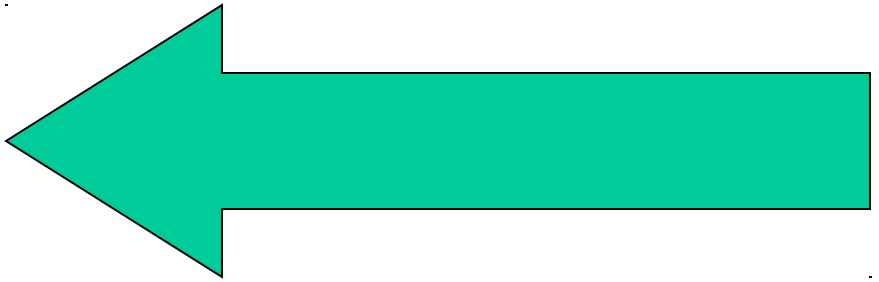
Nowcasting with a dedicated mesoscale model and with a radar-NWP fusion technique

J.-M. Moisselin, J. Hoffman, N. Merlet, P. Cau, I. Bouissières

Météo-France
Nowcasting Department
June 2016

Outlines

AROME-NWC Description

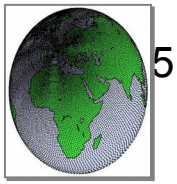


The use of AROME-NWC

Data fusion with AROME-NWC

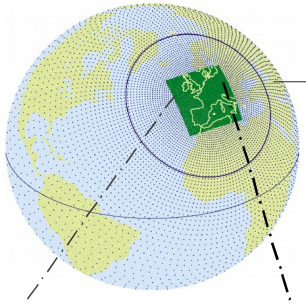
METEO FRANCE

Main NWP models

Ensemble Forecast ARPEGE:  5

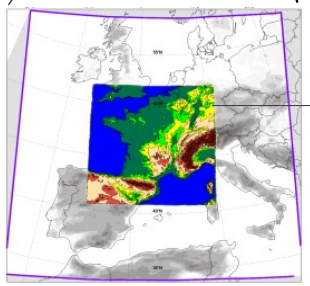
(twice a day, fc range max. 90-108 hrs, lower resolution than ARPEGE)

ARPEGE



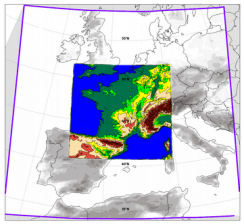
Resolution 10 km
Global Model ARPEGE,
Forecast up to 4 days

AROME



Resolution 1.3 km
Mainland France model AROME,
Forecasts up to 36 hours

AROME-NWC

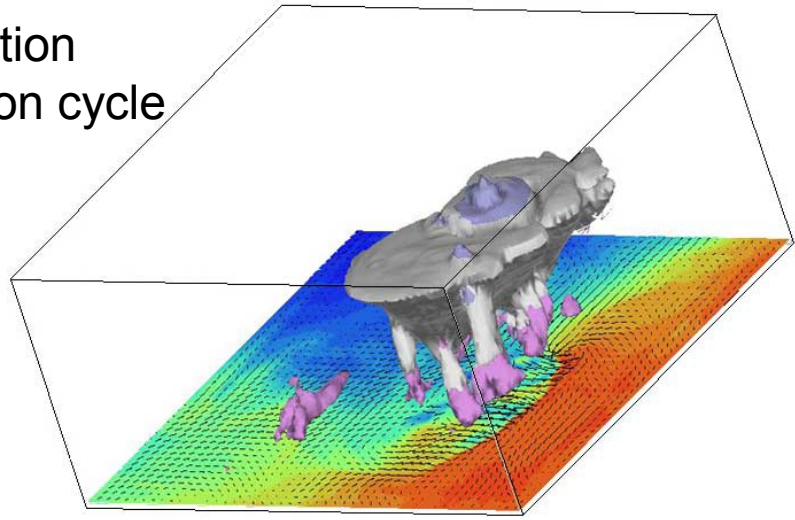


24 time a day

AROME–NWC: Now Operational

New opportunities:

- NWP compliant with mesoscale and resolved convection
- Special work on spin-up, data assimilation, assimilation cycle
- Increase of computer power



A specific version of AROME for nowcasting

- Assimilation window [-10,+10]
- Operational March 2016

AROME - NWC goals

- Extend the maximum forecast range
- Provide trends on phenomena

Forecast of several parameters: wind, temperature, humidity, but also reflectivities, precipitation, kind of hydrometeors

- Hourly refreshed
- Available within 30 minutes after the latest observations
- Max forecast range = 6 hours
- Resolution of forecast 15' (H+15, H+30, H+45, H+60, H+75, … H+360)

METEO FRANCE

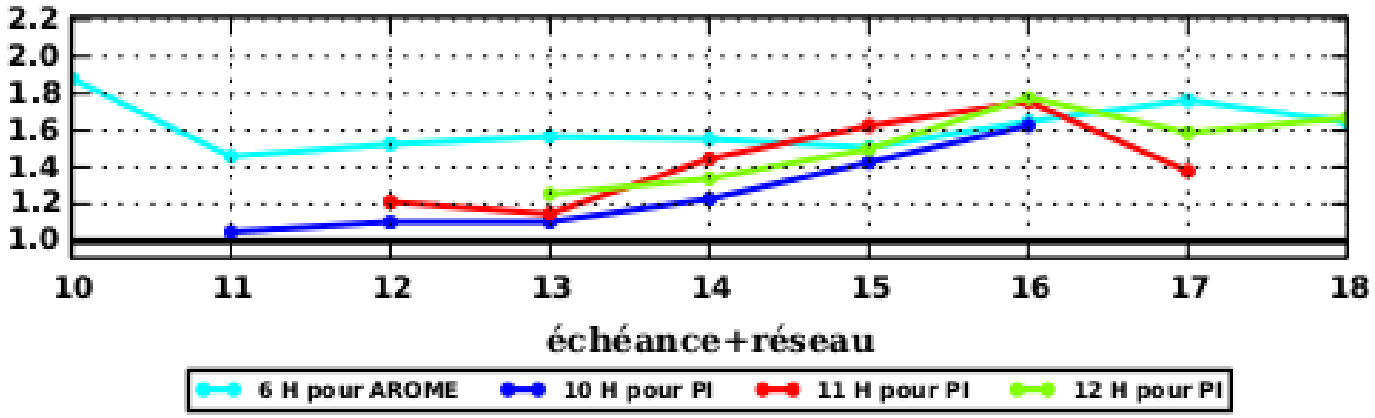
AROME-NWC *cut-off impact* and comparison with AROME

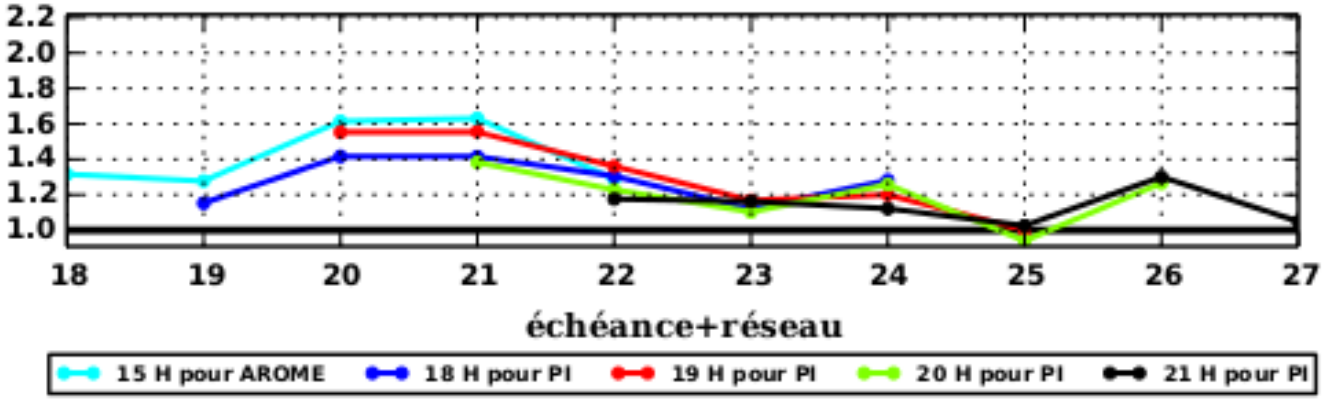
		NWC	
	AROME-France	AROME-PI (-10,+10)	*AROME-PI (-20,+20)*
cutoff	+ 02h15	+ 00h10	*+ 00h10*
Status	OPER	OPER	*Test*
Degrees of freedom	approx. 800 millions		
Max of assimilated observations at 12 h	110 000	82 000	*87 000*
Radar	75 000 (68 %)	75 000 (91 %)	*75 000 (86%)*
Surface	7 500 (7 %)	5 200 (6 %)	*7 500 (8%)*
AMDAR	3 200 (3 %)	300	*1 200 (1,3%)*
Soundings	11 000 (10 %)	300	*600*
SAT	14 000 (13 %)	40	*200*
GPSsol	1 000 (1%)	0	*1 000 (1%)*

(Pierre Brousseau, CNRM-GAME)

METEO FRANCE

Scores AROME-NWC



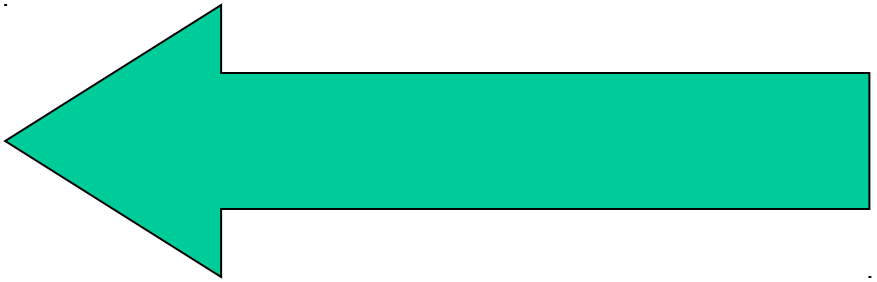


Bias of QPE ≥ 10mm/1h

Outlines

AROME-NWC description

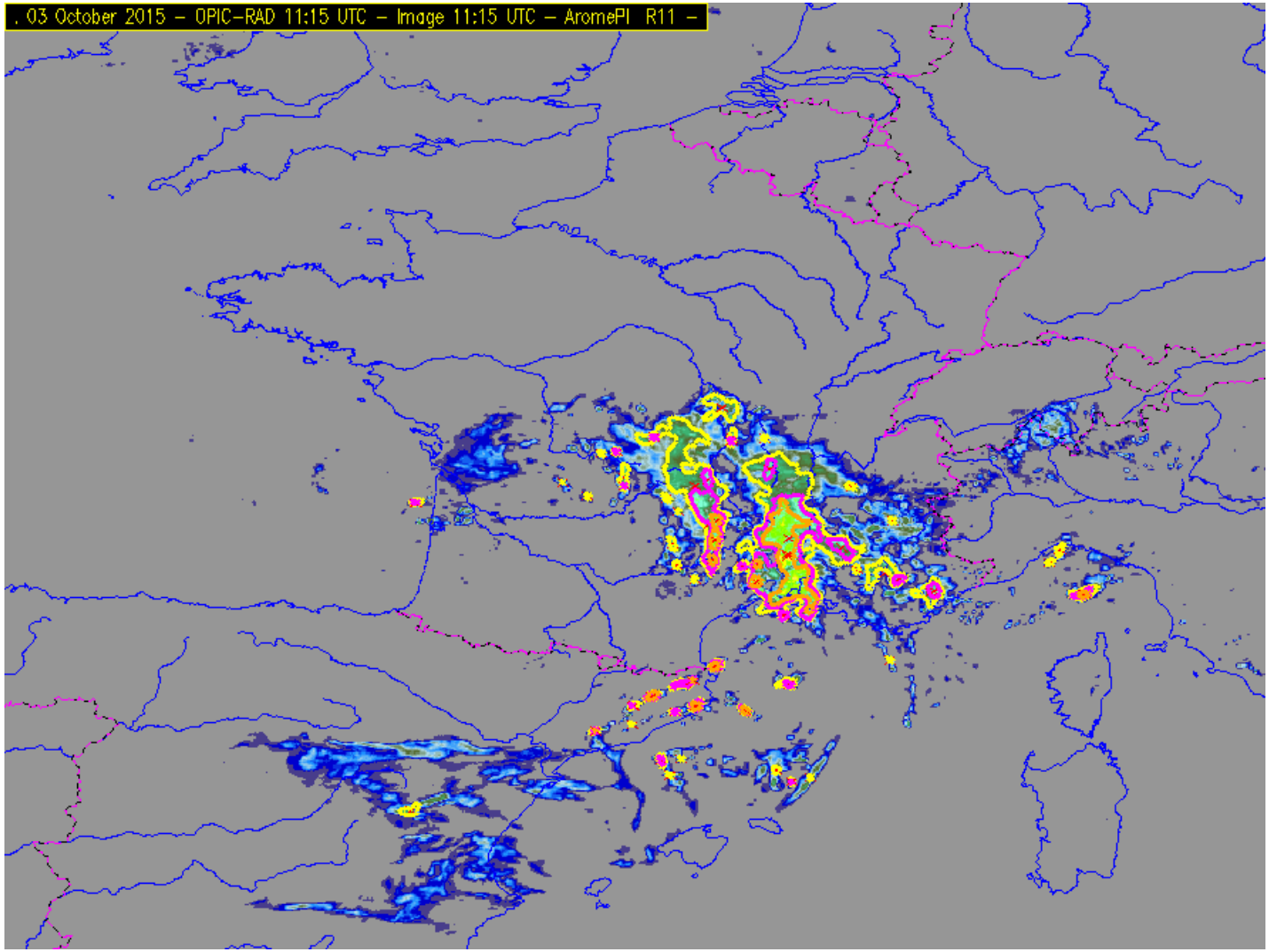
The use of AROME-NWC



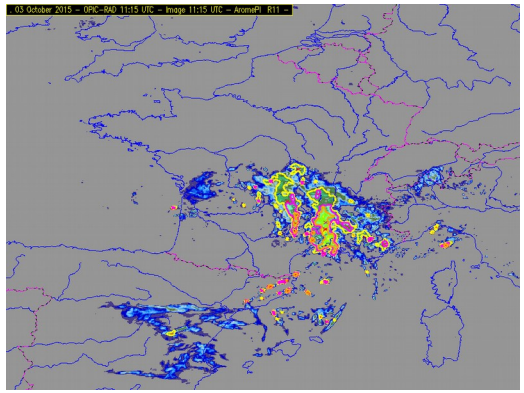
Data fusion with AROME-NWC

METEO FRANCE

Convection Nowcasting Object with AROME-NWC reflectivities as input

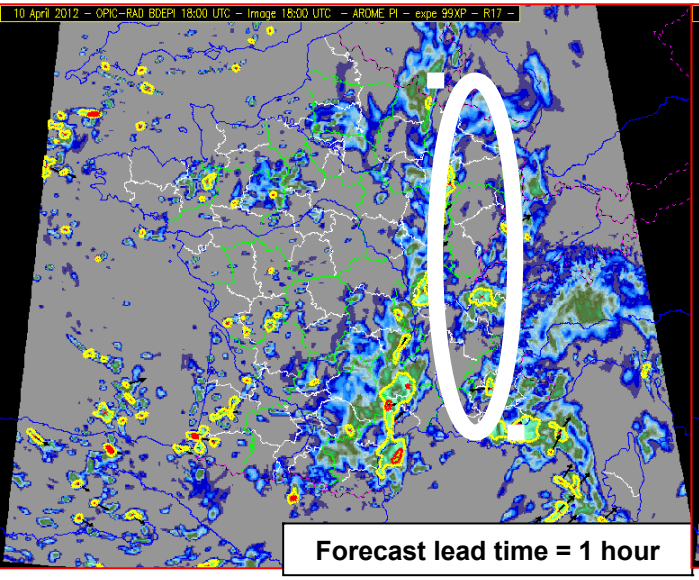


Convection Nowcasting Object with AROME-NWC reflectivities as input

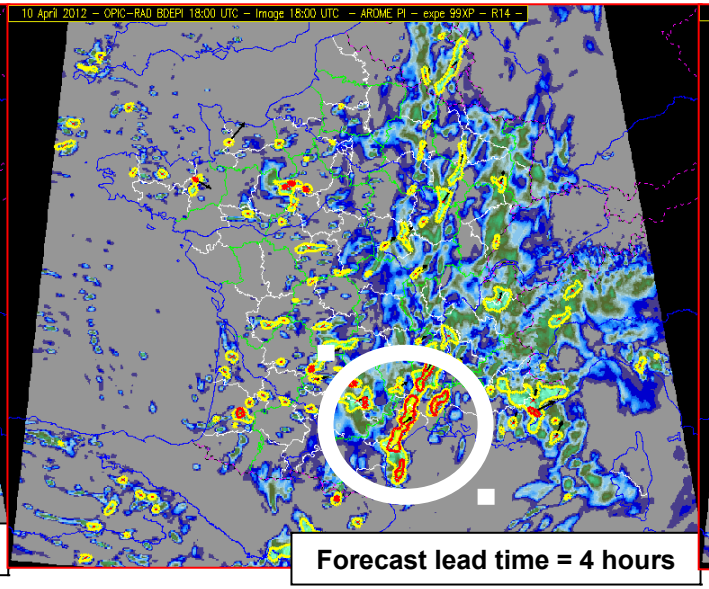


anim_CONOwithAROME.gif

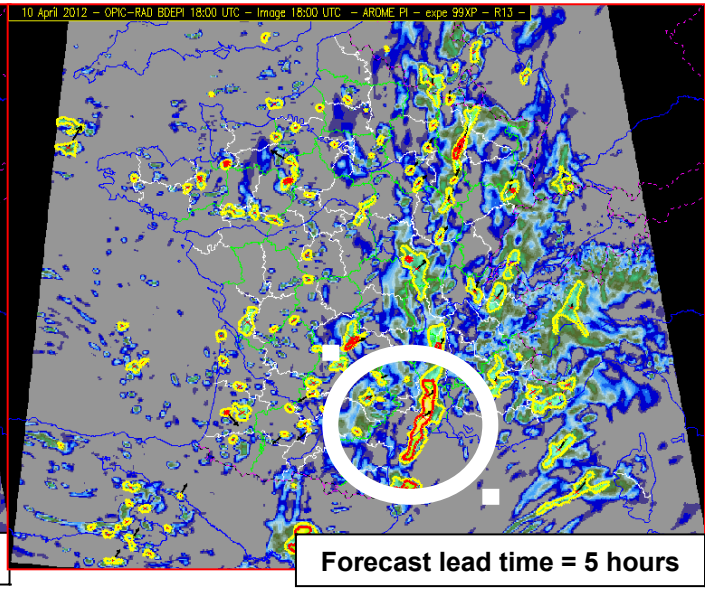
AROME-NWC reflectivities
same validity time 2012 April 10, 18 UTC



Forecast lead time = 1 hour

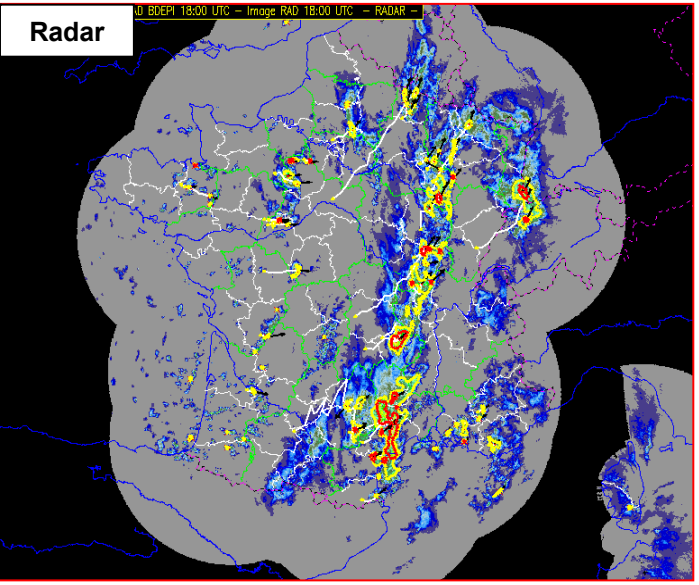


Forecast lead time = 4 hours



Forecast lead time = 5 hours

Radar



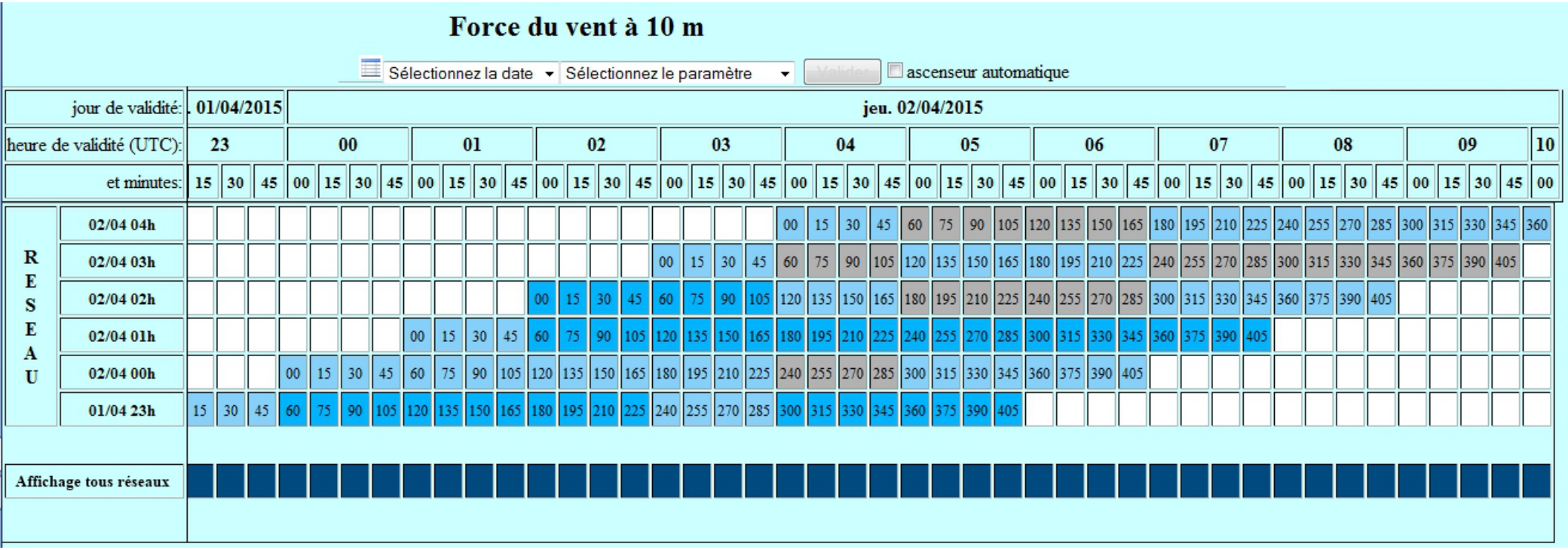
Correct forecast of general features of reflectivity fields but

- +1 hour: correct dry area eastward high reflectivity line
- +4 and +5 hours: correct high reflectivity patterns in the South

The choice of the last issue of AROME-NWC is not necessarily/systematically the best option

web-dashboard for forecasters

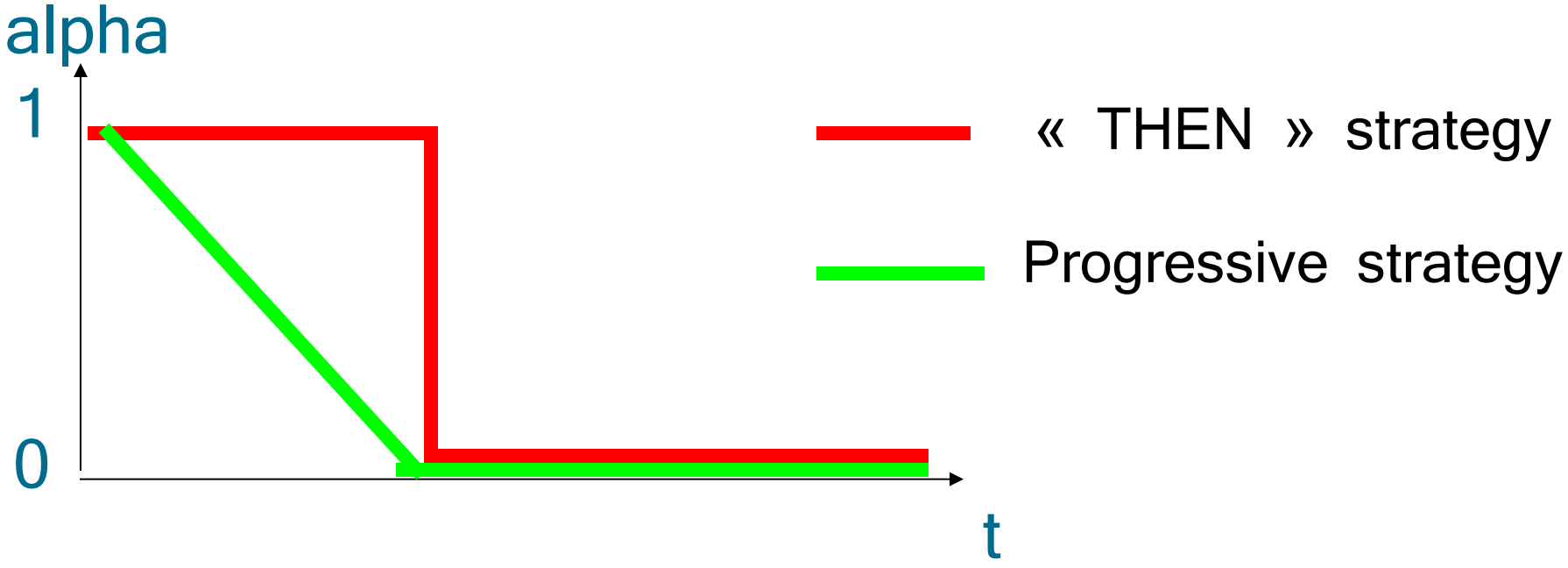
For the 6 past run
For model output or elaborated diagnosis (convection, fog, etc.)
Cell coloured accordingly a quantile



Goal :
1) To help forecasters to quickly identify the met. situation and the parameters to watch.
2) To provide a synthetic representation of information

Fusion – General case (1/2)

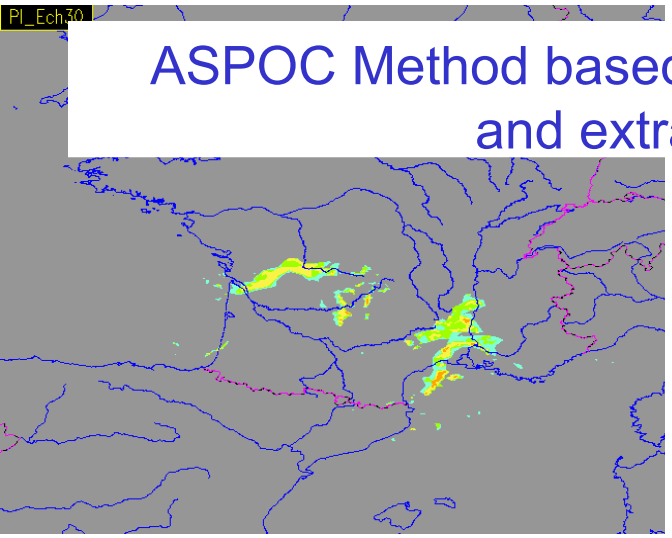
Fusion = alpha Obs-based methods + (1-alpha) Arome-NWC

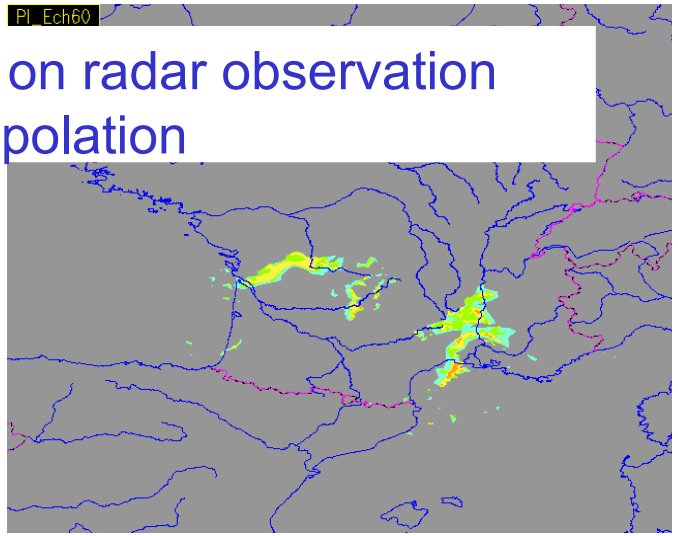


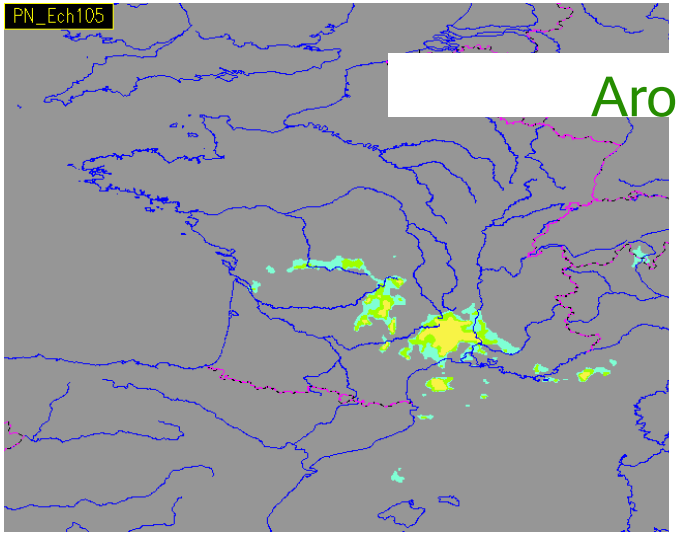
THEN STRATEGY. Arome-PI used after radar image extrapolation, without any fusion: rough, simple, not seamless at all !

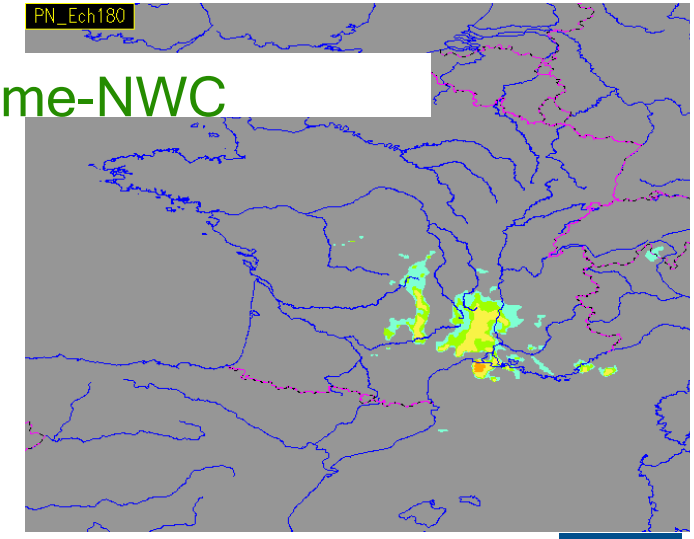
t

ASPOC Method based on radar observation and extrapolation









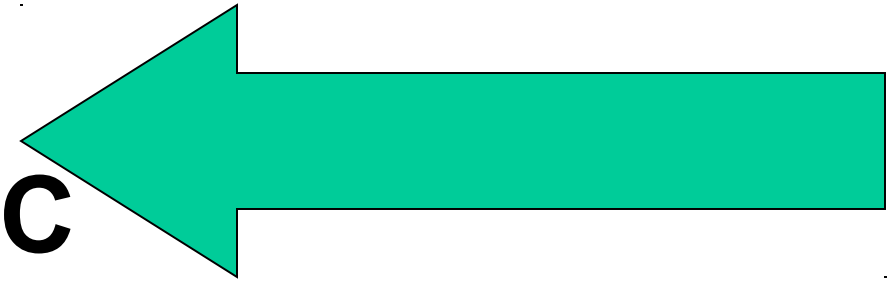
Arome-NWC

Outlines

AROME-NWC Description

The use of AROME-NWC

Data fusion with AROME-NWC



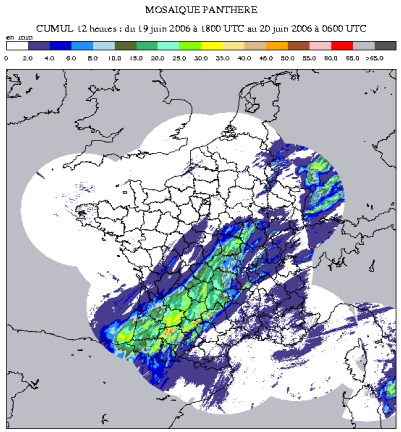
METEO FRANCE

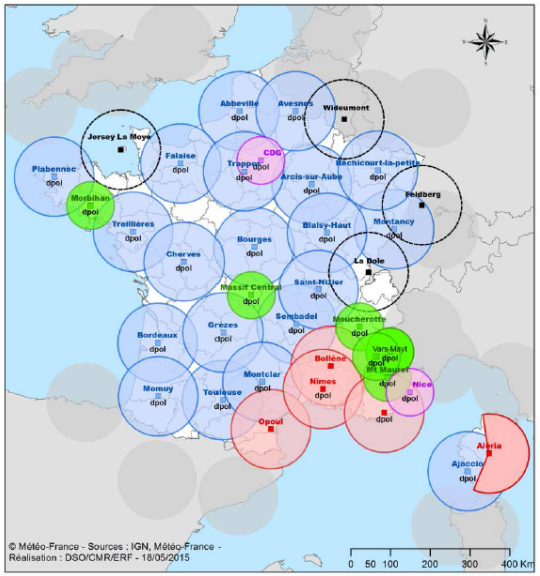
The 2PIR method – French radars network

The French radar **composite** image is processed with 30 conventional radars. The radar network has the following characteristics

- All Dopler, 27 double polarisation
- C (26), S or X band
- 1km / 1dBZ / 5 mn

QPE is then available every 5 minutes calibrated with rain gauge



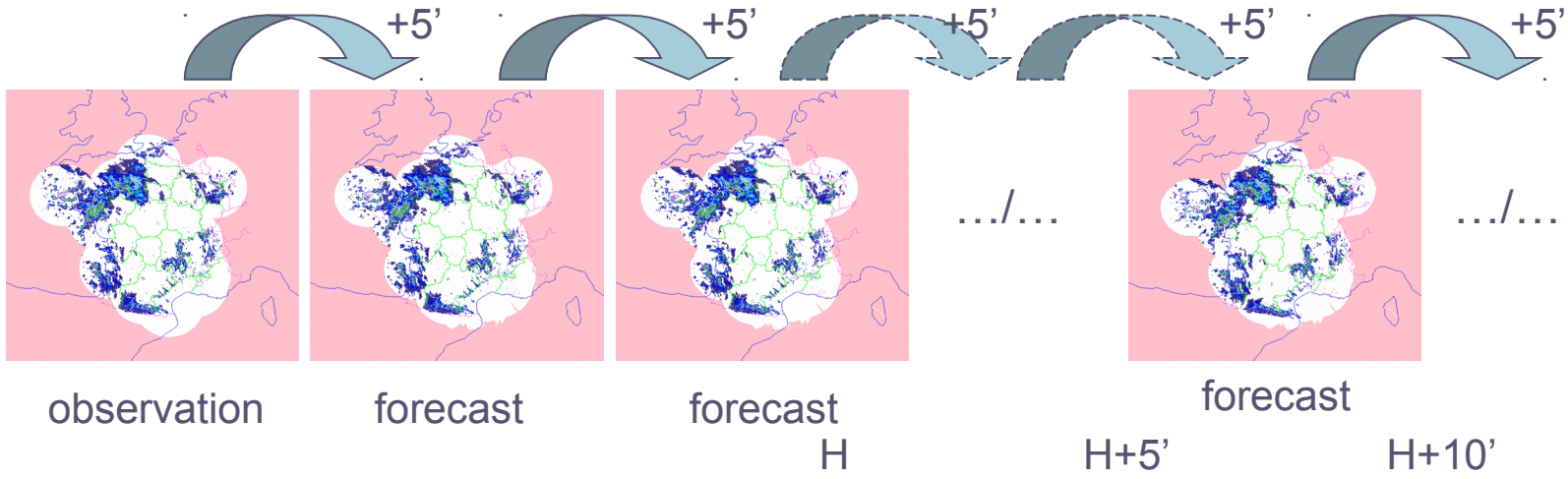


The 2PIR method – Main principle

The core of the method: two main processes

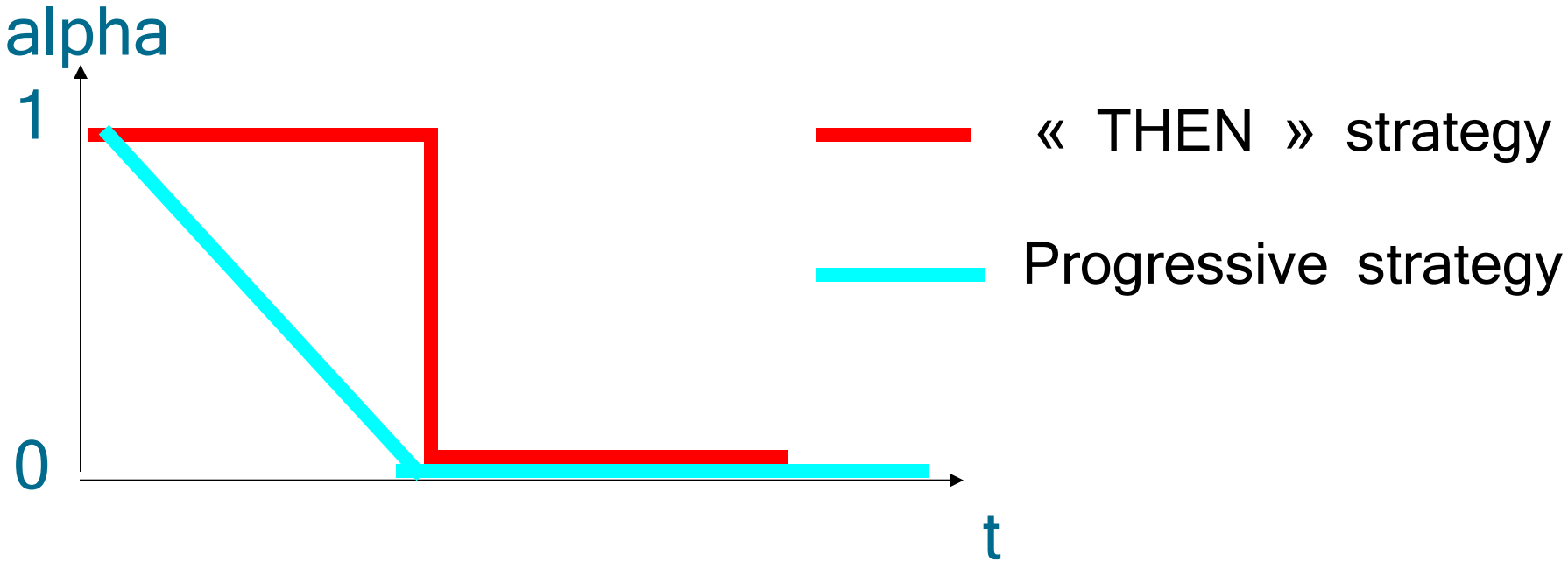
Comparison of an observed radar image with a previous one
→ Identification of cells displacement
→ Dagnosis of a motion field

Extrapolation, applying the motion field to the observed radar image
→ Forecast images



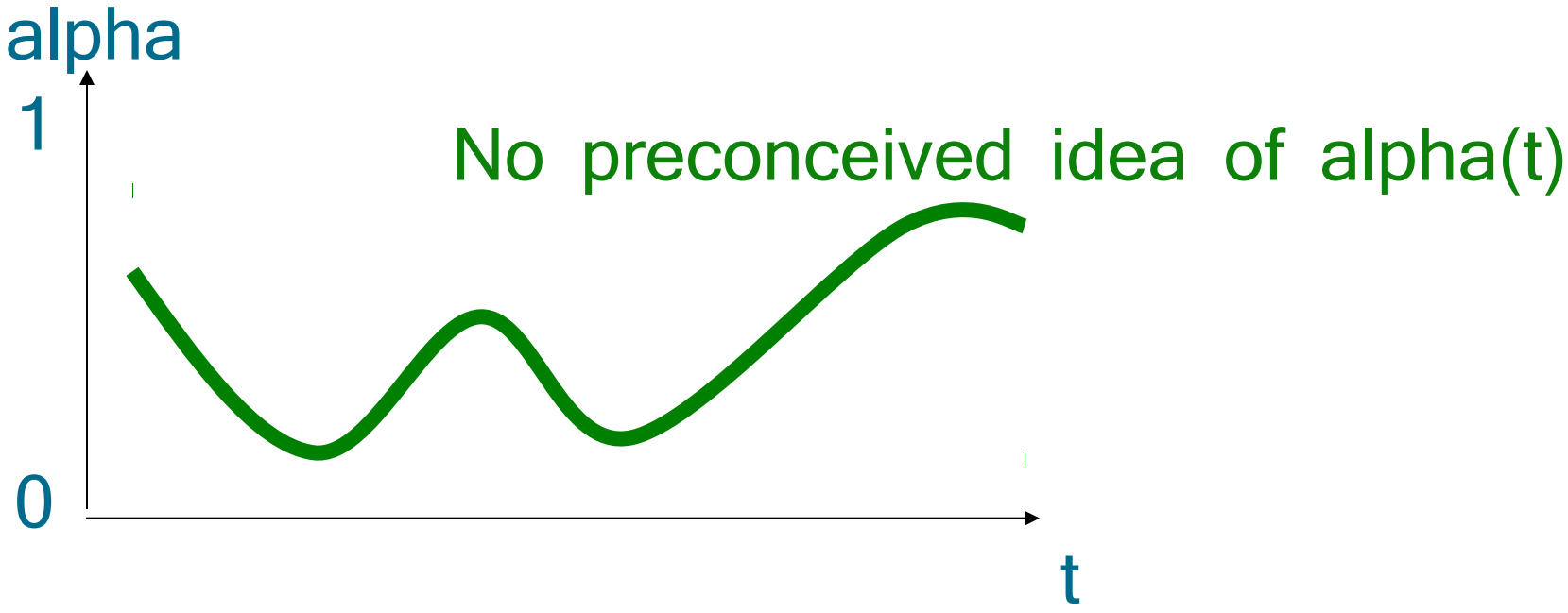
Fusion – General case (1/2)

Fusion = alpha 2PIR + (1-alpha) Arome-NWC



Fusion – General case (2/2)

Fusion = alpha 2PIR + (1-alpha) Arome-NWC



Fusion: Adaptive and Self-Confident Algorithms

See for example

Auer, P., Cesa-Bianchi, N., & Gentile, C., 2002. *Adaptive and self-confident on-line learning algorithms*. J. of Computer and System Sciences, 64, p. 48-75.

Development of the method in our context: O. Mestre, P. Cau

Two experts for France domain

* 2PIR (up to 3 hours!, refreshed every 5 minutes). 5' resolution of forecasts
* The last Arome-NWC available (refreshed hourly). 5' resolution of forecasts

Example:

Time=H+45

Validity date=H+60

Last AROME-NWC: AROME-NWC at H

Expert1=2PIR of H+45, forecast range +15'

Expert2=forecast range +60' of AROME-NWC

In Development

METEO FRANCE

Fusion: adaptive and Self-Confident Algorithms

Matrix dimensions

- Performed day by day
- Ensemble of initial states 12*24=288
- Ensemble of forecast range 180/5=36

Fusion = alpha 2PIR + (1-alpha) Arome-NWC

Application Alpha: forecast range dependent but the same for all grid points

Alpha defined by dynamical 24hours training

Verification and training: radar QPE

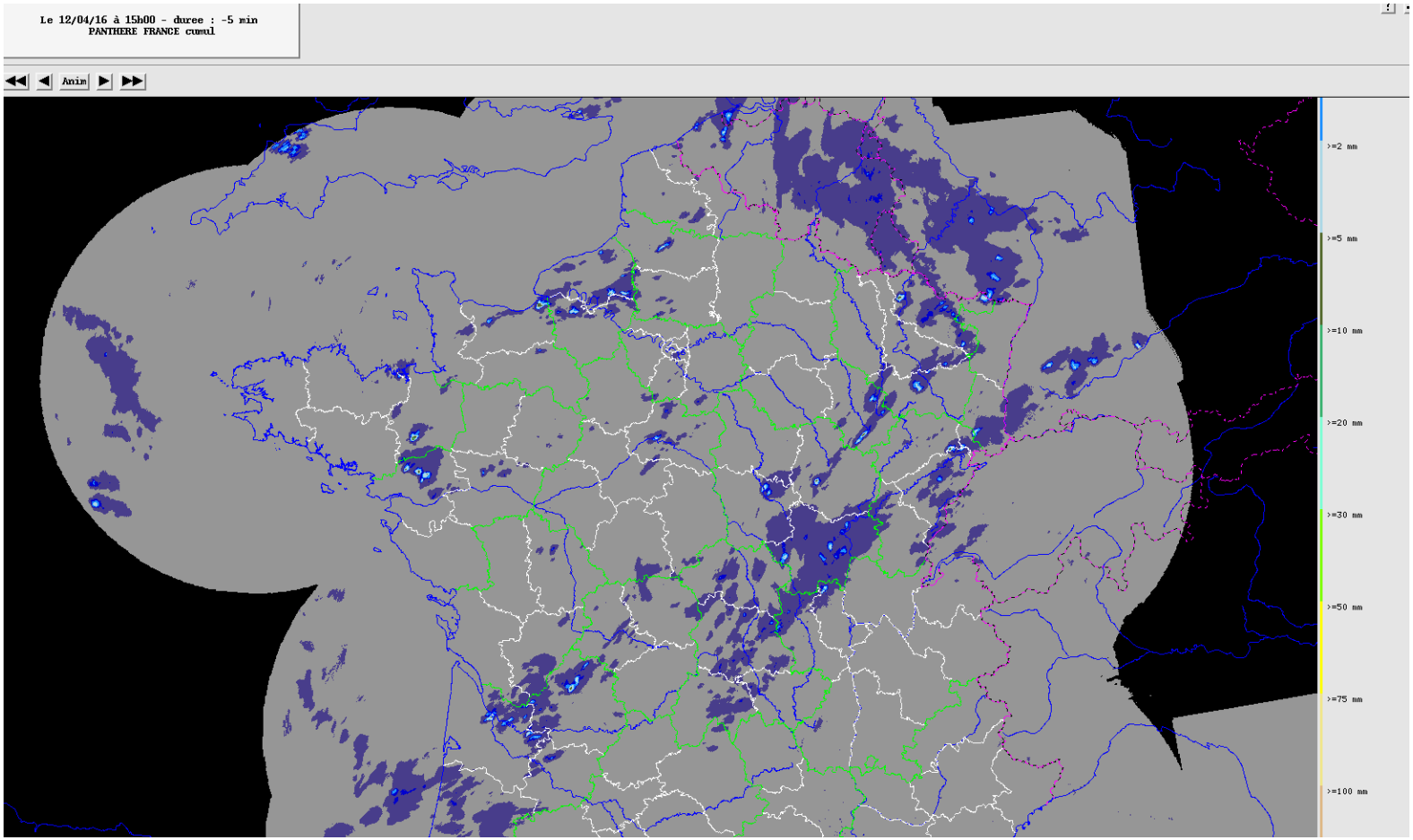
Strategy for minimizing the regret: to be better than best expert (or not so far away)

4 training speed tested

In Development

METEO FRANCE

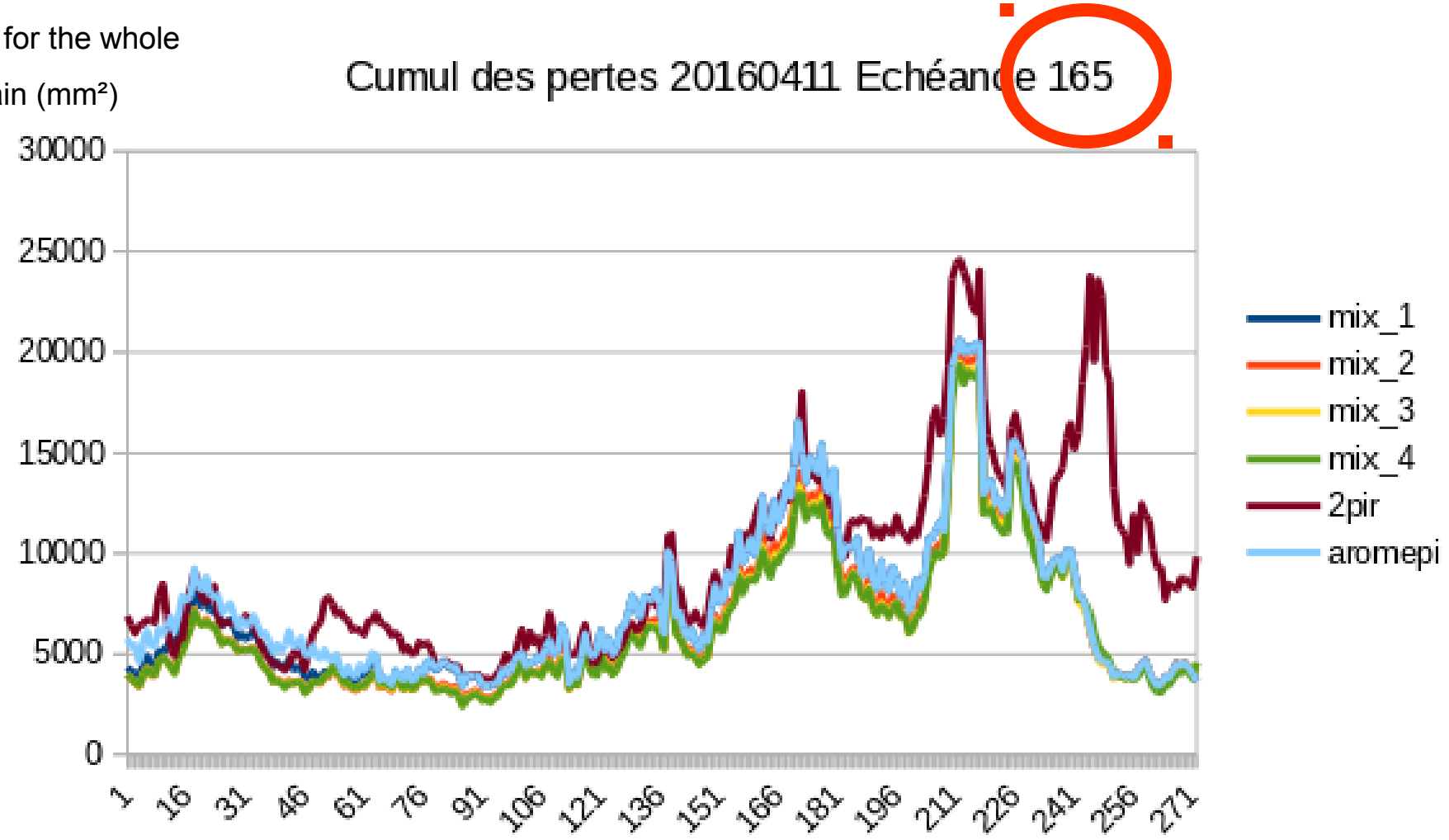
11 - 15 April 2016 convective rainfall



In Development

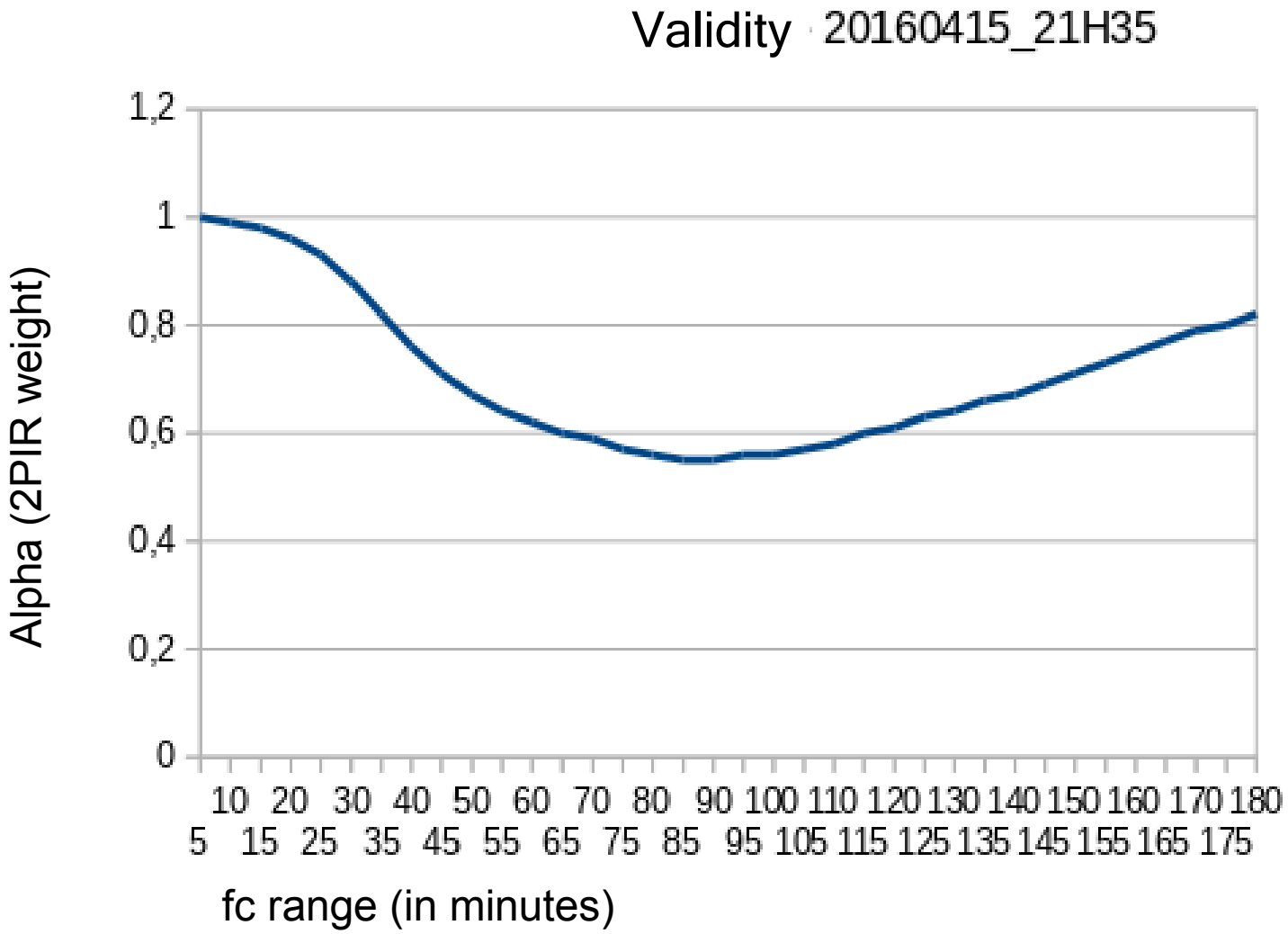
Is the best expert chosen by the method ?

Error for the whole domain (mm²)



In Development

The contribution of experts



Simple

Smooth

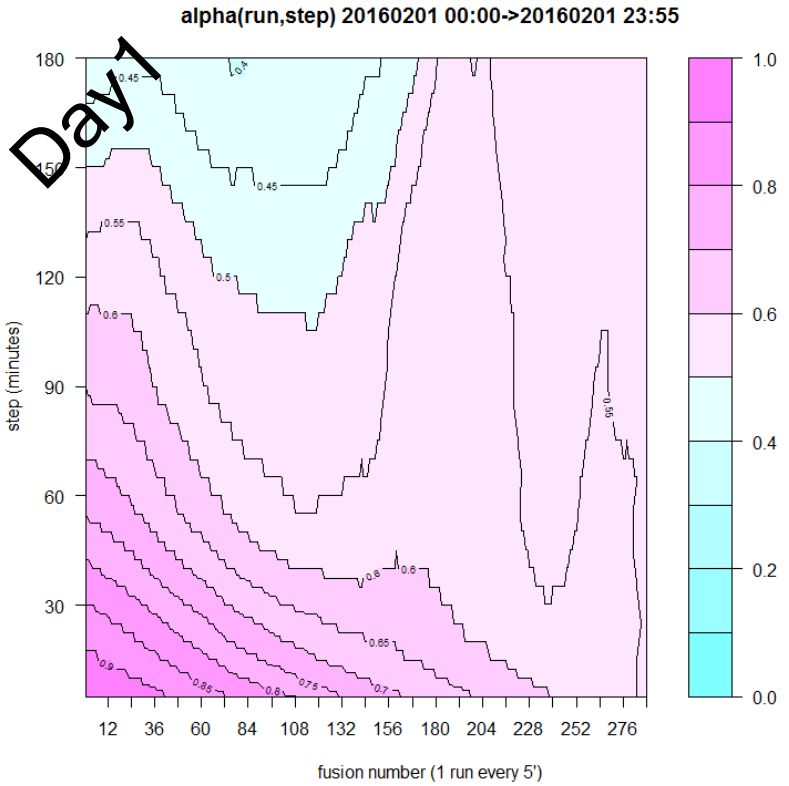
Smart

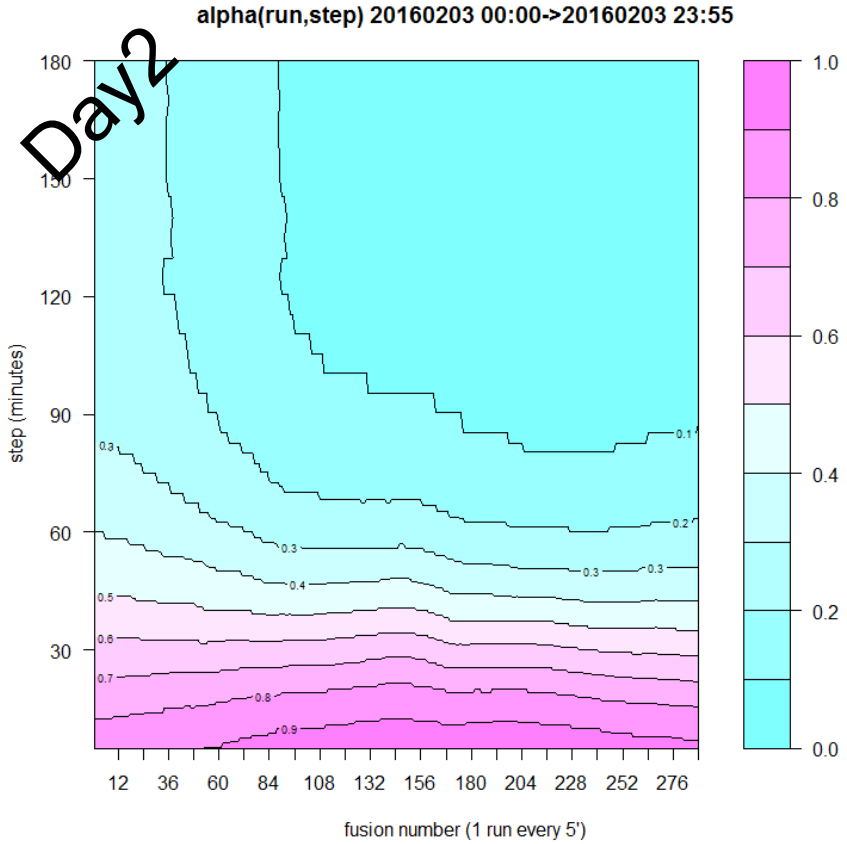
Surprising

In Development

The contribution of expert for two 24hours period

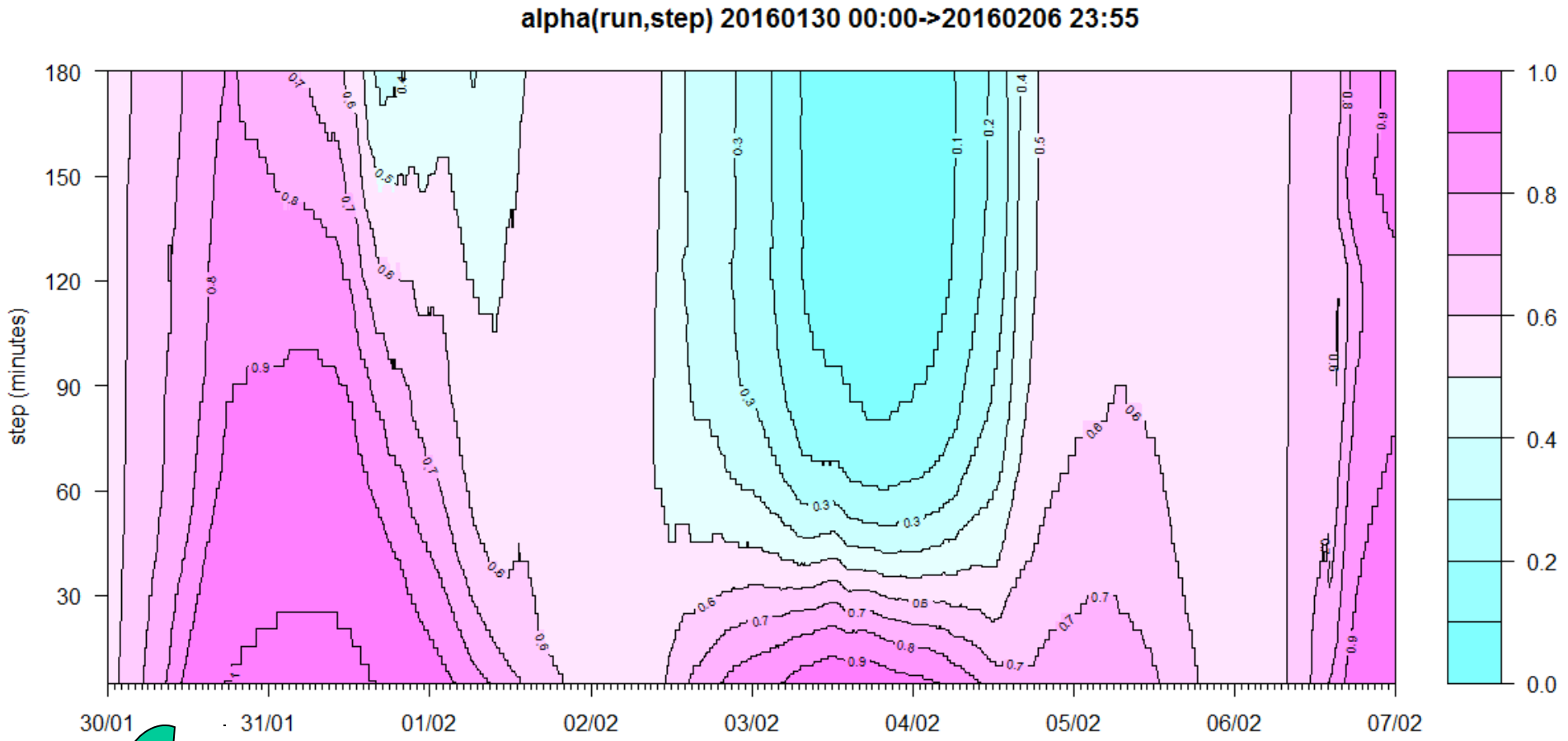
Fusion = alpha 2PIR + (1-alpha) AromePI



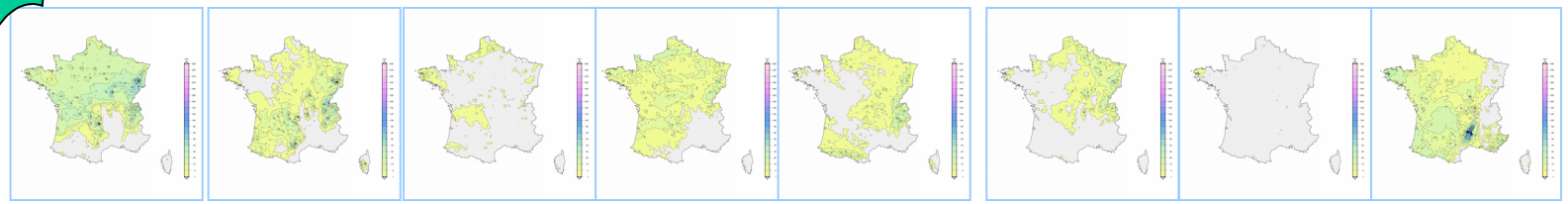


In Dev

The contribution of expert for a 8-days period



Daily rainfall



In Development

Conclusion

AROME-NWC. Not a new model but a new engineering production. Built for nowcasting

Use by forecasters. Need to adapt, condense, highlight the relevant information

Use in data fusion process: for products

Thanks for your attention