

Overview of the weather radar networks and products in the “north-western” Mediterranean region (Spain, France and Italy)

P. Tabary¹, J. Parent-du-Châtelet¹, M. Franco², R. Cremonini³, C. Ciotti⁴ and G. Vulpiani⁵

¹ Centre de Météorologie Radar, Météo France, France

² GRAHI/UPC, Barcelona, Spain

³ ARPA Piemonte, Torino, Italy

⁴ CNMCA, Italian National Meteorological service, Rome, Italy

⁵ Department of Civil Protection, Roma, Italy

pierre.tabary@meteo.fr



METEO FRANCE
Toujours un temps d'avance



***Dear HYMEX researchers,
if you are interested in :***

- 1) the high-resolution (1km²x5') 3D wind and microphysical fields in precipitation,***
 - 2) the high-resolution (1km²x5') surface rainfall accumulation (both over land and over the Sea),***
 - 3) the low-level wind and humidity fields in pre-convective situations,***
- then you are a soon-to-be radar addict !***

Radars in Europe : the OPERA Network

Operational Programme on Exchange of weather RADar information. Weather radar programme of EUMETNET

- 150 Weather radars
- About 100 Doppler radars
- ~ 10 radars have Dual-polarization
- Dual-pol is becoming operational standard



Weather radar situation and perspectives in north-eastern Spain

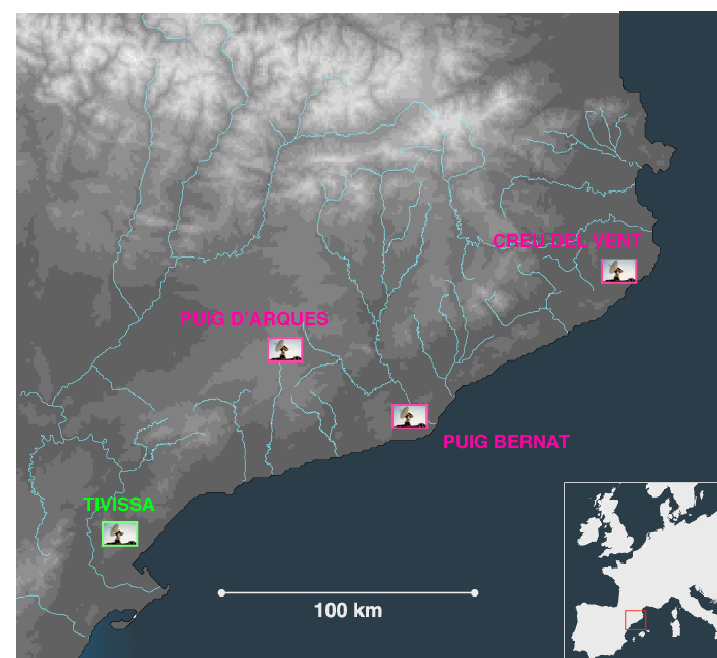


+ one newly installed radar in Mallorca

Spanish Met Service radar network (AEMET formerly INM)

- C-band, Doppler radars;
- Upgrade currently underway;
- No polarimetric capabilities

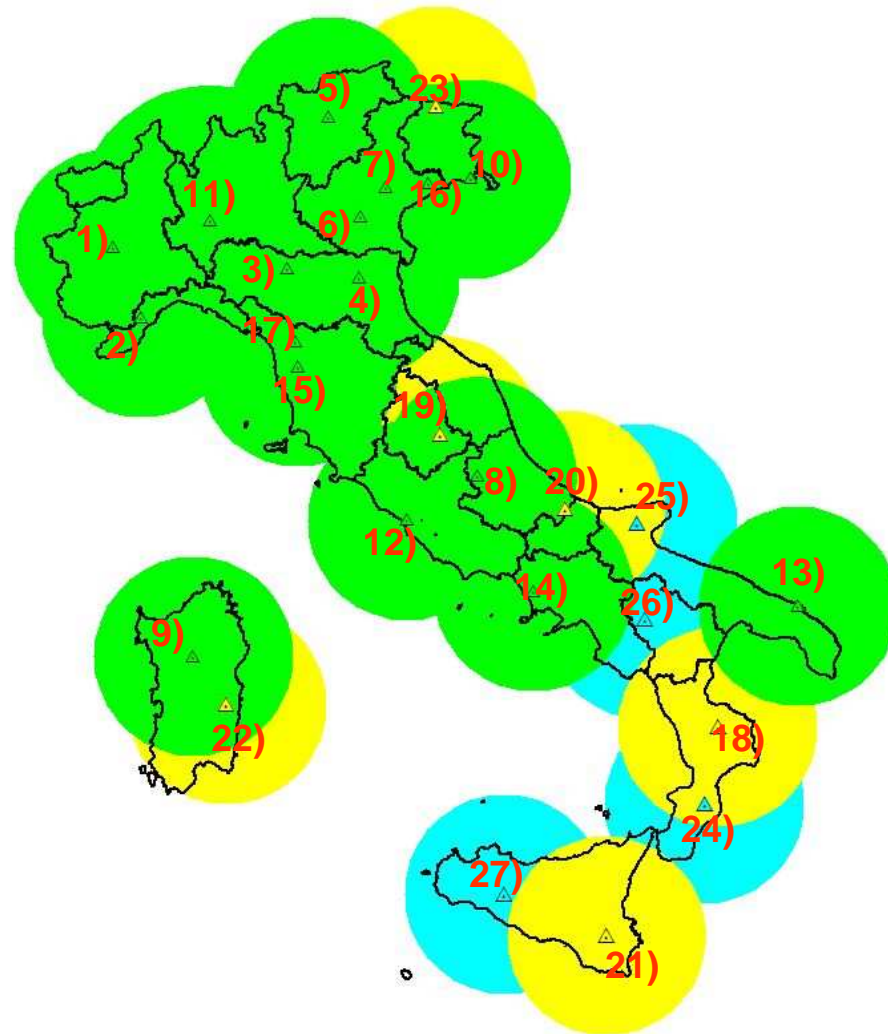
METEOCAT WEATHER RADARS



MeteoCat radar network

- Radome-covered, low-power, C-band, Doppler radars;
- 16 elevation angles revisited every 6 minutes;
- No polarimetric capabilities

C-band radar systems National Weather Radar Coverage - 125km



- △ 17 Operational Radars
- △ 6 Close to be: Operative or Installed
- △ 4 Planned Radars

Reference : Gianfranco Vulpiani, Dept. Of Civil Protection, Rome, Italy

REGIONAL METEO SERVICES

- 1) Bric della Croce (Owner: Regione Piemonte; Polarization: on going upgrade to polarimetry)
- 2) Settepani (Owner: Regione Piemonte and Regione Liguria; Polarization: dual)
- 3) San Pietro Capofiume (Owner: Regione Emilia Romagna; Polarization: dual)
- 4) Gattatico (Owner: Regione Emilia Romagna; Polarization: dual)
- 5) Monte Macaion (Owner: Regione Trentino Alto Adige and Provincia autonoma Trento; Polarization: single)
- 6) Teolo and
- 7) Concordia Sagittaria (Owner: Regione Veneto; Polarization: single)
- 8) Monte Midia (Owner: Regione Abruzzo; Polarization: single)
- 9) Monte Rasu (Owner: Regione Sardegna; Polarization: single)
- 10) Fossalon di Grado (Owner: Regione Friuli Venezia Giulia; Polarization: single)

ENAV

- 11) Linate (Polarization: single)
- 12) Fiumicino (Polarization: single)

AIR FORCE

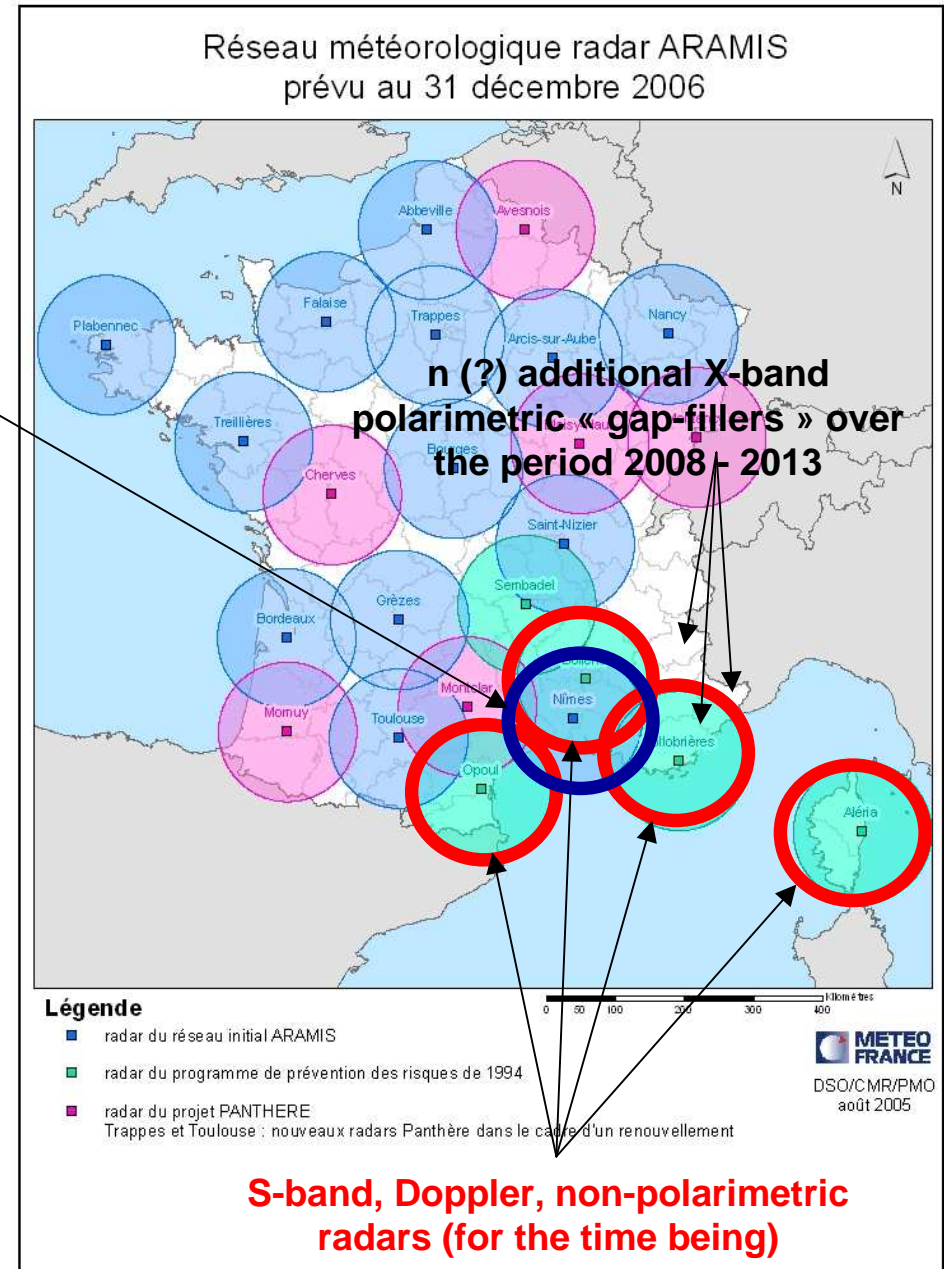
- 13) Brindisi (Polarization: single)
- 14) Grazzanise (Polarization: single)
- 15) Pisa, (Polarization: single)
- 16) Istrana, (Polarization: single)

DPC

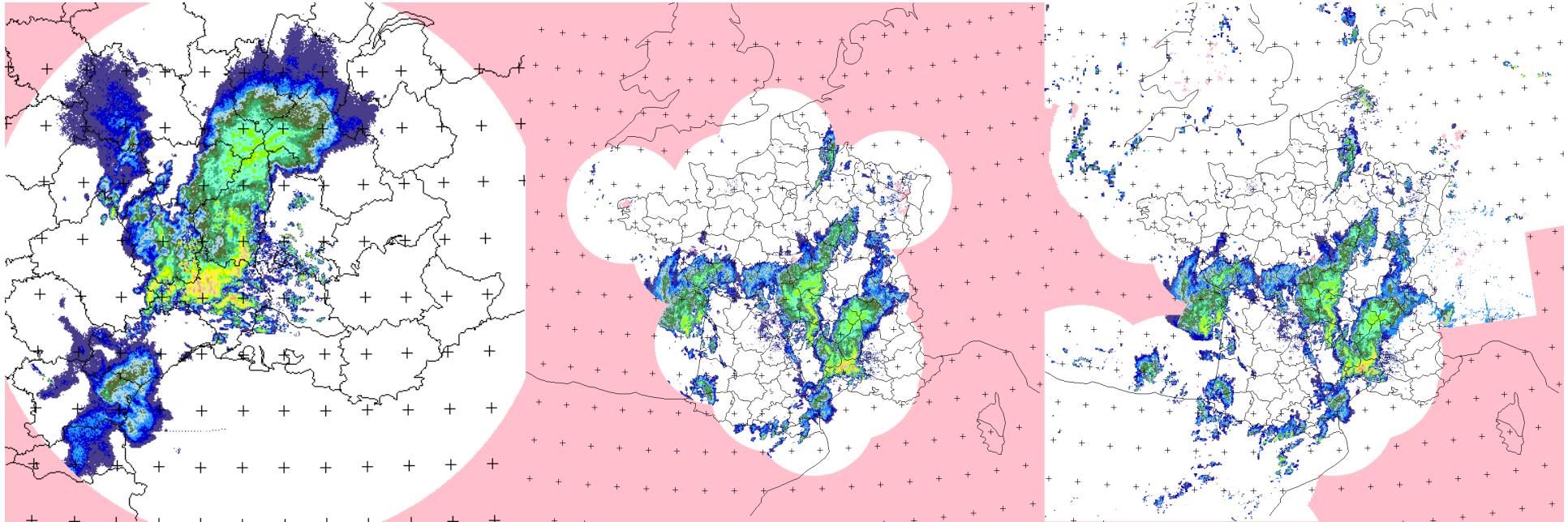
- 17) Monte Crocione (Polarization: single)
- 18) Monte Pettinscura (Polarization: single)
- 19) Monte Serano (Polarization: single)
- 20) Monte Il Monte (Polarization: dual)
- 21) Monte Lauro (Polarization: single)
- 22) Monte Armidda (Polarization: single)
- 23) Monte Zoufplan (Polarization: dual)
- 24) Monte Pecoraro (Polarization: single)
- 25) Montenero (Polarization: single)
- 26) Monte Lifo (Polarization: single)
- 27) Monte delle Rose (Polarization: single)

Weather radar situation and perspectives in southern France

Nîmes S-band Doppler polarimetric radar



Products (1) : the good old reflectivity image



Single radar

512 km x 512 km

fréquency = 5 minutes

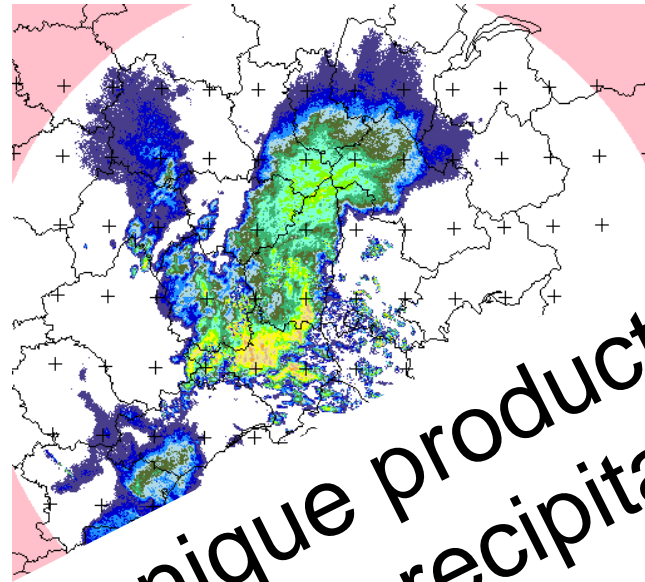
French composite

9 September 2002 at 00.00 UTC

**European composite (to
become operational in
the frame of
EUMETNET/OPERA
Phase III)**

Reflectivity image → Detection and quantification of precipitation intensities

Products (1) : the good old reflectivity



A unique product to qualitatively monitor the precipitation fields over time.

This is the « historical » product generated from radars.

composite

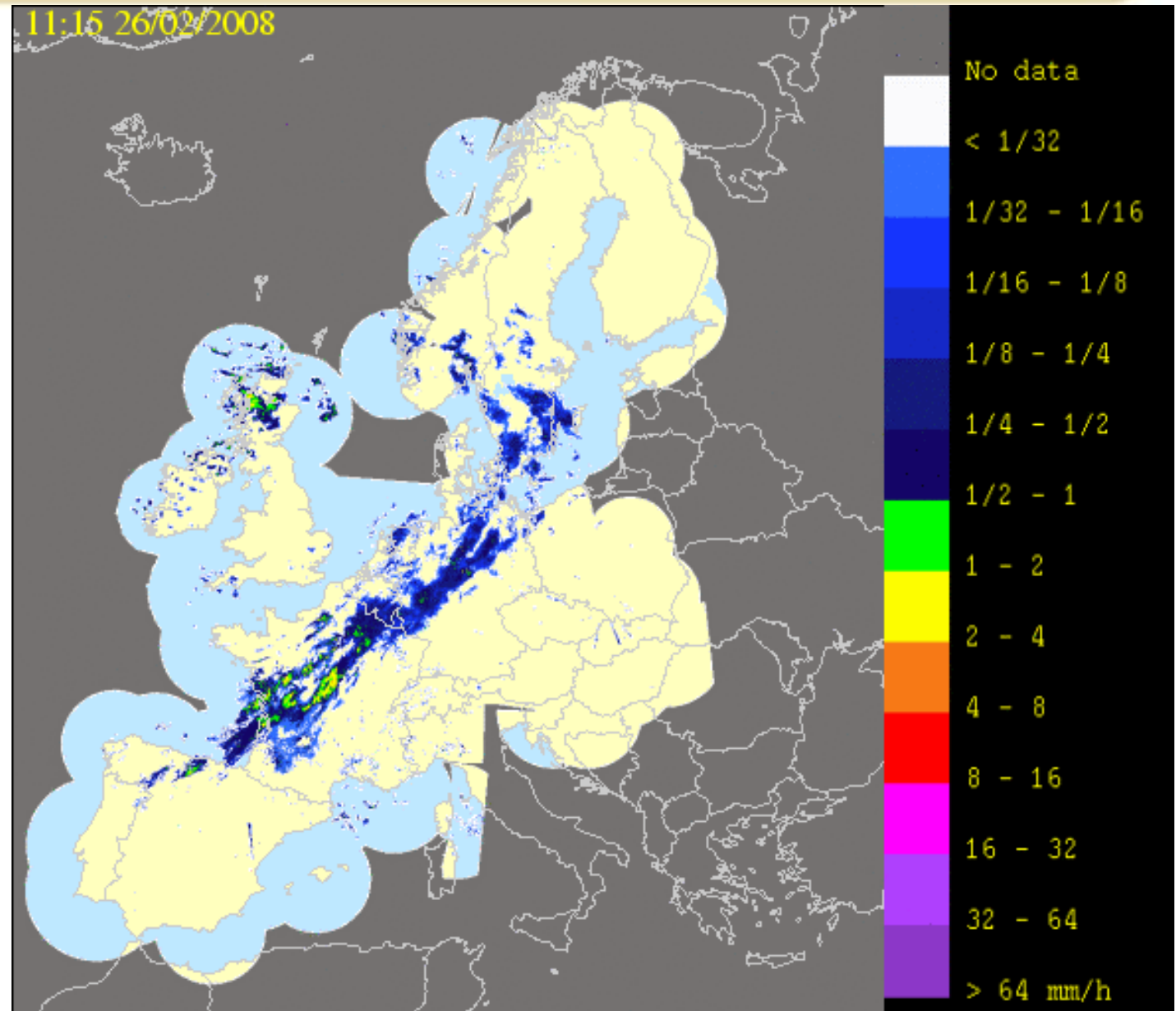
European composite (to become operational in the frame of EUMETNET/OPERA Phase III)

9 September 2002 at 00.00 UTC

Reflectivity image → Detection and quantification of precipitation intensities

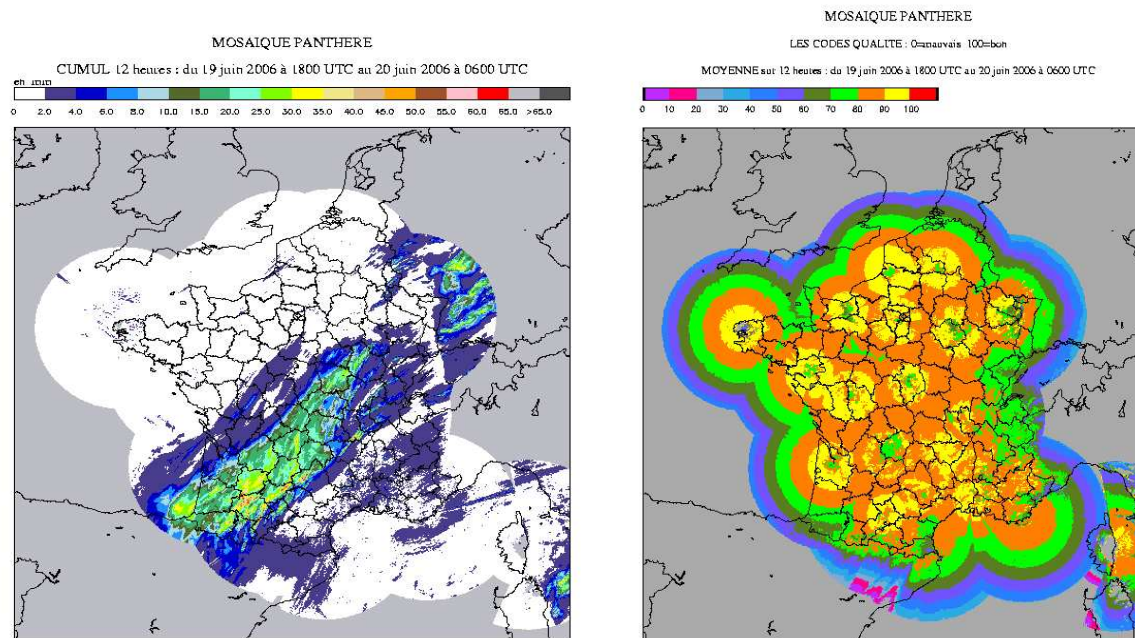
OPERA radar datahub. Prototype european composite

- April 08: Functional specifications discussed in OPERA
- June 08: Functional specifications approved (?) by EUMETNET/PB-OBS
- Autumn 08, settle budget with EUMETNET/Council
- Early 2009: Start of development of operational data hub
- January 2010: Start operation of data hub



Products (2) : Quantitative Precipitation Estimations

One example : French 24h QPE composite (left) + quality indexes (right)



Typical space-time resolution : 5 minutes x 1 km²;

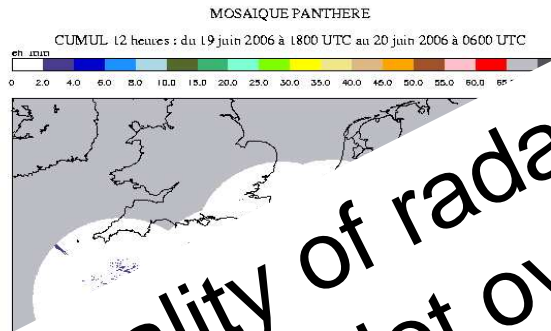
Product available as a « single radar » or (better) a composite map;

Almost always adjusted in real-time with rain gauges;

Includes a lot of real-time processing (correction for numerous errors)

Products (2) : Quantitative Precipitation Estimation

One example : French 24h QPE composite (le 20 juin 2006)



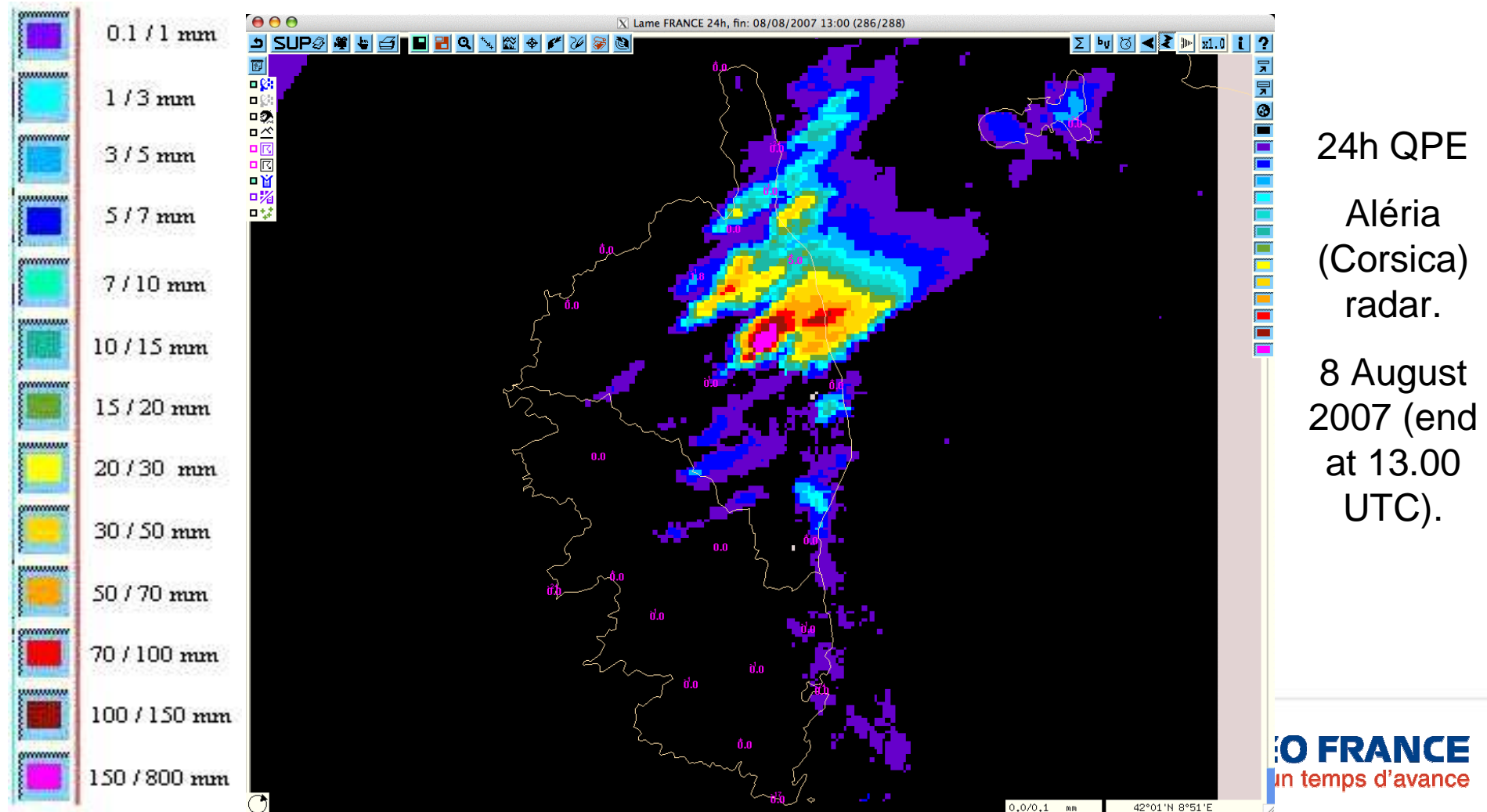
The quality of radar QPE has been improving a lot over the past years.

Radar QPEs are the only solution for applications at high space time resolution or for rainfall estimation over the Sea.

1. minutes x 1 km²;
2. « radar » or (better) a composite map;
3. adjusted in real-time with rain gauges;
4. real-time processing (correction for numerous errors)

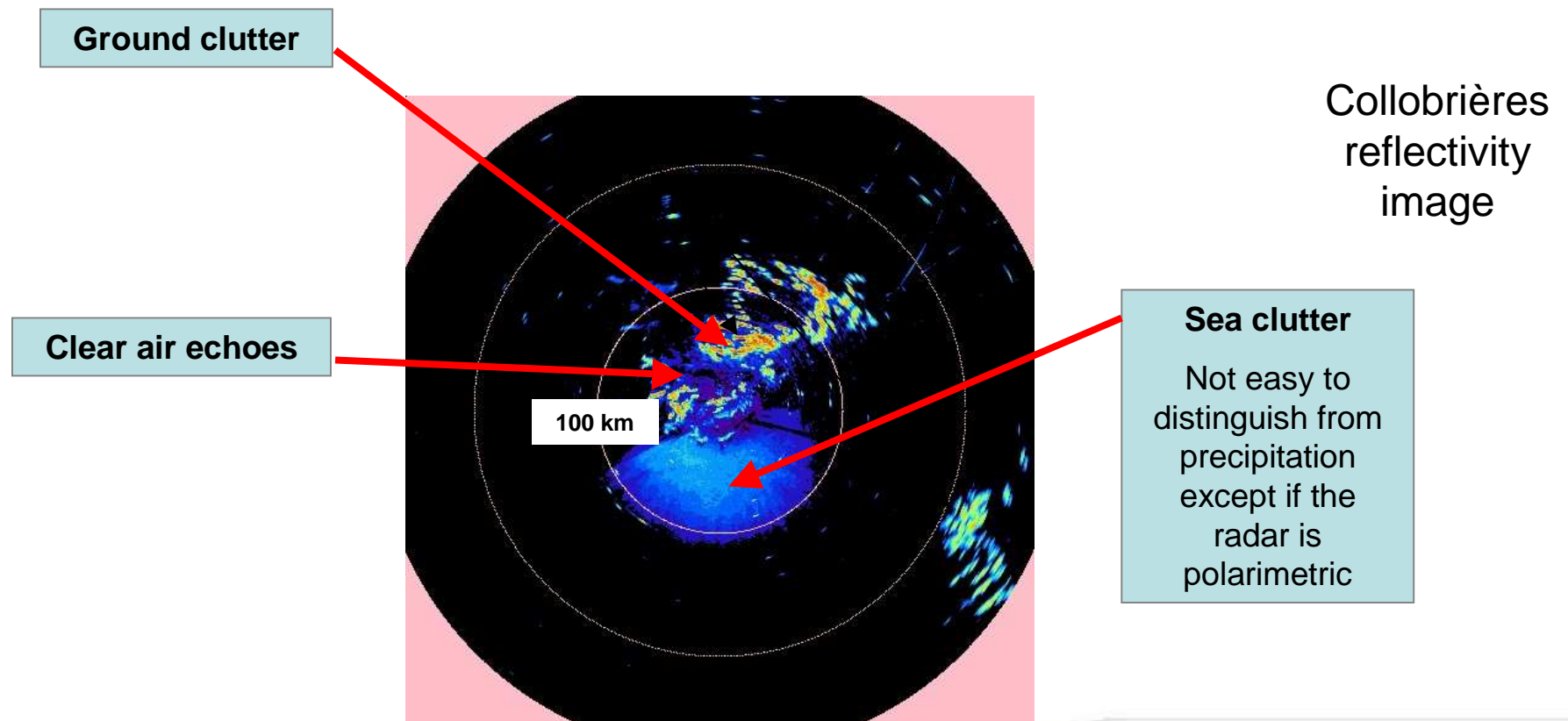
Products (2) : Quantitative Precipitation Estimations

Does it rain over the Sea ? Yes !



Products (2) : Quantitative Precipitation Estimations

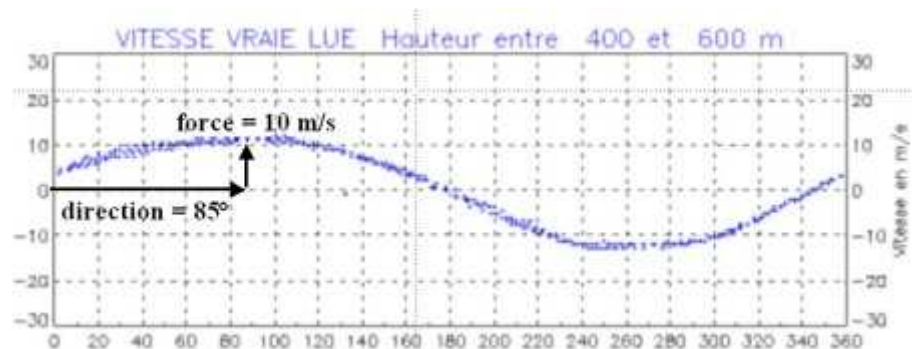
Does it rain over the Sea ? Actually, no ...



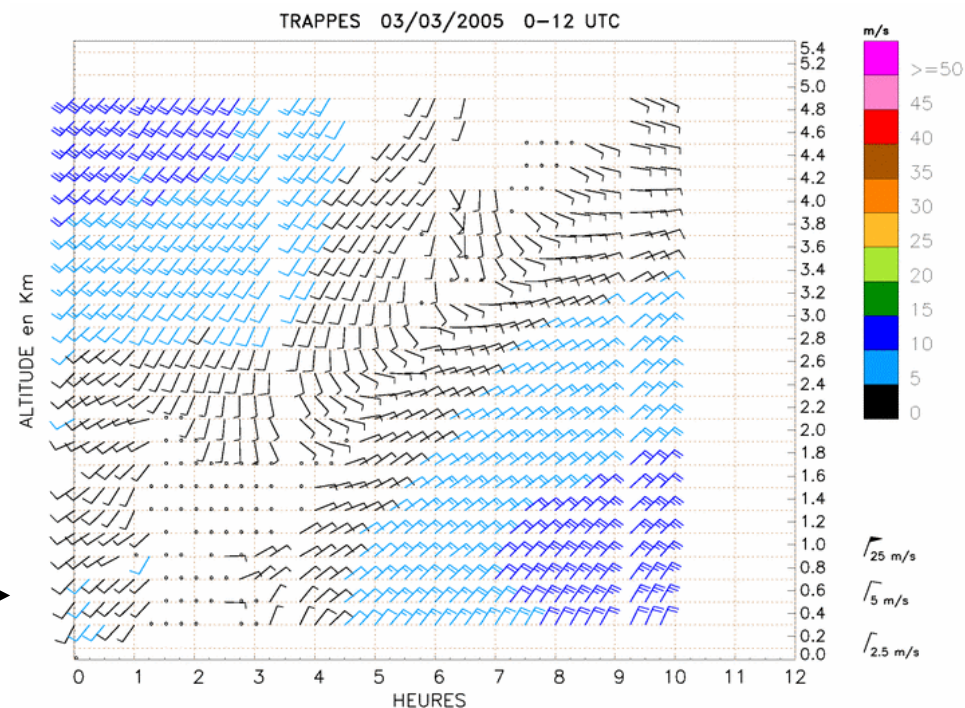
Products (3) : Doppler data and products

- **The immense majority of radars operated in the NW mediterranean region are Doppler;**
- **They provide PPIs (conical scans) of radial velocity (i.e. wind vector projected along the viewing direction of the radar antenna) along with the PPIs of reflectivity (and for dual-pol radars PPIs of polarimetric variables);**
- **Radial velocities may be extremely difficult to interpret. The #1 user of raw Doppler information is NWP via data assimilation;**
- **Two main products can be generated from the raw Doppler information :**
 - **(classical) VAD wind profile : vertical profile of the horizontal wind above the radar;**
 - **(much more innovative !!!) 3D Multiple-Doppler wind fields in overlapping areas;**

VAD wind profiles



Assumption : wind is locally linear at each height level within, say, 30 km around the radar;



12h time series of VAD wind profiles
obtained from the Trappes (Paris) radar
data



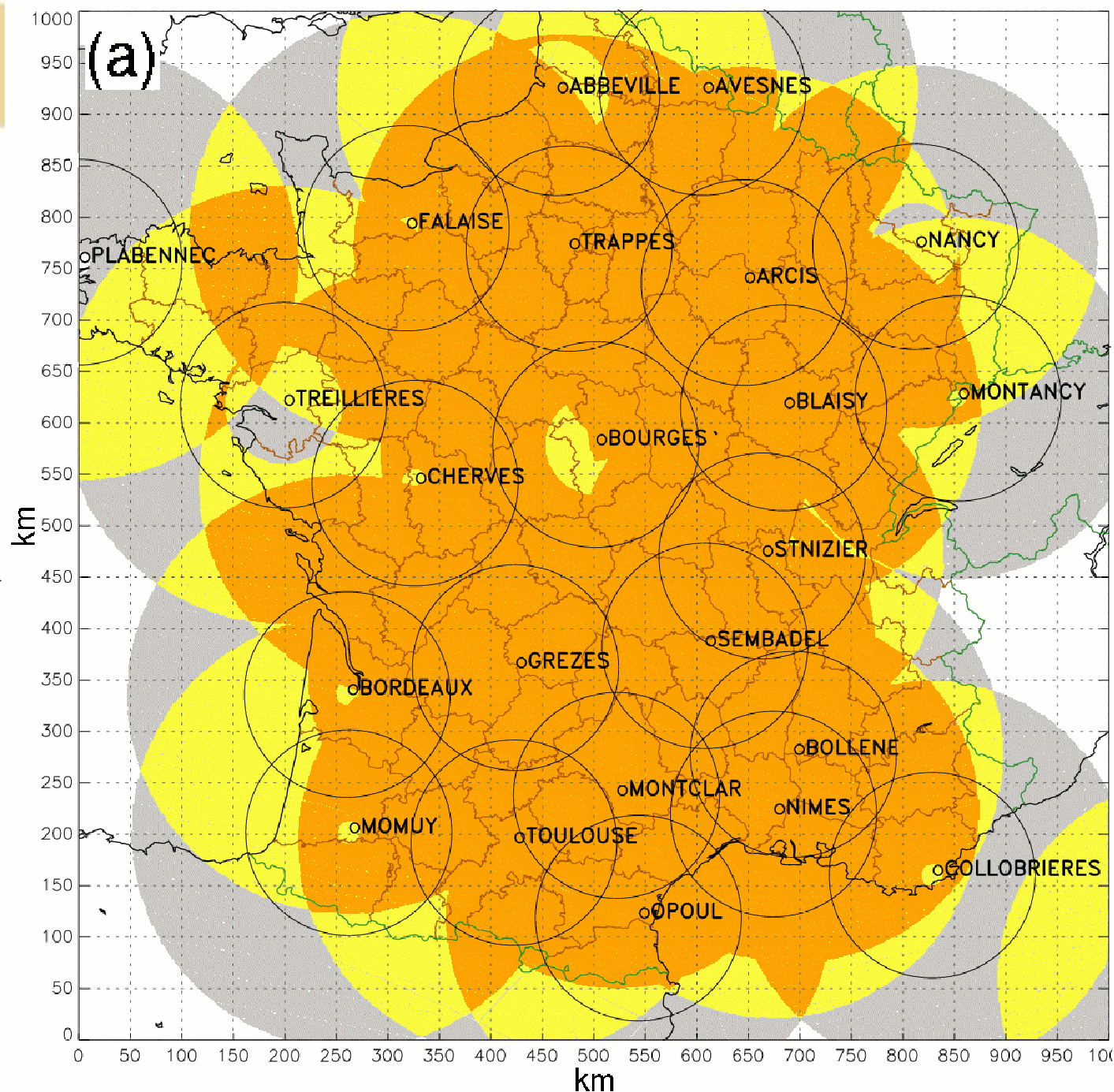
3D Multiple-Doppler wind fields in overlapping areas

Expected Doppler
radar overlapping at
2000 m above sea
level in 2008



*Bousquet et al. GRL
(2007)*

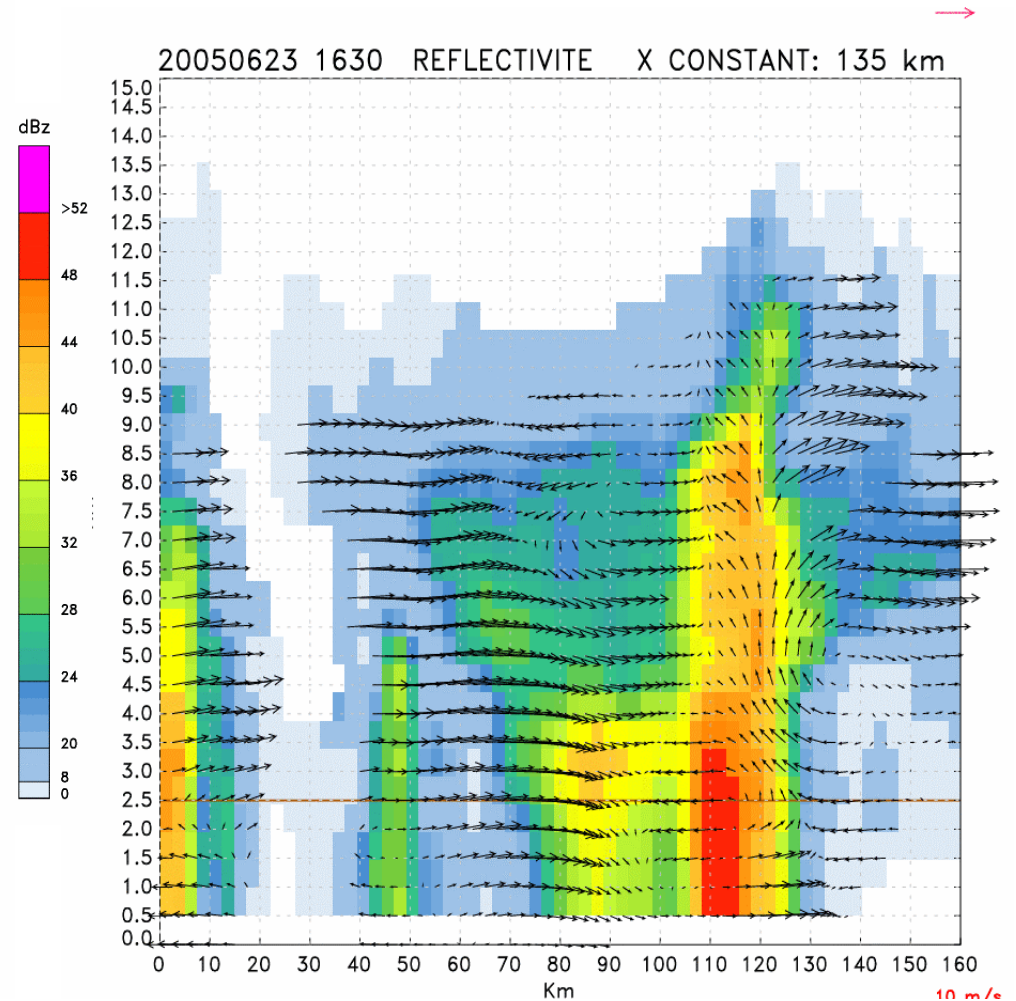
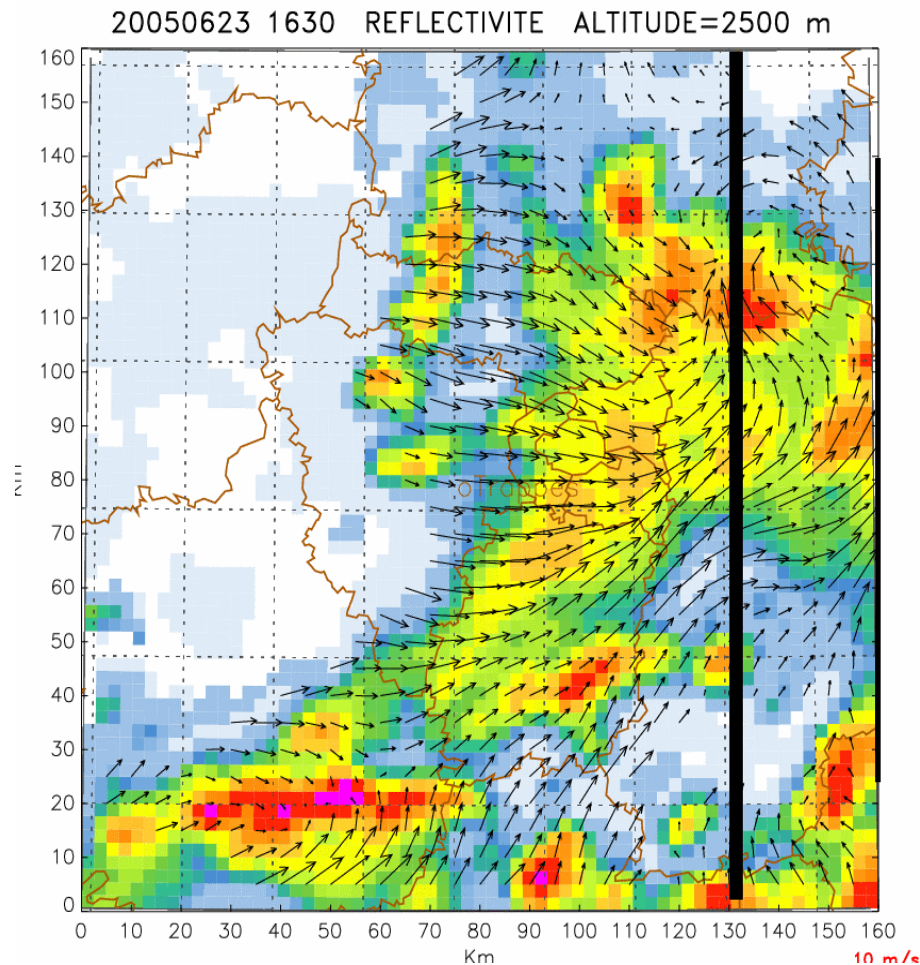
*See also the
Mediterranean
Multiple-Doppler
project presented by
Olivier Bousquet
during this workshop*



3D wind and reflectivity fields retrieved in an operational environment in the Paris area

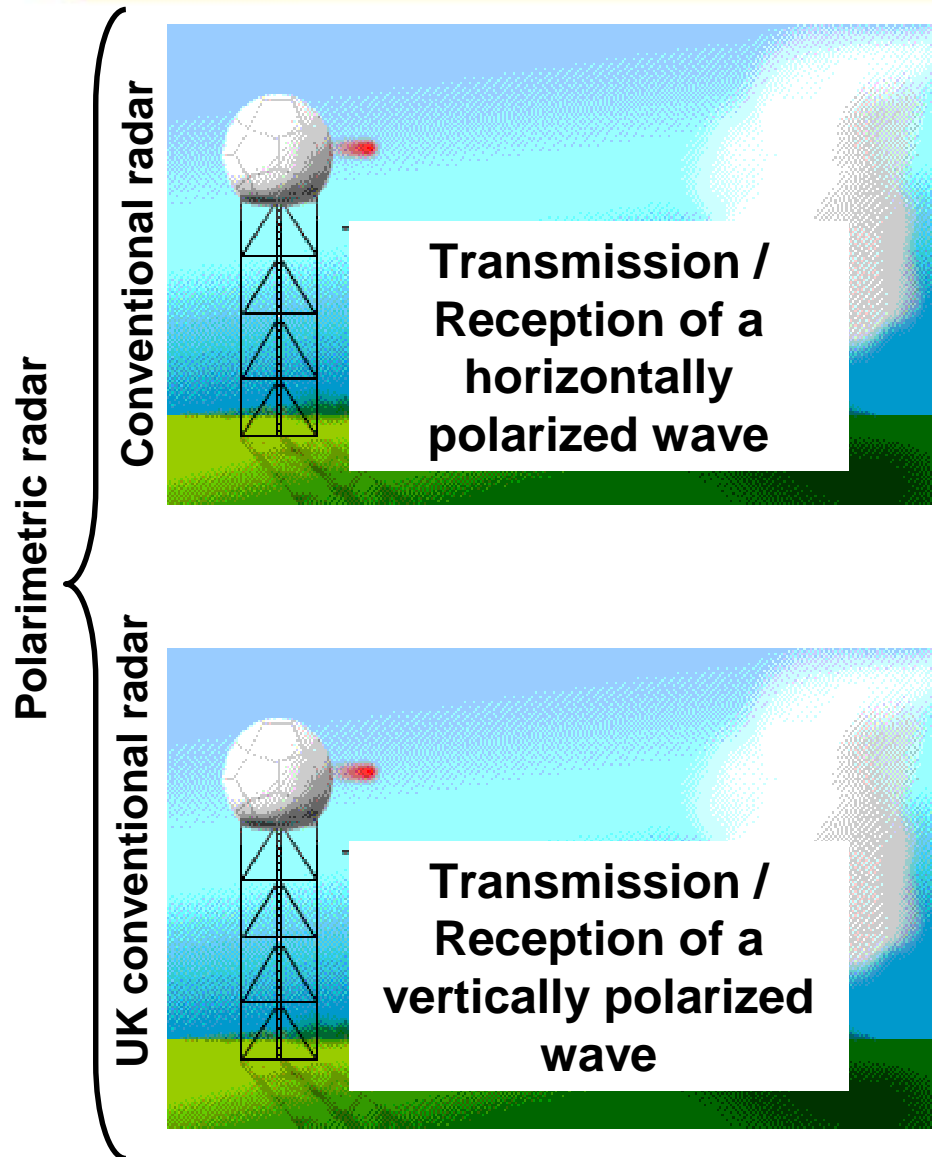
Coupe horizontale à 2500 m

Coupe verticale

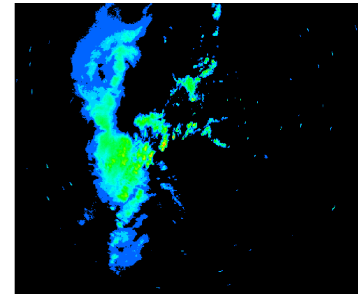


Bousquet et al. GRL (2007), see also the Mediterranean Multiple-Doppler project presented by Olivier Bousquet during this workshop

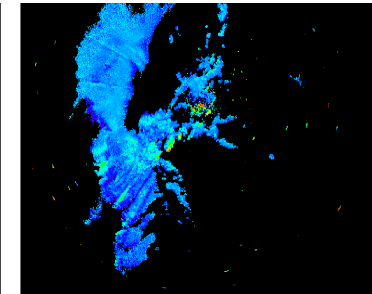
Products (4) : Dual-polarization data and products



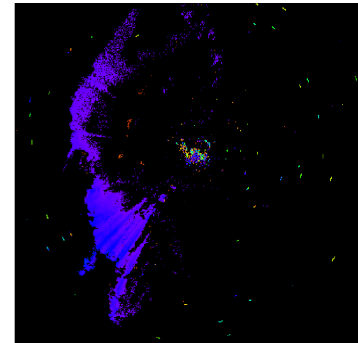
Horizontal reflectivity
 Z_H (dBZ)



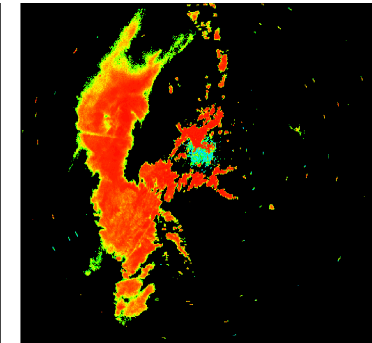
Differential reflectivity
 $Z_{DR} = Z_H - Z_V$ (dB)



Differential phase Φ_{DP} (°)



Correlation coefficient $\rho_{HV}(0)$



French C-band Trappes radar

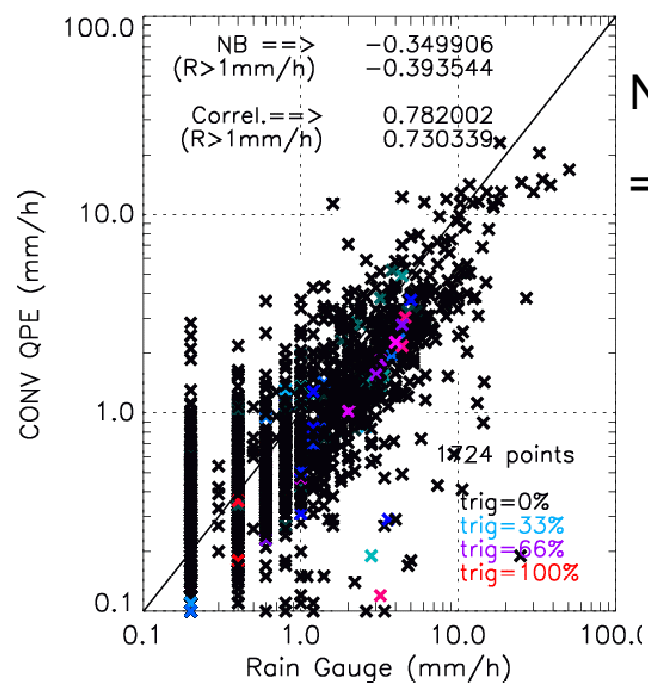
1.5° elevation angle - 18 August 2004 - 12.00 → 13.45 UTC

Products (4) : Dual-polarization data and products

- Dual-polarization is becoming the standard of operational radars;
- Dual-polarization improves the existing products (e.g. rainfall accumulations) by :
 - ☐ Correcting for attenuation by rain (provided that the signal is not lost !);
 - ☐ Removing non-precipitating echoes (in particular Sea Clutter);
 - ☐ Retrieving the appropriate ZR relationship;
 - ☐ Checking the calibration of the radar;
- Dual-polarization also offers new products such as :
 - ☐ Hydrometeor types (rain / snow / hail / ...);
 - ☐ Discrimination between birds, insects, ...
 - ☐ Sea surface properties ?

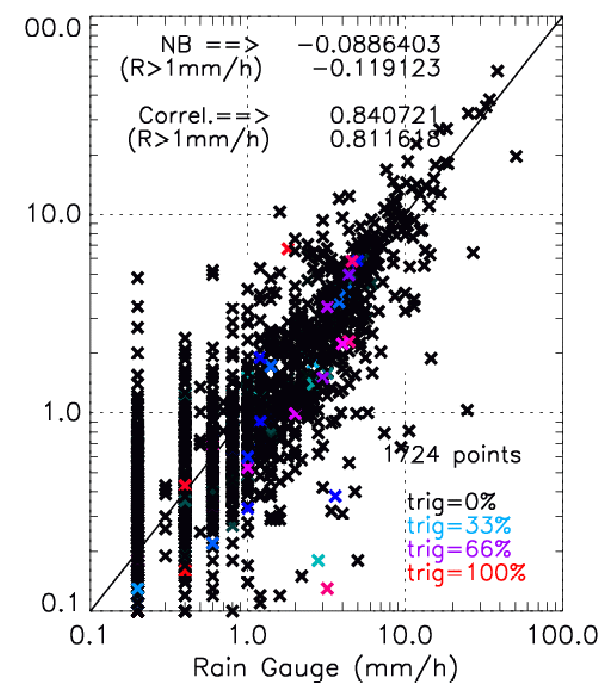
Trappes – 12 episodes of 2005 – Hourly radar – rain gauge comparisons

Conventional QPE



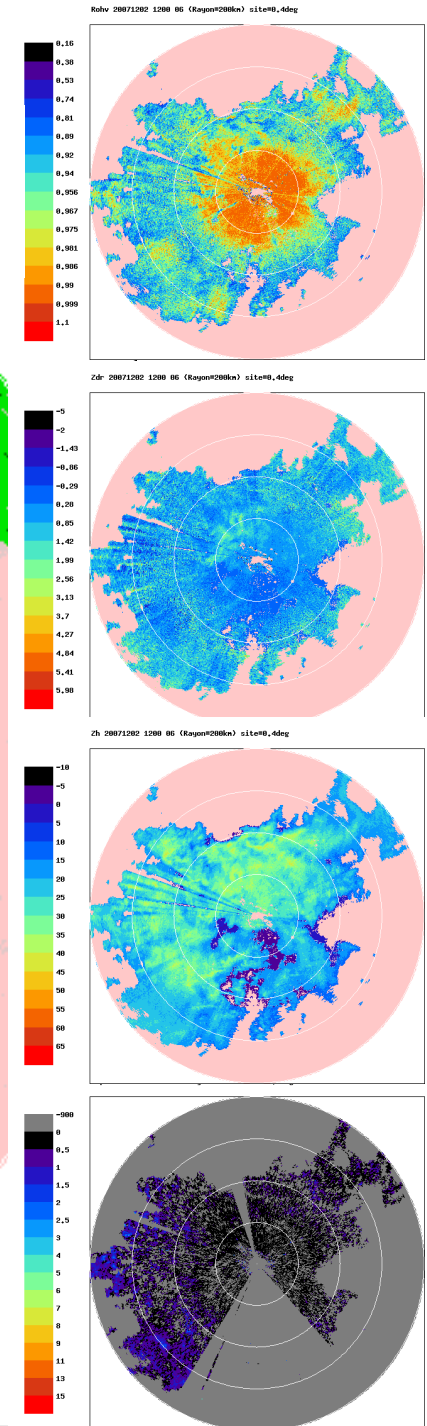
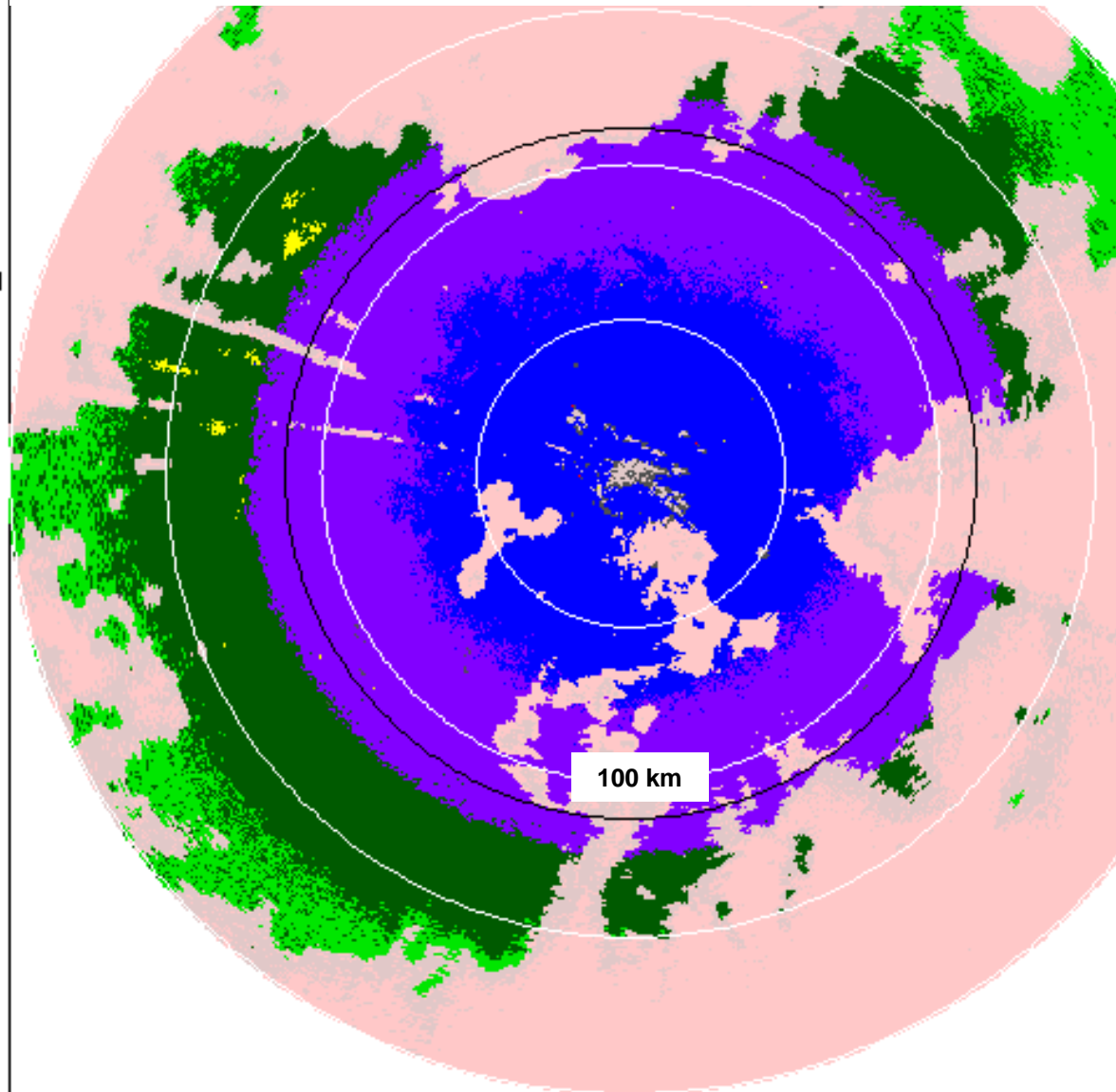
NB (Normalized Bias)
 $= \Sigma \text{radar} / \Sigma \text{raingauge} - 1$

Polarimetric (ZPHI®) QPE (Testud et al. 2000)



Type 20071202 1200 06 (Rayon=200kn) site=0.4deg

Hydrometeor classification on a conical scan (PPI) at 0.4°



Products (5) : wind and humidity in clear-air conditions

- As a summary of the previous slides, a network of Doppler / polarimetric radars is potentially able to provide the full 3D, high resolution (1 km²) and frequent (5 minutes) kinematical (Doppler) and microphysical (polarimetry) properties of precipitating systems, including the precipitation totals.

Products (5) : wind and humidity in clear-air conditions

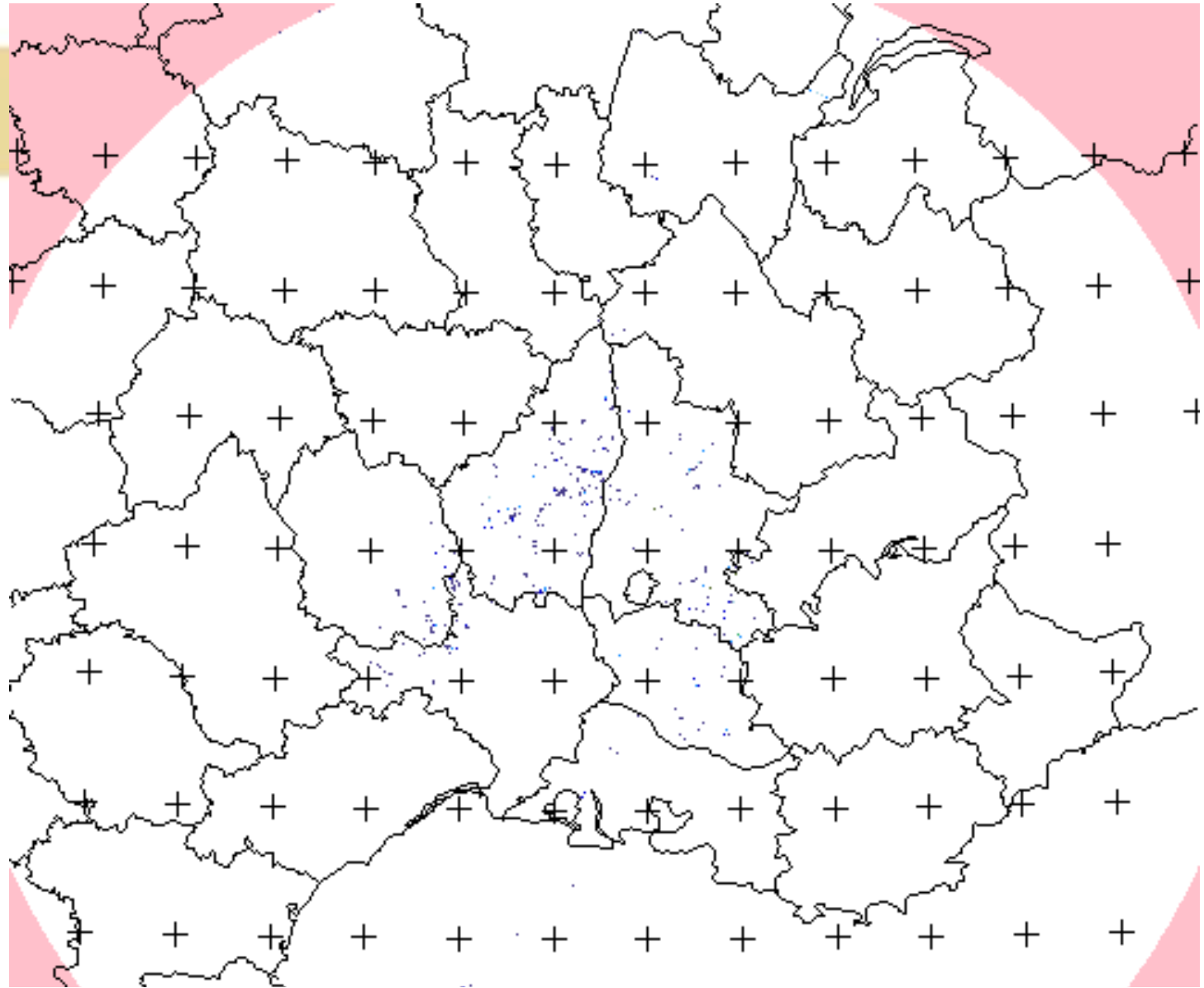
- As a summary of the previous slides, a network of Doppler / polarimetric radars is potentially able to provide the full 3D, high resolution (1 km²) and frequent (5 minutes) kinematical (Doppler) and microphysical (polarimetry) properties of precipitating systems, including the precipitation totals.
- But radars can also be used during dry periods to retrieve :
 - the low-level humidity field using the phase of the radar signal on ground-clutter targets (refractivity technique proposed by F. Fabry, U. Mac Gill); **see yesterday's (?) poster by Chiraz Boudjabi (Météo France).**
 - the boundary layer wind field using clear-air passive tracers (insects or refraction index gradients);



**S-band Bollène
radar**

**Animation over
one night**

**Threshold at 8
dBZ**



If radars are sufficiently close to each other (< 70 km) then low-level dual-Doppler winds can be retrieved in clear-air.

Thank you !

- **MeteoCat**
Sergi paricio
Coordinador
Sergi Paricio [<sparicio@meteocat.com>](mailto:sparicio@meteocat.com)
- **AEMET**
Marcelino Manso
Jefe del Servicio de Teledetección
marcelino@inm.es
(ils n'ont pas encore change les e-mail)
- **ARPA Piemonte**
Area Previsione e Monitoraggio Ambientale
Roberto Cremonini
via Pio VII, 9
10135 TORINO ITALIA
Tel. +39 011 1968 0282
Fax. +39 011 1968 1341

- **OPERA : Dr. Iwan Holleman**

KNMI, Netherlands P.O. Box 201, NL-3730
AE, De Bilt T +31 30 2206818 W

www.knmi.nl/~holleman

www.knmi.nl/opera

« Having defined data policy agreement, data will be made available for HYMEX 2009-2013 »

- **Gianfranco Vulpiani, Department of Civil Protection, Rome, Italy,**
gianfranco.vulpiani@protezionecivile.it



METEO FRANCE
Toujours un temps d'avance