

# Assimilation of radar data in AROME and in Europe

## Review and prospects

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## 1. Main features of radar assimilation within AROME

- Short history
- Radar network over France
- Impact on forecast performance

## 1. Illustrations

- Importance of quality of raw data
- Importance of « no-rain » assimilation

## 1. Planned activities

- Towards the use of European radars (OPERA)

# Assimilation of radar data in AROME : a short history

- Since 2005 : Development of the AROME data assimilation system :
  - ALADIN heritage : 3D-Var + observations but with **3-h cycling**
  - Choice of radar data and method:
    - French territory fully covered with 24 Doppler radars
    - High frequency observations of radial wind and reflectivity
    - Assimilation of volume data from individual radars
    - Computation of model reflectivities using modelled hydrometeors, to compare with observations
  - Strong interactions with the Météo-France radar expert team (DSO/CMR) to define scientific and technical needs

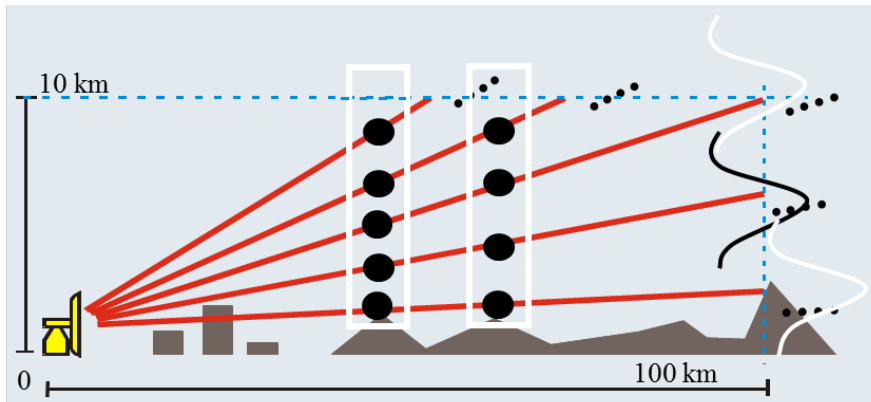
# Current operational use of rada data

## French ARAMIS network

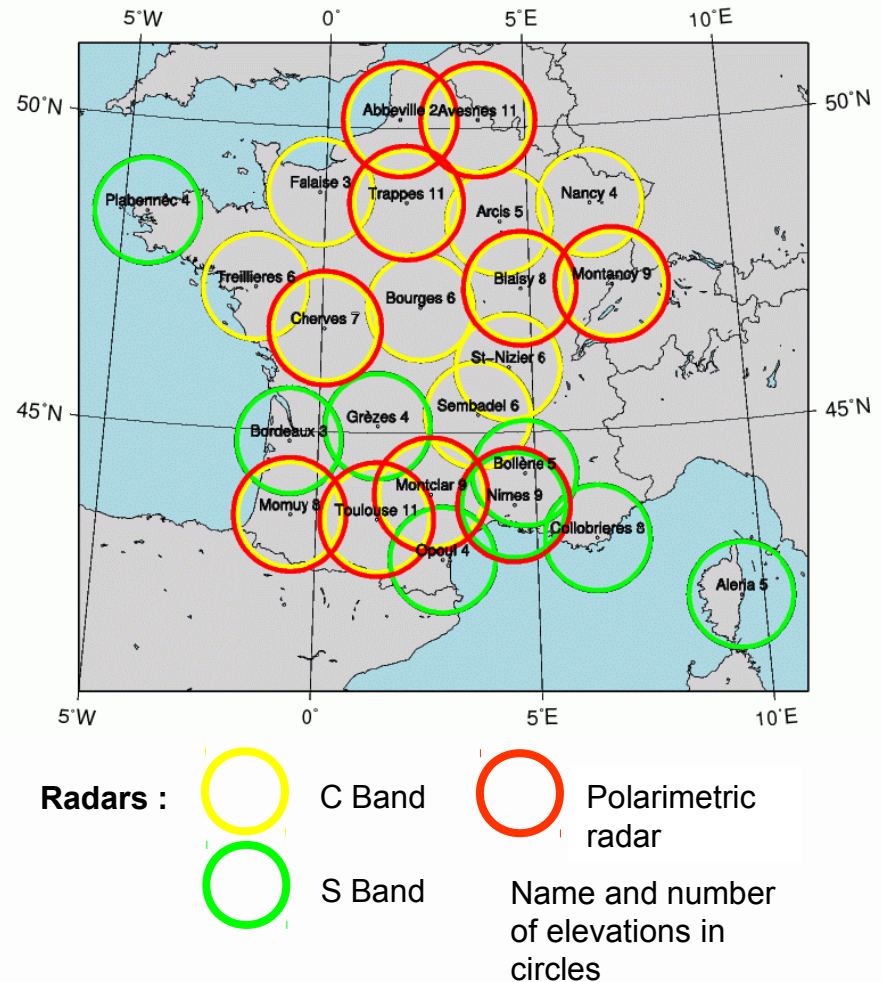
- 24 Doppler radars, 10 Polarimetric, between 3 and 11 PPIs in 15'

## Within AROME:

- Radial wind from 22 radars
- Reflectivity from 24 radars

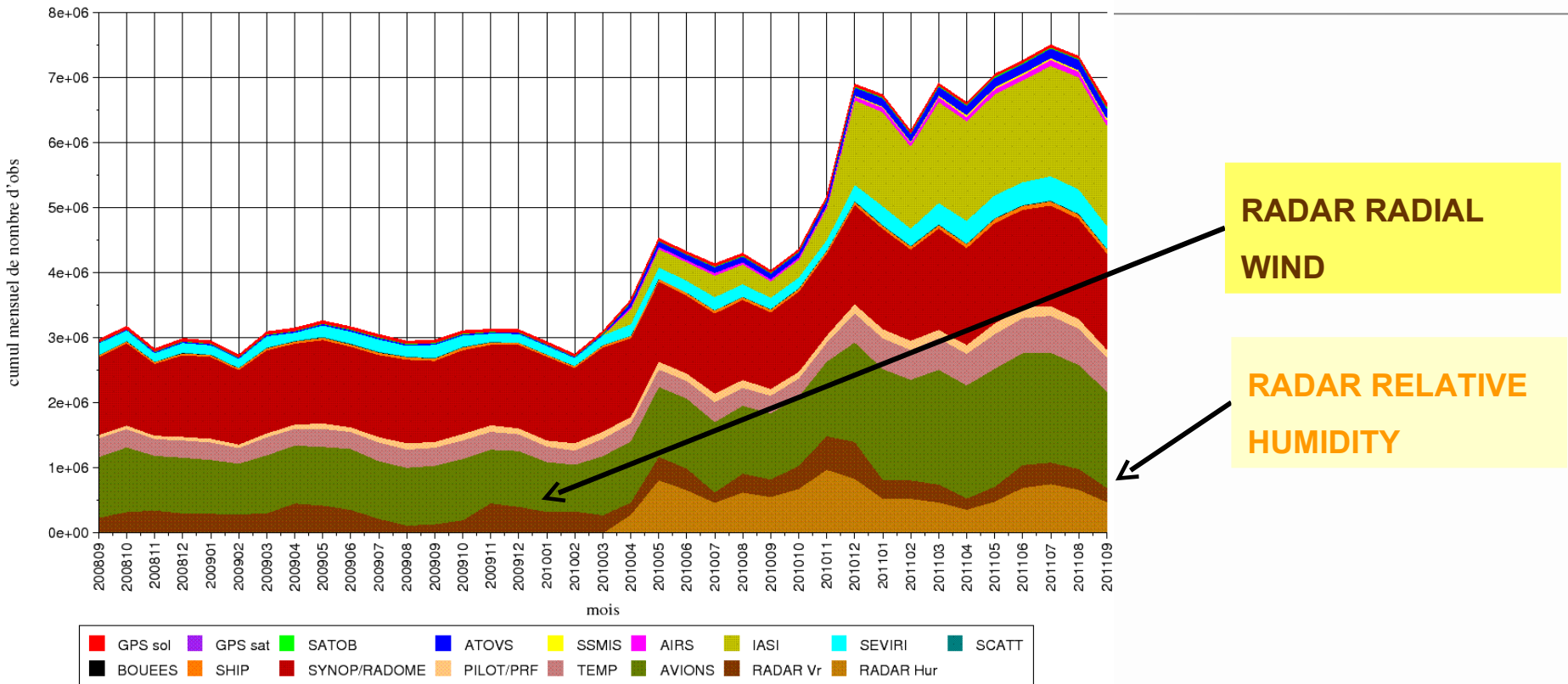


Radar observations considered as profiles in the model



# Data usage in the AROME 3D-Var system

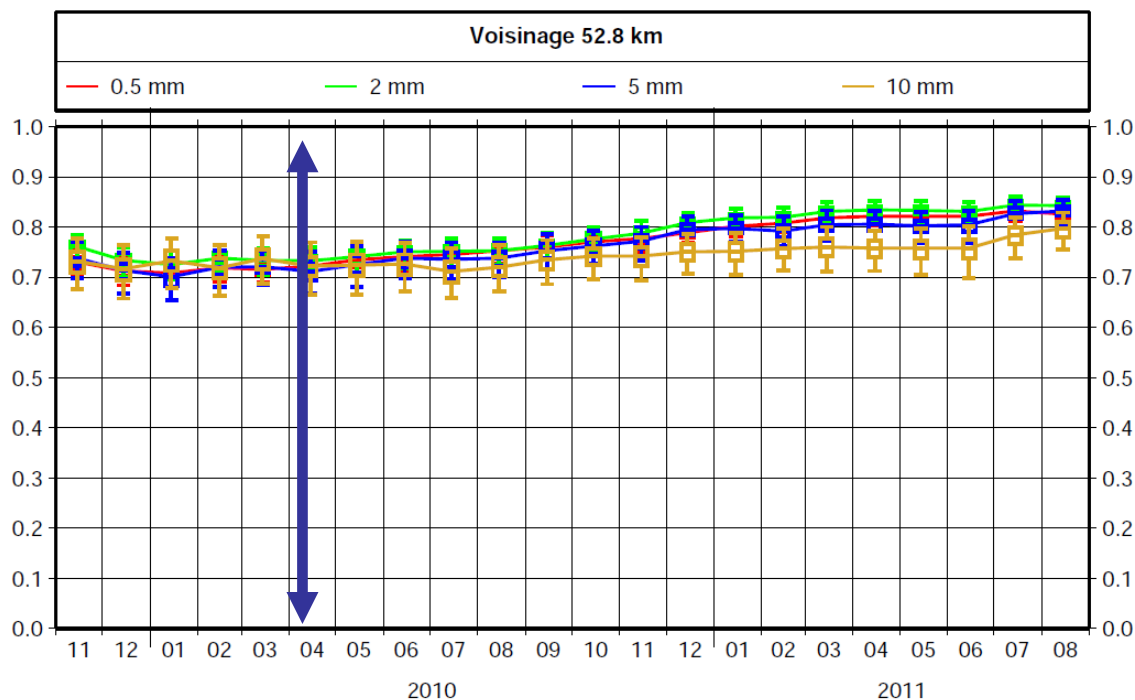
## Monthly averaged number of data used in AROME



- November 2008 : AROME becomes operational including radar radial winds
- Summer 2009 : Assimilation of improved radar radial winds
- Spring 2010 : Operational assimilation of radar reflectivities
- Autumn 2010 : Improved assimilation of « no rain » information from reflectivities

# Precipitation Brier Skill Score

Large improvement in short range forecast  
since assimilation of radar reflectivities in April 2010

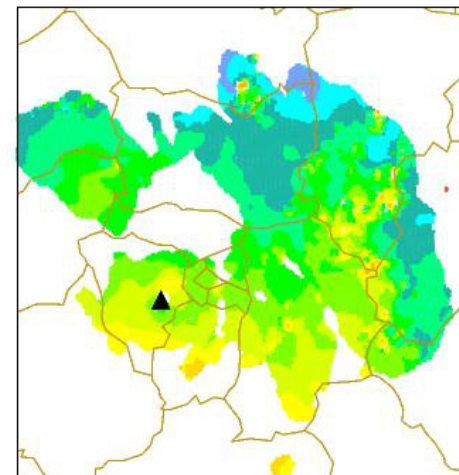
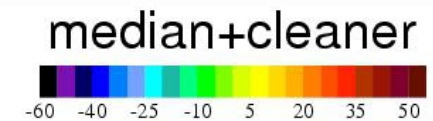
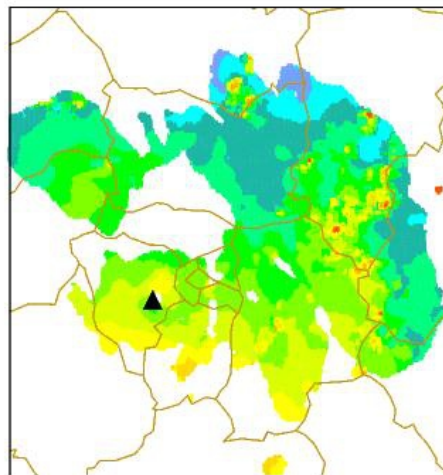
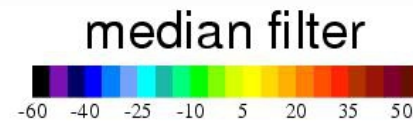
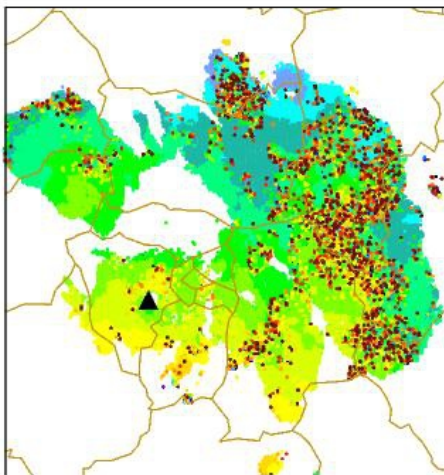
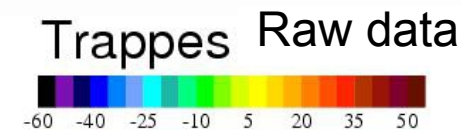


Lead time 6h

# Screening : pre-processing and quality control

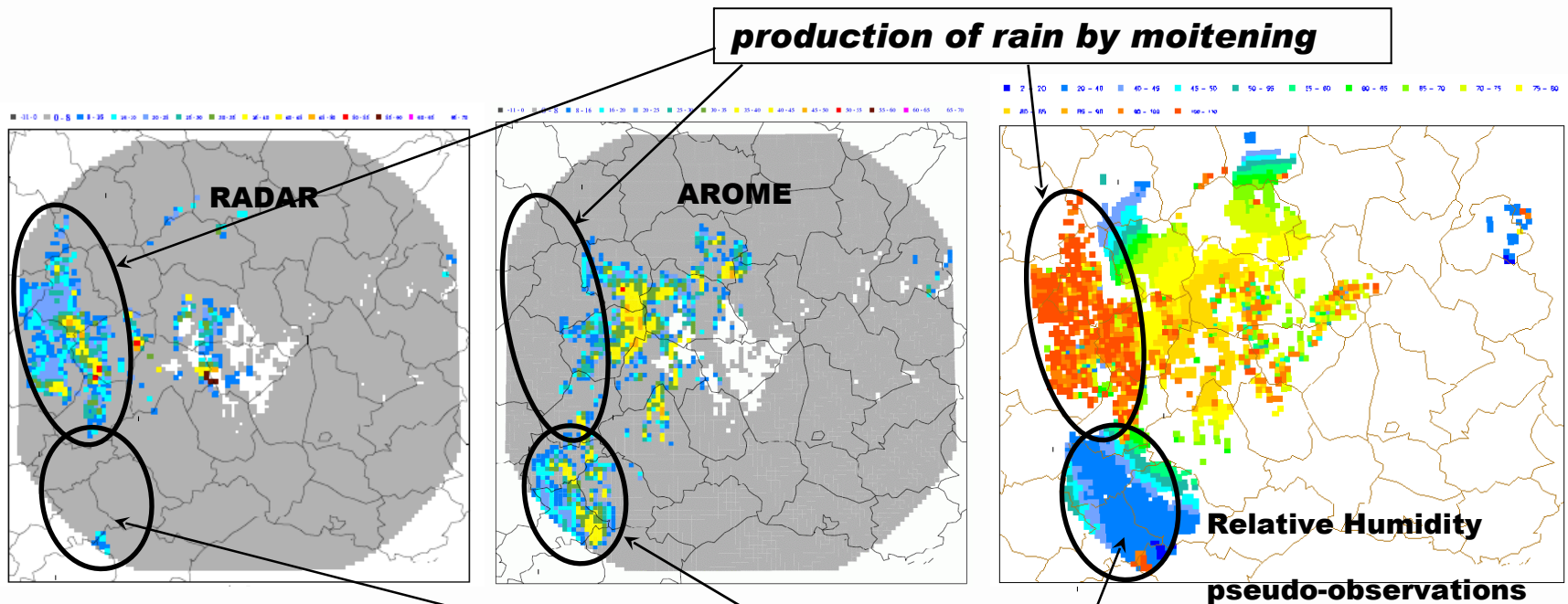
- Useful information provided by the radar producers (CMR) : ground clutter, clear air echoes, sea clutter, anomalous propagation, rain attenuation, pixels below noise level, ...
- Importance of pre-processing and post-processing : very restrictive data selection

## Example of pre-processing of radial wind



# Use of « no rain » information

Experience has demonstrated the importance of accounting for the « no-rain » information in the assimilation

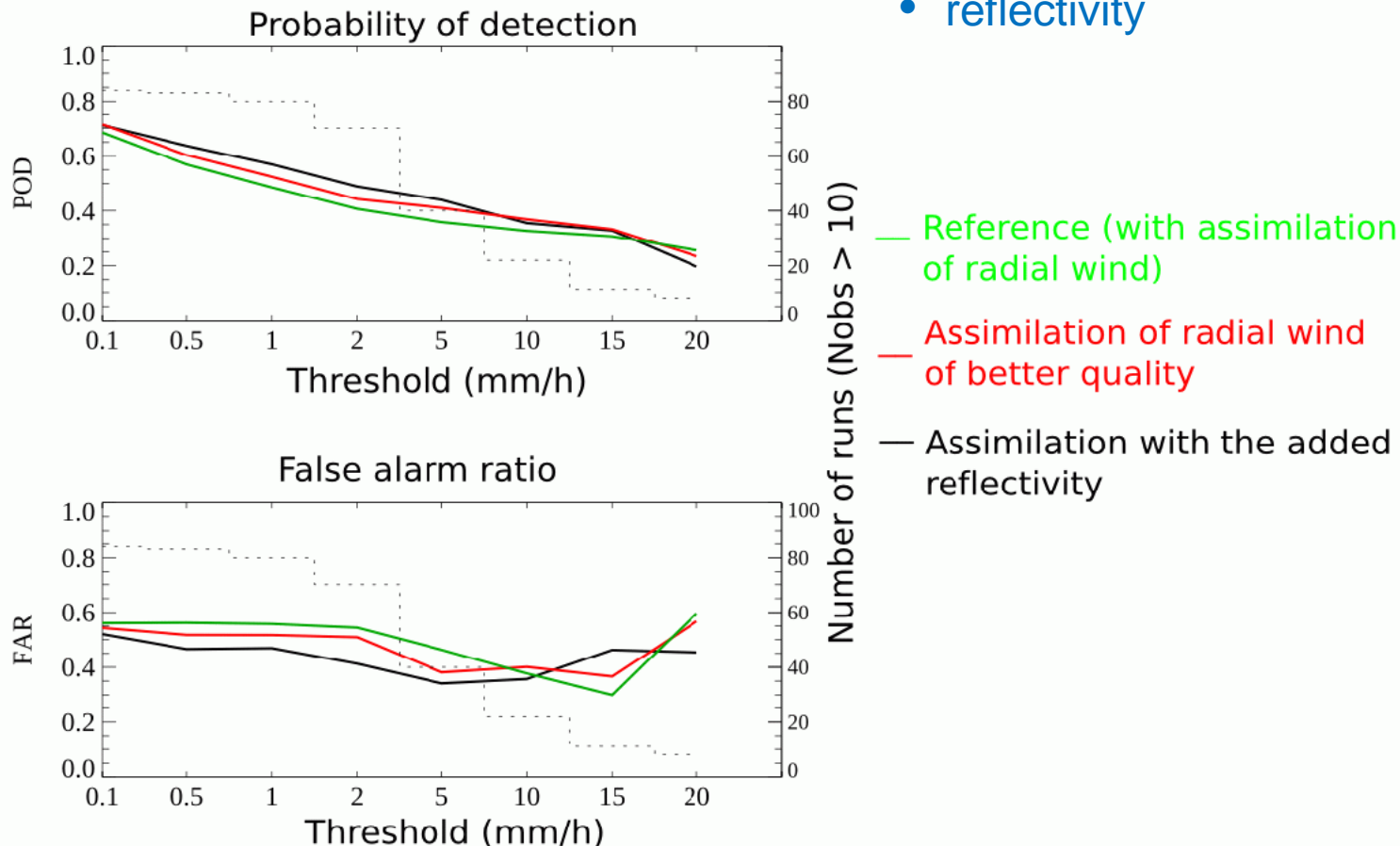


Requirement: knowledge of the sensitivity of each individual radar to be able to correct the model

Scores over 36 days in winter:  
average of time series

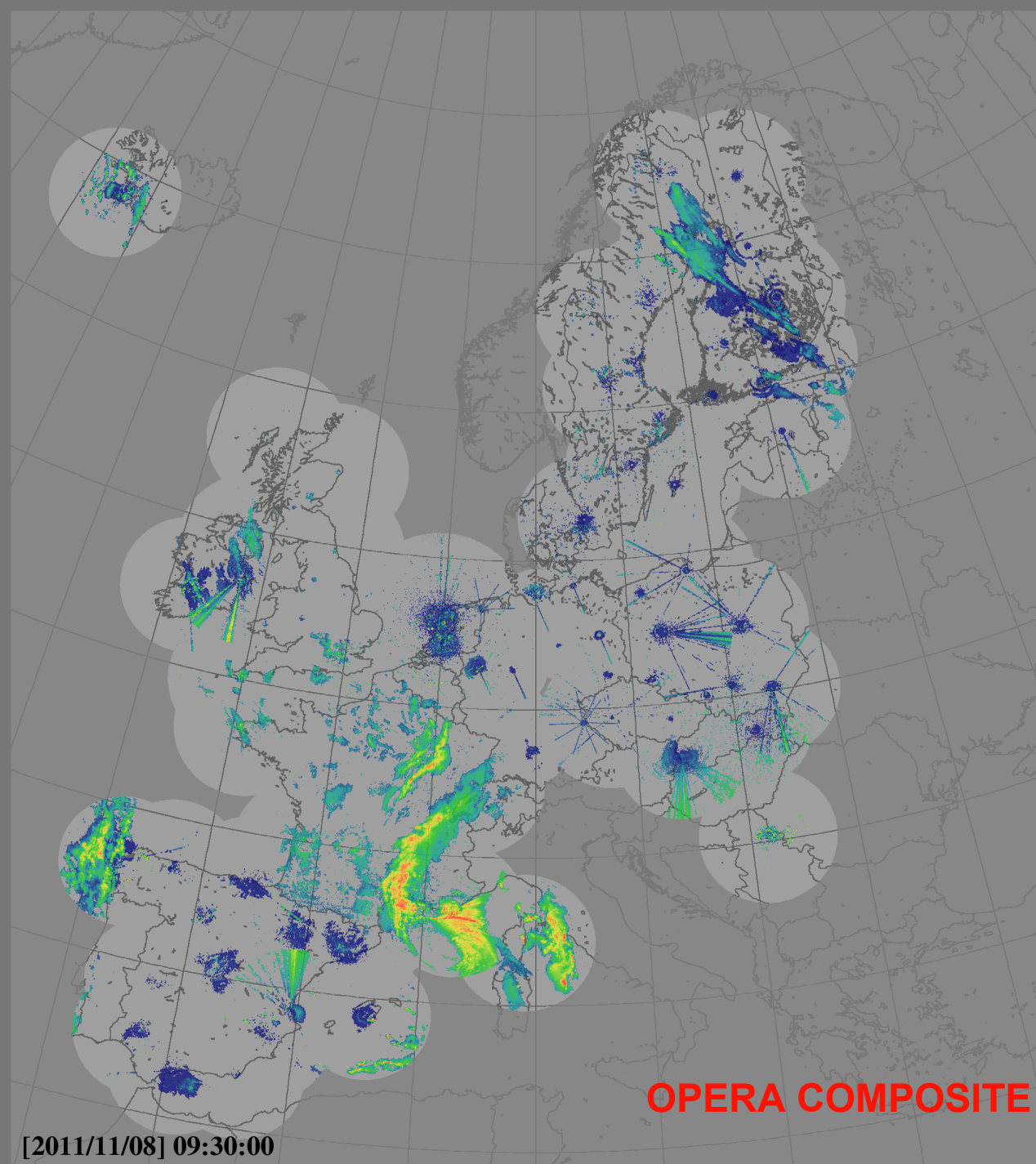
Significant impact on scores of:

- Better quality of radial wind
- reflectivity



- Operational assimilation of radar data in AROME with a positive impact
- Strong involvement of various teams at Météo-France (CNRM/GMME, CNRM/GMAP, DSO/CMR) and collaborations have started with HIRLAM and ALADIN consortia
- Application to other models :
  - **Assimilation of radial winds was tested in ALADIN 3D-Var**
  - **Assimilation of reflectivities can be introduced in ALARO 3D-Var (despite different microphysics)**
  - **Assimilation of radial winds and reflectivities started in HARMONIE 3D-Var (Norway, Netherlands)**

- The availability of radar reflectivities is growing within the EUMETNET OPERA project (112 Radars from 16 Countries) but are not exchanged
- Radial winds are not available (could be easily exploitable)
- The **exchange of radar data** could benefit to data assimilation systems in Europe, at the cost of necessary telecommunication infrastructure
- Radar networks can be upgraded without changing all the radars (eg Doppler, polarimetry)
- **Required information in OPERA files** to identify non-meteorological echoes and non-rainy areas : **need to work with data producers in different countries to improve data usefulness**
- **Strong positive feedback to OPERA needed to specify demands**



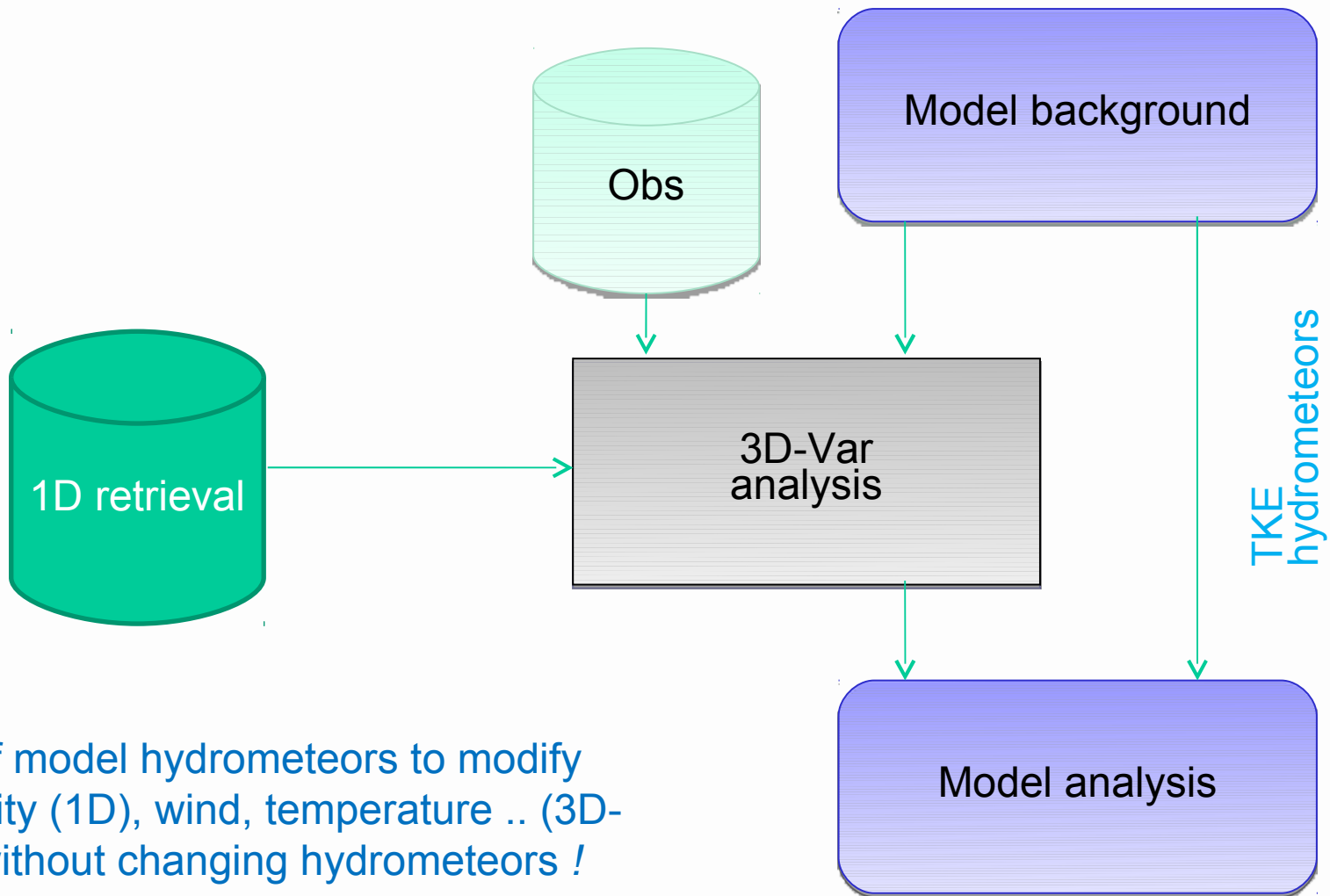
Questions?



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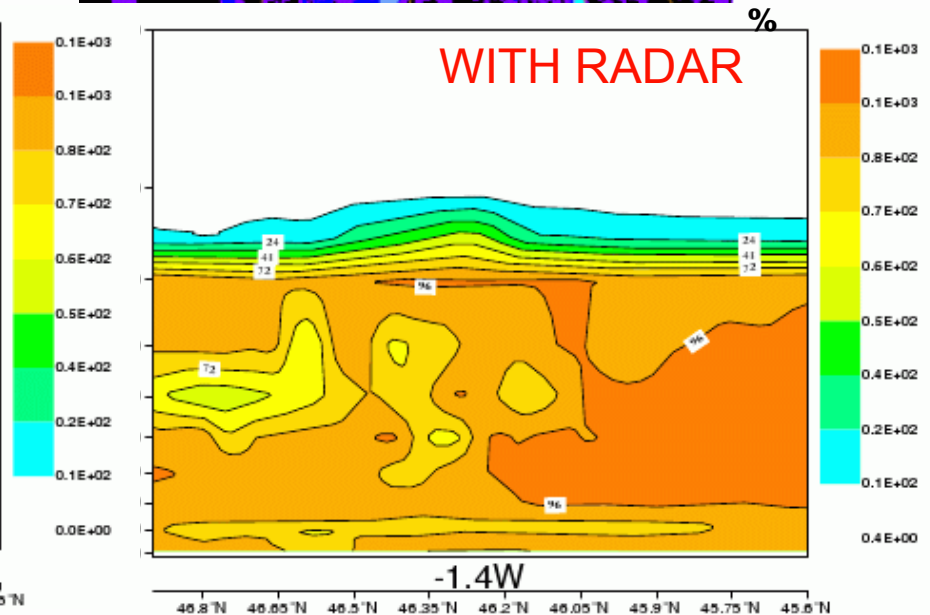
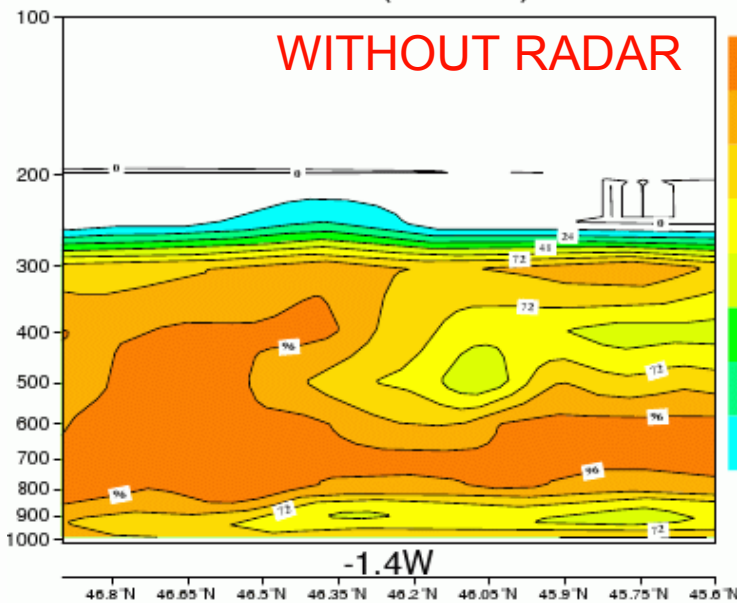
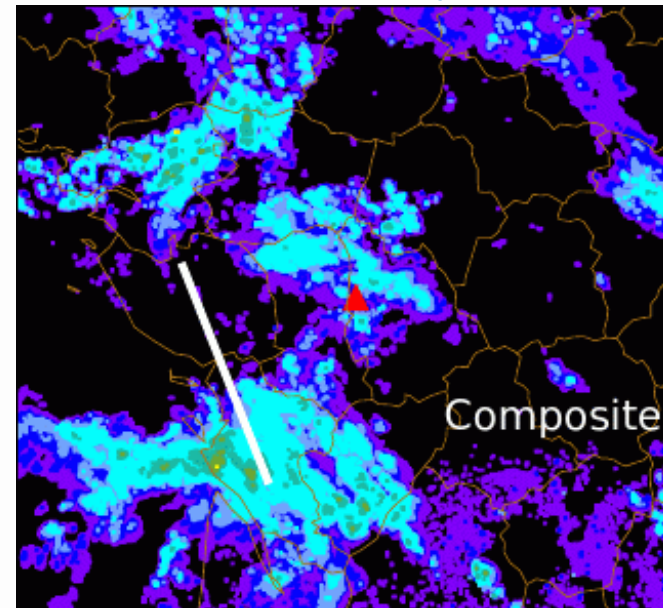
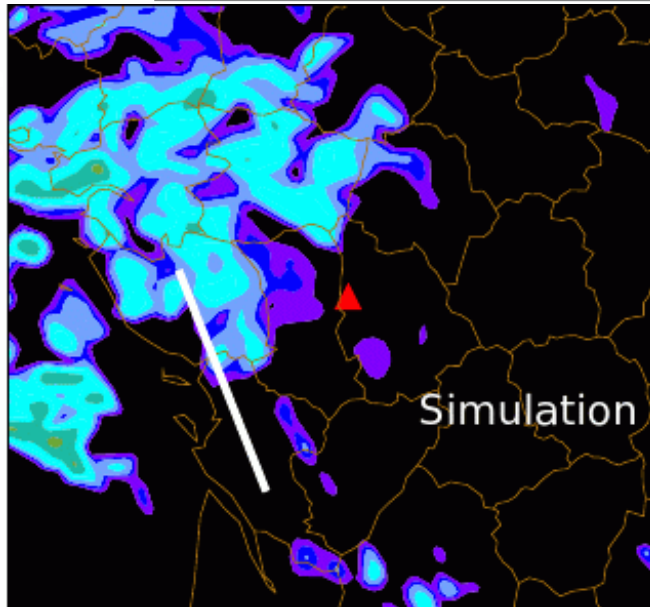
# 1D+3D-Var methodology



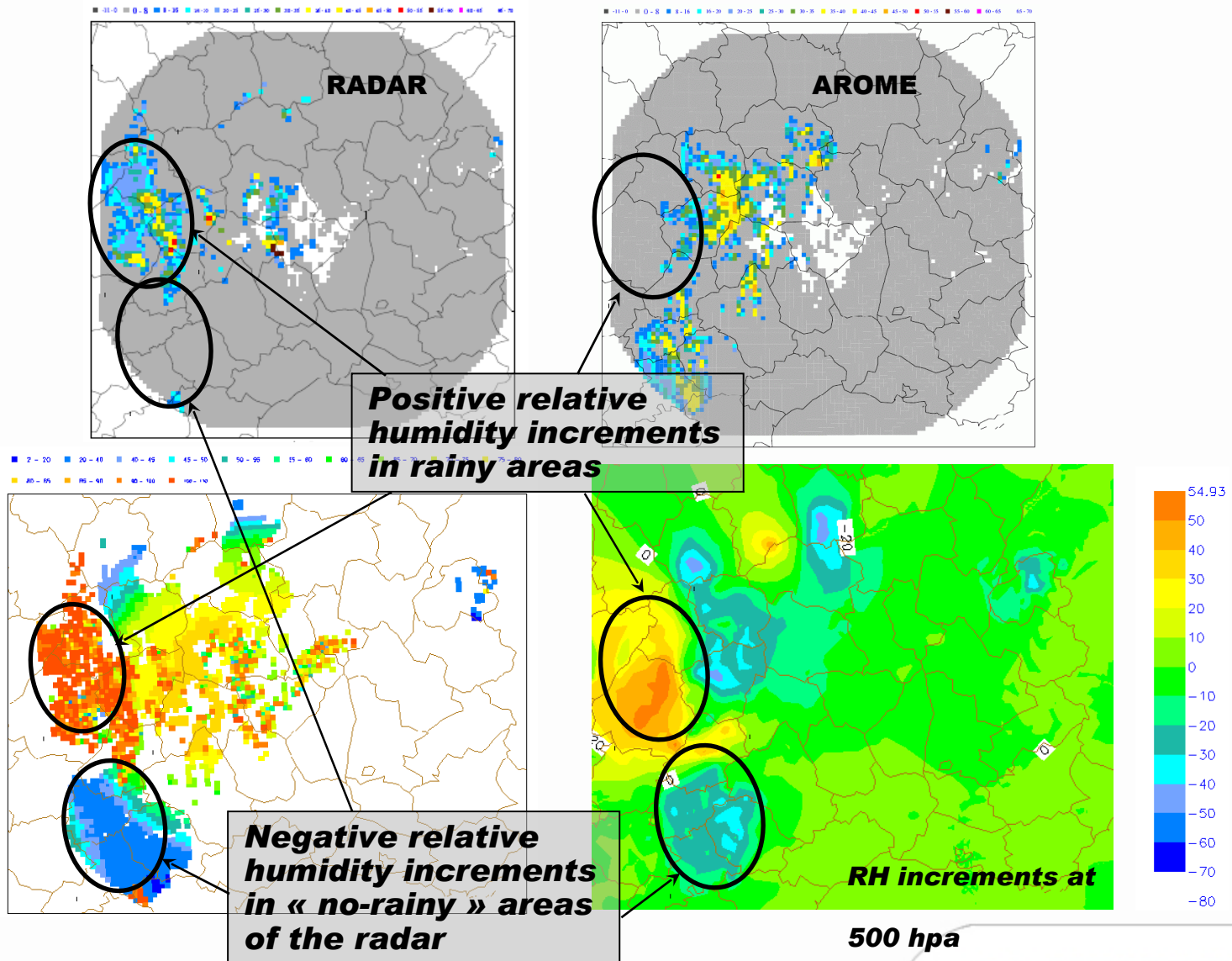
Use of model hydrometeors to modify humidity (1D), wind, temperature .. (3D-Var) without changing hydrometeors !

# Illustration – Analysis differences with and without radar reflectivity assimilation

Cherves



# Effect on 3D-Var analysis



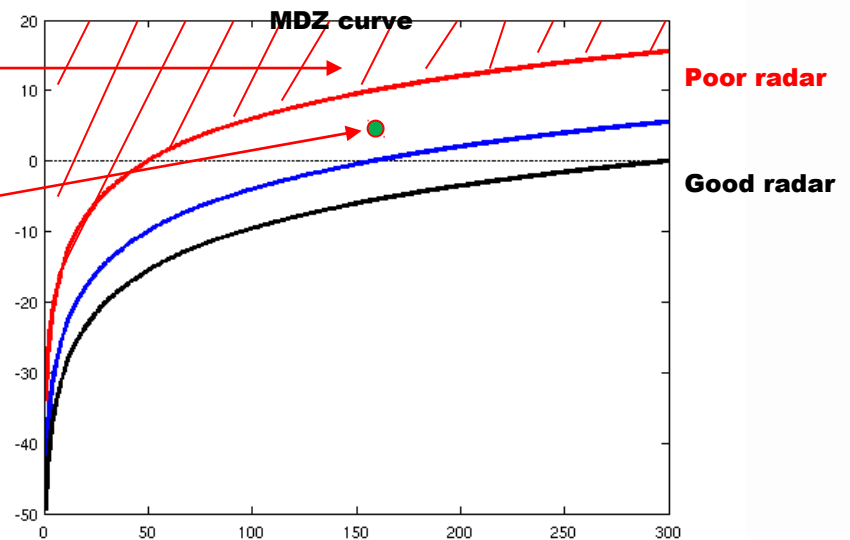
# On the use of « no rain » information

Experience has demonstrated the importance of accounting for the « no-rain » information in the assimilation => better balance between creation and destruction of rainy areas in the model

*Rain in radar  
(SNR>0)*

*Good radar can dry  
the model*

*No information from  
poor radar*



Minimum detectable Z as a function of distance from the radar

Requirement: knowledge of the sensitivity of each individual radar to be able to correct the model

## But beware...

### 1. 2 problems:

- *If too much noisy pixels, smoothing by filters but weak quality of wind field after filtering*  
=> **Need for a good quality of radial wind** (identification of clear sky echoes, low SNR) and **need for a quality flag**
- *Nyquist velocity is often reduced for a better quality of data, but then areas of strong winds are removed and high convective gusts are lost or smoothed*  
=> **Need for a minimum Nyquist velocity around 30 m/s**

1.