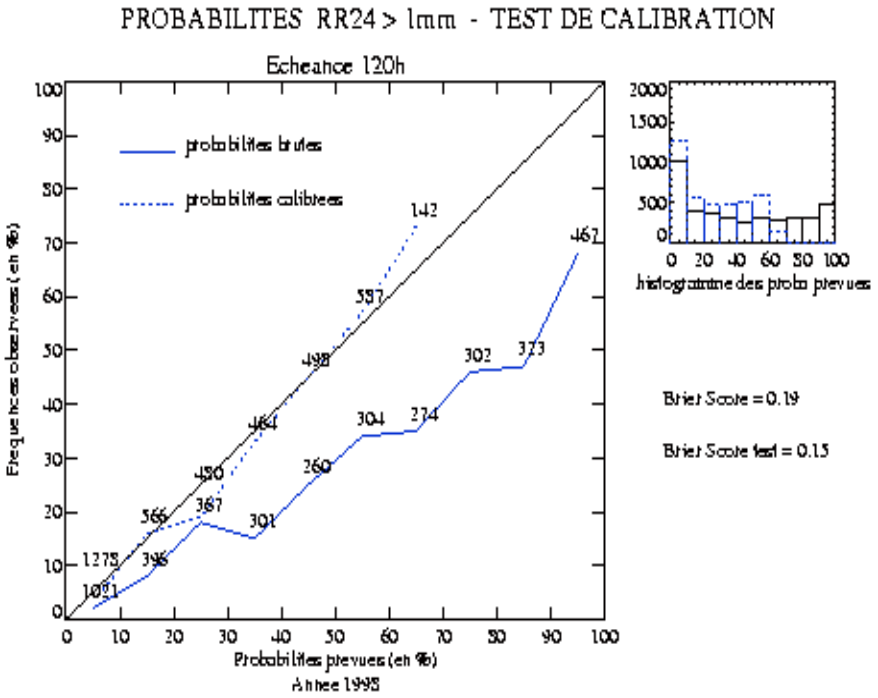


Use of calibrated probabilistic products

Example of calibrated probabilities of RR24>1mm for 156h



- Calibrated probabilities : related to the observations
- Interactive probabilities : choice of the threshold



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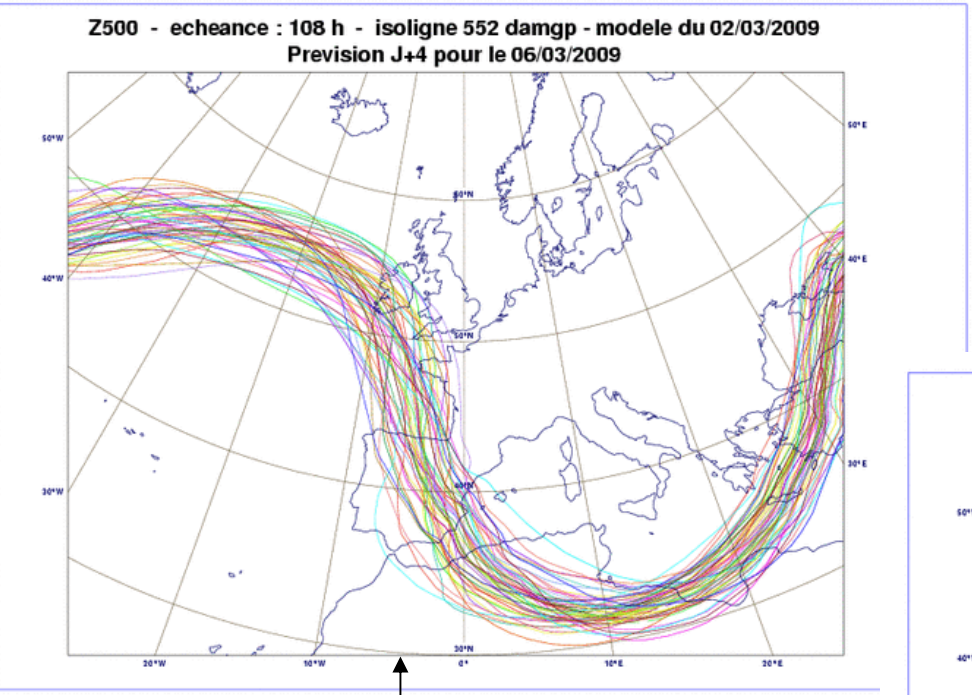
Spread and confidence index

- The spread indicates the « uncertainty » (« envelope of solutions »):
  - Low spread : great confidence, small error
  - High spread : weak confidence, but not necessary large error !
  - Spread can depend on the parameter
  - The uncertainty increases generally with the range, but not always
- EPS products used to analyse spread :
  - Spaghettis Z500
  - Tubing (number of tubes, no longer used)
  - EPSplumes, EPSgrams (local products)
- Confidence index used for D+4, D+5 and D+6/D+7 :
  - Global index for general public : a subjective measure of “uncertainty”
  - Scale from 1 (very weak confidence) to 5 (very strong confidence)
  - First, the index is obtained by analysing objectively the spread and the stability concerning the forecast supra-synoptic scenario, and also the uncertainty of the weather forecast (ex : uncertainty with warm blocks in altitude concerning low level clouds)
  - Second, subjective adjustments taking account of the range (comparison with the average confidence index for this range).

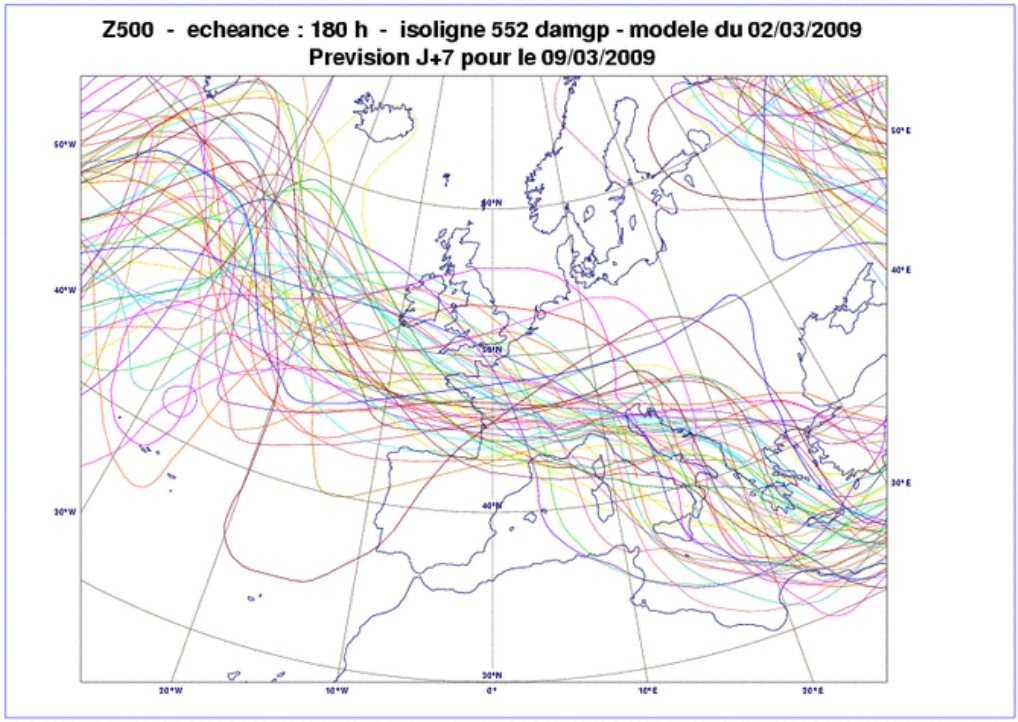
Spaghettis Z500



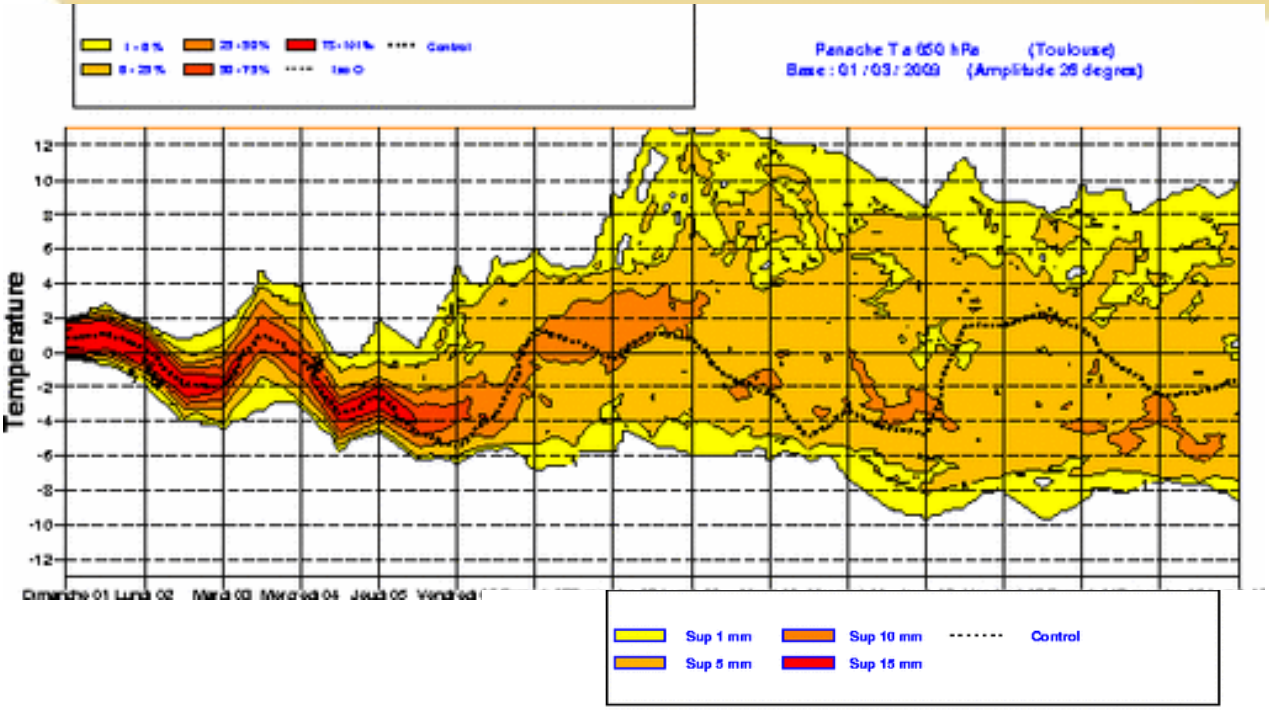
Example of low spread for D+4

The spaghettis Z500 give a good estimation of the spread

Example of high spread for D+7

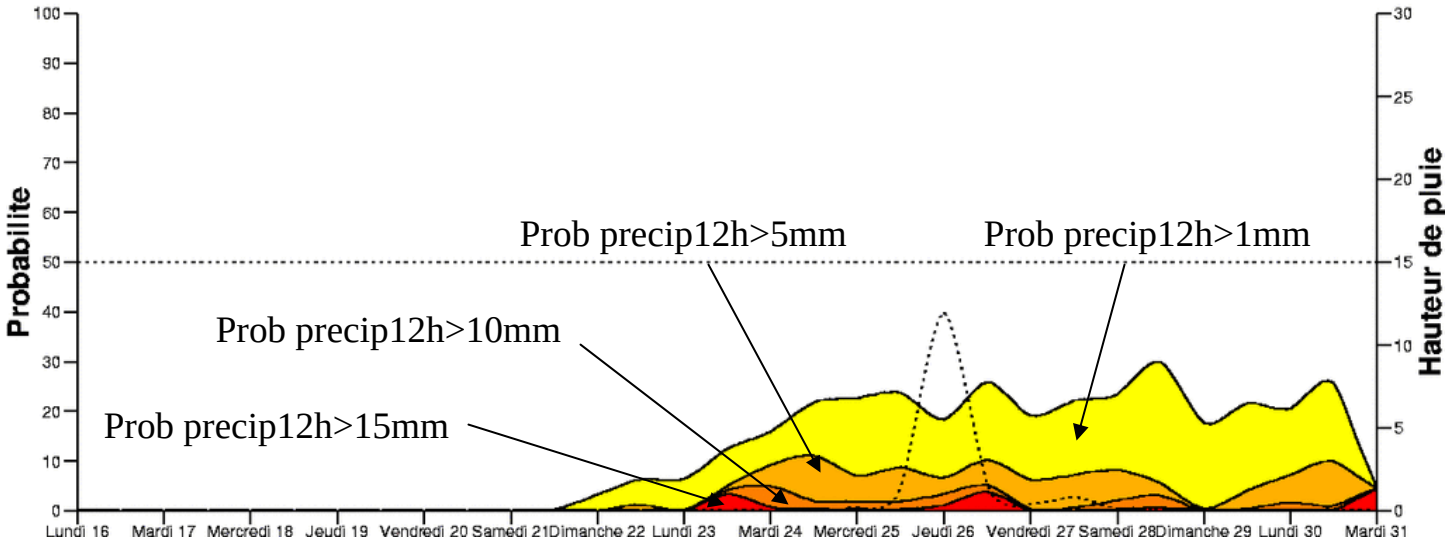


EPS plumes



Time evolution of probabilities : on one point, Toulouse on this example

To use probabilities, it is recommended to know their quality (see EPS verification)



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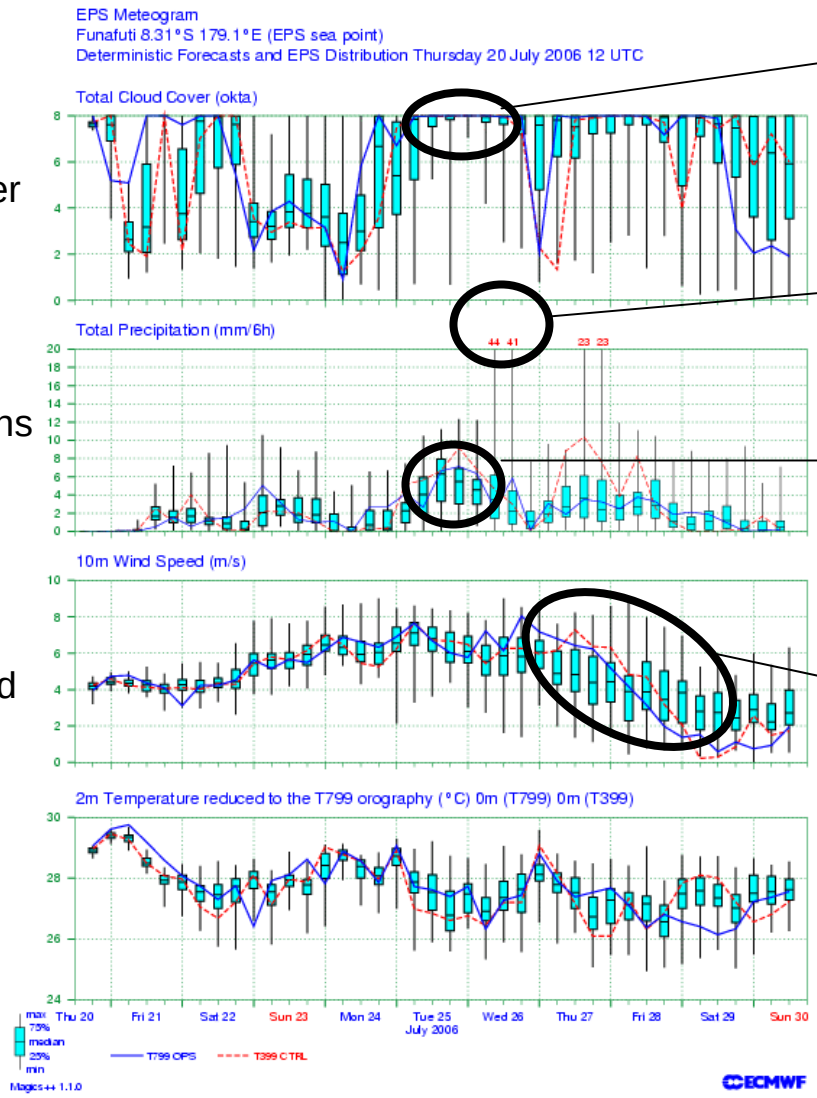
Interpretation of EPSgrams : local products

Total Cloud Cover

Total precipitations

10 m Wind Speed

2m Temperature



signal of covered sky

risk of heavy rain

high reliability in precipitation occurence

decrease of wind speed

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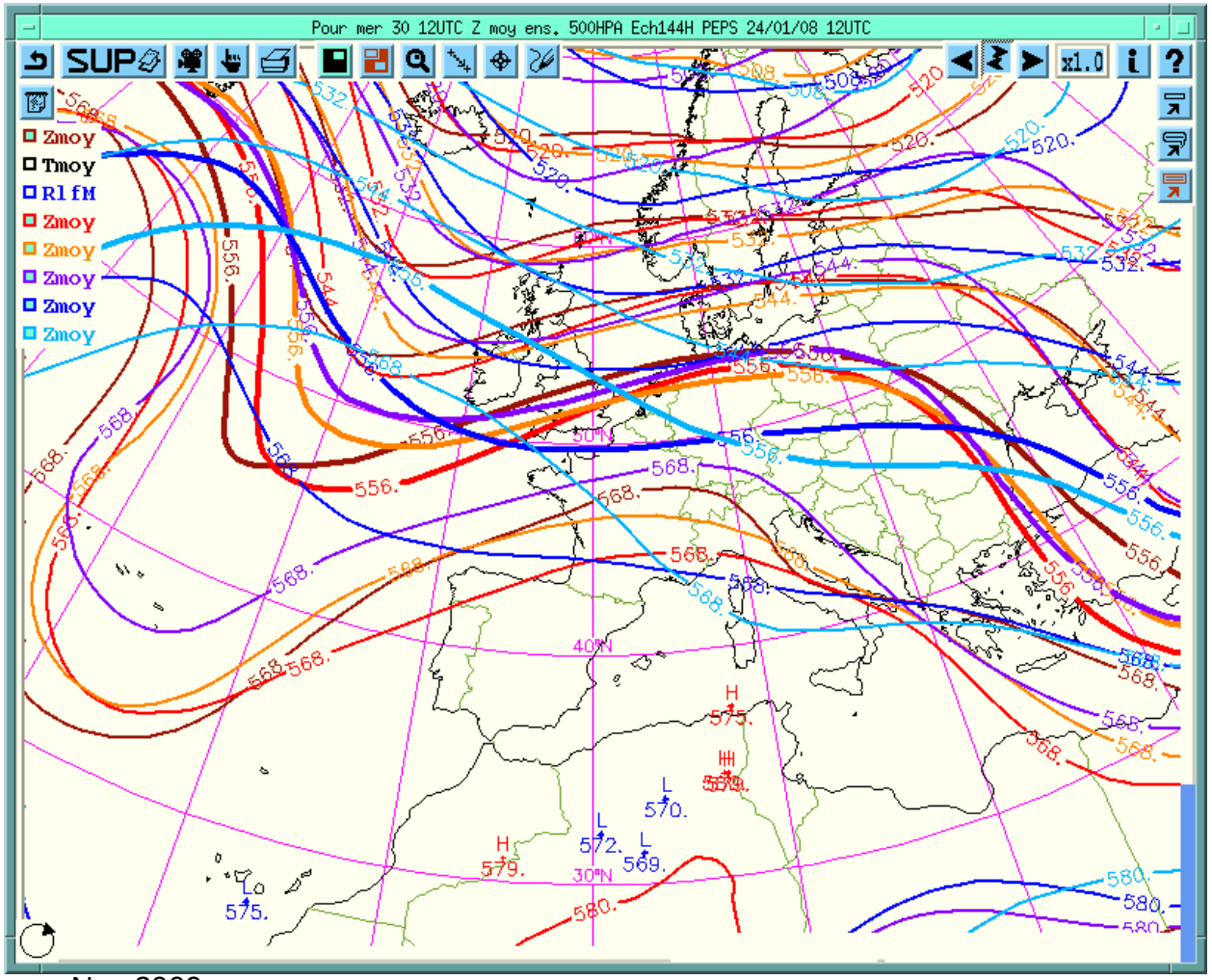
Stability of EPS runs

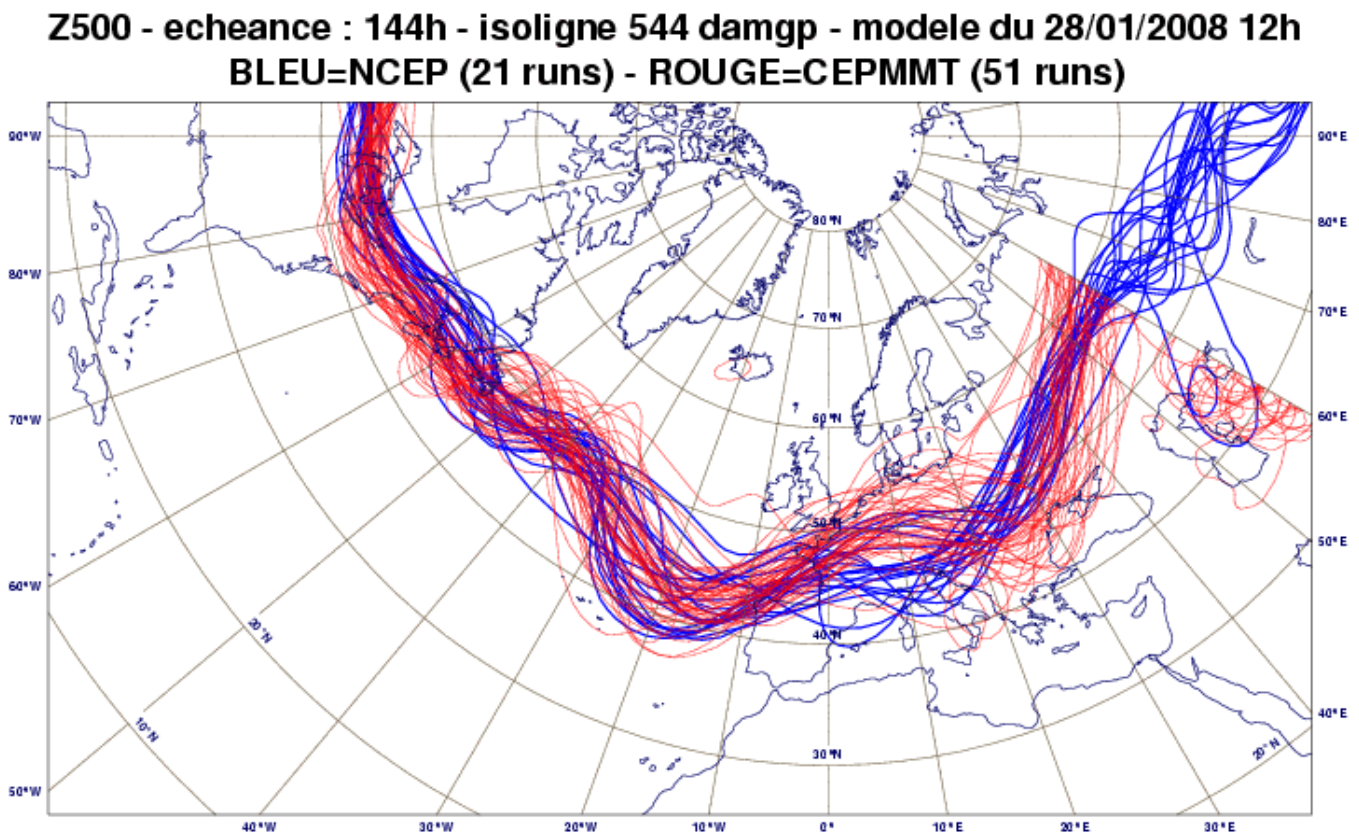
Example of successive runs of EPS for Z 500



- Comparison of successive EPS runs for a defined field : ensemble mean ZT500, T850, MSLP
- A good stability indicates a good confidence
- A low stability generally indicates a low predictability
- But a significative change on the last run can indicate a relevant change in forecast.

Coherence between EPS and NCEP

Blue : NCEP Red : ECMWF



- Comparison between EPS and NCEP spaghettis Z500
- Coherence between both spaghettis can confirm the analysis of the EPS spread.

Symbols used for D+4 to D+7

Weather symbols

	**Mainly sunny, clear or slightly cloudy sky (summer)**
	**Mainly foggy, thick low clouds (winter)**
	**Unsettled weather with showers**
	**Unsettled weather without rain**
	**Temporarily cloudy sky**
	**Mainly cloudy sky**
	**Mainly rainy weather**
	**Temporarily rainy weather**

Risk symbols

	**Risk of thunderstorms (generalized)**
	**Risk of snow on plain**
 Mt	**Risk of snow on mountain**

Wind symbols

	**Moderate wind** (gusts <35-40 kt) For D4 and D5
	**Strong wind** (gusts >=40 kt)

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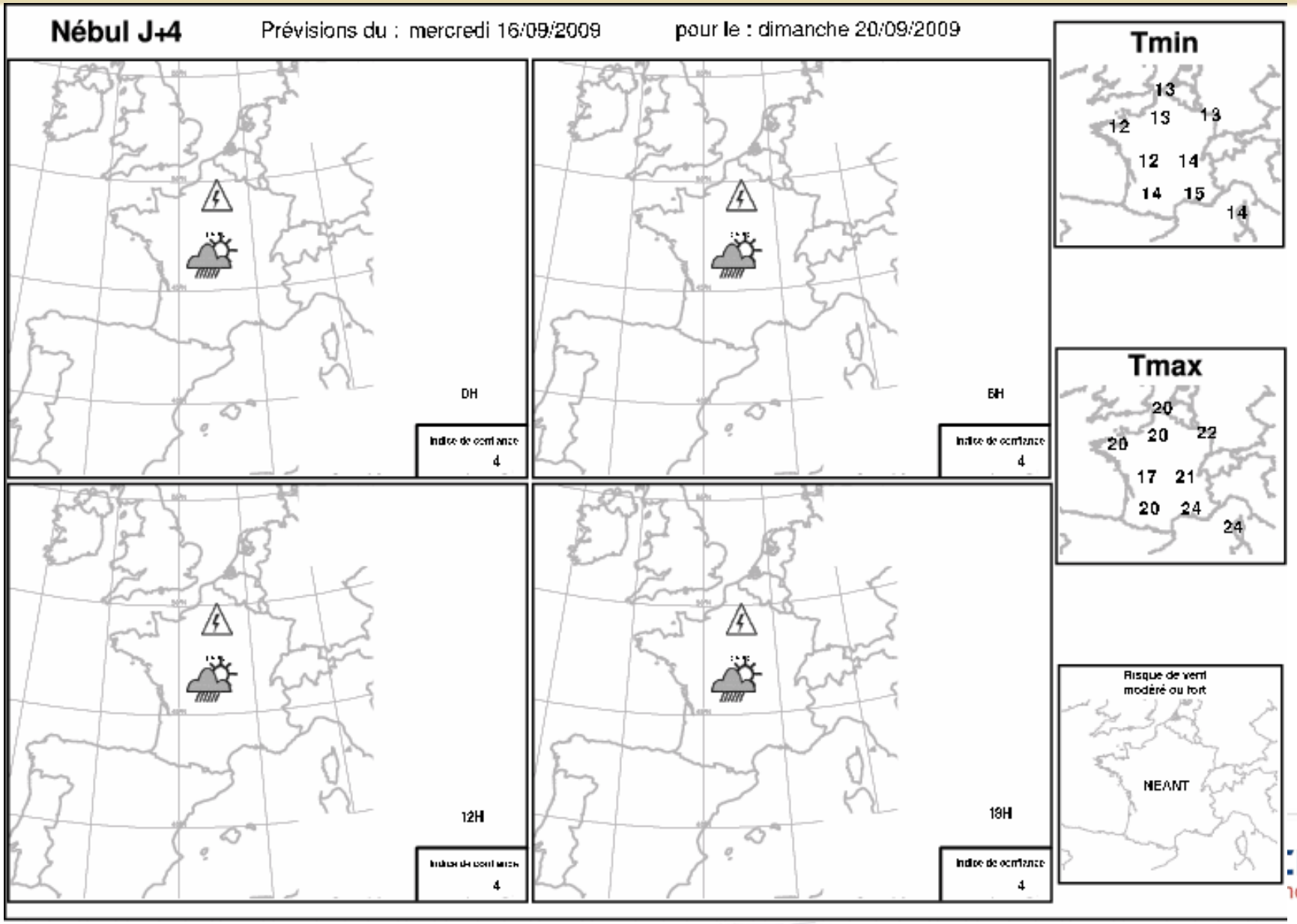
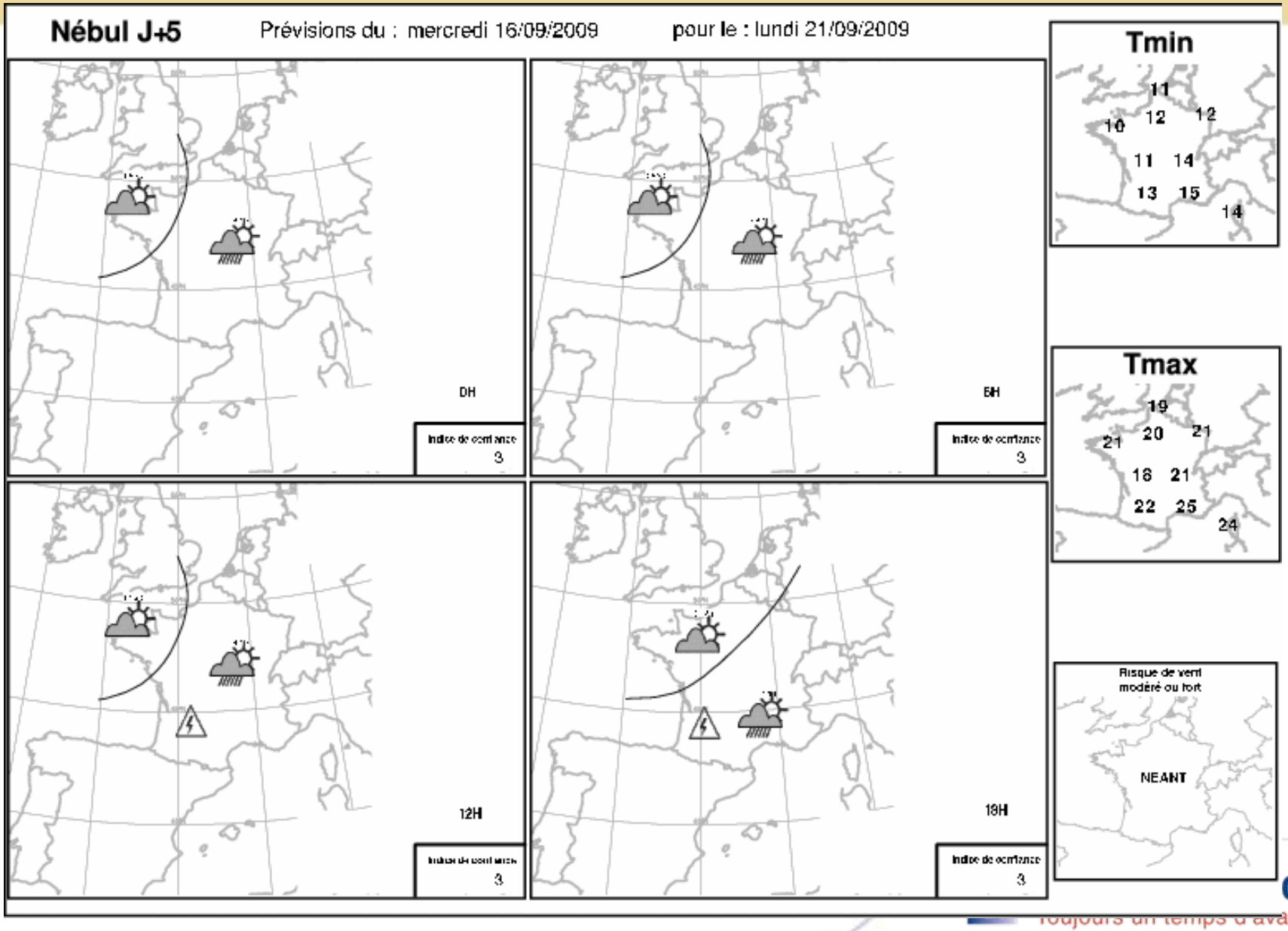
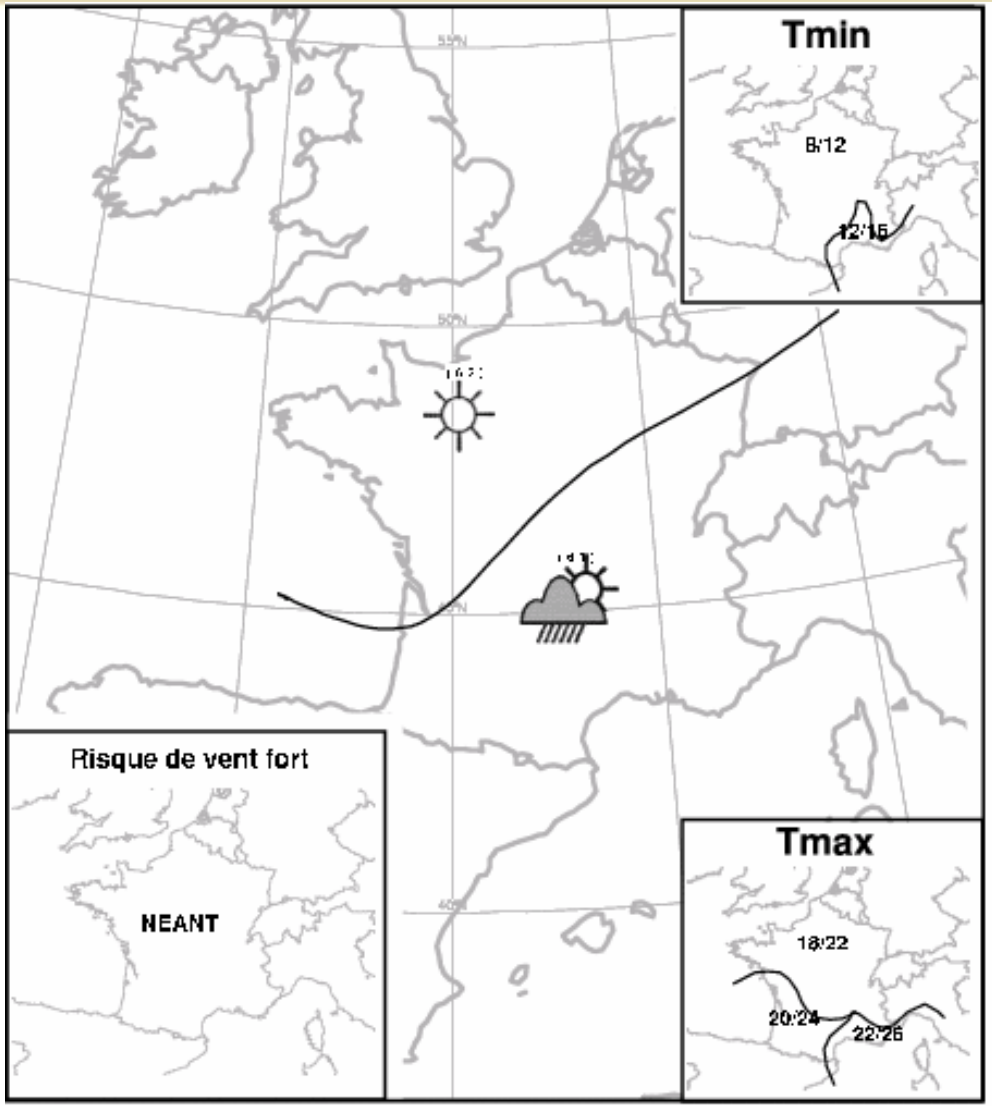
Example of internal production for D+4

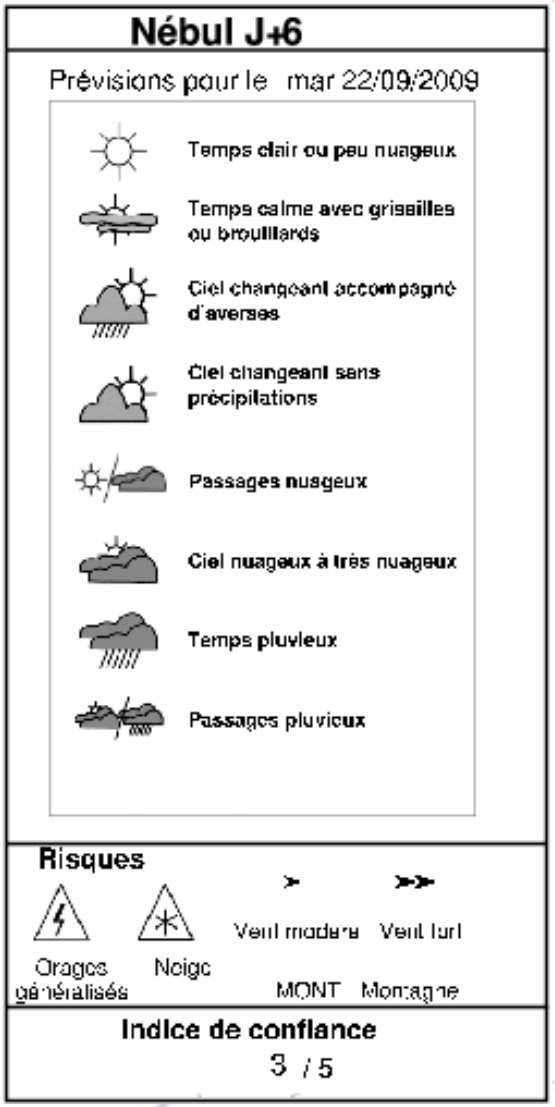


Example of internal production for D+5



Example of D+6 (same for D+7)





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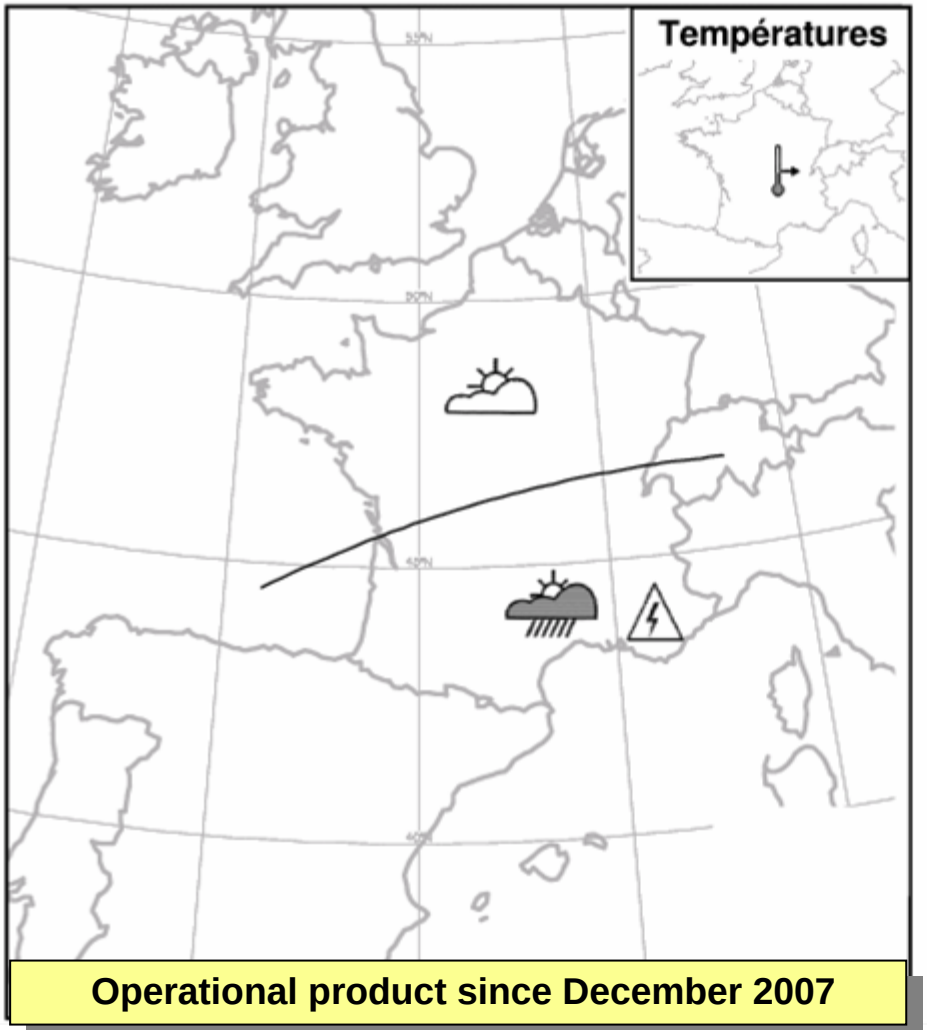
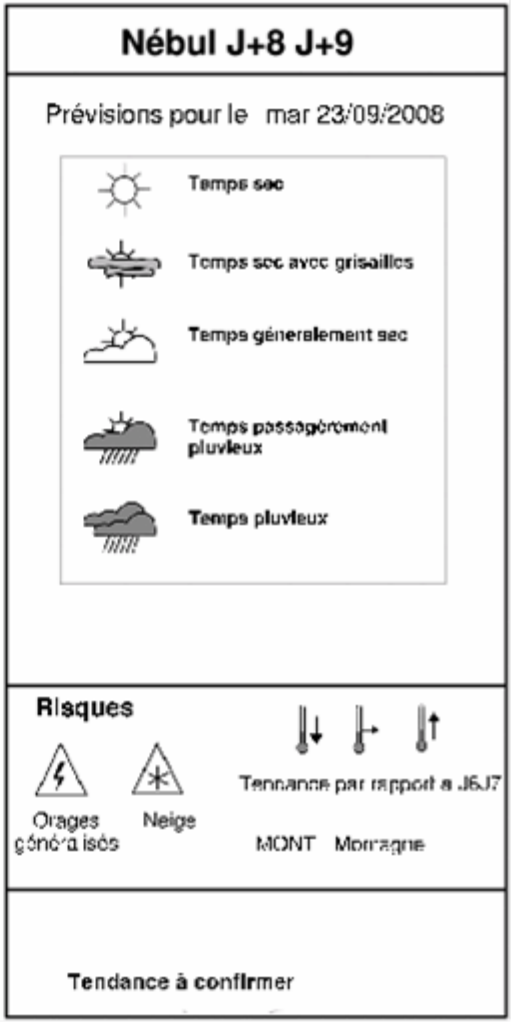
Weather trend for D+8/D+9





Operational product since December 2007

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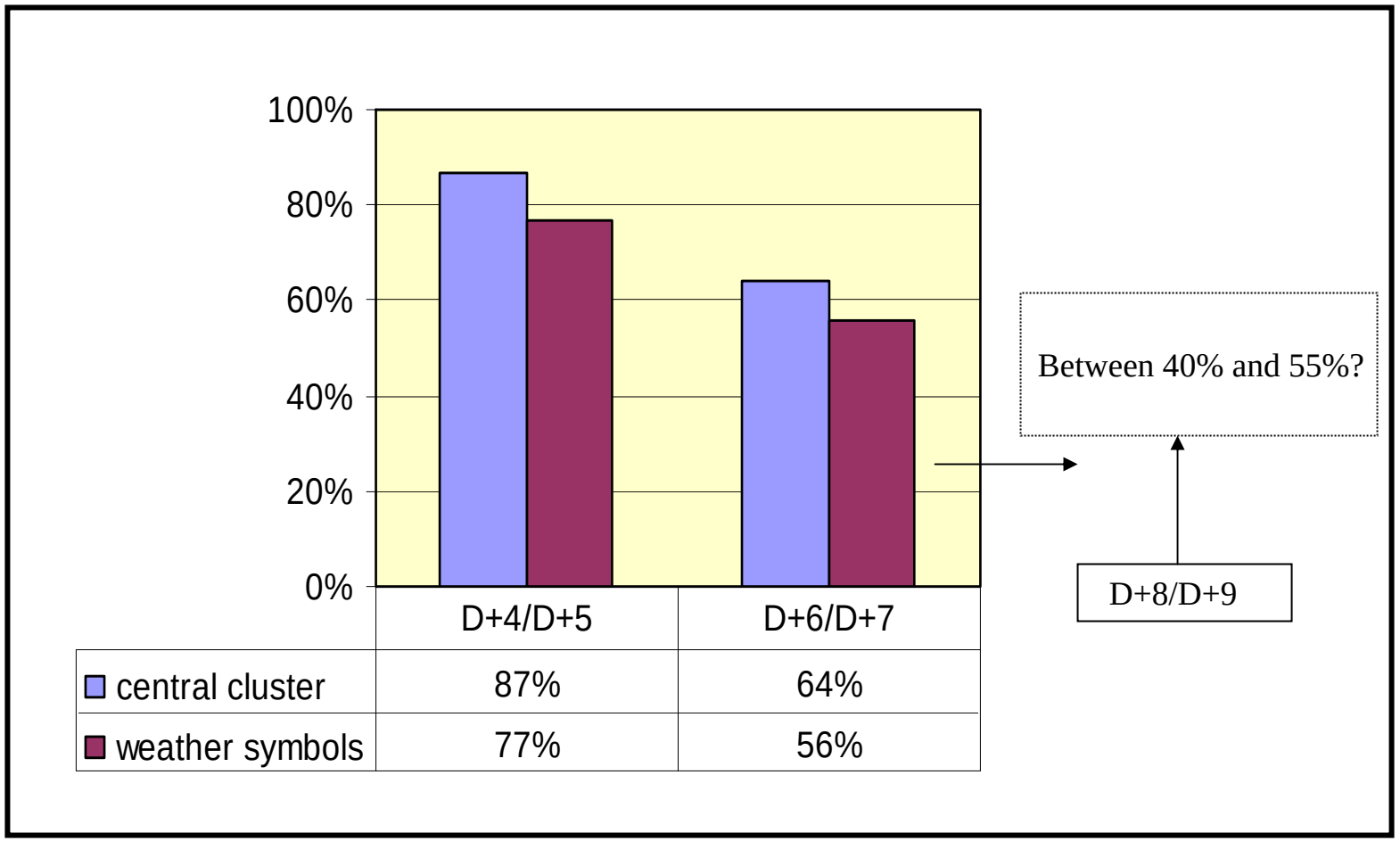
Medium range forecast verification (from 01/01/09 to 15/09/09)



	D+4/D+5	D+6/D+7
central cluster	87%	64%
weather symbols	77%	56%

New system of forecast verification for D+6/D+7

Automatic verification of weather charts issued for D+6/D+7, compared to analysed weather charts (used for telephone bulletins verification)

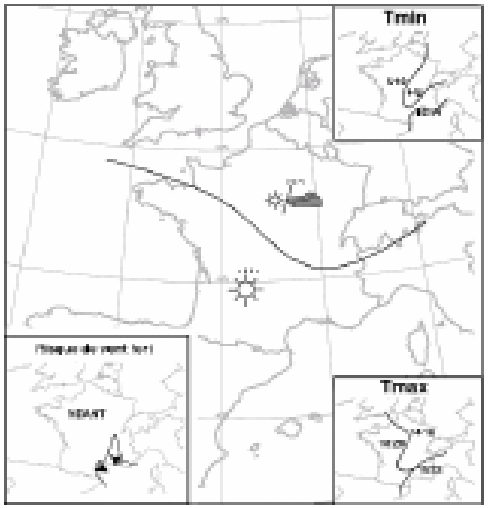
- Analysis for each area of weather forecast :
  - Average of 2 marks : one for cloudiness, one for precipitations
  - Malus (negative) for snow, thunderstorms, nature of precipitations, frequency of greyness

  → Final mark for the area
- Medium range mark over France :
  - Average of all marks, taking account of the number of departments in each area
  - Malus (negative) for wind if necessary
- Rules for giving marks :
  - Marks are given between 0 (failed forecast) and 10 (perfect forecast)
  - An error in cloudiness forecast is less strictly marked than an error in precipitations forecast
  - The mark given for a non-detection is as strict as for a false alert.

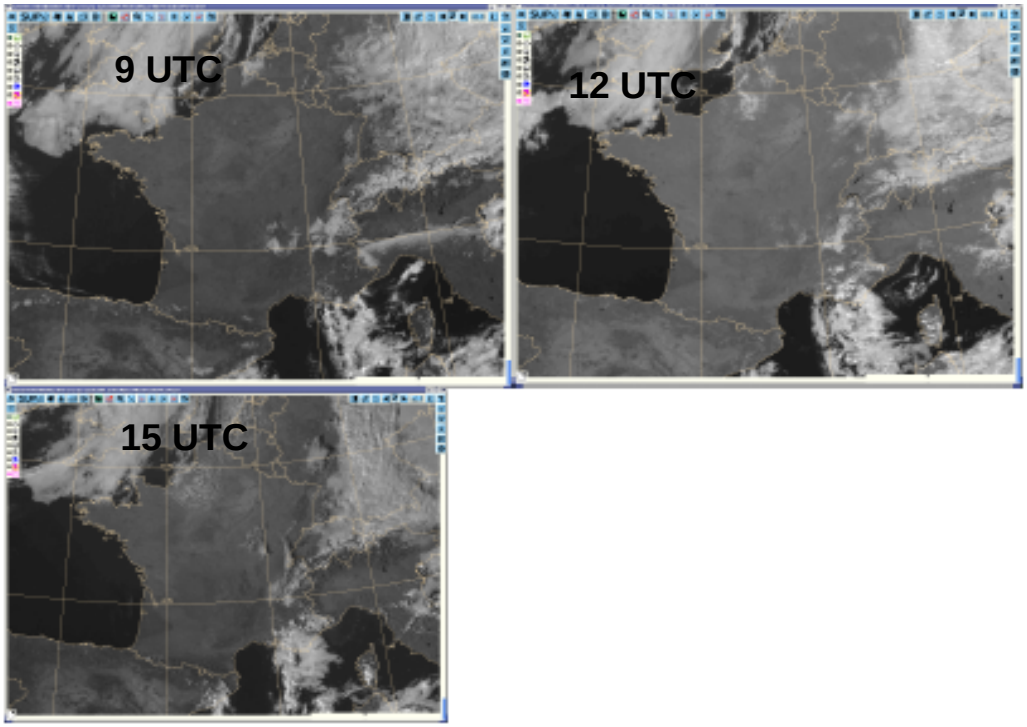
Example for D+7

Forecast from 8 October for 15

Mark obtained : 8,6 /10



Satellite pictures on 15 October



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Conclusion on medium range forecast

- Good signal for the Large Scale, get from the EPS (ensemble mean at 500 hPa and probabilities)
- Good interpretation of the forecasters :
  - Based on production of weather symbols
  - Also for dangerous phenomena
- Interest of a human interpretation :
  - Synthesis of global and local data
  - Synthesis of the most likely weather-type
  - To bring out risk of dangerous phenomena (strong winds, snow, thunderstorms) ➔ risk of thunderstorms good around 60% at D+4!

Outline

Use of ECMWF products at Météo-France :

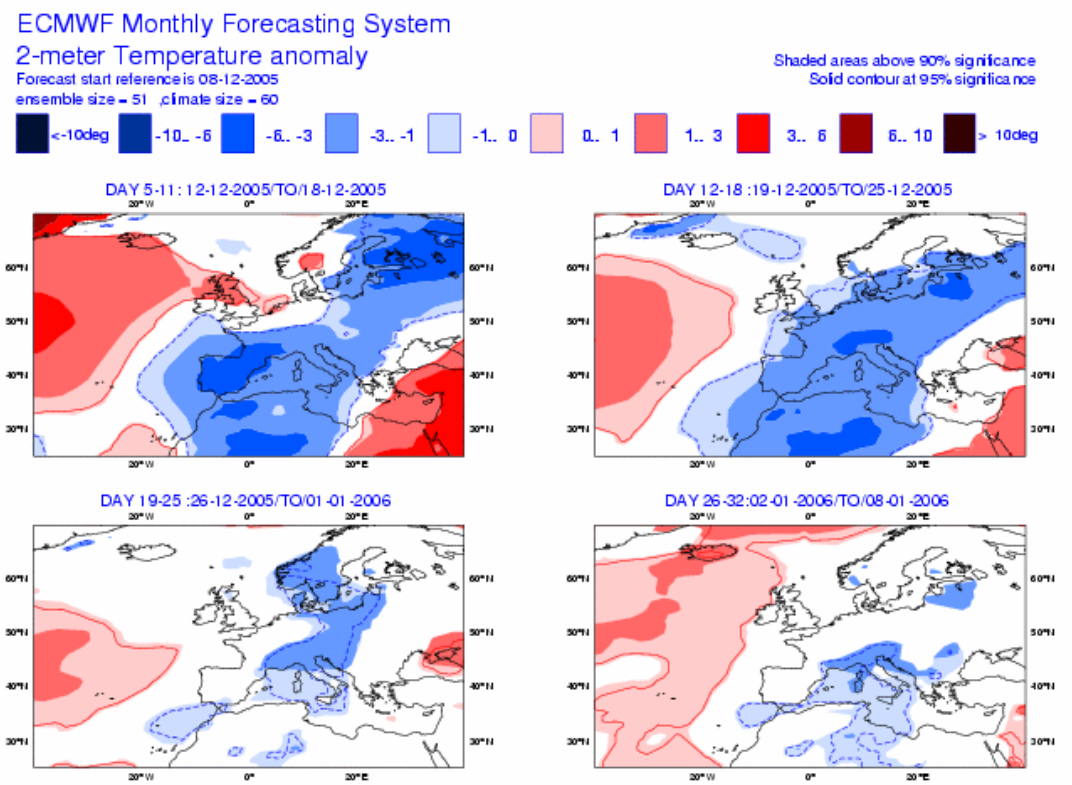
- Operational forecasting at Météo-France
- Severe weather forecast for D+2 and D+3
- Medium range forecast
- **Monthly weather forecast**

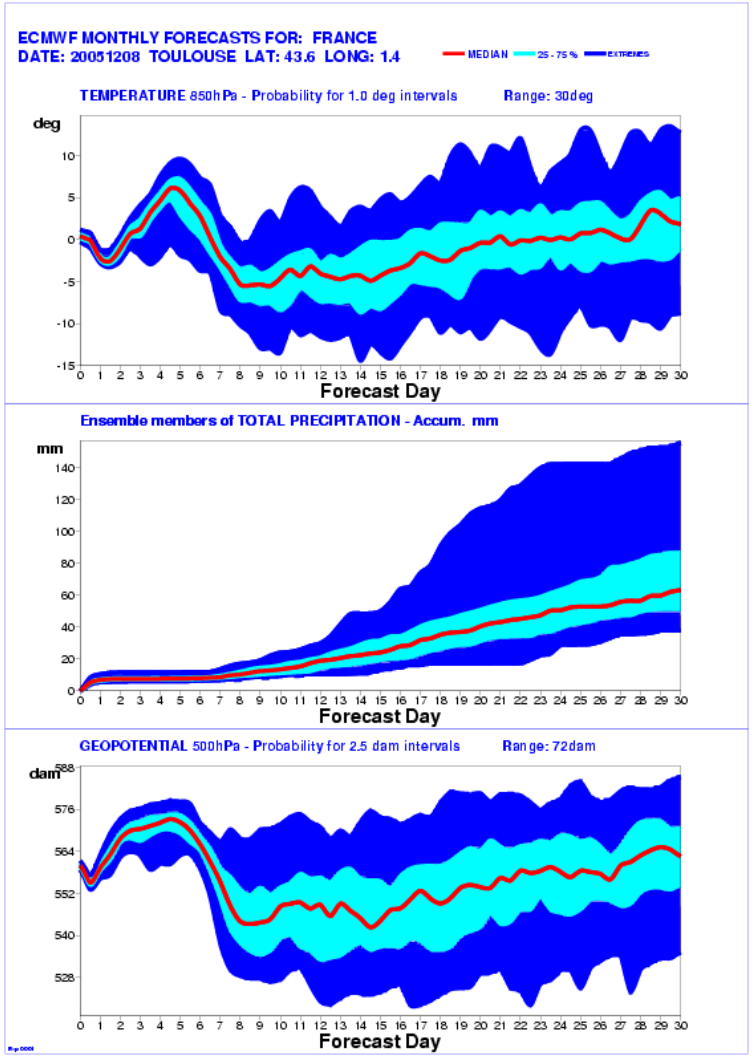
Production of MF at extended range

- Since January 2006, monthly forecast of temperature anomalies over France, issued every Friday, for Electricity of France
- Since July 2007, expert comment of calibrated probabilities :
  - From D+4 to D+14
  - Every day
  - For internal use
- Since February 2009, test of a monthly forecast bulletin :
  - Issued every Saturday, based on monthly forecast system, from W2 to W4
  - Can be updated on Monday for coherence with medium range forecast
  - Including a D+15 text for general public
- From January 2010, new bulletin for D+8/D+9 :
  - Text for general public (complementary to the weather chart)
  - Will be included in the telephone bulletins
- Seasonal weather trend available on Internet

Production of Météo-France at extended range is based on ECMWF monthly forecast system

Monthly weather forecast over Europe





Since January 2006, monthly forecast of temperature anomalies over France, issued every Friday, for Electricity of France

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Stage Prévision Saisonnière
nicole.girardot@meteo.fr

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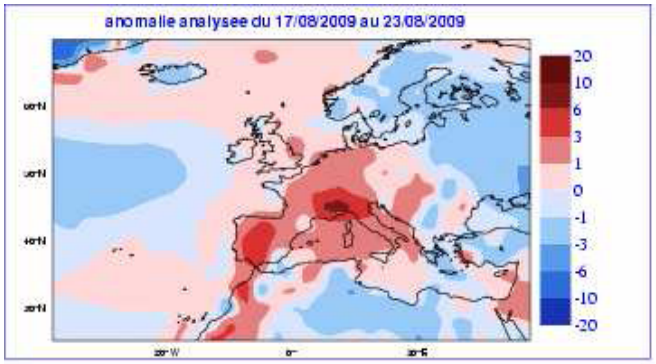
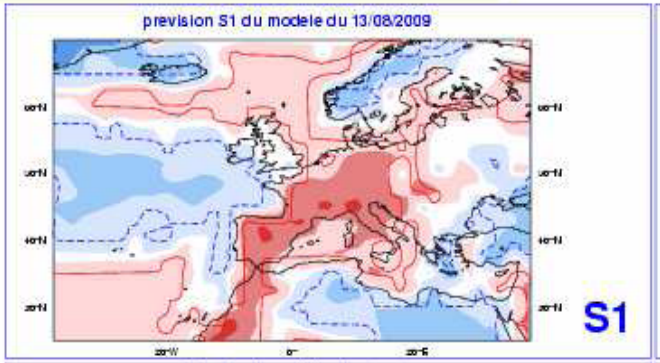
Weekly forecast verification

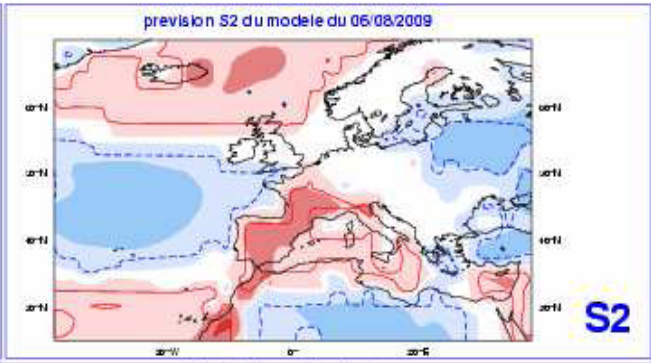


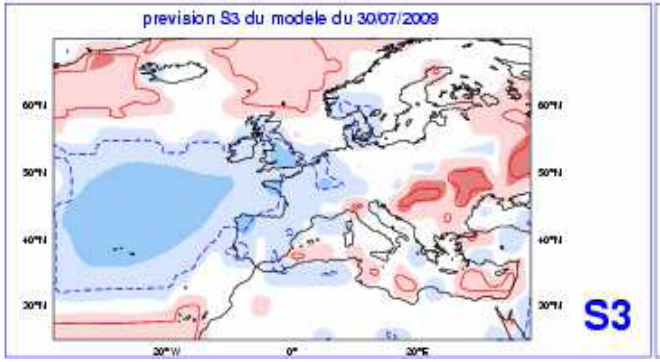
Verification

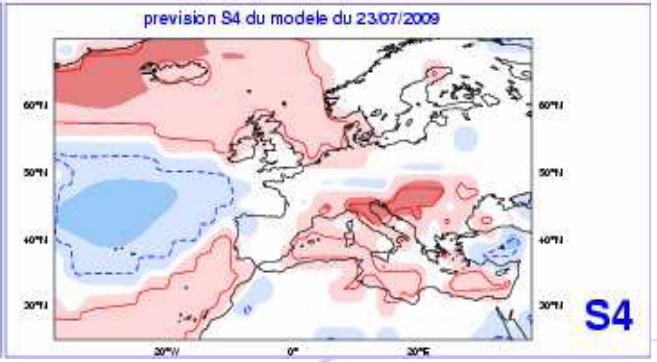
semaine du 17/08/2009 au 23/08/2009

Anomalie hebdomadaire de T2m









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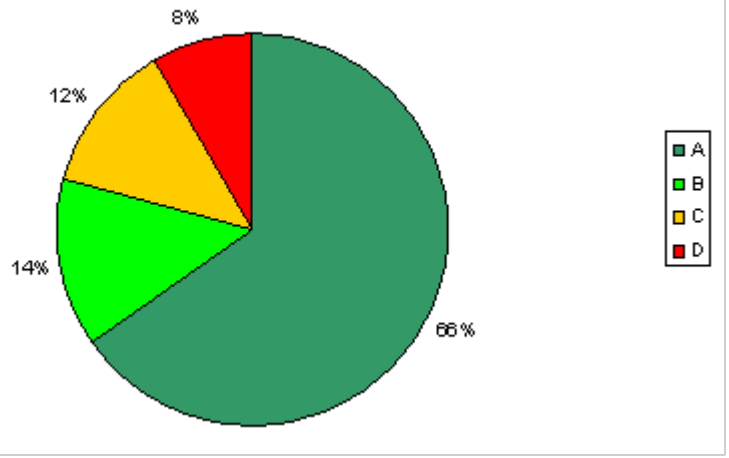
Verification of forecast over France

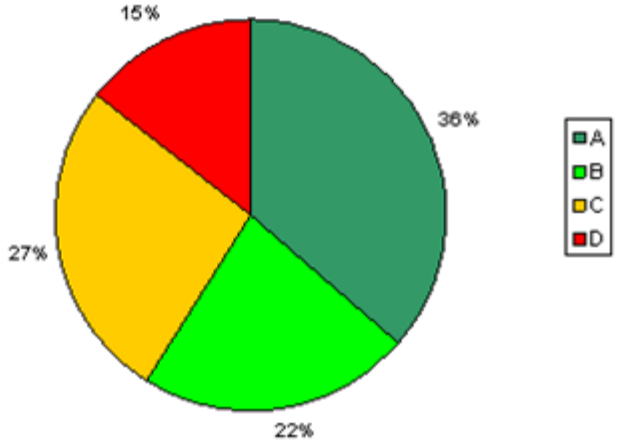
- Almost 5 years of verification at Météo-France, corresponding to more than 240 weeks
- Only over the area « France »
- A mark is given for each forecast, with 4 levels :
  - A : very good forecast
  - B : good trend (good anomaly but forecasted on a small part of the area, or no signal for a contrasted or very weak observed anomaly)
  - C : forecasted anomaly but no observed anomaly, or much more frequently, no forecasted anomaly but an observed anomaly
  - D : forecasted anomaly opposite to the observed anomaly
- Sample of almost 1000 marks

Verification from Week 1 to Week 4

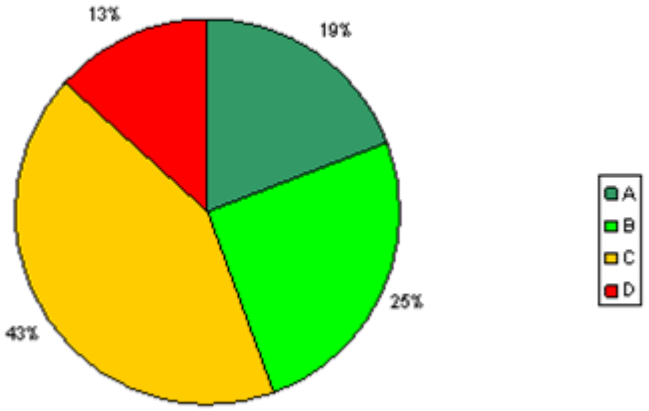
Week 1



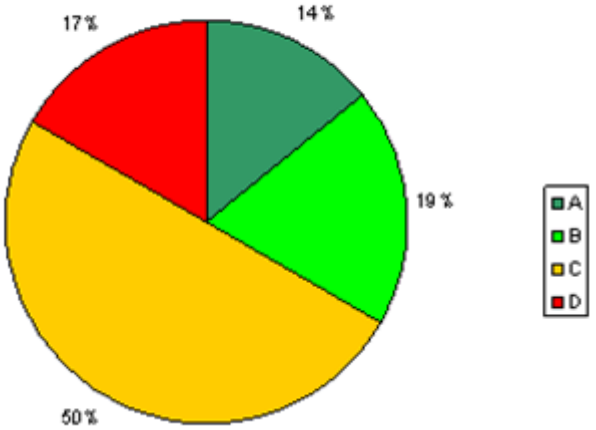
Week 2



Week 3



Week 4



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General comments

- Forecast is generally good, even very good for week 1 (W1)
- Forecast remains good for week 2 (W2) than decreases quickly
- However, the last results show a narrowing of the forecast qualities from week 2 to week 4
- The increasing number of C marks for W3 and W4, and the decreasing number of D marks for W2 and W3 are both due, in a large part, to the weeks where no forecast signal is detected (and an anomaly to analysis climatology is often observed)

Cases with signals for W3 and W4

- Questions :
  - Is the signal in weeks 3 and 4 rare ?
  - Is it of good quality ?
- Method :
  - These special cases and their marks are studied apart
  - The weak signals (in intensity or geographically) are added in this small sample
- Results :
  - More than half of the cases correspond to signals for week 3
  - When there is a signal for week 3, it is quite good in almost 2 cases out of 3
  - When there is a signal for week 4, results are divided between good and bad trends. But maybe there is an improvement (to be confirmed later).

	W-3	W-4
A	28	22
B	41	22
C	11	8
D	31	39
TOTAL	111	91

Cases with pronounced signals

	W-1	W-2	W-3
A	65	8	1
B	3	1	0
C	3	0	0
D	0	1	0
TOTAL	71	10	1

- Same calculation for the pronounced signals (>3°C over a large part of France)
- Fery few cases beyond week 1
- Very good results. The opposite signals are really exceptional.

Winter 2008/2009

	W-1	W-2	W-3	W-4
A	10	7	8	5
B	3	3	4	6
C	1	4	3	4
D	1	1	0	0
TOTAL	15	15	15	15

- Good results for the overall winter, and excellent results for the coldest period (beginning of January)
- Results are strangely better for week 3 than for week 2.
- Week 4 gives very interesting results.

Sliding means over 1 year