Recent developments in variational assimilation systems at MF and Aladin partners

Claude Fischer;
Zahra Sahlaoui, Fatima Hdiddou (DMN/Maroc);
Gergely Bölöni (Hun. Met. Serv.); Marian Jurašek (SHMU/Slovakia);
Ludovic Auger, Loïk Berre, Bernard Chapnik, Claudia Faccani, Thibaut Montmerle, Eric Wattrelot (Météo-France);
Günther Haase (SMHI/Sweden)

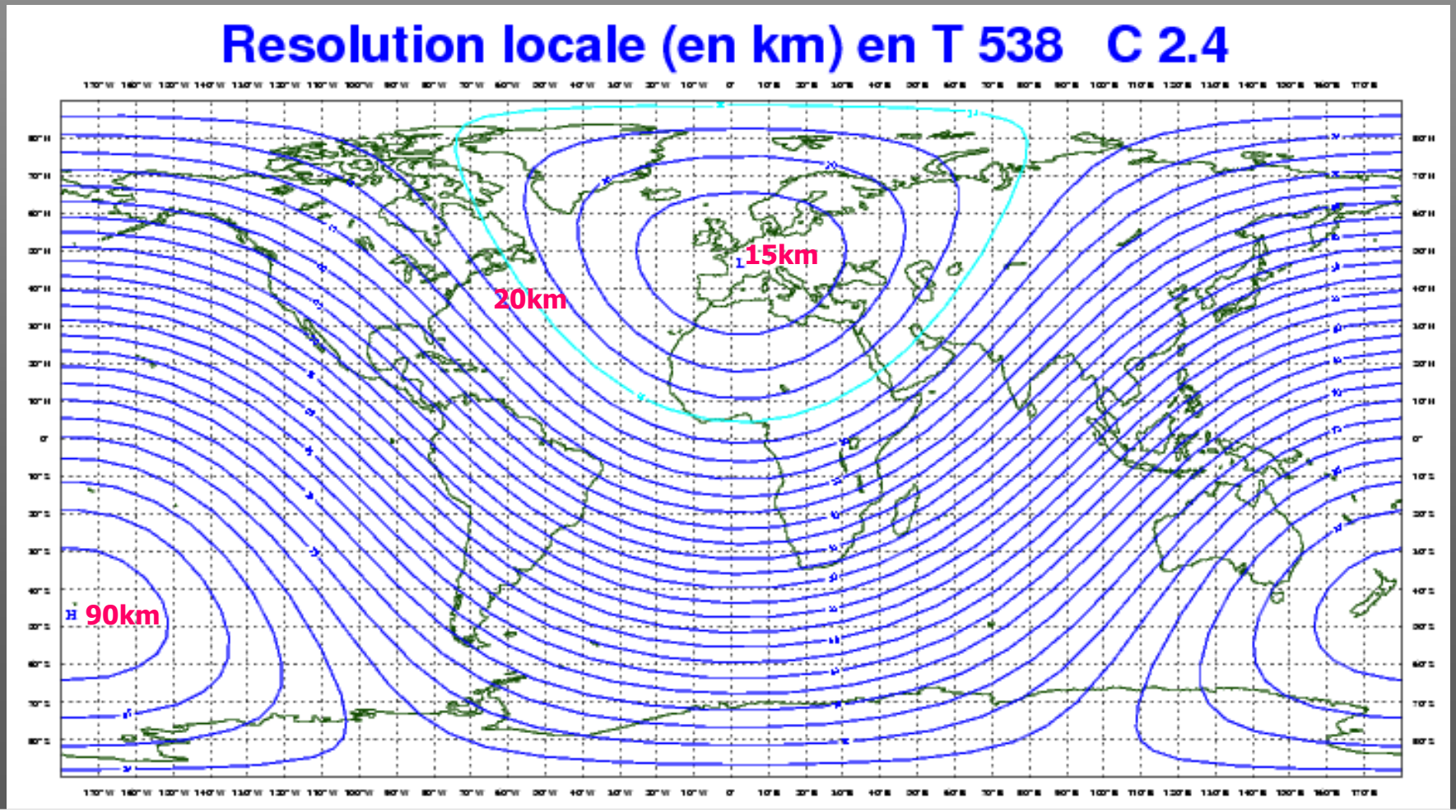
Overview

1. ARPEGE global assimilation:
   1. Resolution
   2. Observations
   3. Ensemble of analyses, ensemble VAR
2. Progress in regional assimilation (ALADIN-FR & AROME)
3. Radar data (AROME):
   1. Wind
   2. reflectivities
4. Aladin 4D-VAR
5. Outlook

The ARPEGE global model

T_L 538 C2.4 pole at lat. 46.5° / lon. 2.6°
Local resolution in km

Vertical resolution: 60 levels



The ARPEGE global assimilation

Global spectral model: T_L538 C2.4, 60 levels

Associated grid: 15 km (France) $\rightarrow$ 86 km (antipodes)

Collaboration with ECMWF

6-hour window multi-incremental 4D-VAR with two outer loops at T_L107C1.0 and T_L224C1.0

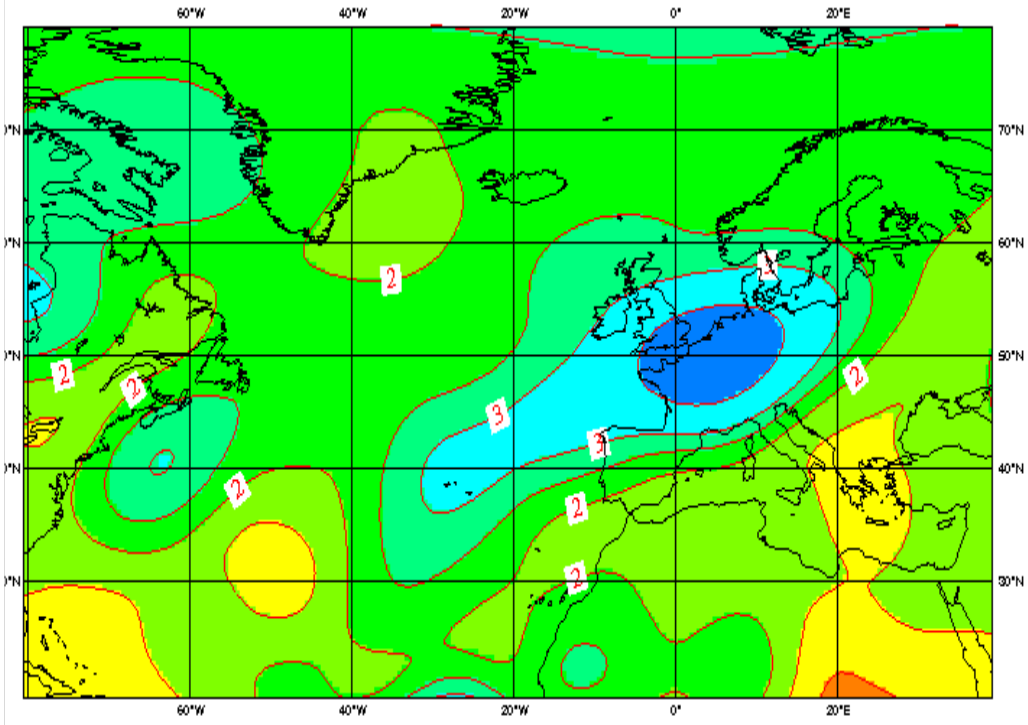
Only dry simplified physics in the TL/AD for the time being

Recent achievements in the global ARPEGE 4D-VAR

- Observations:
  - Variational bias correction scheme (Feb. 08)
  - New sets of satellite data (July 08):
    - assimilation of AQUA/AIRS channels (~54 channels in total),
    - assimilation of MetOp/IASI channels (~50 channels), MetOp/HIRS,
    - assimilation of MSG/SEVIRI Clear Sky Radiances (the 2 so-called "water vapour channels"),
    - assimilation of clear-sky microwave radiances over sea (DMSP F14 SSM/I),
    - Increase in the number of assimilated microwave radiances (AMSU-A/B, MHS from NOAA and MetOp) over land, in clear-sky, using improved surface emissivity computation (no additional channels used),
    - Increase the number of assimilated GPS-RO data (improved vertical thinning), with an assimilation from 1km to 6km at the lowest (from poles to equator) until 25km (top)

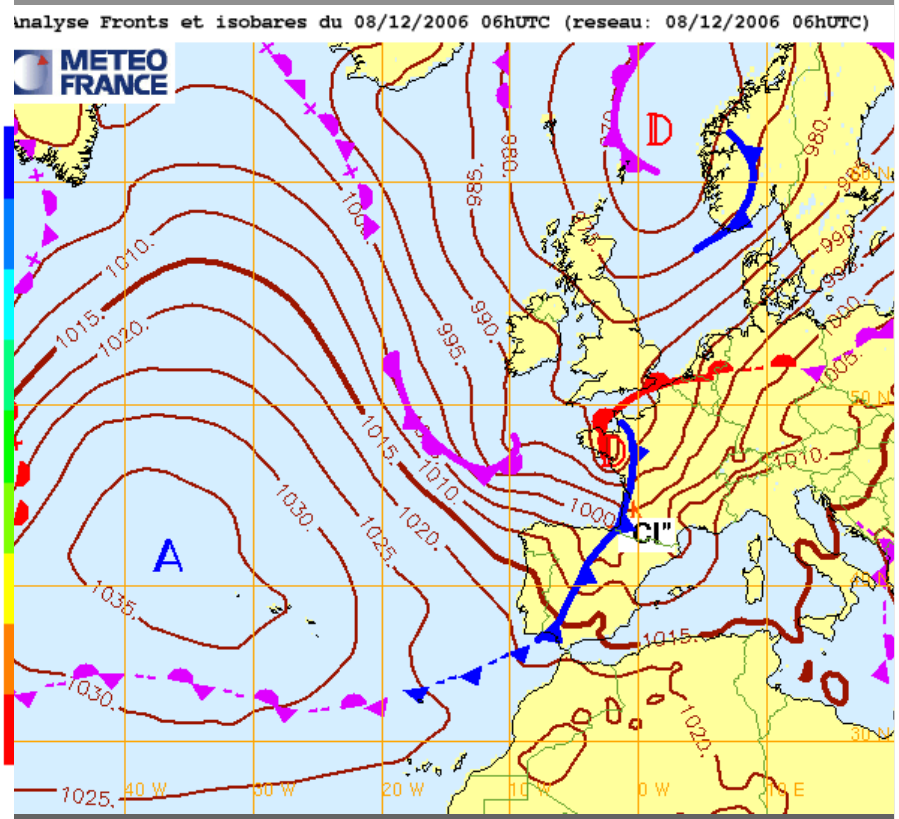
Recent achievements in the global ARPEGE 4D-VAR

- Ensemble assimilation: 6 assimilation cycles of 6h-window 3D-VAR FGAT in TL358C1.0L60 (Feb. 08)



Ensemble dispersion:

large sigmab over France



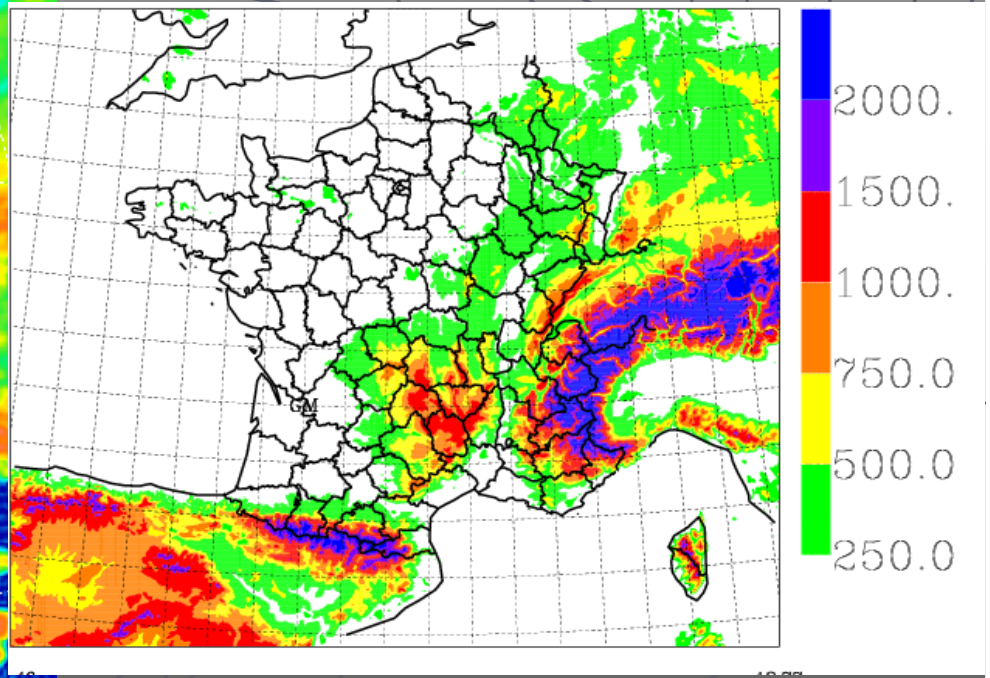
Mean sea level pressure :

storm over France

ALADIN and AROME-France domains

ALADIN-FRANCE

AROME-FRANCE



Some basic facts on the Aladin and Arome models

- 3D-VAR (no FGAT)
- Continuous assimilation cycles:
  - Aladin (6 hourly assim, coupled with Arpège, δx=9.5km),
  - Arome (3 hourly assim, coupled with Ald-Fra, includes NH dynamics and sophisticated $\mu\varphi$, δx=2.5km)
- Observations:
  - Synop: surface pressure, T2m and RH2m (day), 10m winds
  - SHIP winds, drifting buoys
  - Aircraft data
  - SATOB AMV winds
  - Soundings (TEMP RS, PILOT, wind profilers)
  - Satellite radiances: NOAA and METOP (AMSU-A/B, MHS, HIRS), Meteosat-9 SEVIRI
  - scatterometer winds
  - Ground-based GPS zenital delays
  - Radar radial winds, radar reflectivity (via RH retrievals)

Recent achievements in the regional ALADIN-FR/AROME 3D-VAR's

- ALADIN-FR:
  - Many new observations following the progress of ARPEGE (July 08)
  - Switch off RH2m/T2m in night time
  - VarBC for SEVIRI raw radiances and retrieve ARPEGE's b.c. for other radiances
  - Implement an O.I.-based surface assimilation (under test, Oct/Nov 08 ?)
- AROME:
  - Advanced pre-operational status, switch to oper scheduled for ~ November '08

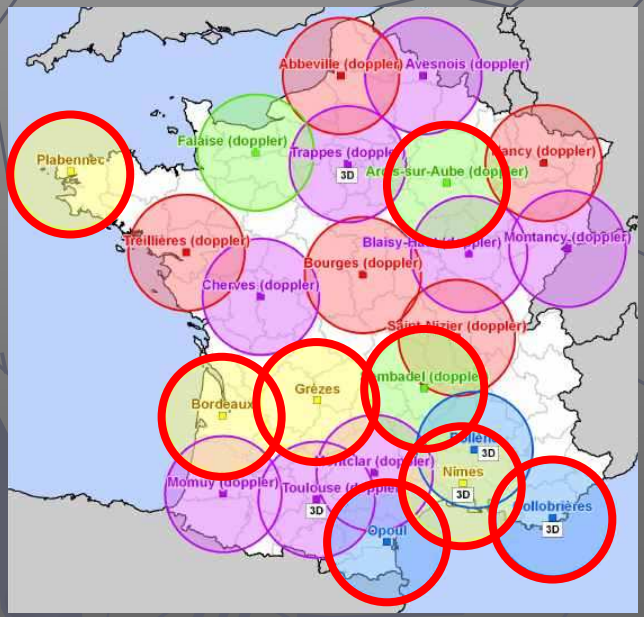
Radar data assimilation (AROME)

- Doppler radial winds (Vr)
- Reflectivities

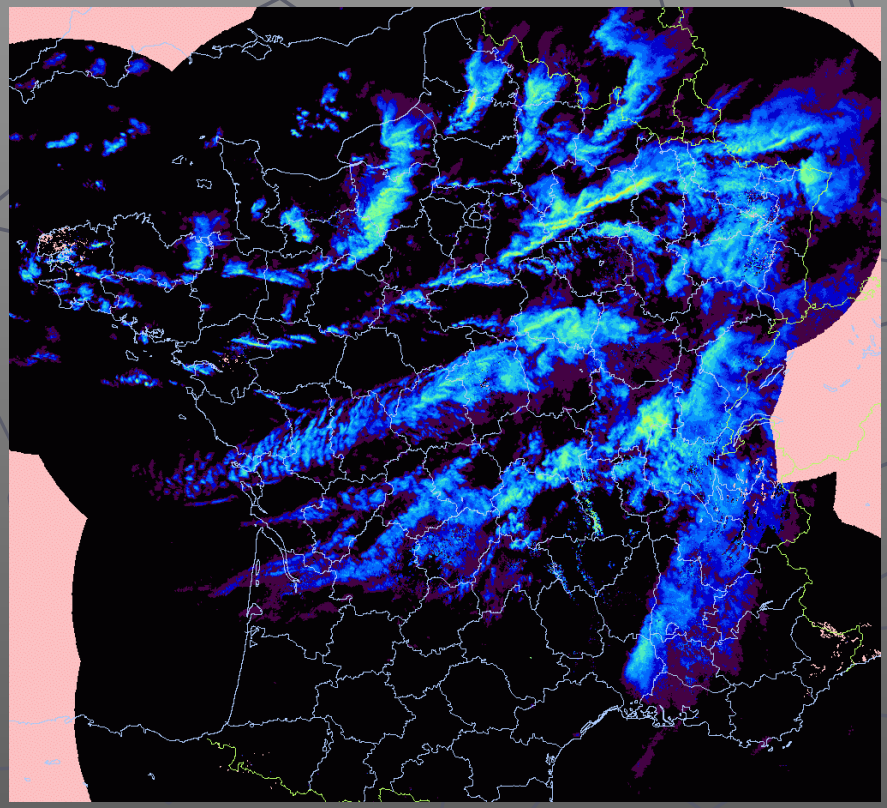
Pertinent assessment of the impact of radar data:

One needs to go to QPF scores and fine-scale flow analysis (field of horizontal divergence)

Severe wind situation on Northern France (early December 2007):



non Doppler radars



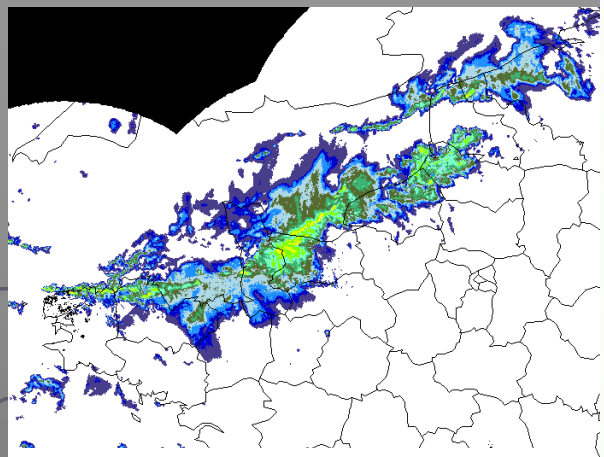
December 3rd, 00 UTC

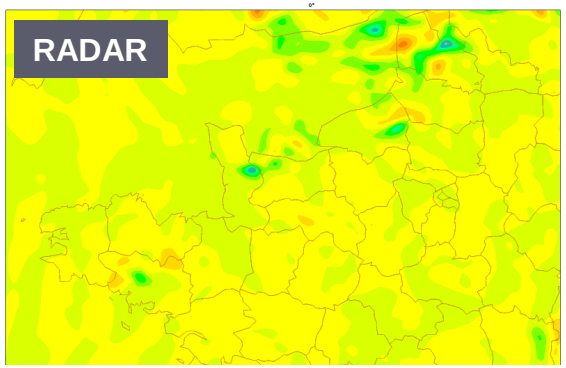
$\Rightarrow$ area of interest is well covered with radar wind information

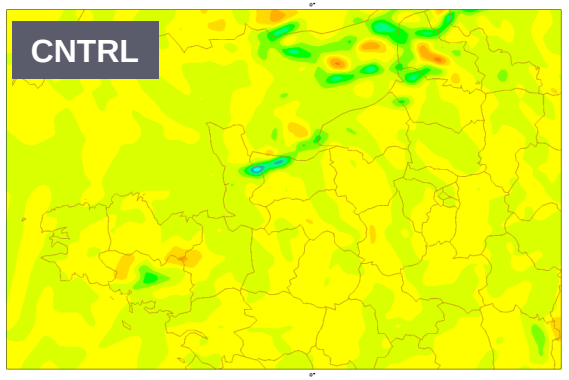
Analysis of divergence at 950 hPa

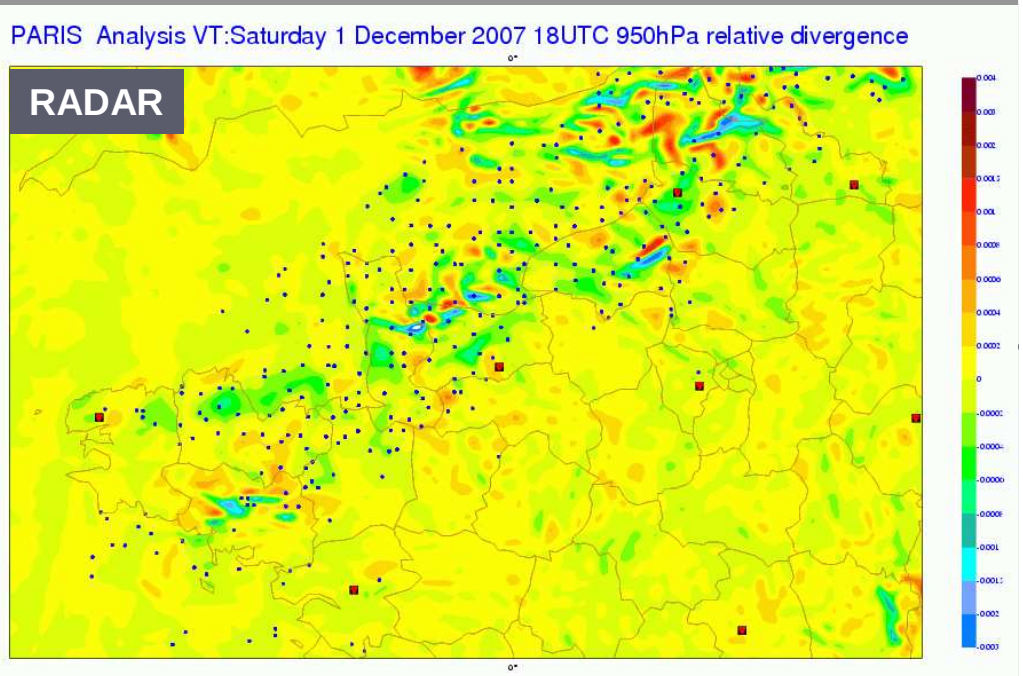
01/12/07
18 UTC

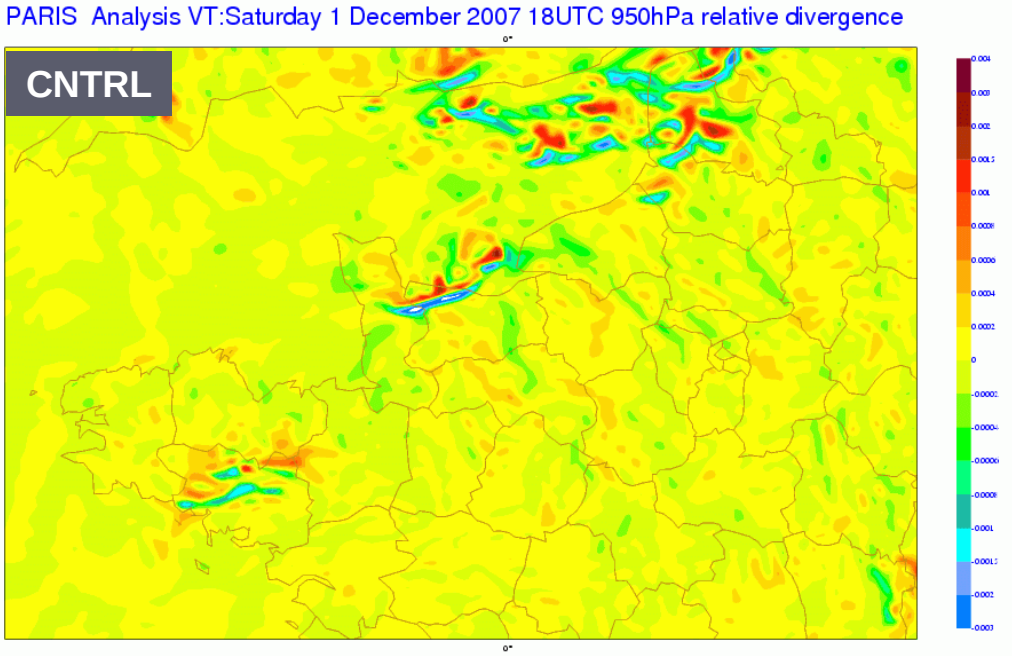
Guess









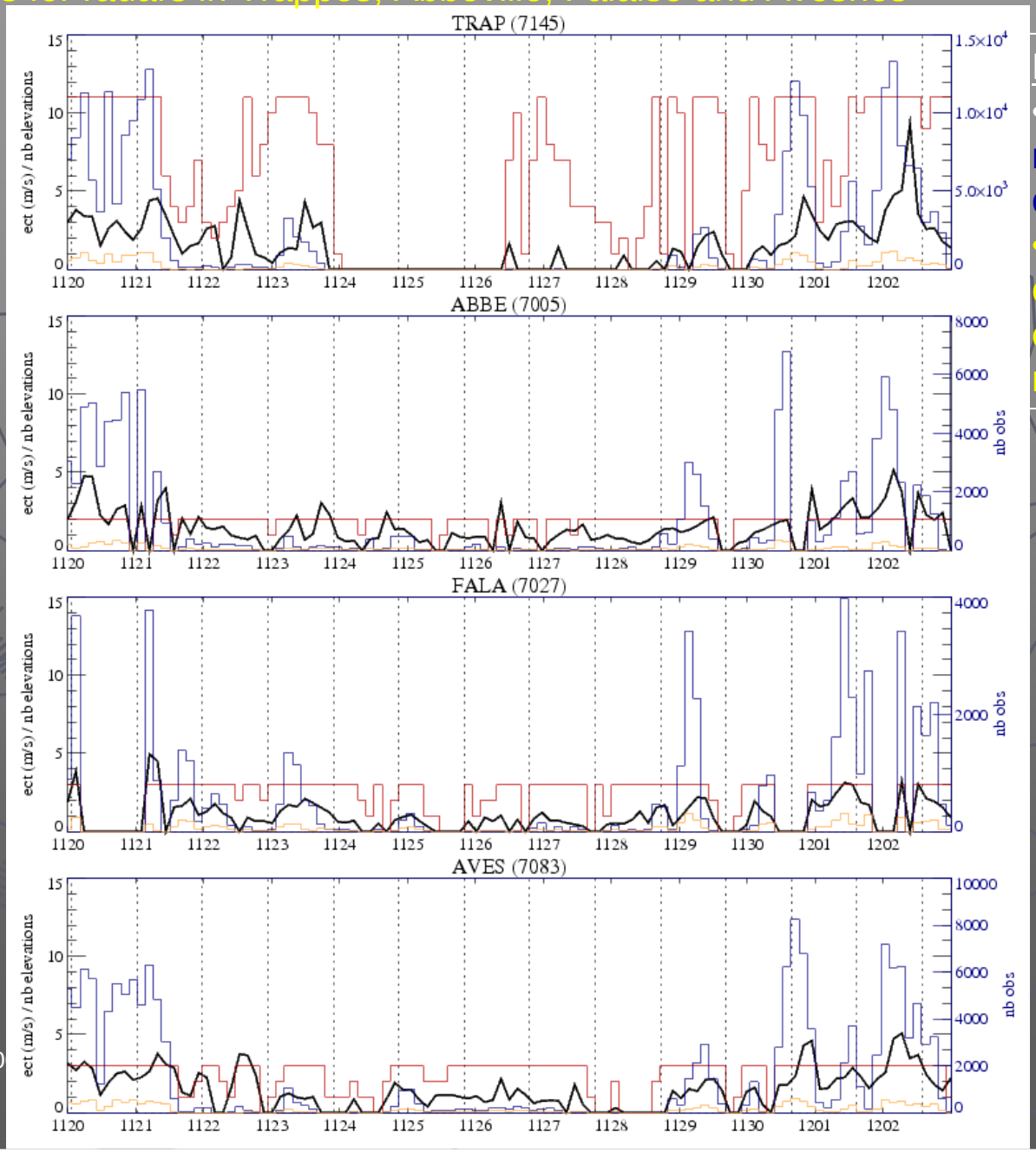


Monitoring of radar radial wind observations

Example of 15 days for radars in Trappes, Abbeville, Falaise and Avesnes

Red: number of elevations

Black: mean variance of Vr computed over slices of 10 deg. Site angle, per elevation



Histograms:

- Blue: total number of observations
- Yellow: number of observations entering minimization

Radar reflectivity assimilation

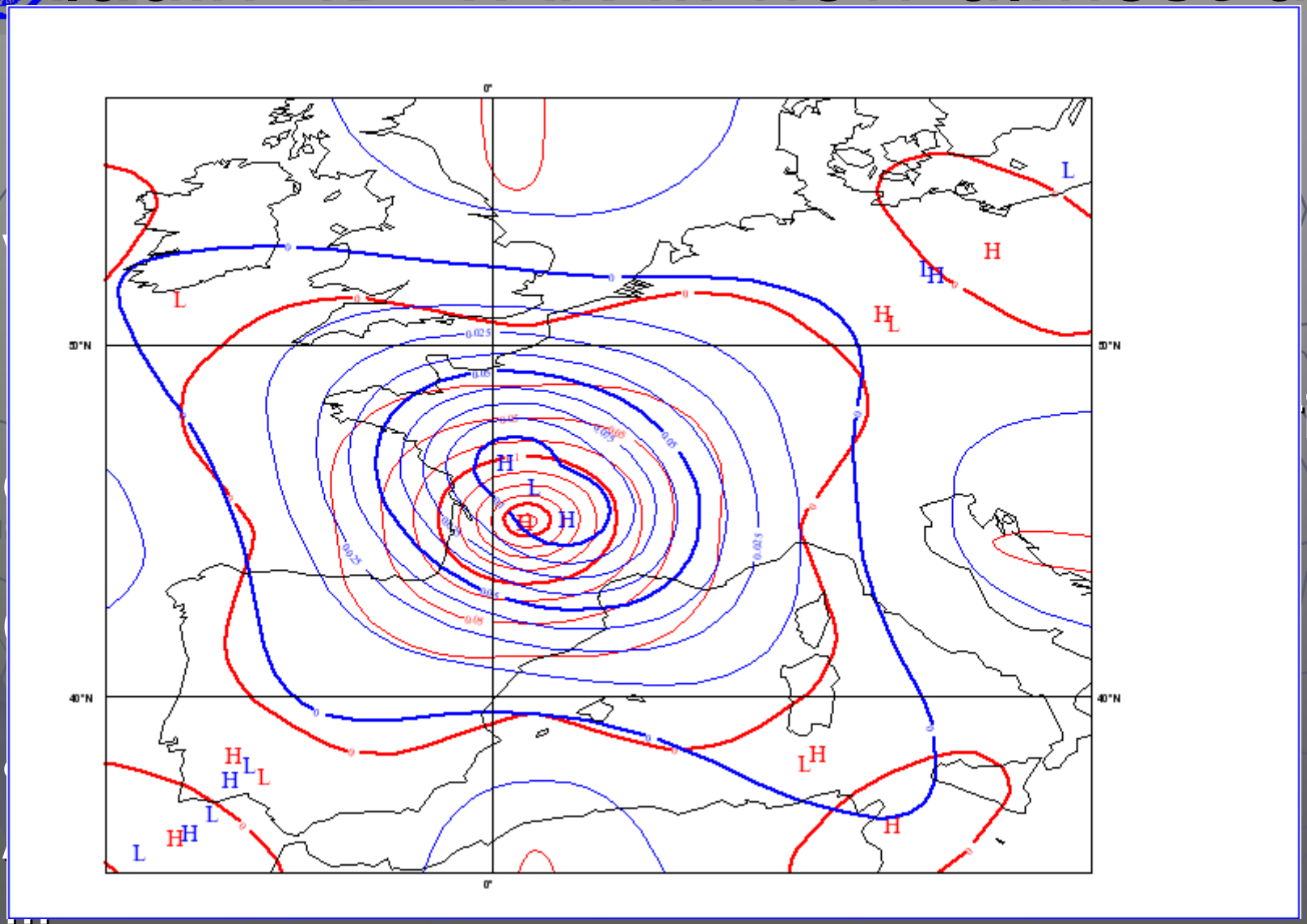
Goal :

Operationnally assimilate radar reflectivities in AROME by 2009-2010

Method :

- Volumic (3D) reflectivity data routinely available at MF since August 2007, in real time. Pre-processing check to remove erroneous data (soil and sea clutters, …)
- Reflectivity observation operator ready, simulates modelled reflectivities.
- Quality control check by a gross comparison of observed and modelled columns.
- Assimilation in the AROME system via a 1D+3DVar: reflectivities are inverted into pseudo-observations of relative humidity profiles (whose impact is expected to be bigger than when modifying the hydrometeor fields).

Aladin 4D-VAR ... now almost a



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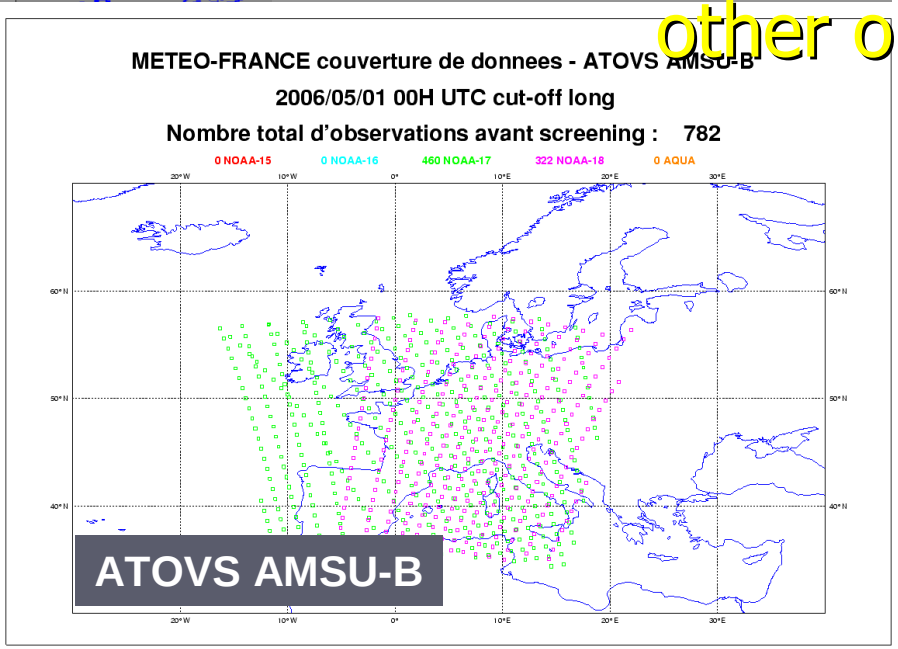
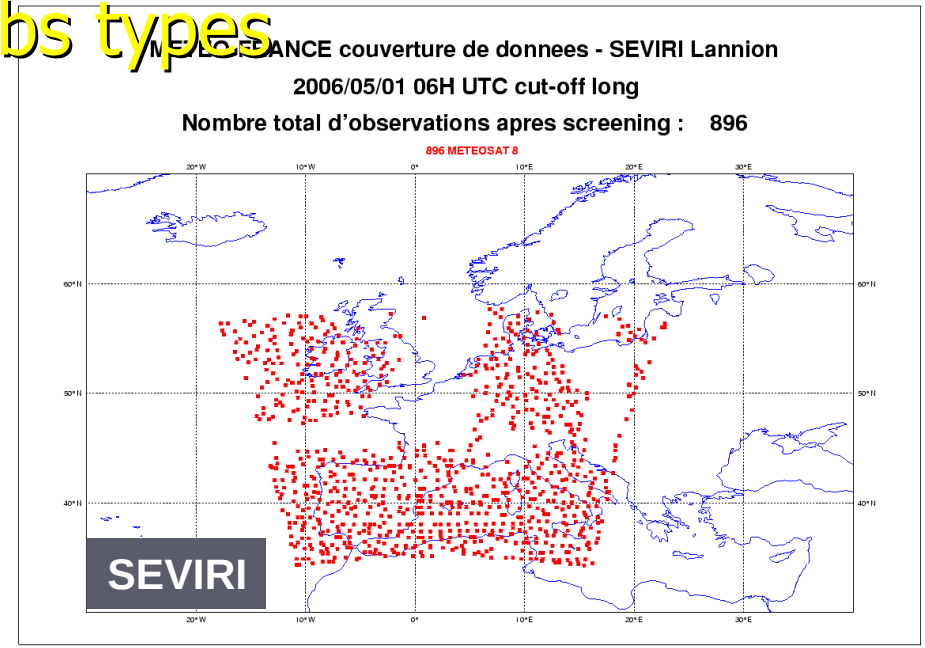
Outlook

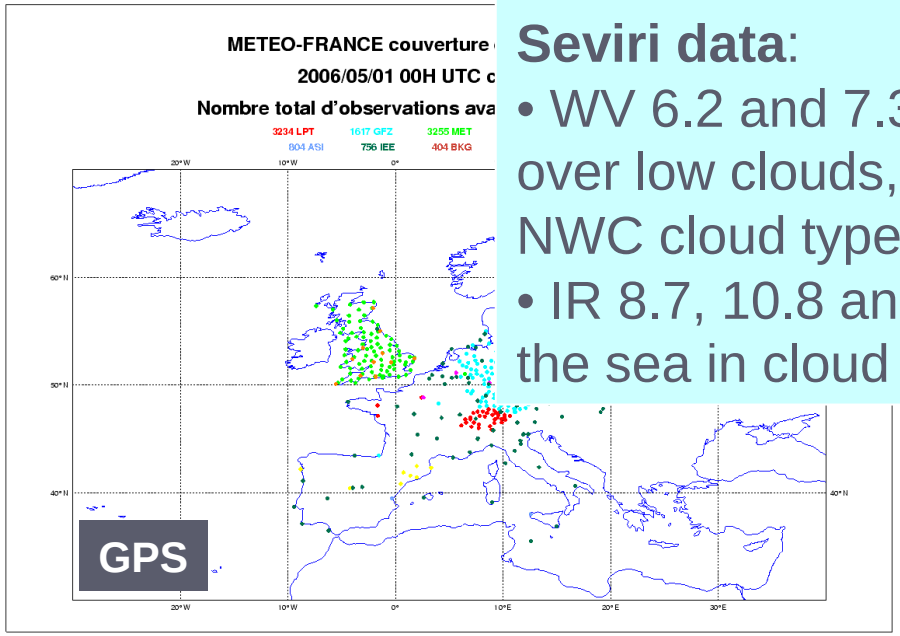
- New observations for LAM assimilations:
  - Microwave radiances over land
  - Radar data: 2008 (radial winds), 2009 or 2010 (reflectivities)
  - Cloud boguses ?
  - Combine upper-air analyses with a surface assimilation (simplified EKF) => J.-F. Mahfouf
- Other R&D aspects
  - Common Aladin-Hirlam 4-year plan: Harmonie 4D-VAR
  - Ensemble DA including research on how to « optimally » treat the B.C.
  - LAM wavelets (Alex Deckmyn and coll.)

شكرا على اهتمامكم

SEVIRI in Ald-Fra: data coverage as compared with other obs types

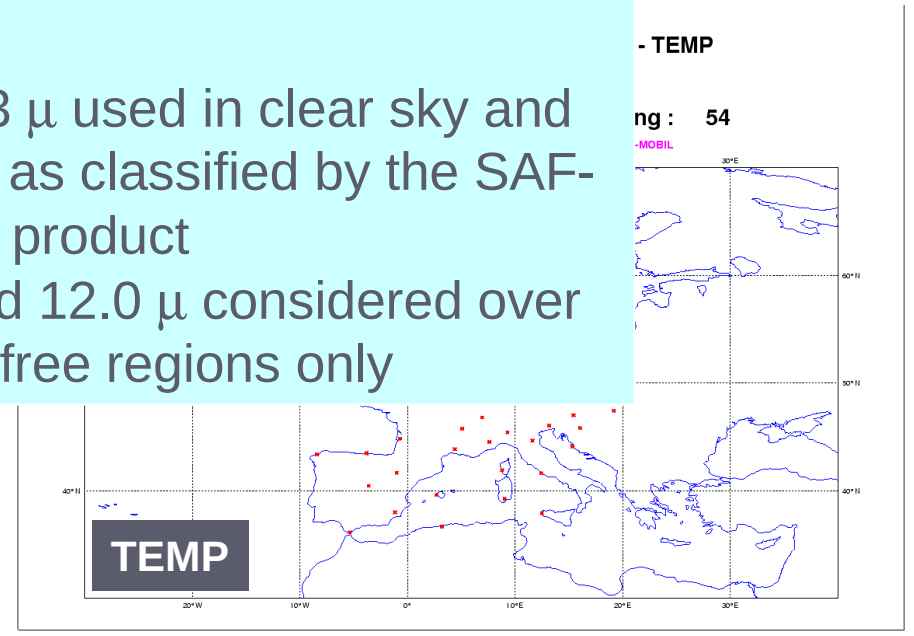




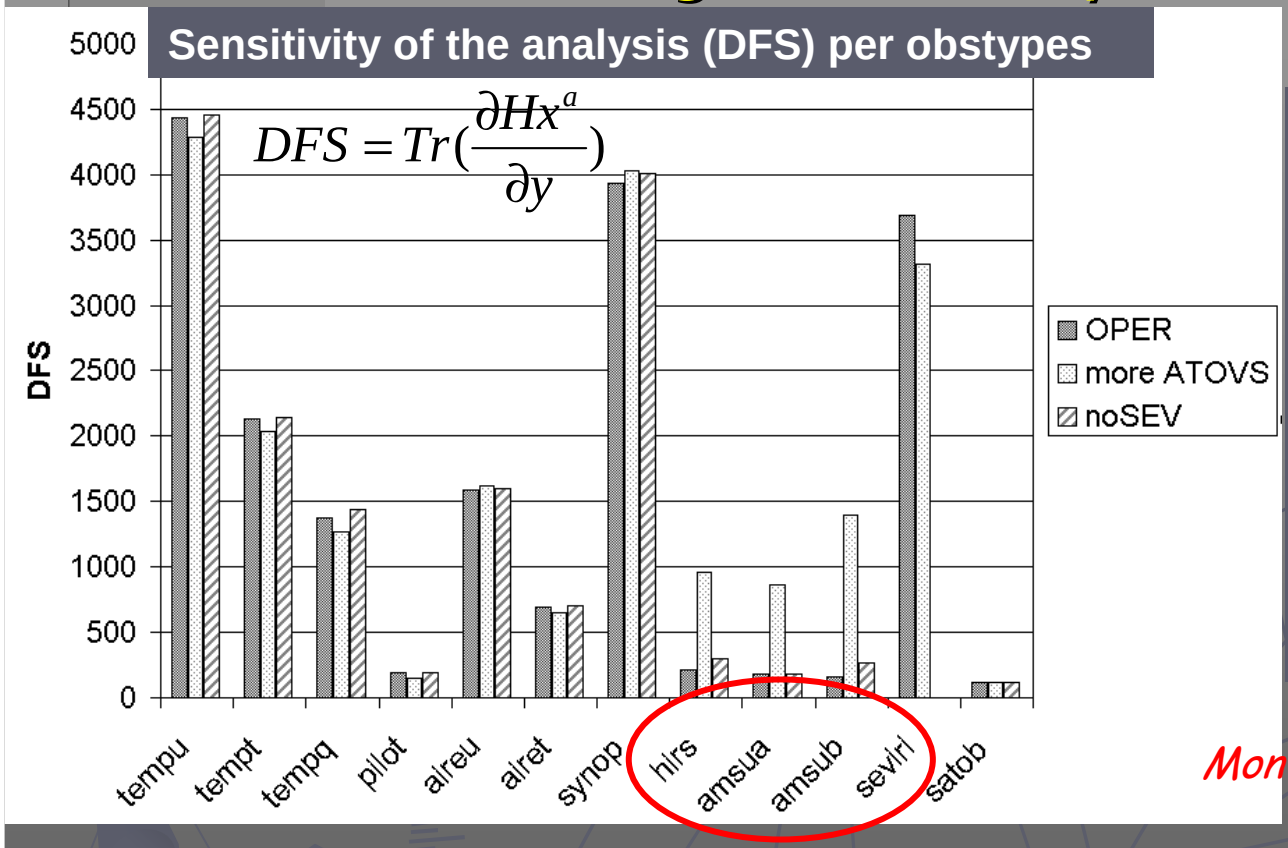


Seviri data:

- WV 6.2 and 7.3 μ used in clear sky and over low clouds, as classified by the SAF-NWC cloud type product
- IR 8.7, 10.8 and 12.0 μ considered over the sea in cloud free regions only



Impact of radiances from polar orbiting v/s geostationary sat.



OSEs:

OPER: ALADIN/France oper

moreATOVS: OPER with **denser ATOVS data** (AMSUA, AMSUB and HIRS) : 1 pixel/80 km vs. 1/250 km)

noSEV: OPER **without SEVIRI**

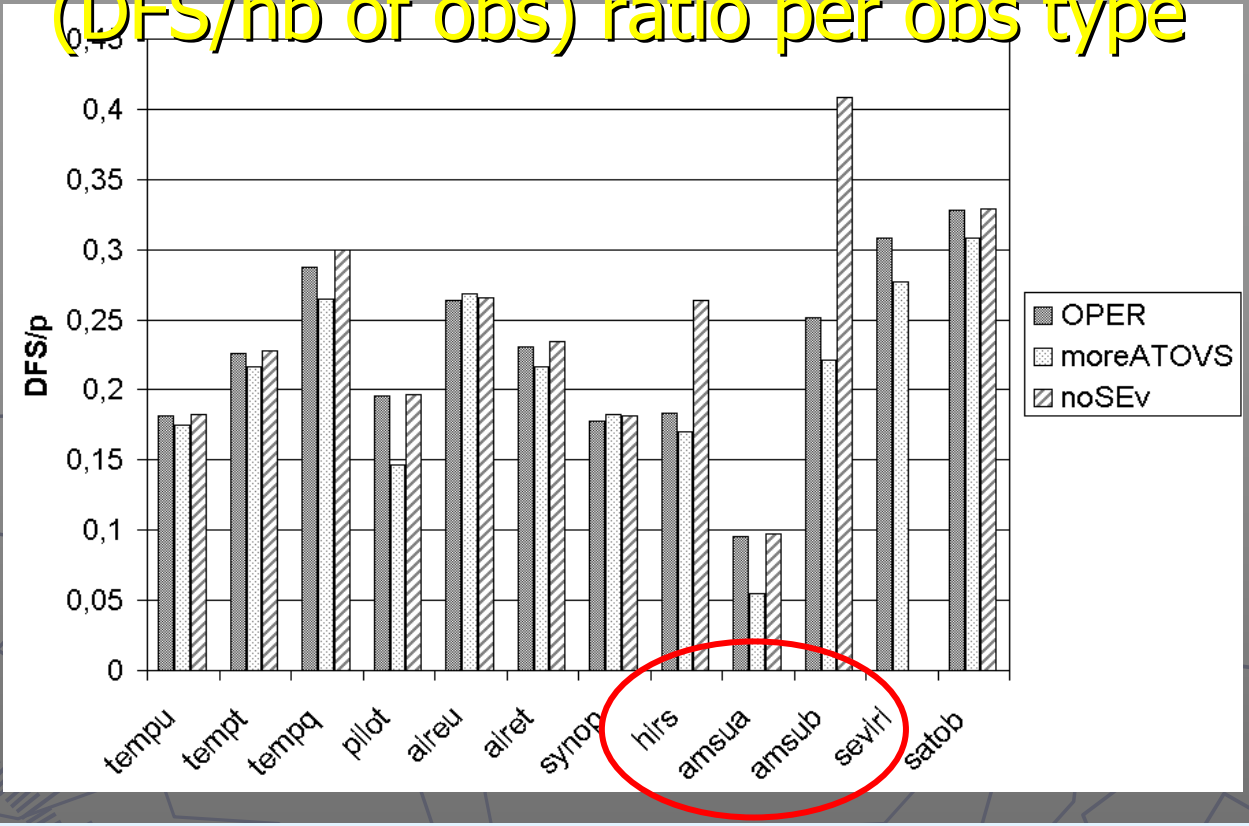
Montmerle etal., QJRMS, 2007

⇒ OPER: about equal info. Content for TEMP / aircraft / SYNOP & SEVIRI

⇒ large increase of DFS for ATOVS data (especially AMSUB) for moreATOVS coupled with a decrease for SEVIRI: **the influence of SEVIRI data in the analysis is reduced by the new information brought by extra ATOVS data**

⇒ without SEVIRI data, DFS values for HIRS and AMSUB almost double

(DFS/nb of obs) ratio per obs type



⇒ For moreATOVS, DFS/p is slightly reduced for HIRS and AMSUB : **using more data decreases the individual influence of one radiance in the analysis**

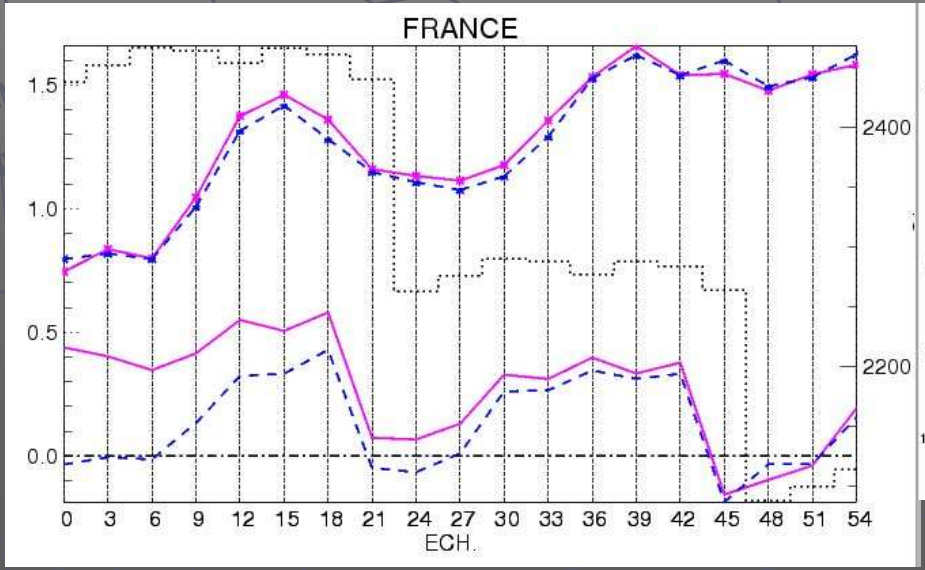
⇒ **This reduction is accentuated for AMSUA** because of the broad structure functions that are used in the high troposphere/low stratosphere

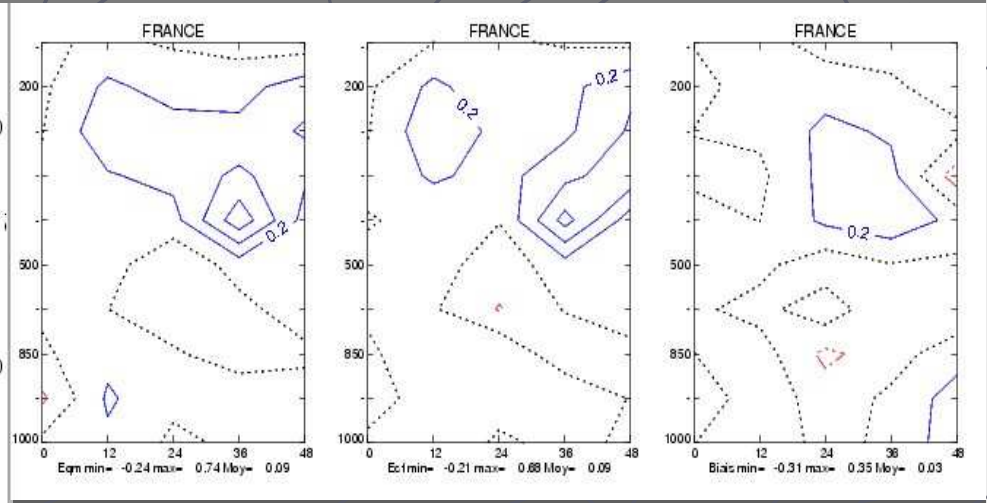
⇒ For noSEV, the individual influence of one radiance is much higher than in OPER : **This shows the complementarity of datasets that are sensitive to the same atmospheric component** (very interesting for r6 and r18)

Montmerle et al, 2006

10m wind observations in ALADIN-France

- ~2750 stations from synoptic network
- Monitoring over 4 month data (September 2006 – December 2006)
- Blacklisting when correlation between obs and model value < 0.3 => 101 stations blacklisted
- Slight improvement with blacklisting
- Experimental period : 01/09/2006-15/09/2006
- Good scores, especially in terms of sea-level pressure, tropospheric wind and tropospheric humidity





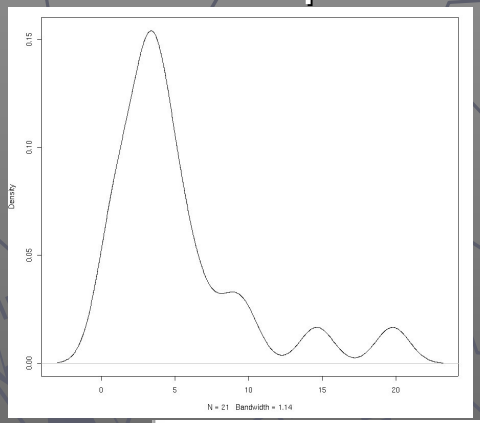
RMS STDEV BIAS

Comparison to pressure surface observation

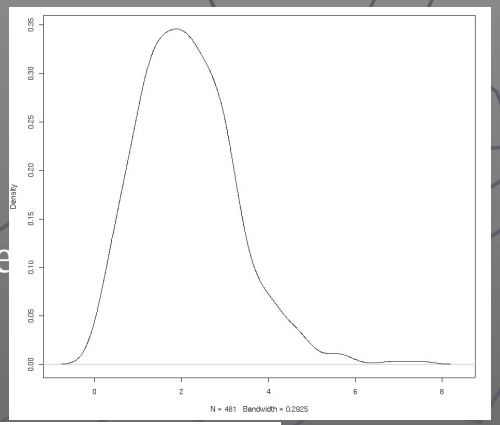
Scores to TEMP for wind force

Elimination of non-Gaussian innovations ?

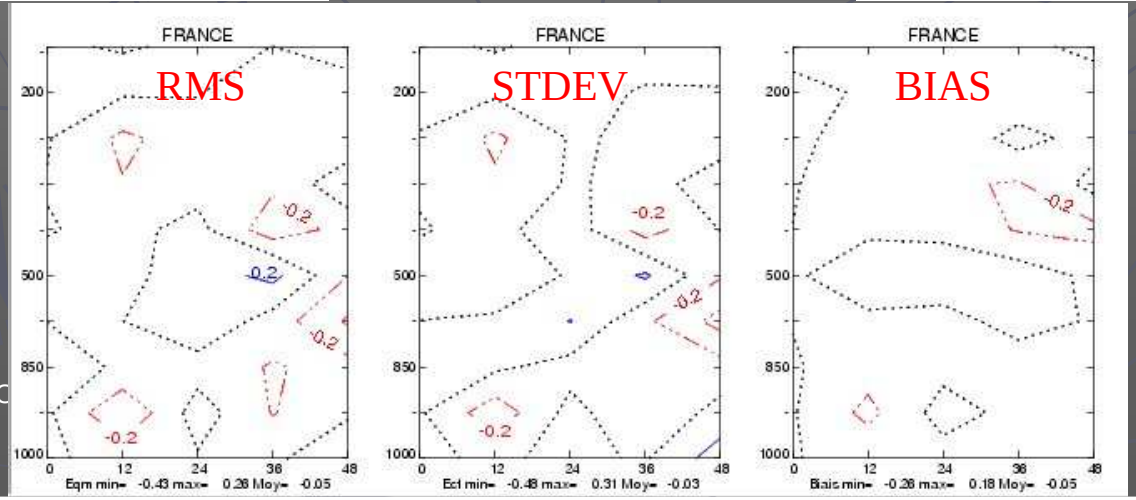
- Test with removal of 600 stations (out of 2753) showing the less Gaussian aspect for innovations
- Test based on good amount of population inside the 3 thresholds : σ, 2σ, 3σ
- No improvement, instead slight deterioration



Bad station (PDF too
Far from Gaussian profile



Good station



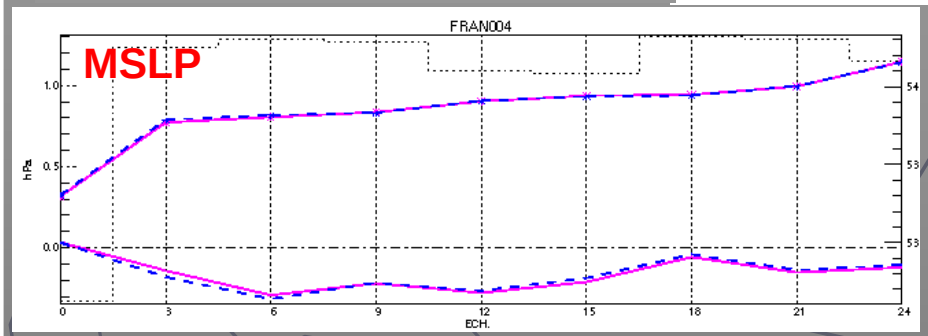
Deterioration of wind
Scores compared with TEMP

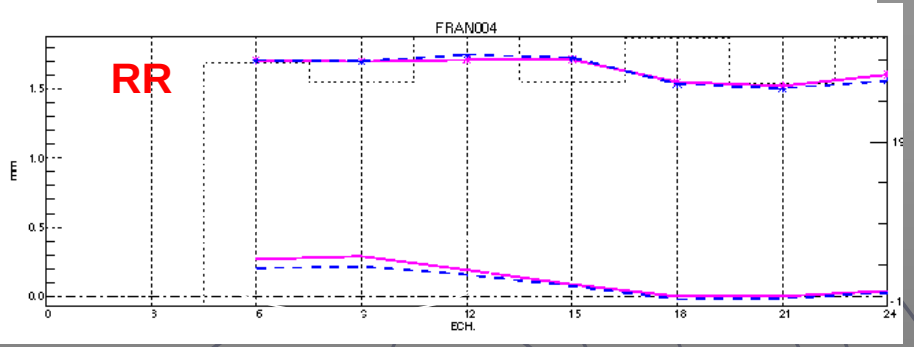
Vr: neutral to slightly positive scores in AROME-France

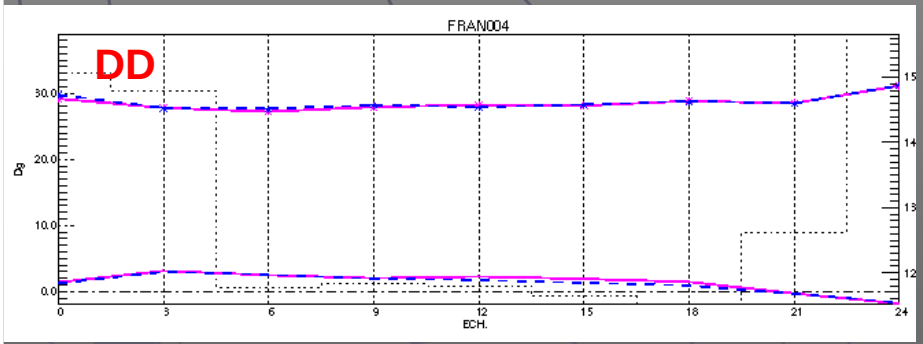
35 cas, 05/11/2007_15UTC -> 10/12/2007_12UTC

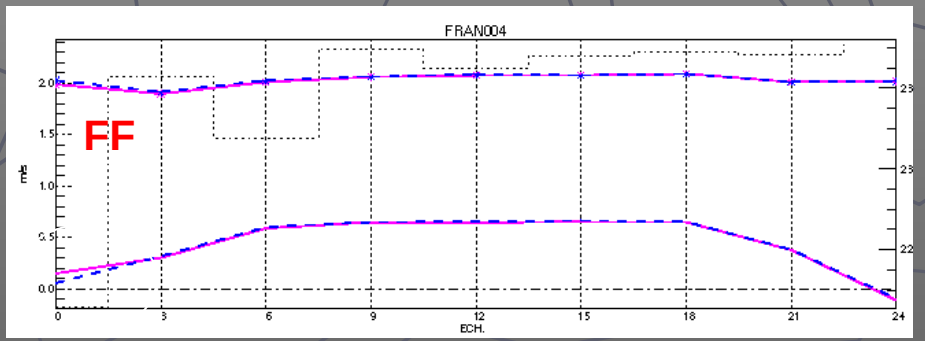
Biais P61Z7.r12/SYNOP — Biais P622U.r12/S

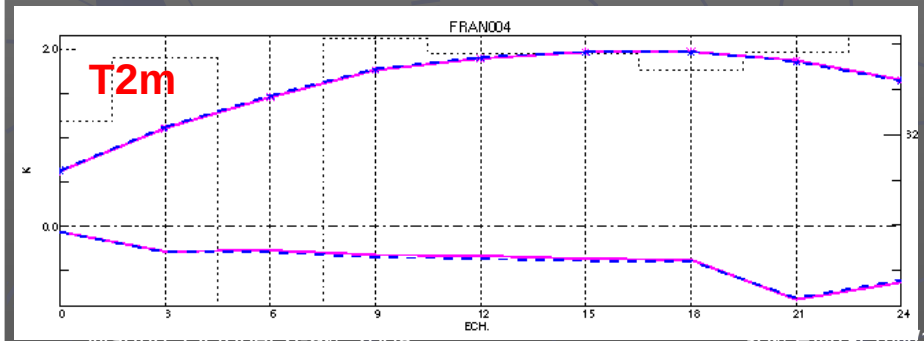
Eqm P61Z7.r12/SYNOP — Eqm P622U.r12/S

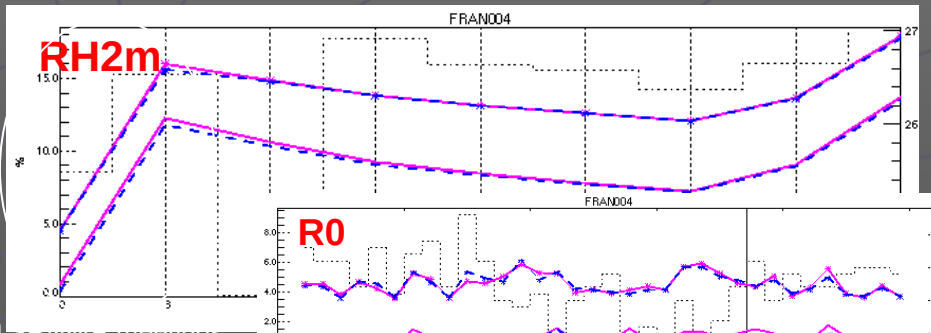


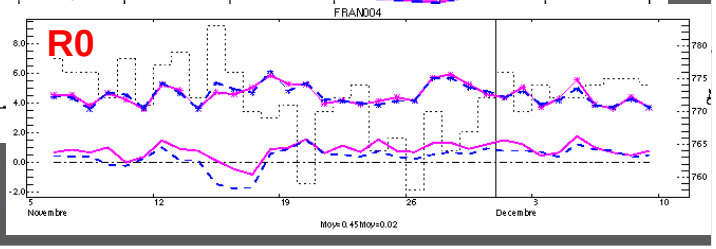










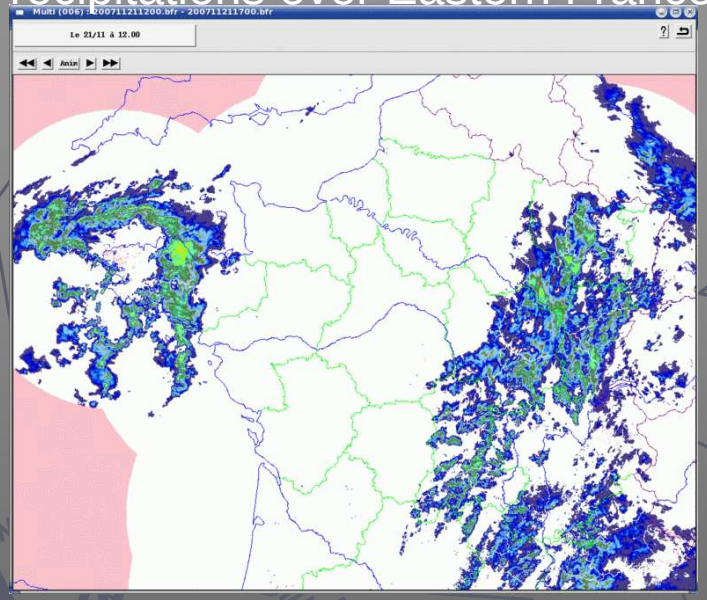


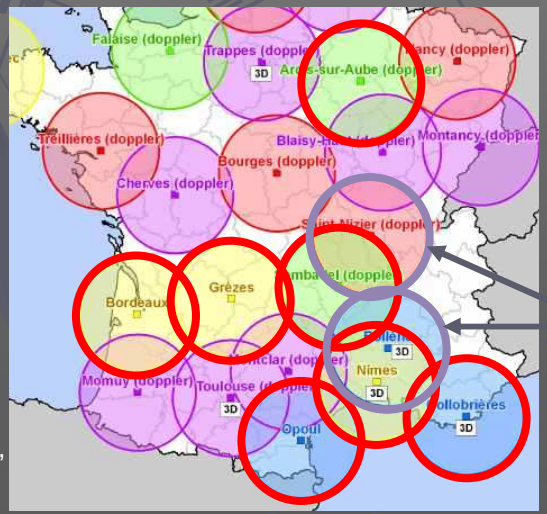
A case with non-operating radars

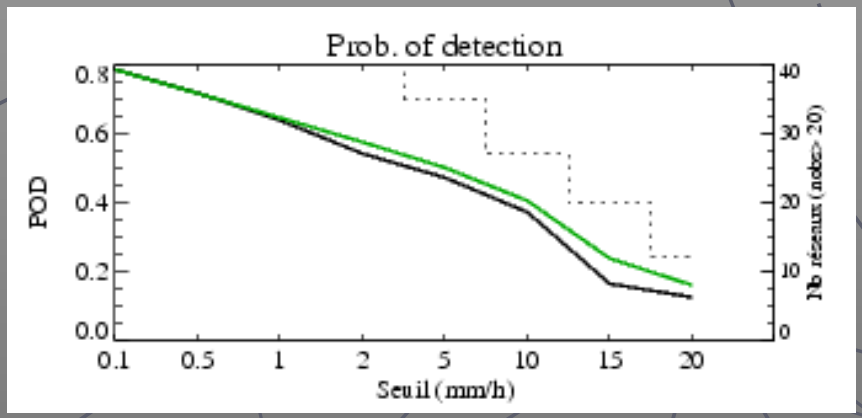
QPF scores:

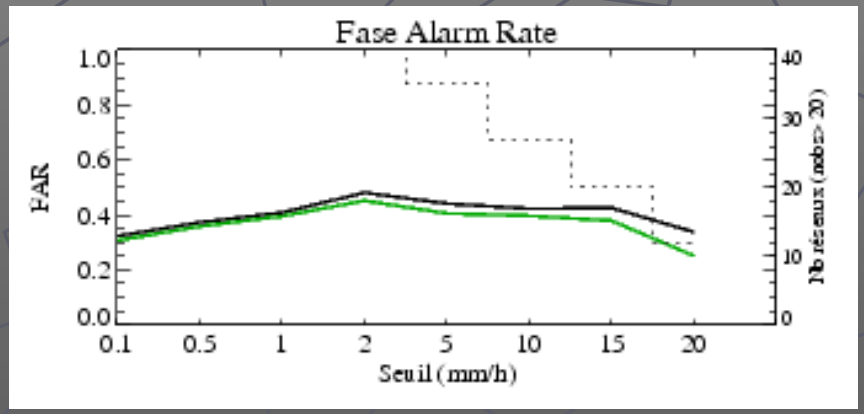
A more difficult period for the radar experiment: **Nov. 19th, 00 UTC -> Nov. 24th 00 UTC**

Precipitations over Eastern France







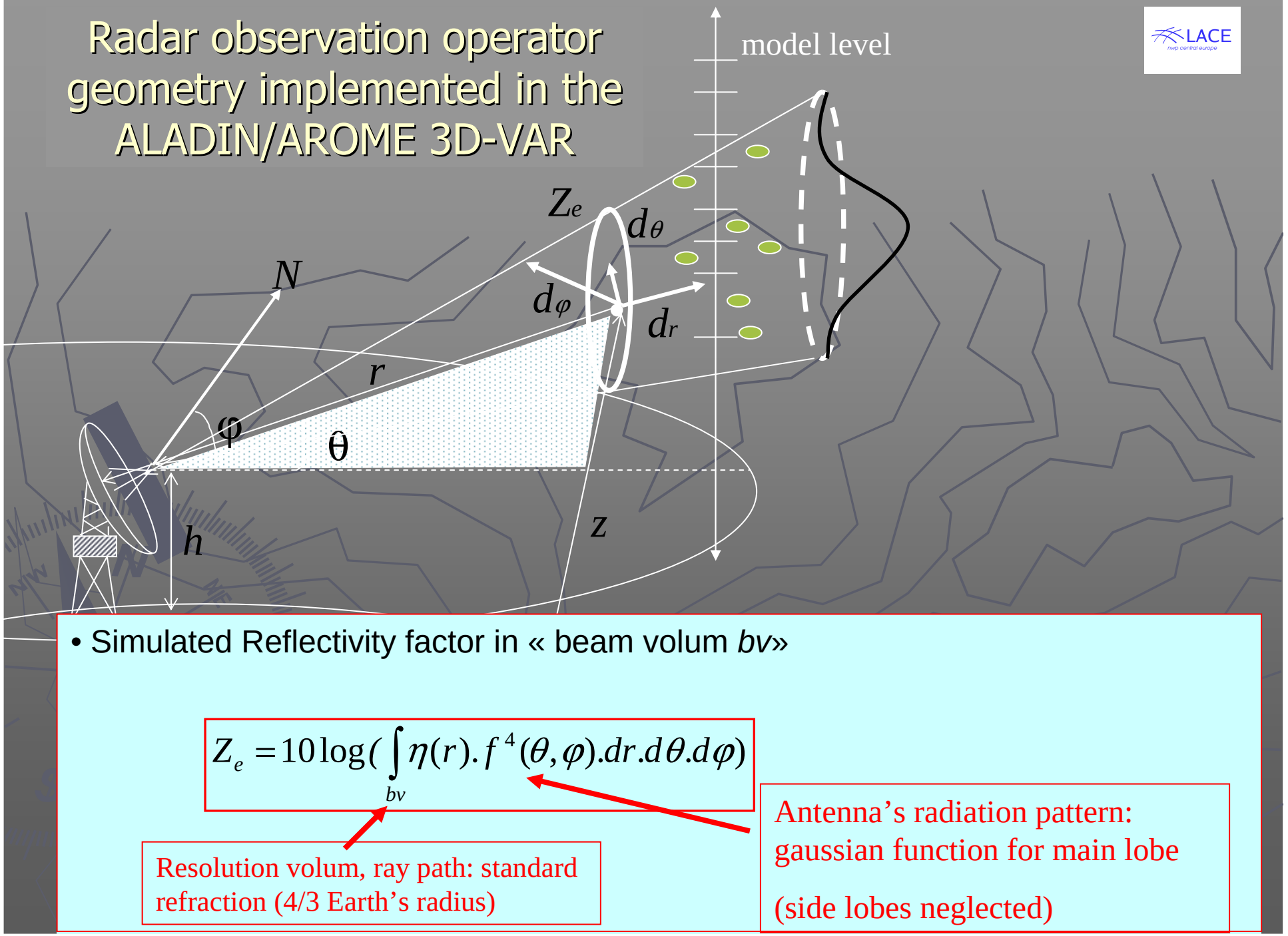


Malfunctions at Bollène and St Nizier

RADAR

CNTRL

Radar observation operator geometry implemented in the ALADIN/AROME 3D-VAR



- Simulated Reflectivity factor in « beam volum *bv*»

$$Z_e = 10\log\left(\int_{bv} \eta(r).f^4(\theta,\varphi).dr.d\theta.d\varphi\right)$$

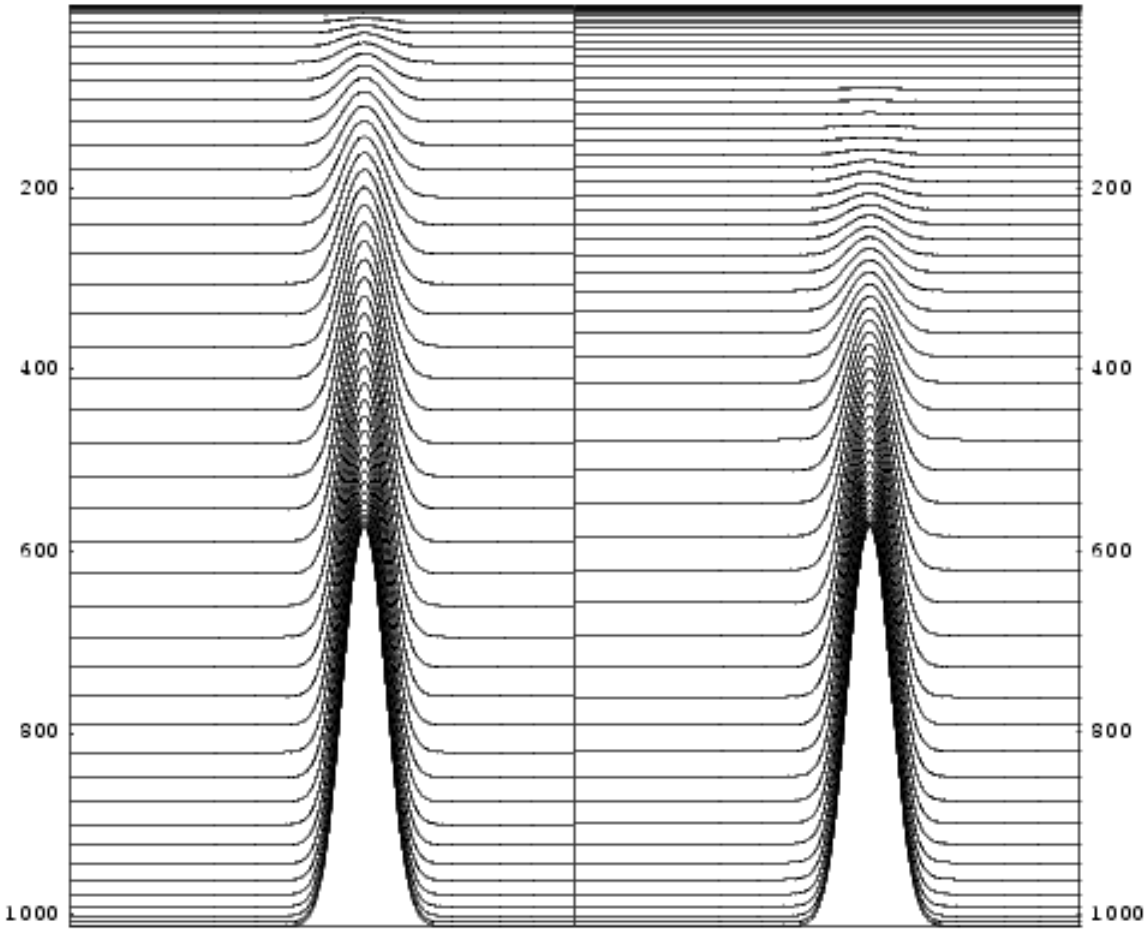
Resolution volum, ray path: standard refraction (4/3 Earth's radius)

Antenna's radiation pattern: gaussian function for main lobe

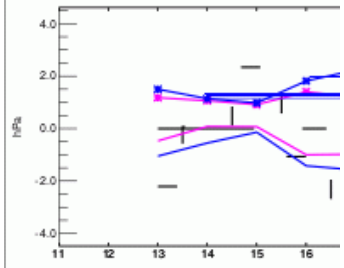
(side lobes neglected)

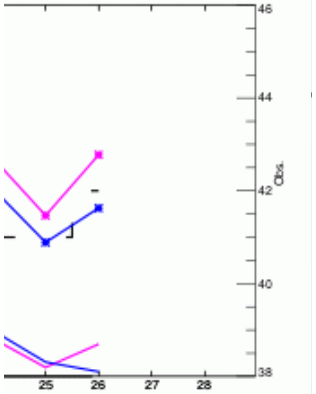
Sensitivity of « OSE's » to B matrix

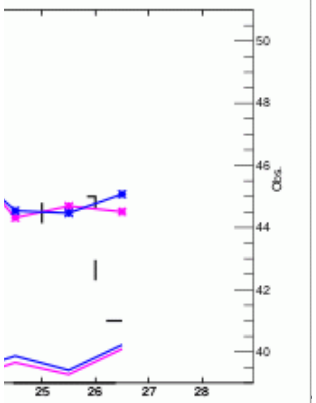
Impact of using
(here, vertical l
46 to 60) in the
W/r to using th
Recomputed er
(work of Abdel



MSLP 48h







Change of B m
interpolated 46
60 level ensemble fct stats (Jan. 19th)

Preparations for 3D-VAR in Morocco

- Assimilation of NOAA/ATOVS radiances in BUFR format
- Local pre-treatment of MSG / SEVIRI
- Local R&D with the Aladin 3D-VAR; operational declaration only scheduled after porting to DMN's next super-computer