Impact of cloudy radiances in global numerical weather prediction model.

Nadia Fourrié, V. Guidard, T. Pangaud and F. Rabier

CNRM-GAME

Météo-France and CNRS

Toulouse

Outline

In operations : Assimilation of AIRS cloudy radiances, Methodology, results

A step further : Cloud-affected IASI radiance simulation

Summary and future work

Assimilation of AIRS cloudy radiances_

- **Method used for the assimilation of AIRS cloudy radiances affected by mid- to low-level clouds**

Cloud parameters determined with CO2slicing (120 channels)

Minimisation of $F_{k,p}$

$$F_{k,p} = \frac{(R^{k}_{clr} - R^{k}_{obs})}{(R^{K_{ref}}_{clr} - R^{K_{ref}}_{obs})} - \frac{(R^{k}_{clr} - R^{k,p}_{cld})}{(R^{K_{ref}}_{clr} - R^{k_{ref},p}_{cld})}$$

Robs: observed radiance
Rclr: clear radiance simulated from the model
Rcld: radiance with opaque cloud at pressure level p
k= channel of the C02 band
Ref= reference channel (surface)
= 917.31 cm-1 (AIRS)

Cloud top pressure:

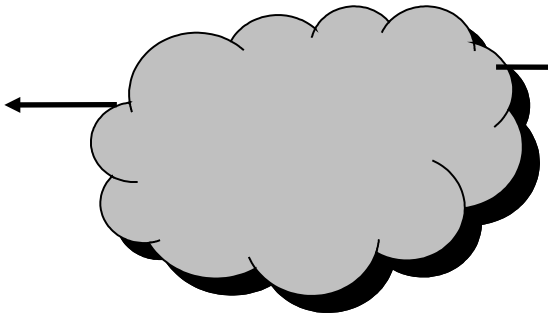
$$p_c = \frac{\sum p_{c,k} w_k^2}{\sum w_k^2}$$

$P_{c,k}$:pressure level minimizing $F_{k,p}$
W_k: derivative of $F_{k,p}$ wrt pressure

Effective cloud fraction

$$N_\varepsilon = \frac{(R^{k_{ref}}_{clr} - R^{k_{ref}}_{obs})}{R^{k_{ref}}_{clr} - R^{k_{ref}}_{cld}}$$

Method



CO2-Slicing

Cloud parameters retrieval (CTP et Ne)

Use of CTP and Ne into RTTOV

Simulated spectrum

Input to assimilation

Cloud-Detect

(Mc Nally and Watts,2003)

Flag each channel

cloudy

clear

Assimilation of cloudy channels

IF 600hPa<CTP<950hPa

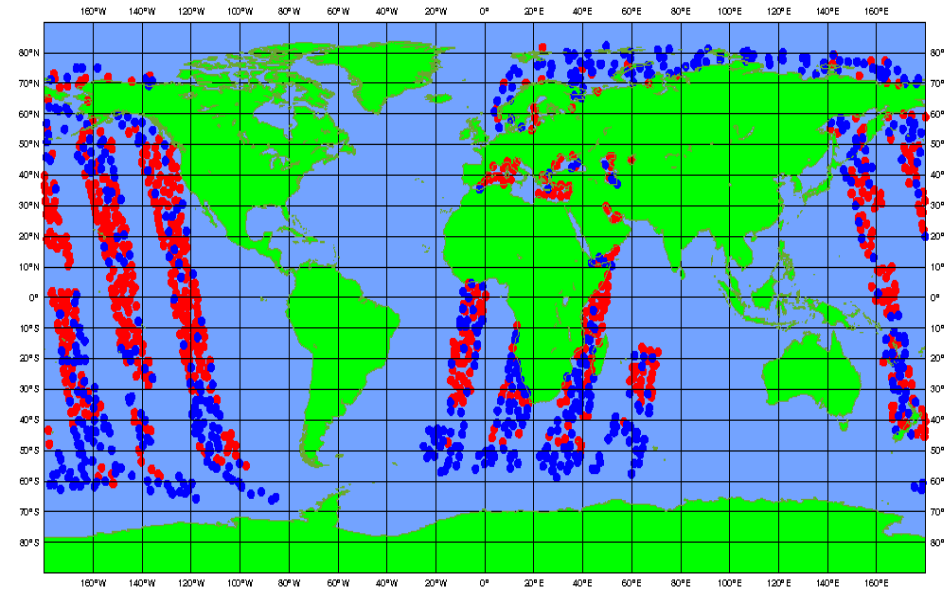
Assimilation of clear channels

AIRS: sigma_o(cloudy) = sigma_o(clear) = 1K

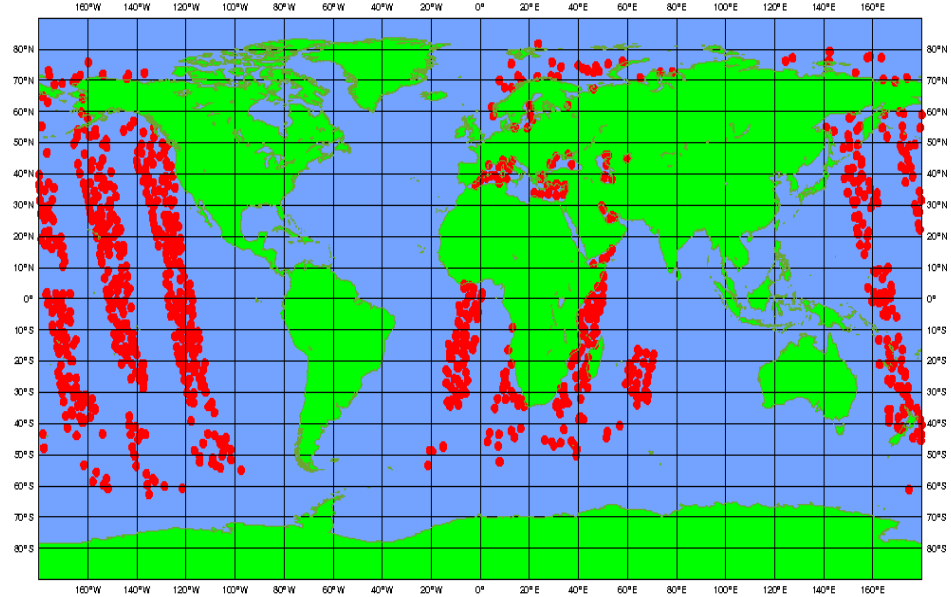
Impact on AIRS analysis

More observations are assimilated, particularly for tropospheric channels (potentially more contaminated by clouds).

EXP: assim clear + cloudy observations



REF: assim clear observations only



Geographical coverage of assimilated observations for the channel 239 (478 hPa:mid-troposphere). 01/09/06 à 00UTC

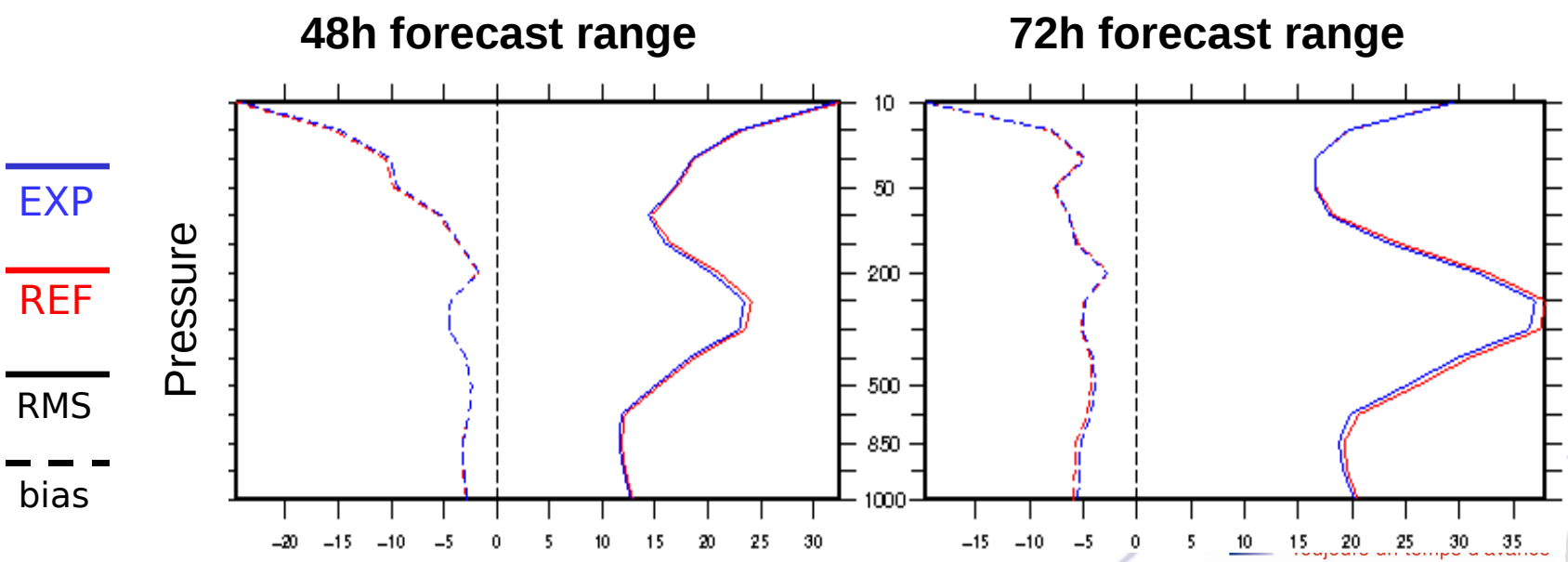
Cloudy obs assimilated

Clear obs assimilated

Impact on forecasts from AIRS

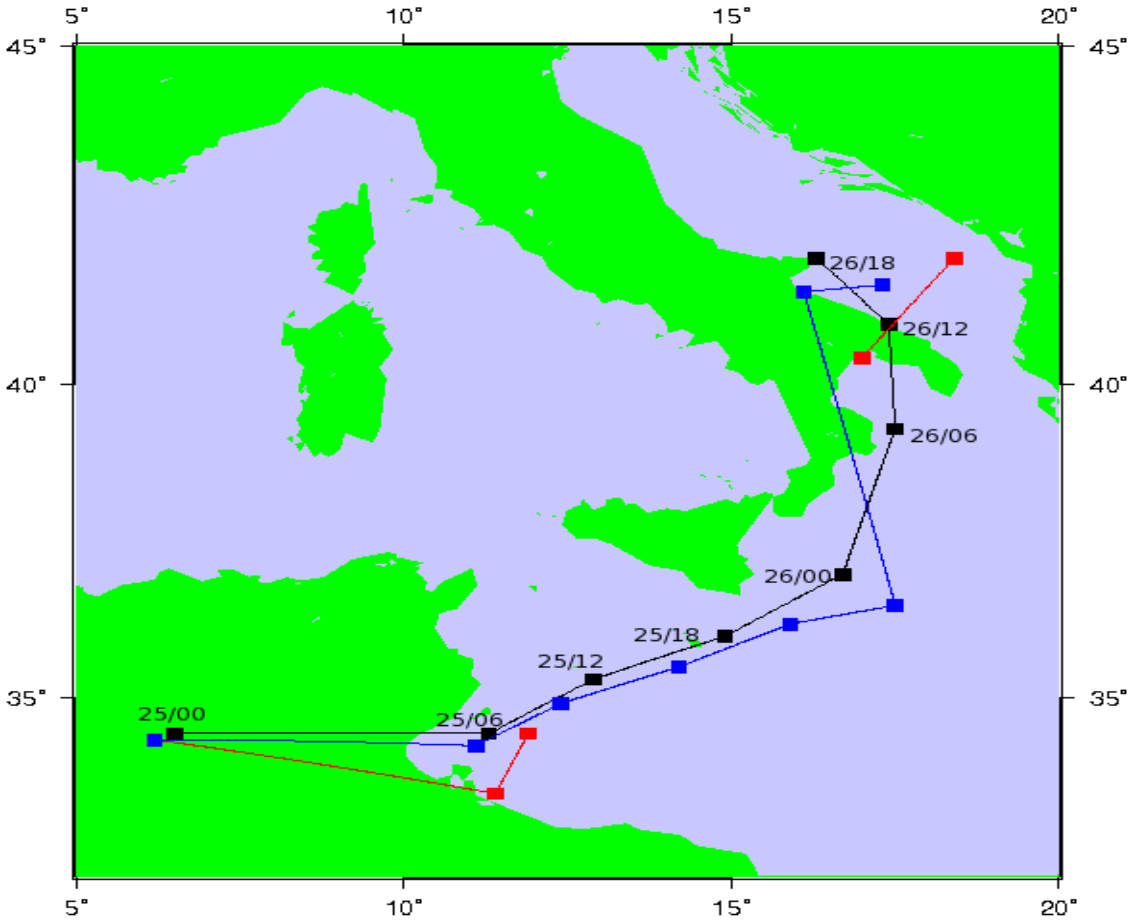
- Statistics accumulated from 01/09/06 to 04/10/06 RMSE difference with respect to radiosonde data
- Positive impact in the whole atmosphere for geopotential, over northern hemisphere, southern hemisphere, tropics and Europe, statistically significant.
- Positive impact for temperature, wind and humidity, but not statistically significant

Europe domain, geopotential field



Case study: predictability of the Medicane storm
(Pangaud et al, 2009, MWR)

•Medicane: Storm that affected the southeastern part of Italy on the 26th of september 2006.



Forecast from **23/09/06 00UTC**:

Improvement of :

- **the trajectory of the storm**
- **The intensity**
- **Precipitations**

ECMWF Analyses

EXP (Clear+Cloudy)

REF (Only clear)

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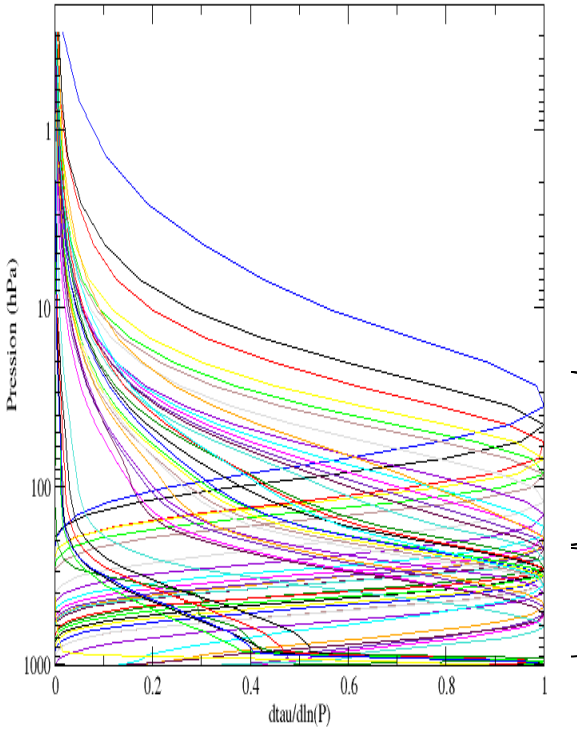
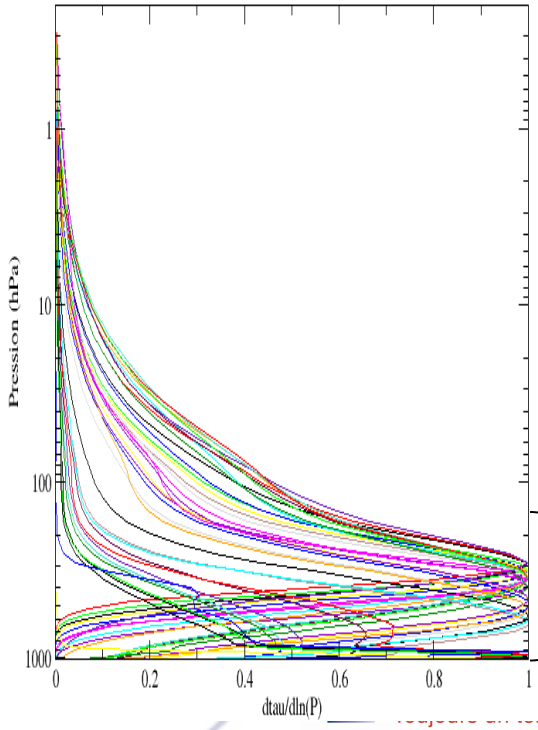
Preliminary study for IASI cloudy radiances:
Impact of the channel set

- Validation in current operational configuration: RTTOV version 9, enhanced horizontal and vertical resolution of the global atmospheric model.
- reference channel. 867 (861.5cm-1)
- 36 channels



16 stratospheric channels

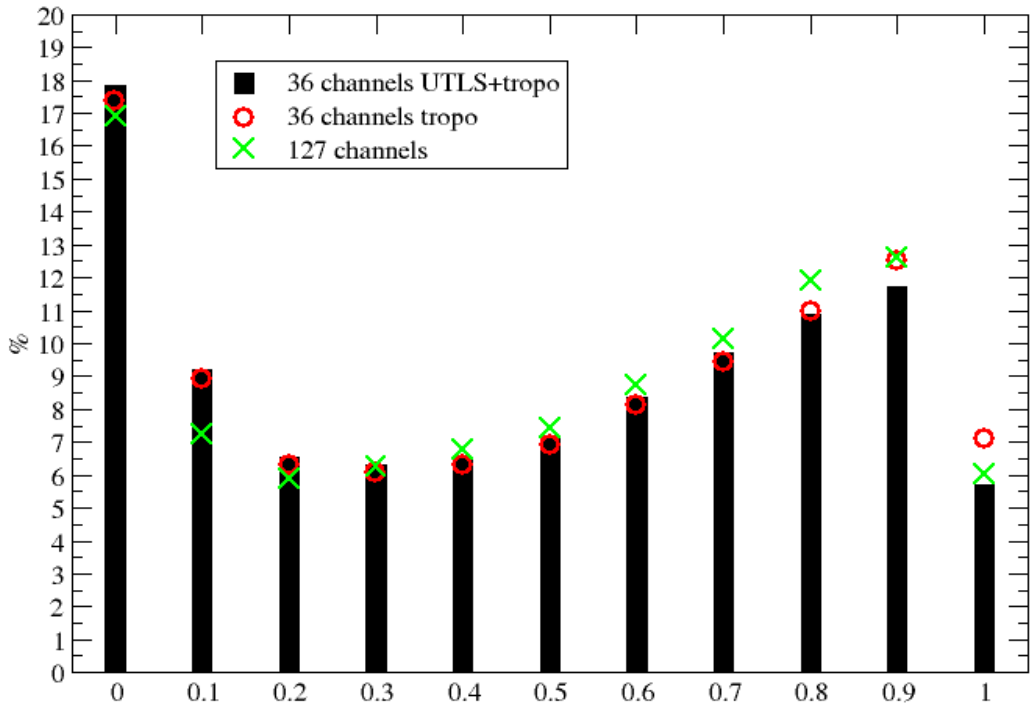
20 tropospheric channels



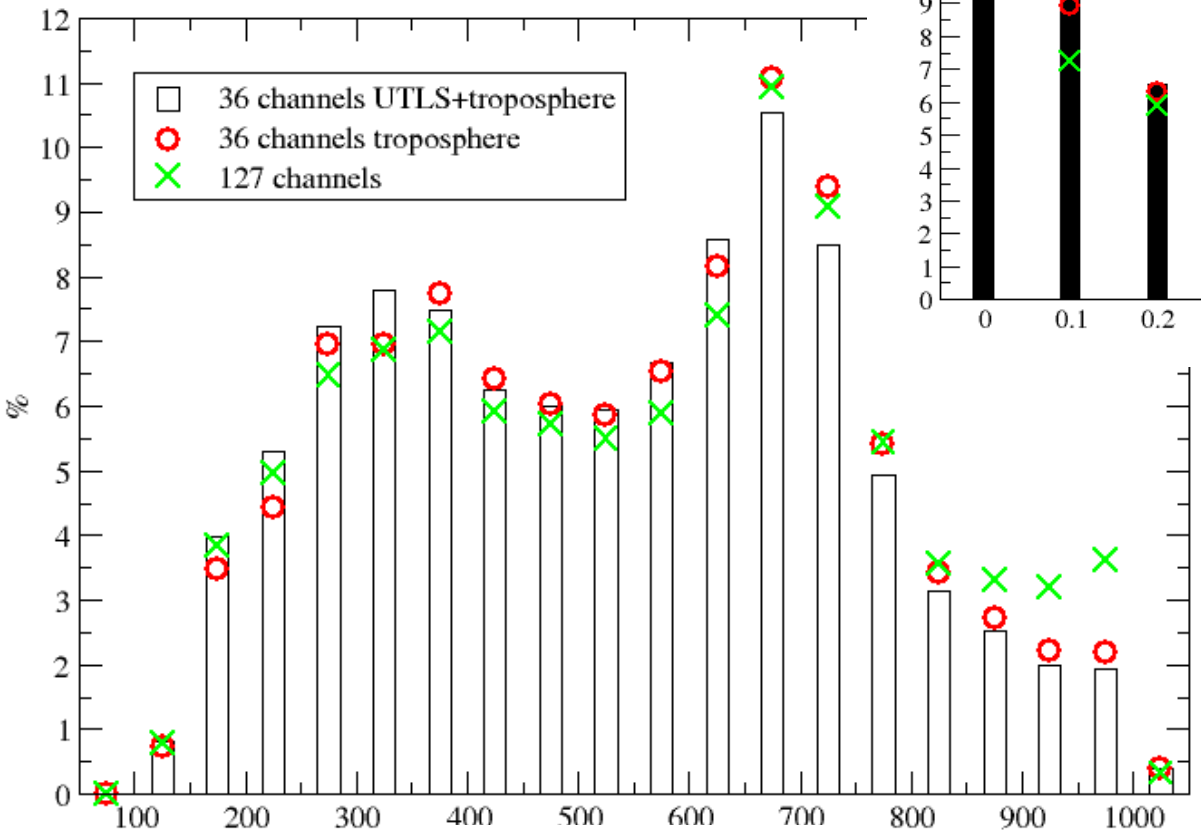
36 tropospheric channels

Evaluation of the cloud parameters from IASI

- Results for 18 November 2009, From 3 UTC to 21 UTC



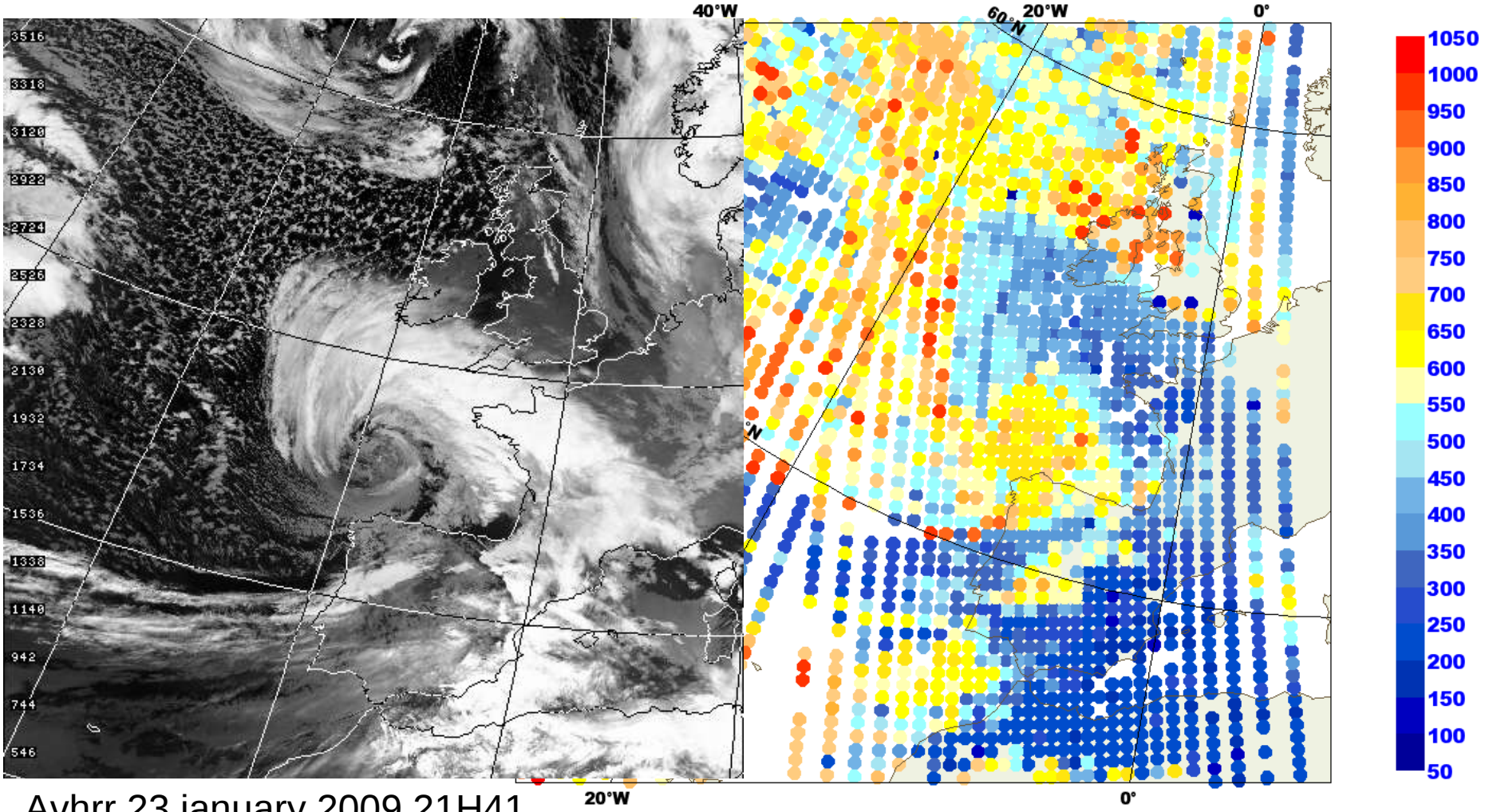
Cloud fraction



Cloud top pressure

Iasi cloud top pressure retrieval

24 January 2009, 00 UTC



Avhrr 23 january 2009 21H41

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Conclusion and future work

- Cloud parameters retrieved with CO2slicing method, input of the RT model in the assimilation process
- Small positive impact of the AIRS cloud-affected radiance assimilation on the forecast skill.
- In operations since February 2009 for the global model and since april 2010 for the mesoscale model AROME.
- Paper by Pangaud et al, 2009, MWR.

- Same methodology applied for IASI as the one used for AIRS
- Choice of a channel set for the cloud parameter retrieval
- First results encouraging: simulation of a winter storm with the assimilation of IASI cloud-affected radiances.

- Further validation of the cloud parameter retrieval
- Assimilation of IASI cloud-affected radiances
- Study for the mesoscale AROME model