

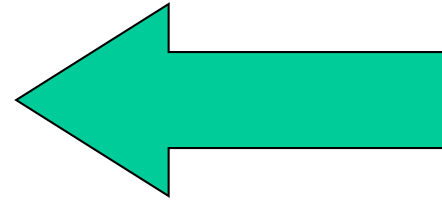
A radar network and products to better detect and forecast severe weather in France

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Jean-Marc Moisselin, Météo France

WSN16, July 25th 2016

Talk outline

The French radar network and products



Heavy rainfall alerts

Convective nowcasting objects

The ARAMIS Metropolitan Network

30 radars in total in 2016

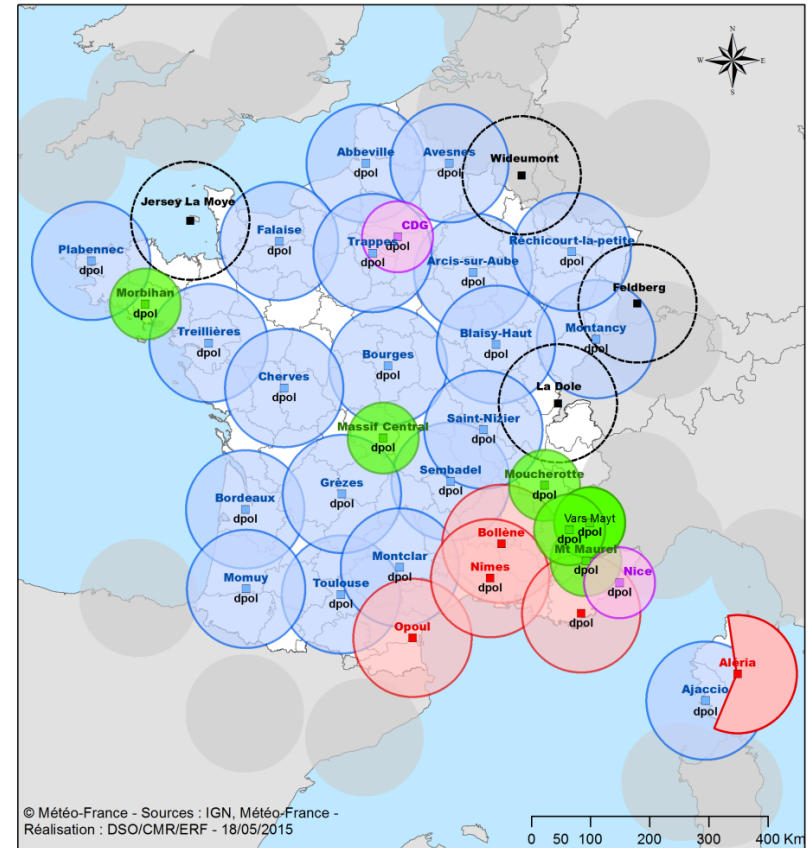
- All Doppler
- 5 S (2 DPOL)
- 19 C (All DPOL)
- 6 X (All DPOL)

3 new radars will be installed in 2017-2018

- 2 X (DPOL)
- 1 C (DPOL)

7 overseas radars (2 S in the Caribbean, 2 S at la Reunion, 3 C in New Caledonia)

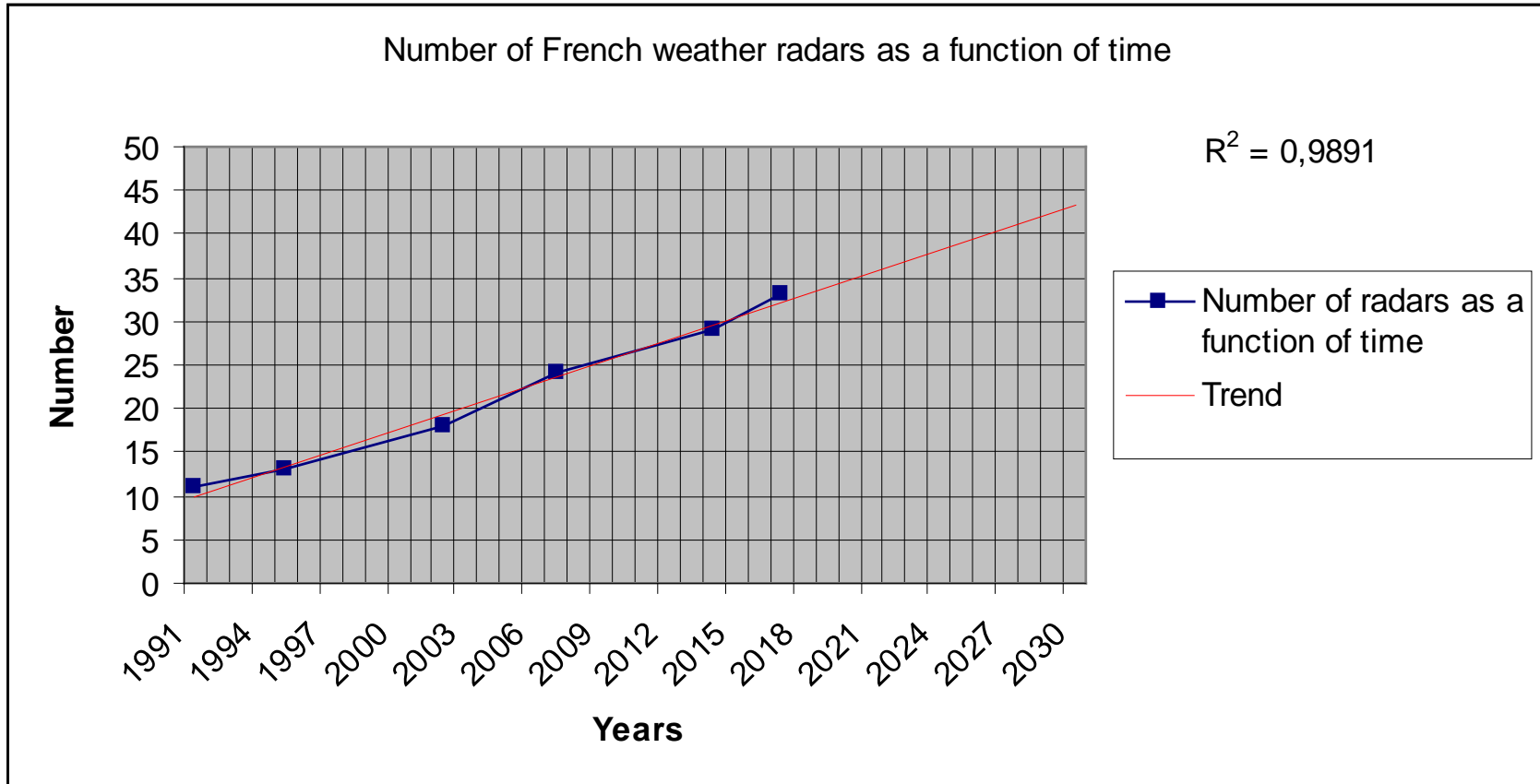
Le réseau de radars mi 2018



Légende

- X band - LEOPARD
- X band
- S band
- C band - radar limitrophe
- C band
- Dpol : dual polarization

Number of radars throughout the years



- The French radar network is now the largest by the number of radars in Europe.
- Dedicated radar staff has remained constant.

Applications of Radar Data in France

❑ Hydrology – Heavy rainfall alerts

QPE composite product

Large investment in DPOL / X-Band / Radar – RG Calibration

❑ Severe Weather Surveillance

Reflectivity composite product

Nation-wide 3D Reflectivity Fields / Wind Shear Mosaics

❑ Numerical Weather Prediction

Reflectivity & Doppler data polar data assimilated into AROME

Work on refractivity and DPOL Assimilation

❑ Aviation

Dedicated X-band Polarimetric Airport Radars

❑ Climate Studies – Reanalysis

10-year (1997 – 2006) hourly QPE reanalysis

The new airport radars



METEOR radars supplied by SELEX (Doppler, DualPol, X band)

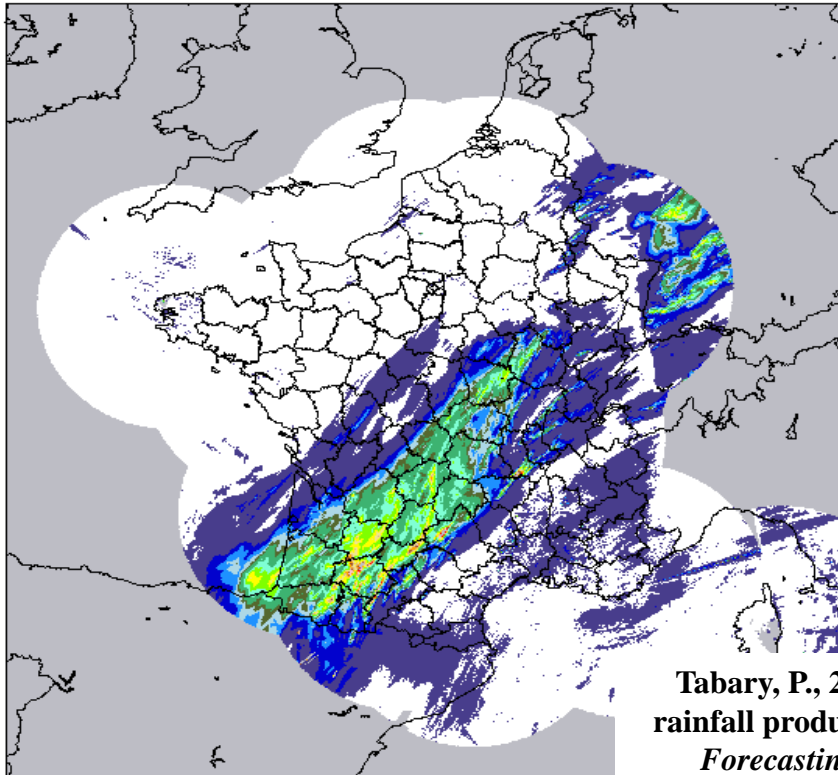
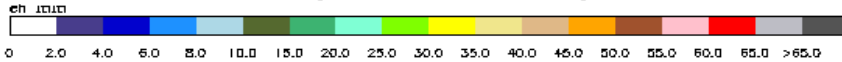
- To provide wind shear alert ROSHEAR to air traffic control.
- Will be integrated in standard QPE product later.

QPE composite product

5', 1 km², nation-wide QPE composite including VPR correction, partial beam blocking correction, dynamic ground-clutter identification, **hourly radar – rain gauge adjustment**, dynamic quality codes, artefact removal using satellite, attenuation correction using DPOL, ...

MOSAIQUE PANTHERE

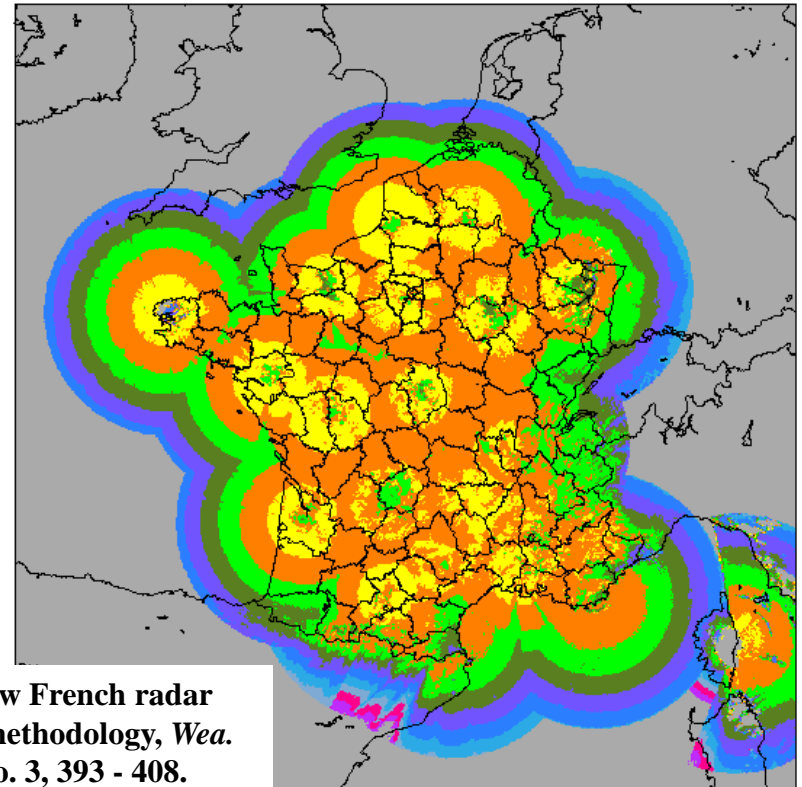
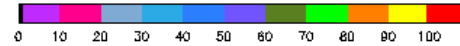
CUMUL 12 heures : du 19 juin 2006 à 1800 UTC au 20 juin 2006 à 0600 UTC



MOSAIQUE PANTHERE

LES CODES QUALITE : 0=mauvais 100=bon

MOYENNE sur 12 heures : du 19 juin 2006 à 1800 UTC au 20 juin 2006 à 0600 UTC

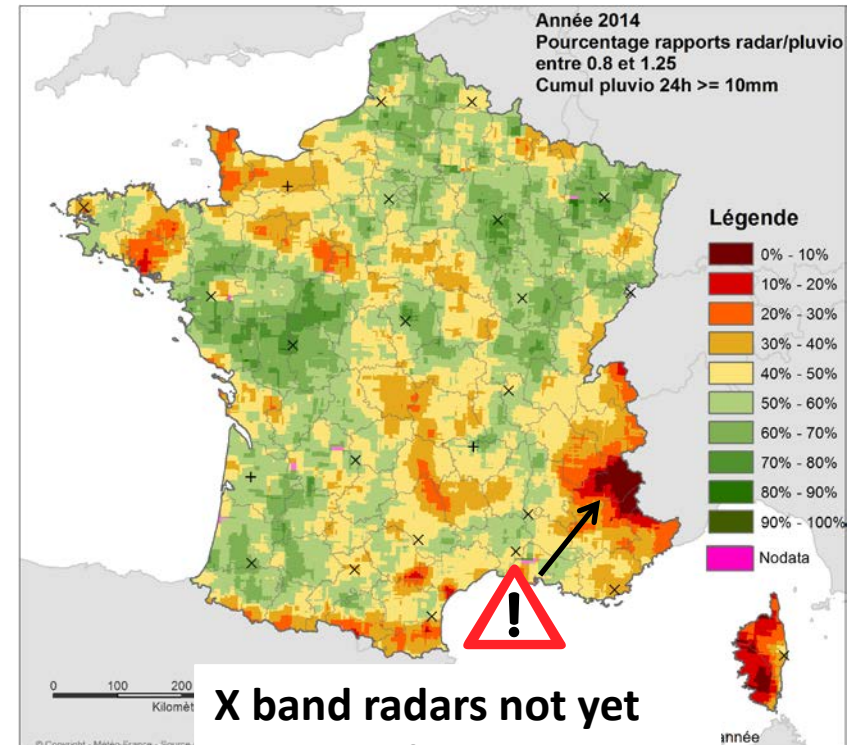
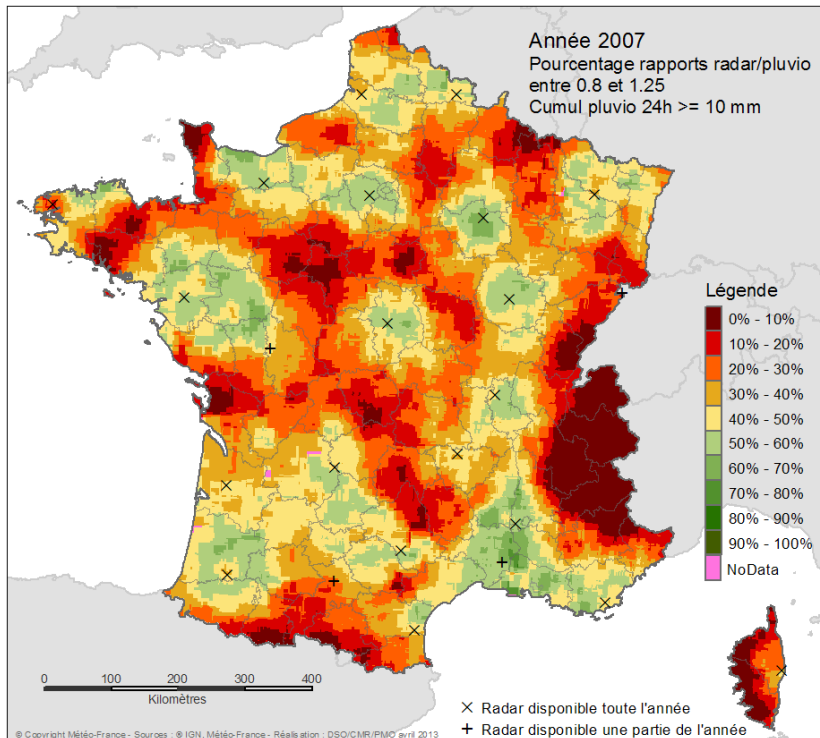


Tabary, P., 2007 : The new French radar rainfall product. Part I : methodology, *Wea. Forecasting*, Vol. 22, No. 3, 393 - 408.

QPE improvement throughout the years

Mean percentage of the radar/gauge 24h accumulations ratios within [0.8; 1.25] over France (Corsica & mountains area included) :

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
29%	35%	39%	43%	42%	45%	45%	46%	45%	?

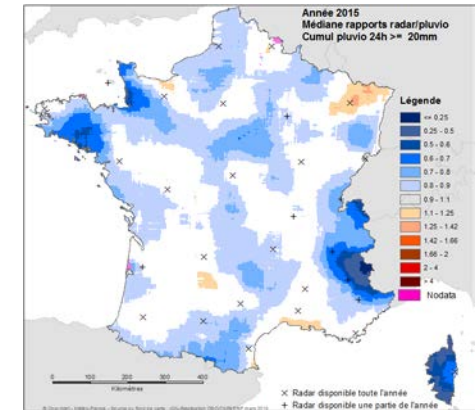


X band radars not yet integrated in 2014-2015

- Progress is rather slow ...
- The score is gradually converging ...but not towards 100% !
- More than 50% of the ratios fall outside the [0.8 ; 1.25] interval ...

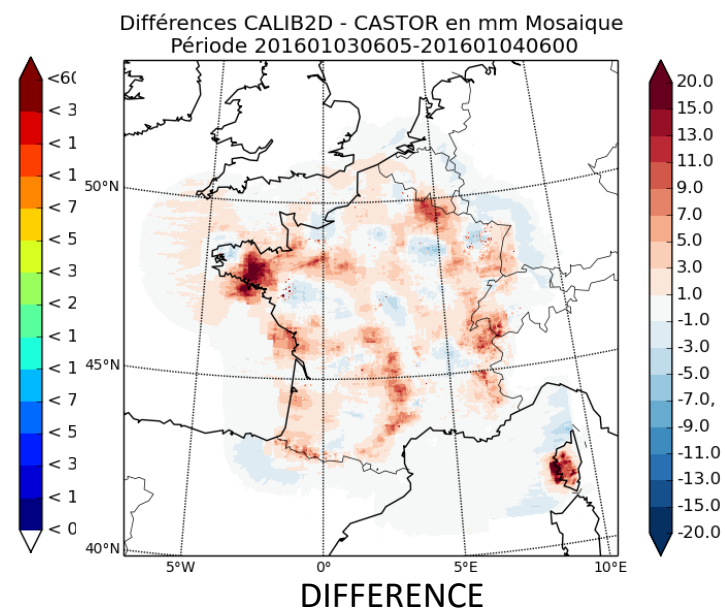
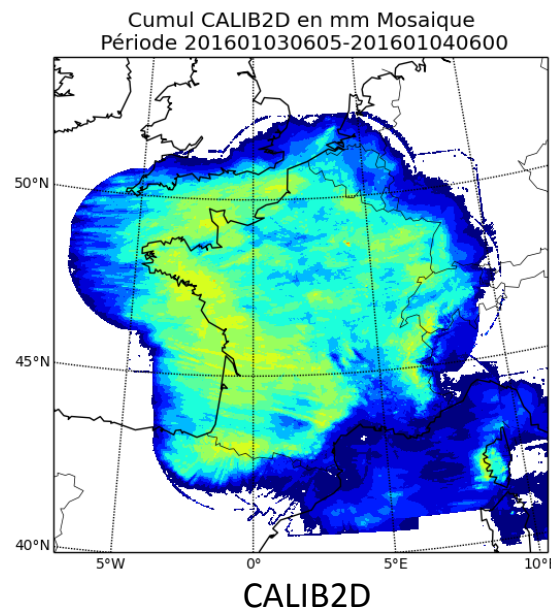
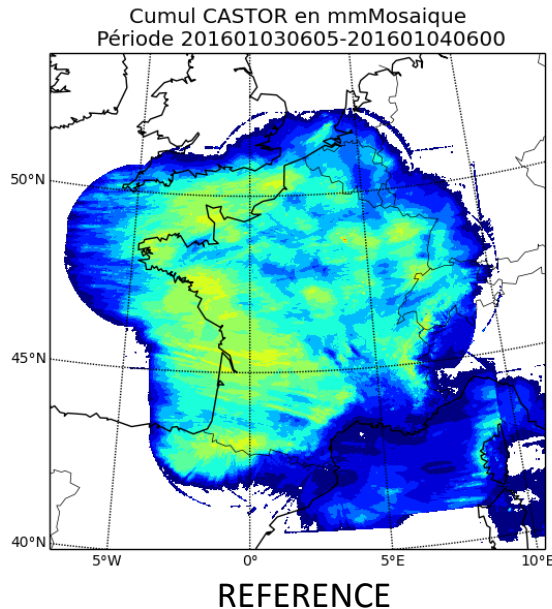
New spatialised gauge adjustment

- The new adjustment procedure generates a matrix of adjustment factors of the size of the QPE image.
- Improves bias in areas with poor coverage



Median of radar/gauge ratios
24H acc > 20 mm

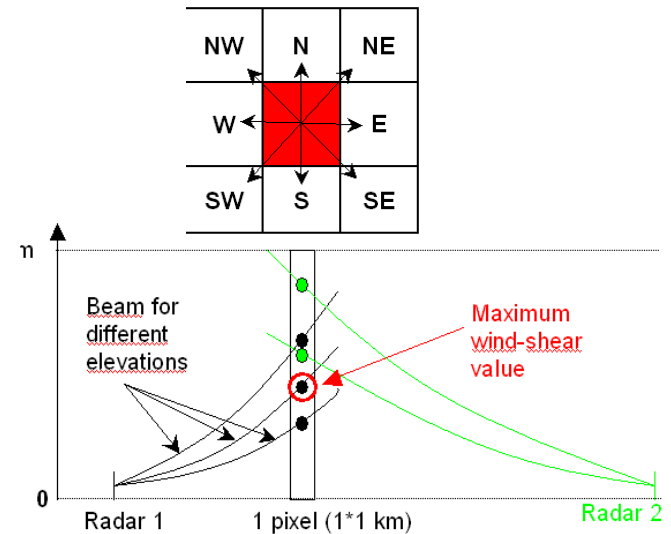
24 hours accumulations on the 4th of Janvier 2016



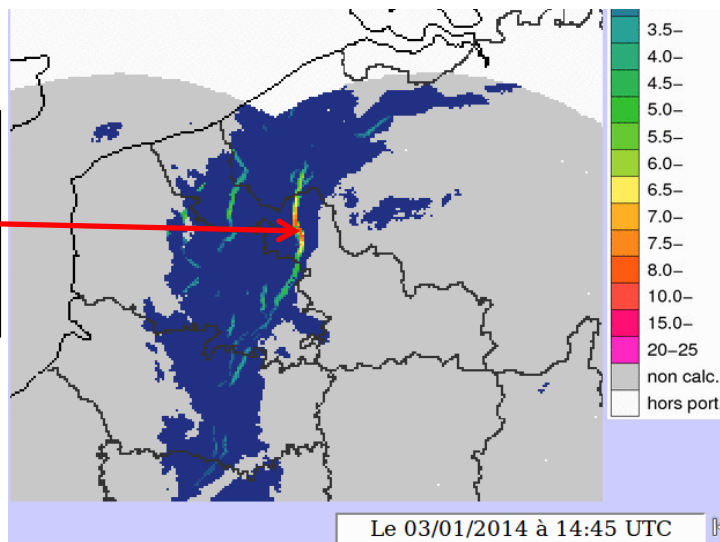
Wind shear 2D composite

Principle :

From the radial velocity fields of the overlapping radars, the wind-shear at each grid point is computed as the maximum value of the gradients between the surrounding pixels

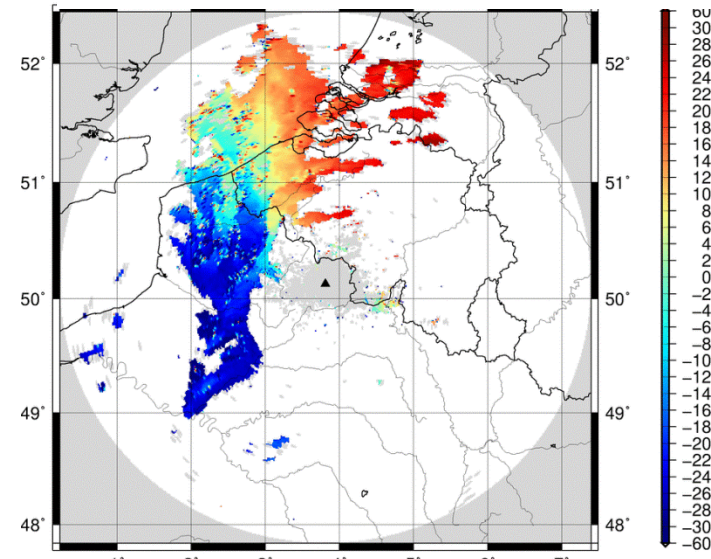


Wind shear 2D composite (m/s/km)



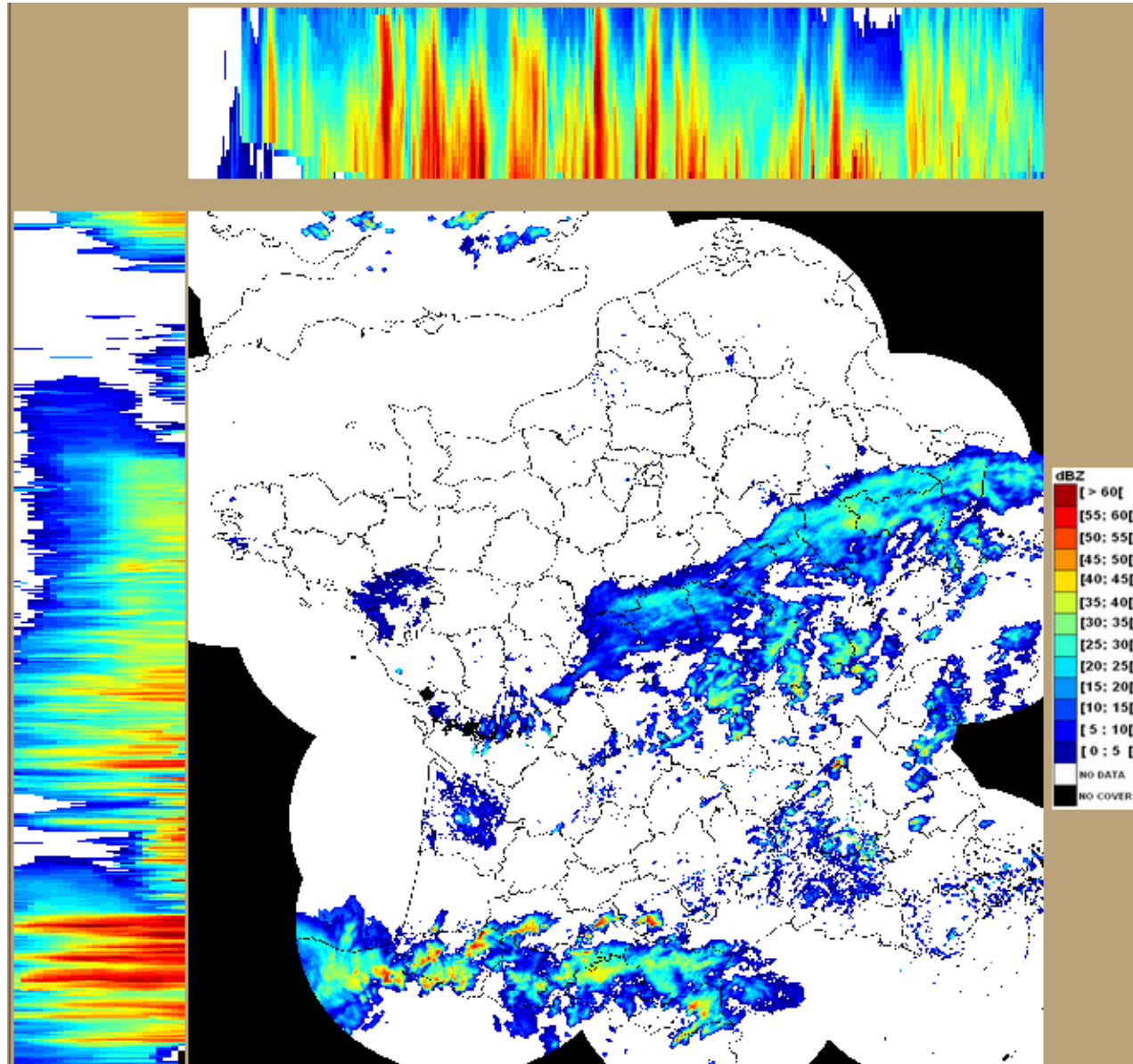
Leers tornado
January 3rd 2014
14:45 UTC

Doppler velocity (m/s)



High resolution 3D reflectivity composite

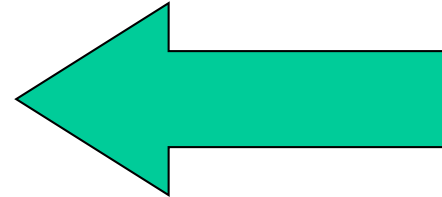
- 1km², 5' resolution 3D composite developed in collaboration with UKMO for SESAR
- 2D from 3D products : Zmax, Echos tops, VIL, POH
- Tested over Europe (150+ radars) in 2015 at 2km², 15' resolution.



Talk outline

The French radar network and products

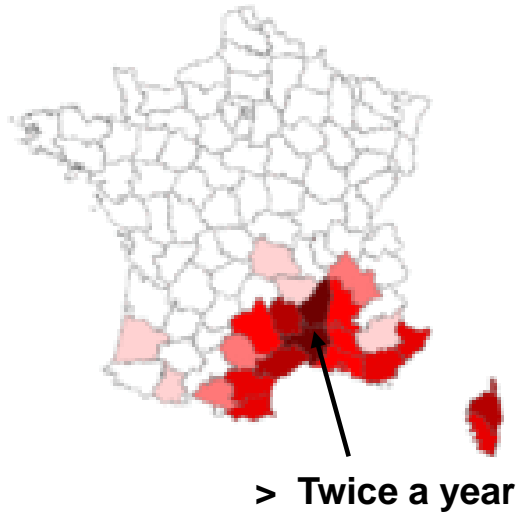
Heavy rainfall alerts



Convective nowcasting objects

Heavy rainfalls in France

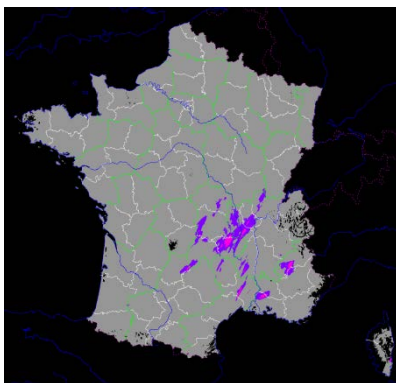
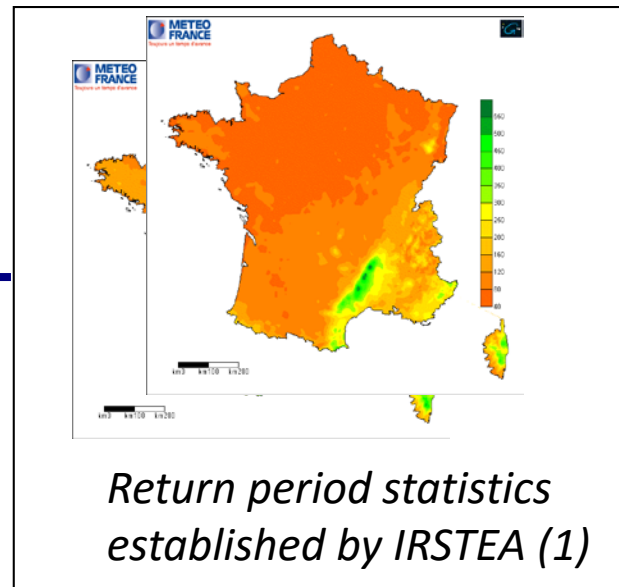
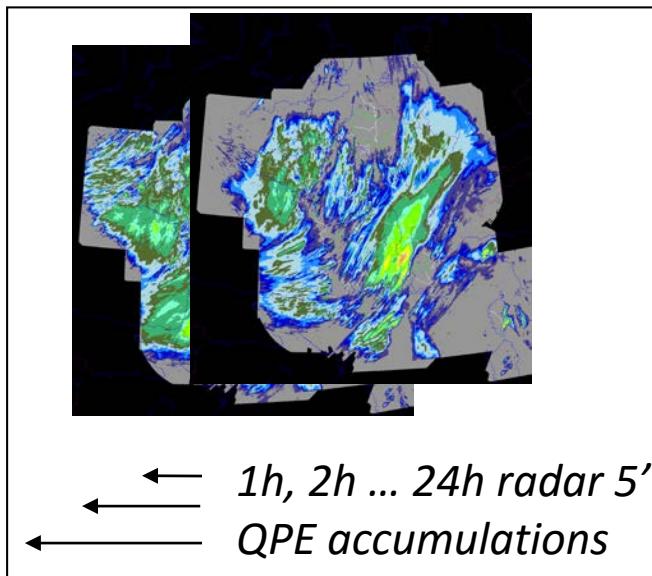
Daily rainfall greater than 200 mm over the 1965 – 2014 period



- In the southeast of France the Mediterranean regions are affected by intense rainfall periods during the autumn called Cevenol episodes
- The aim is to supply an decision-making service to mayors (institutional service), in a fully automatic mode, for the activation of floods management procedures.



Heavy rainfall risk assessment

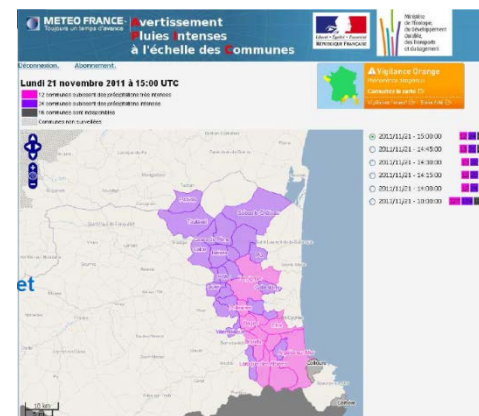


QPE accumulations are compared to a climatology of rare events

1km² diagnosis of exceptional rainfall

Météo France APIC (1) warning service

- Warnings are sent to subscribers via vocal messages, SMS or e-mails when 24h accumulations reach a defined threshold in their area (2).
- Reliable QPE is required to run the service. When radar data are missing or of insufficient quality, specific e-mails are sent to inform of periods of unavailability and areas where the service is not open.
- A web site also provides a map indicate the current warnings and the quality of the service.



1. APIC: Avertissement Pluies Intenses à l'échelle des Communes, i.e. Heavy Rain Commune-wide Warning
2. Commune: smallest french territorial administrative division, like county.

Météo France APIC (1) warning service

- The mean quality of rainfall depth radar data is estimated over the previous year to determine whether the service can be supplied or not for a given area. The APIC service was opened in December 2011 for 80% of the French metropolitan communes
- The APIC service focuses exclusively on precipitations. It doesn't take into account hydrological effects nor ground sensibility to heavy rainfall.
- The APIC service operates on observed radar images. It's not forecasting production

Rainfall 1h-nowcast

- Use of 2PIR method to extrapolate radar QPE images (See Jean-Marc Moisselin talk).
- Application on meteo.fr website to provide rainfall in next hour service



Rainfall in the next hour ?

Prévisions actualisées à 11h10

De 11h20 à 11h25 : Pas de précipitation
De 11h25 à 11h50 : Précipitation modérée
De 11h50 à 12h20 : Pas de précipitation



Couverture du service

Pluie

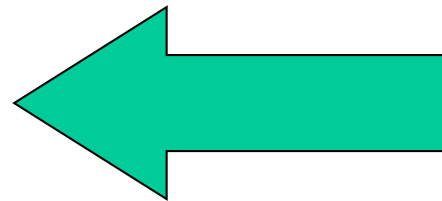
- Pluie forte
- Pluie modérée
- Pluie faible
- Aucune
- Données indisponibles

Talk outline

The French radar
network and
products

Heavy rainfall
alerts

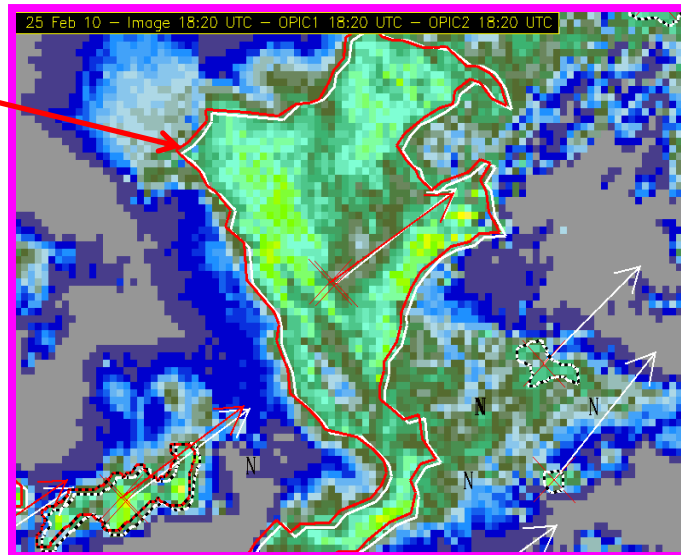
**Convective
nowcasting objects**



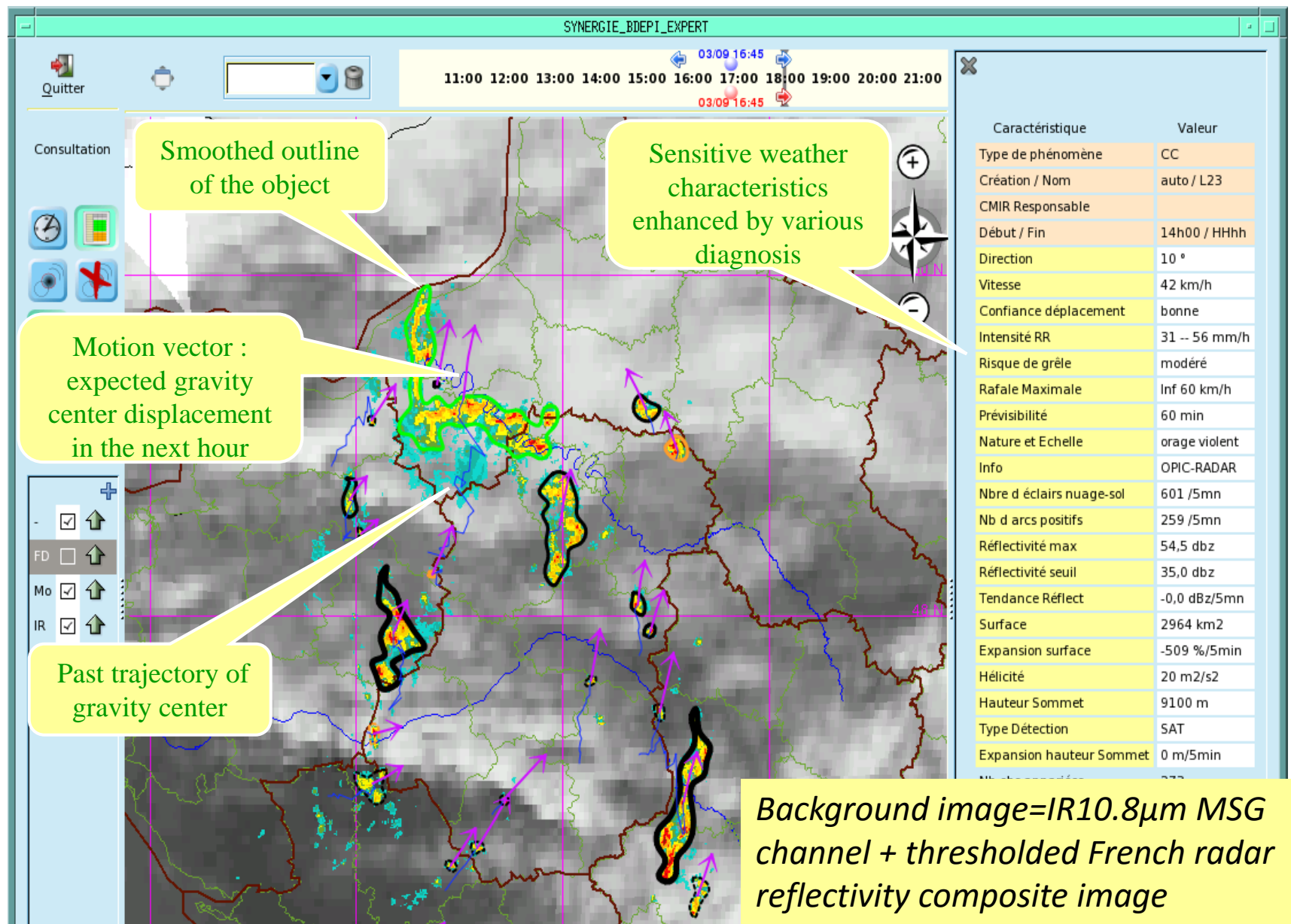
Convection nowcasting objects

- Thunderstorms can be identified as an object using a set of meteorological parameters (wind, lightning, hail, rainfall).
- The object approach makes systems tracking easier. It helps the forecaster – *Objets pour la Prévision Immédiate de la Convection* – OPIC (=CONO)
- Météo-France has developed a production chain to detect, track and characterize thunderstorms and to warn end-users based on OPIC-radar.

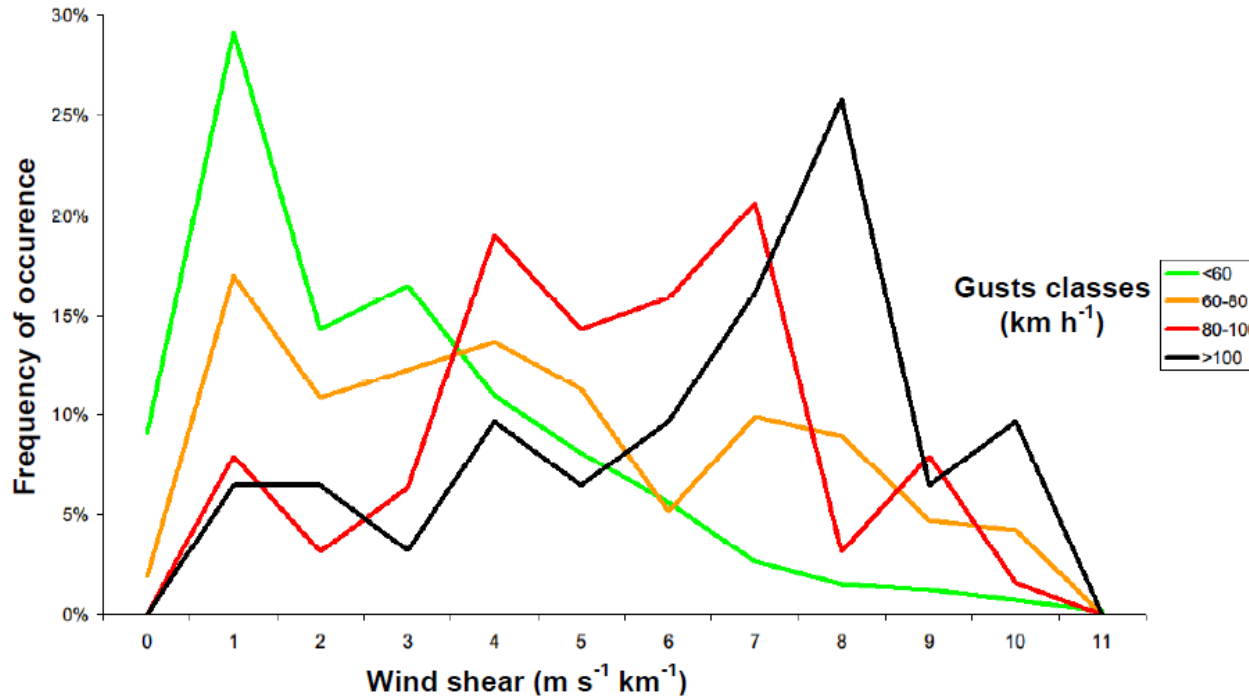
OPIC-radar



OPIC-radar on forecasters' visualisation tool



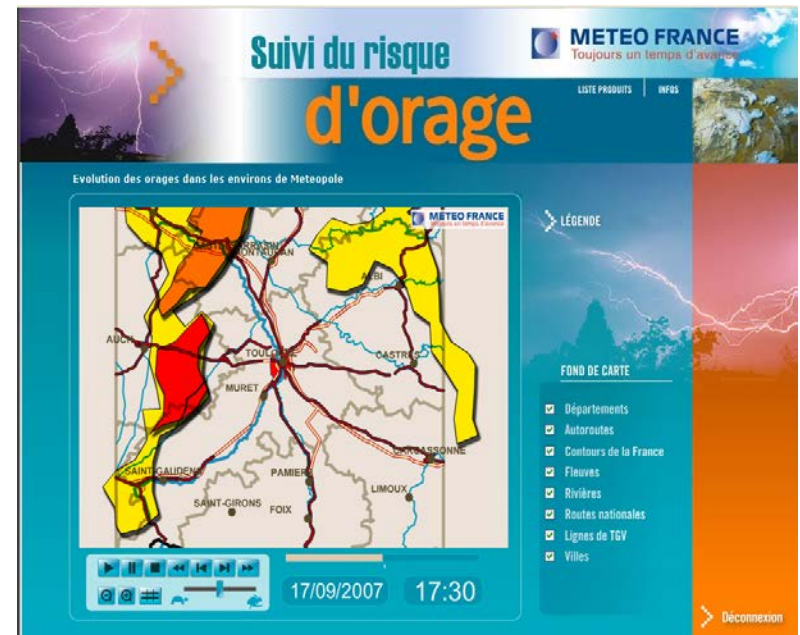
Gust risk in relation to wind shear



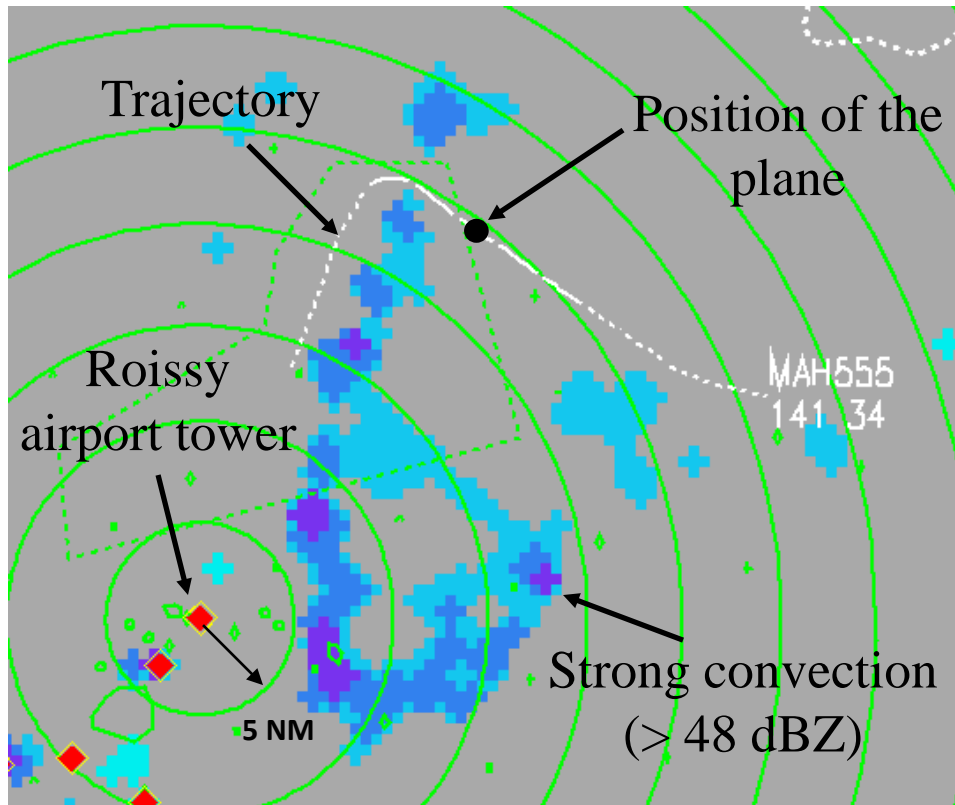
- Moderate link between gust recorded on the OPIC trajectories and the estimated wind shear.
- Wind shear estimation can improve gust risk detection

Thunderstorm warning for end users

- Based on OPIC-radar with 2 intensity levels 35dBZ and 41dBZ
- Warning at a given place, up to one hour before the phenomena
 - End users: place, thunderstorm severity level,
 - Warning: beginning, monitoring, end.
 - Email or SMS distribution
 - Web access with graphics
- Commercialisation since 2008



Convection nowcasting objects for aviation



- ASPOC = Convection monitoring based on weather radar and lightning data
- 4 intensity (dBZ) levels relevant to ATC operations.
- 30-min forecast
- Trial ASPOC-3D, based on wx radar, lightning data and satellite imagery (cloud top, Zmax)

➔ Will soon use high resolution 3D reflectivity composite.

Thanks for your attention !

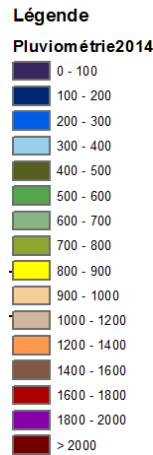
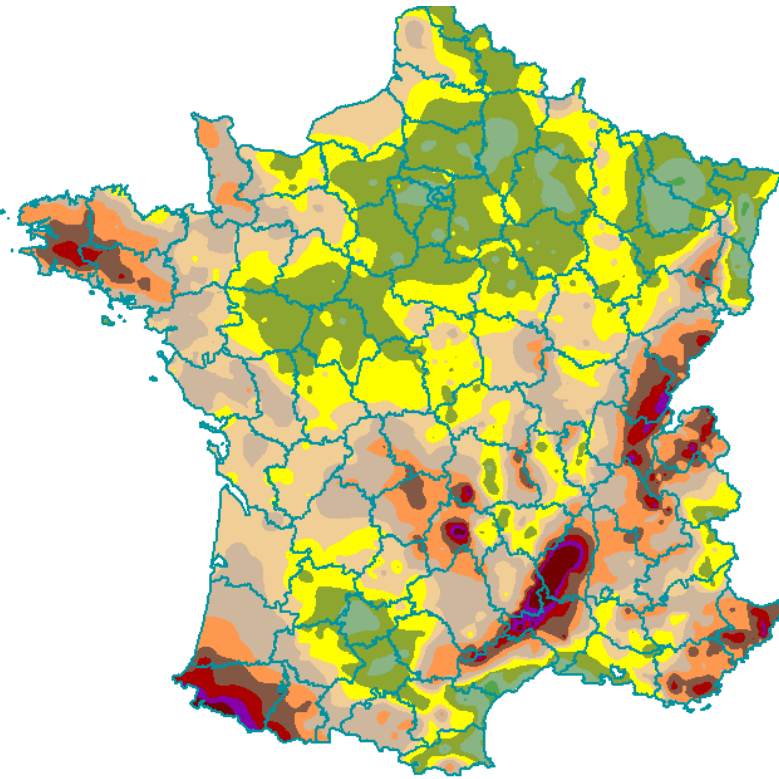
The 2PIR method

- The core of the method : two main processes
 - Comparison of an observed radar image with a previous one
 - identification of cells displacement
 - diagnosis of a motion field
 - Extrapolation, applying the motion field to the radar observed image
 - forecasted images
- An essential refinement
 - Statistical quality index attached to each pixel, used at each step of the 2PIR method.
 - Before the extrapolation of an observed image, a substitution of “wrong pixels” is operated using prior-forecasted values (“filling”)

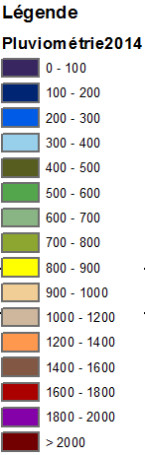
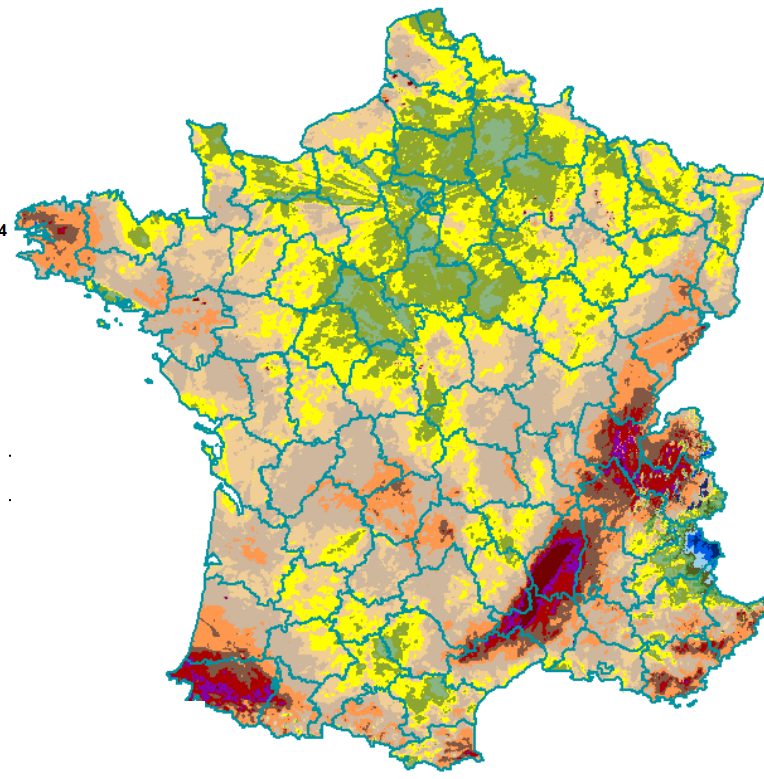
2PIR limitations

- Intrinsic in radar measurement :
 - incomplete recognition of ground and sea clutters
 - clear sky echoes
 - attenuation due to precipitations
 - Orographic mask, anthropic mask (buildings, etc.)
- Due to compositing of local radar images :
 - heterogeneity of radar measurements
- Induced by the 2PIR method :
 - Needs a guess, or a spin-up of 30 to 60 min
 - Orography effects are not managed (blocking, forcing, foehn)
 - Only advection of previously observed cells

Radars and raingauge accumulations for 2014



Raingauge accumulations



Radar accumulations



X band radars not yet integrated in 2014