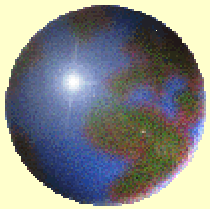

Impact of the assimilation of MSG/SEVIRI radiances in a mesoscale NWP model

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Météo-France CNRM/GMAP

METEO FRANCE

ALCATEL

Outlines

1. Introduction

2. Assimilation of SEVIRI radiances : bias correction and screening

3. Impact on the humidity analysis

4. Impact on short term forecast of cloud cover

5. Conclusion

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Introduction

Context : the AROME project

Météo-France future NWP model at convective scale (expected to become operational around 2008)

- Expected horizontal resolution : 2.5 km
- Non-hydrostatic, explicit microphysical scheme
- Short term forecast from 3 to 36 hours
- Assimilation cycle from 1 to 2 hours

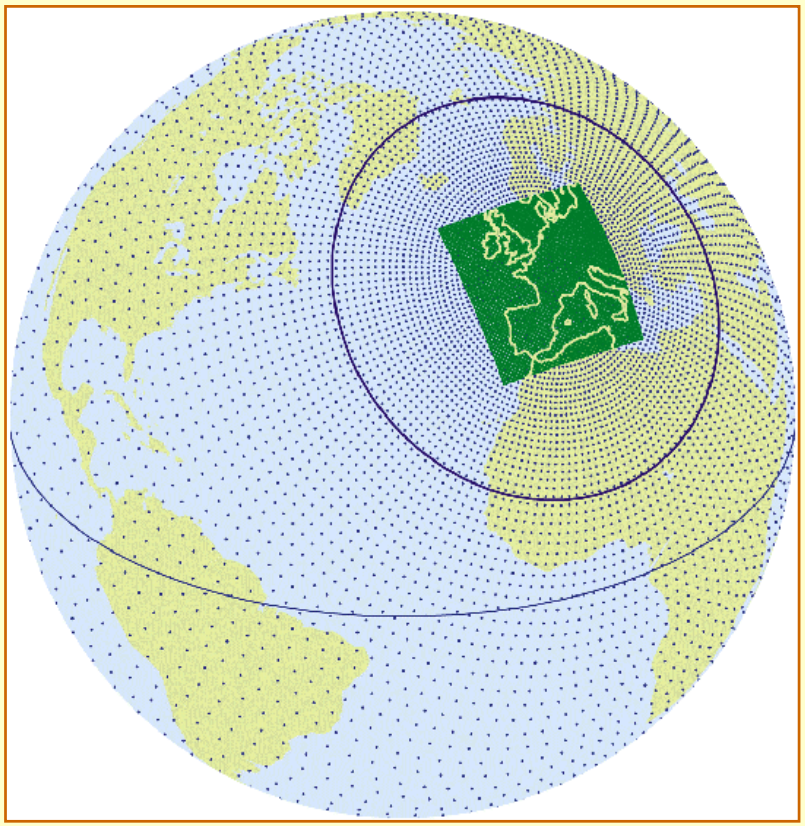
MSG/SEVIRI observations :

- ~ 5 km horizontal resolution over the western Europe
- HRIT every 15 min
- Potential informations on q , T and O_3 spatial distributions

⇨ **Well suited for nowcasting purposes**

Introduction

- **Preliminary studies using the ALADIN LAM model**



- spectral model coupled with ARPEGE operational global model (T_L358 C2.4)
- 2740 x 2740 km^2 square centered on ARPEGE gridmesh that has the highest horizontal resolution
- 41 vertical levels, 10 km horizontal resolution
- Hydrostatic, parametrisations of convection, surface interaction, radiation
- *3D-Var assimilation system*

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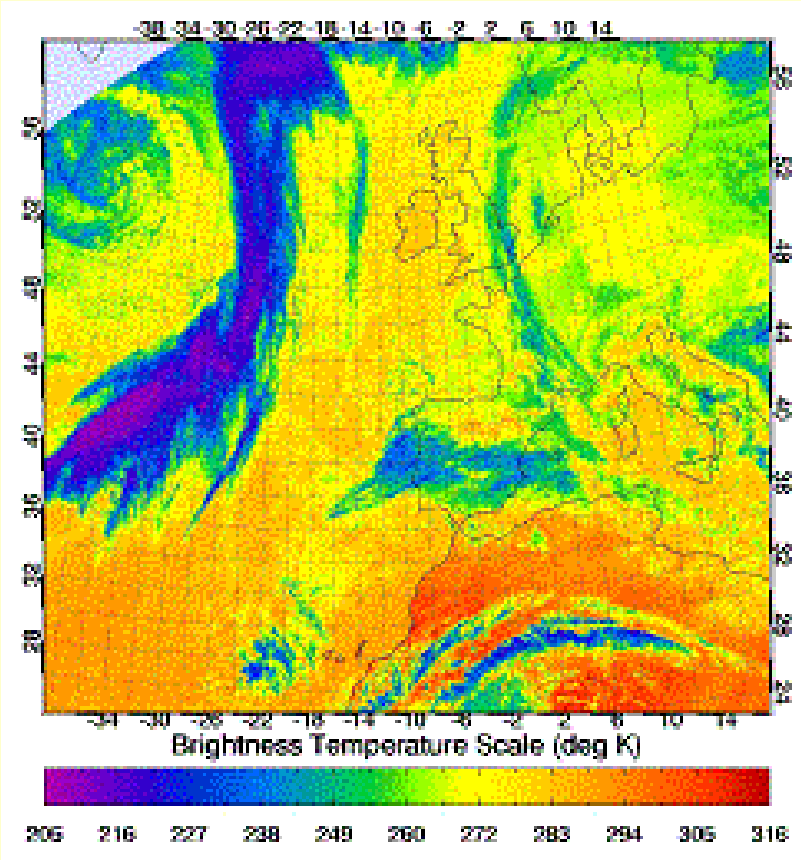
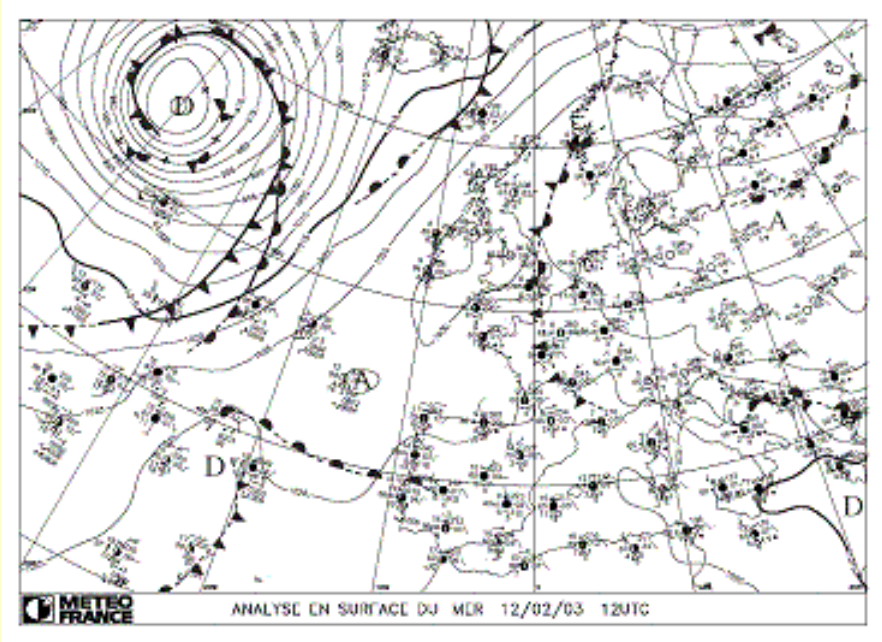
Assimilation of SEVIRI radiances: case study

- **Case study : the 12th of February 2003**





12.0 µ IR Channel

Assimilation of SEVIRI radiances

- **Incremental formulation of the 3D-Var**

$$J(\mathbf{x}) = \tfrac{1}{2}\, \delta x^{T}\mathbf{B}^{-1}\delta x + \tfrac{1}{2}\,(\mathbf{H}\delta x - (y - H[x_b]))^{T}\mathbf{R}^{-1}(\mathbf{H}\delta x - (y - H[x_b]))$$

- δx : increment
- y : T_b observed the 12th of February, 2003 by the 8 IR SEVIRI channels (3.9 -> 13.4 μ)
- H : Observation operator (horizontal and vertical interpolations, fast radiative transfert model RTTOV-6); $\mathbf{H}$ its linear formulation in the vicinity of x_b
- $\mathbf{R} = \mathbf{E} + \mathbf{F}$: observation error covariance matrix
- $\mathbf{B}$: background error covariance matrix

Assimilation of SEVIRI radiances

- **The B matrix:**

  "lagged NMC" method (*Siroka et al, 2002*)

computed from statistics on pairs of forecast valid for the same time, the short term run using initial and lateral boundary data coming from the long-term run

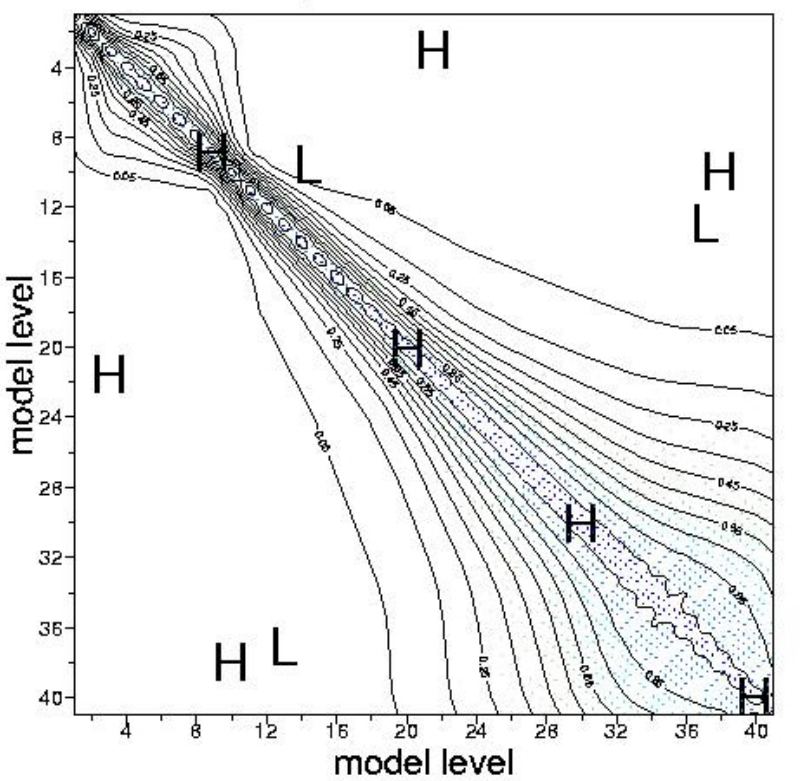
⇨ **Decreasing of the large scale variance**

⇨ **Sharper analysis increments**

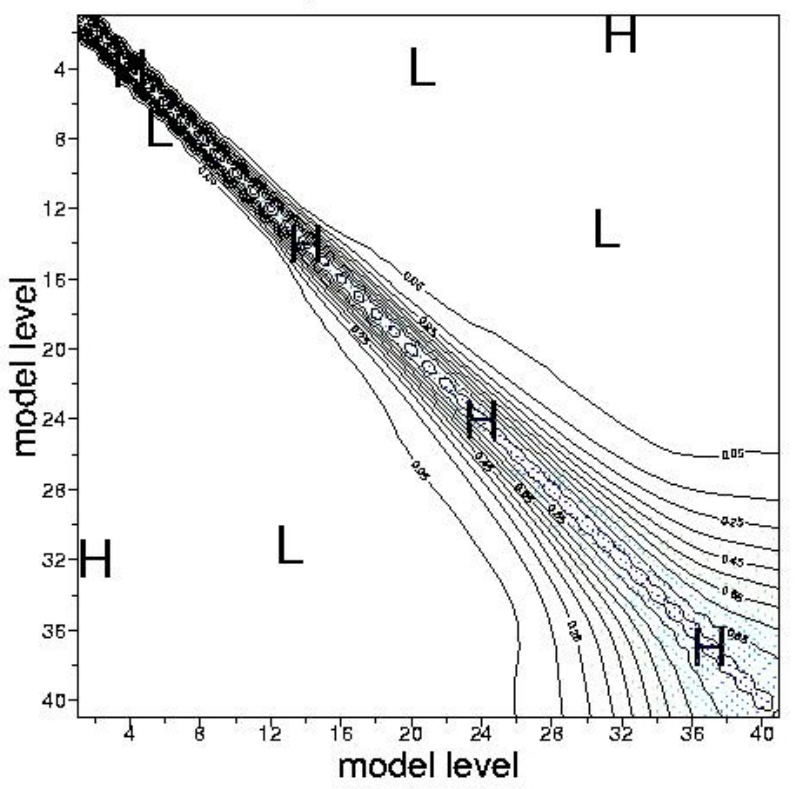
Assimilation of SEVIRI radiances

- **The B matrix**

Average vertical correlations of specific humidity error :



ARPEGE



ALADIN

Assimilation of SEVIRI radiances: bias correction

Bias correction

Before performing the screening, the data need to be **corrected from the bias due the RT model** (scan bias are negligeable for geostationary observations)

⇨ These bias are air-mass dependent

⇨ We use *Harris and Kelly (2001)* algorithm based on an air-mass regression scheme using 4 predictors from the background fields to predict the radiance bias :

- 1000-300 hPa and 200-50 hPa thickness
- model surface skin temperature
- total precipitable water

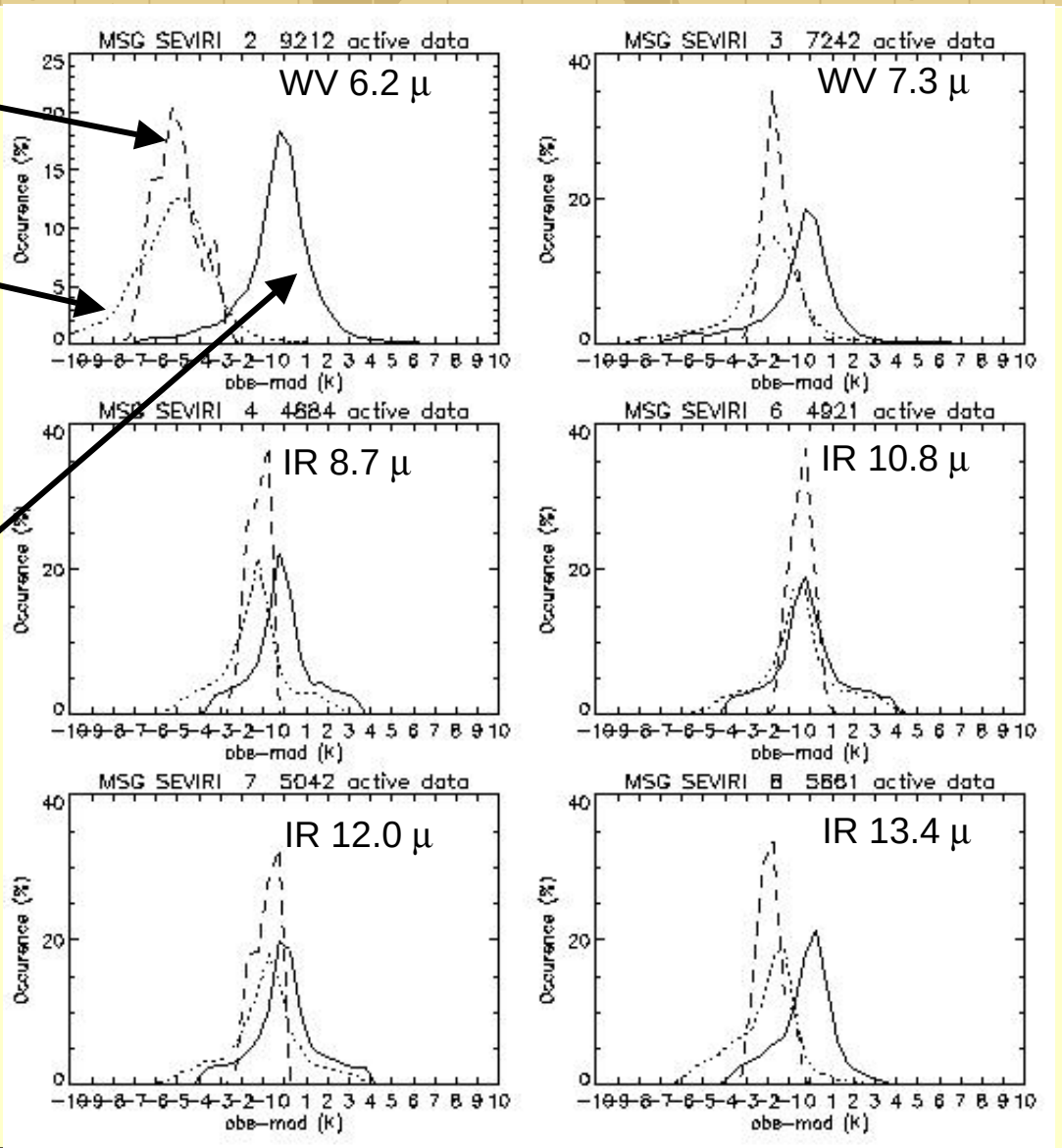
Assimilation of SEVIRI radiances: bias correction

applied bias

(obs-guess) non corrected

(obs-guess) corrected

Channels IR 3.9 μ and 9.7 μ are blacklisted



Assimilation of SEVIRI radiances: screening

Screening

- Channels IR 3.9 μ and 9.7 μ are blacklisted

- **Cloud detection scheme** : using ECMWF Mc Nally and Watts algorithm, only observations performed by channels whose weighting function is maximum above the cloud top are keeped (mainly the 2 WVs)

- **Quality control against the background** :

Rejection threshold on the normalized innovation given by :

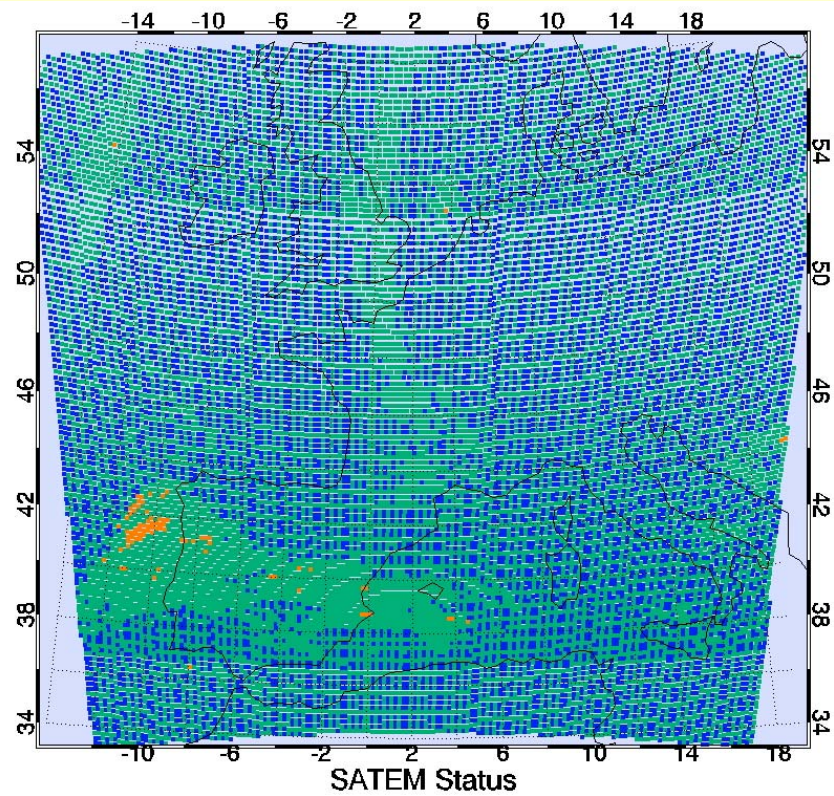
$$((y - H[x_b])/ \sigma_b)^2 > \alpha (1 + \sigma_o^2 / \sigma_b^2)$$

Where σ_o and σ_b are the variances of the observation errors and of the background error in the observation space respectivelly.

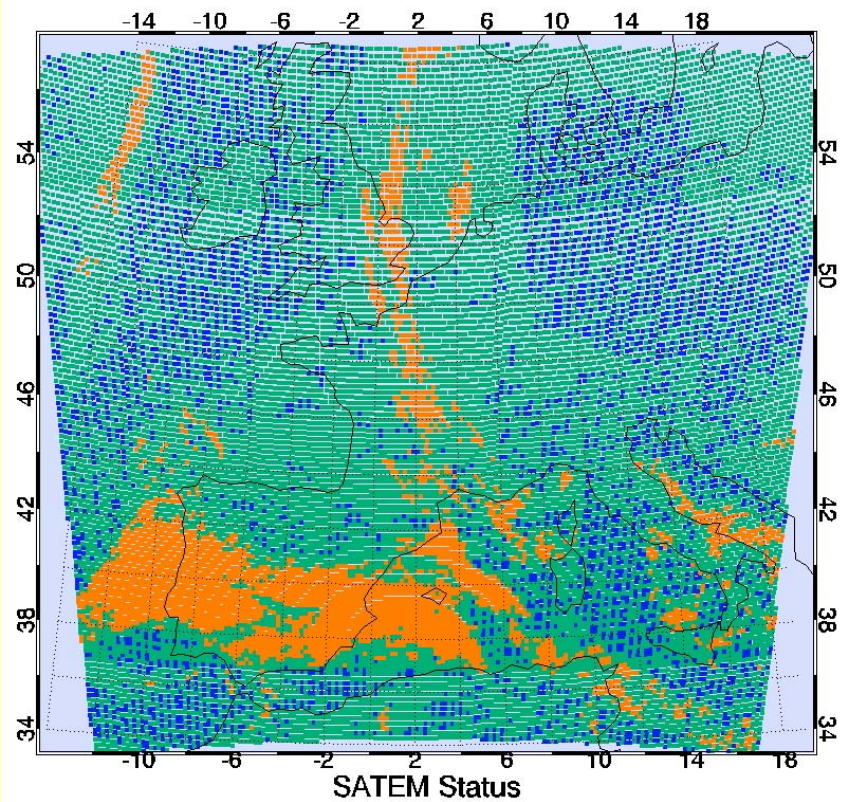
- **Data thinning** : to minimize observation errors correlations, only 1 pixel over 5 is taken into account and a horizontal thinning is also applied (the horizontal range of the increments is broadly 100 km)

Assimilation of SEVIRI radiances: screening

Channel WV 7.3 μ



Channel IR 8.7 μ



Data status :

- active
- rejected
- black listed

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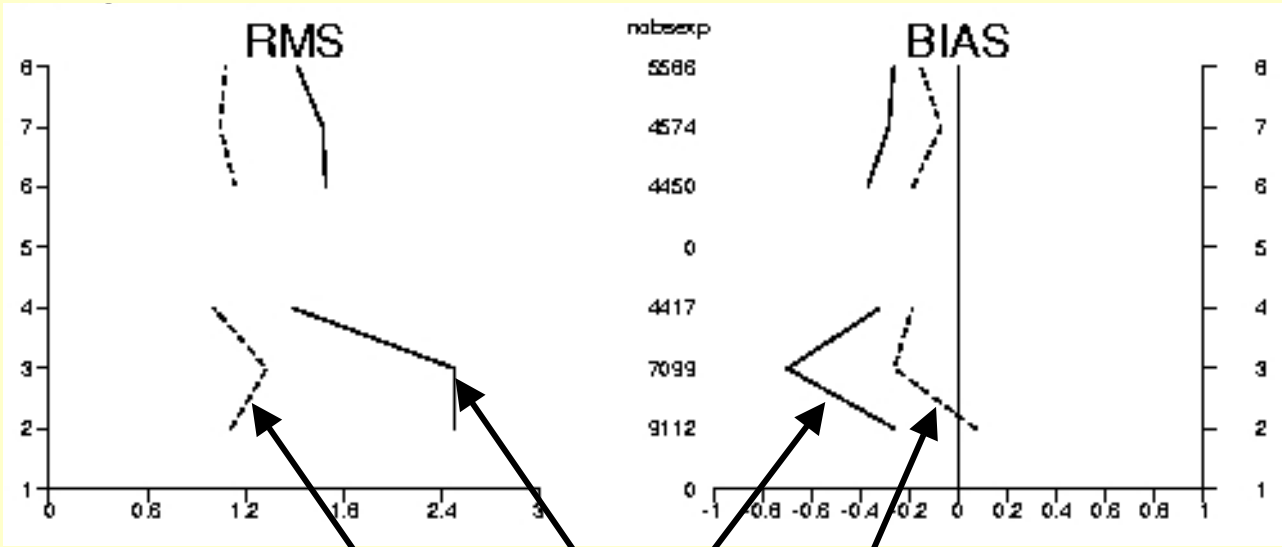
Impact on the humidity analysis: Assimilation stat.

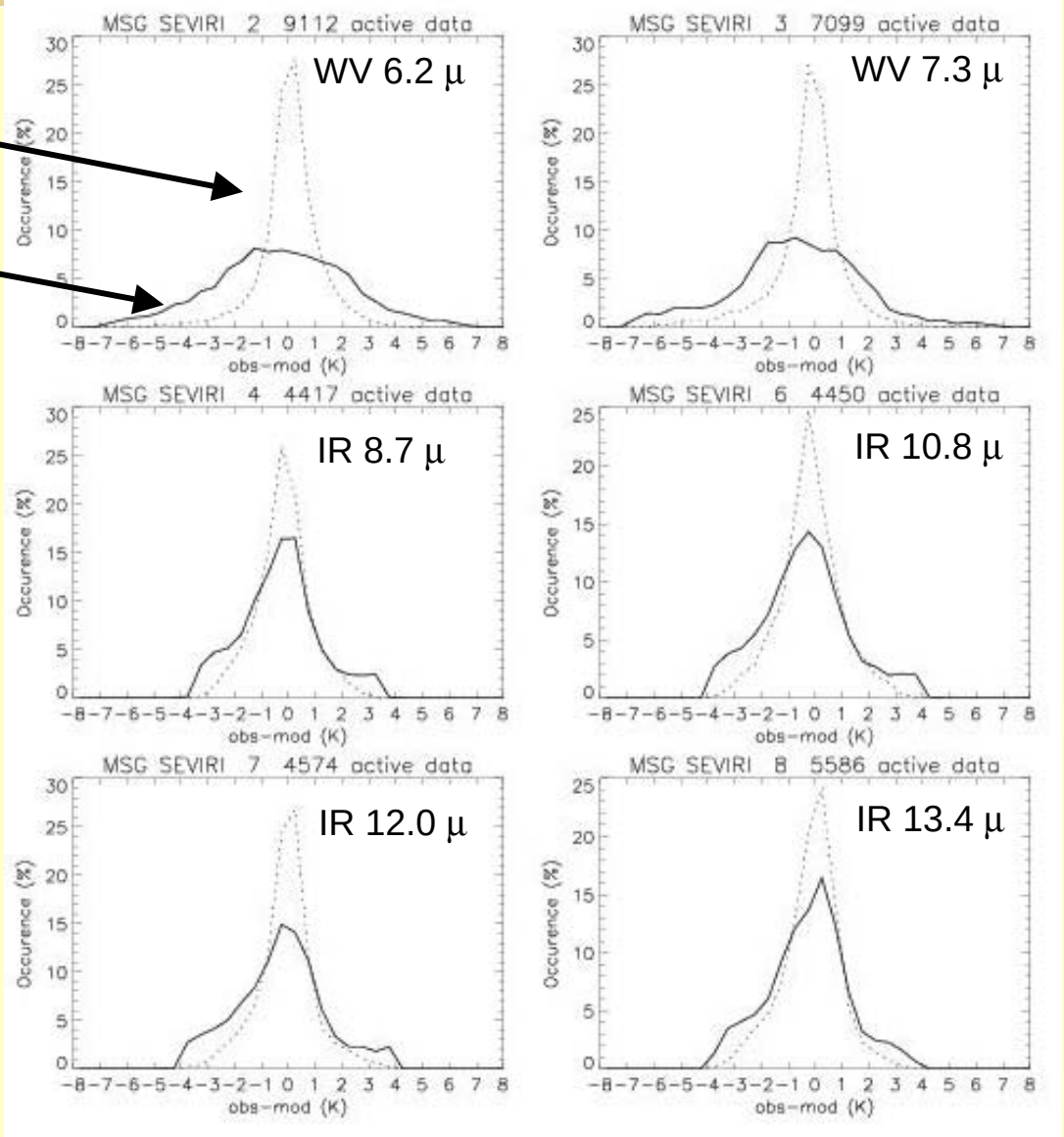
- **Assimilation statistics**



Impact on the humidity analysis: Assimilation stat.

(obs-analysis)

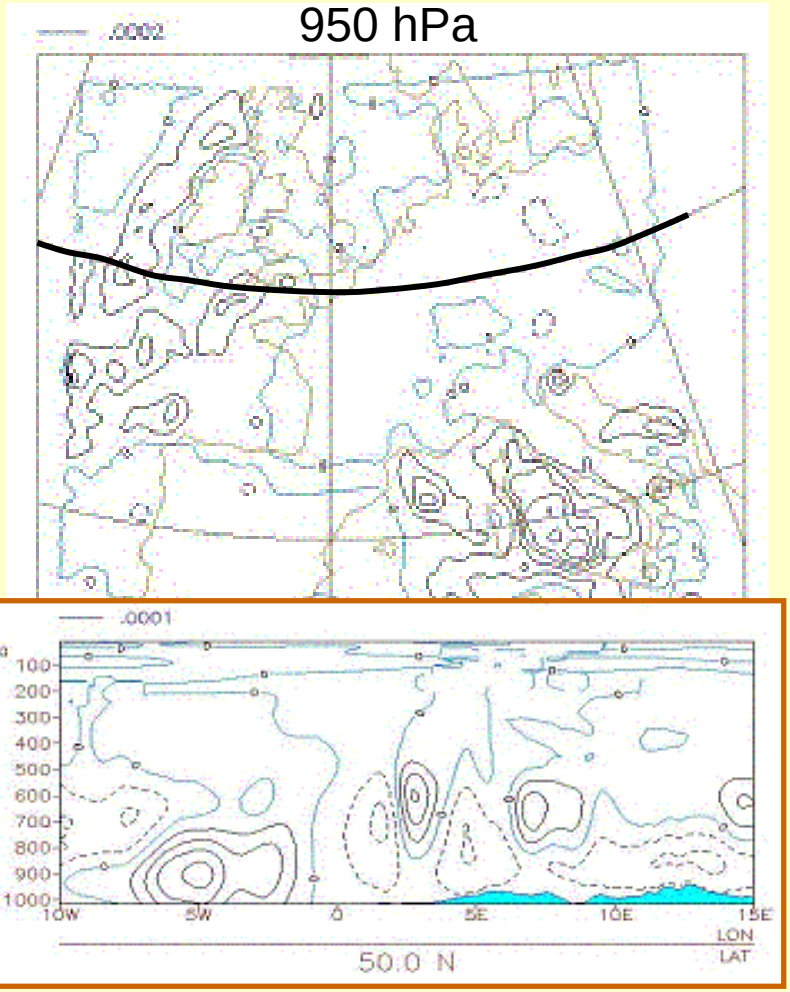
(obs-guess)

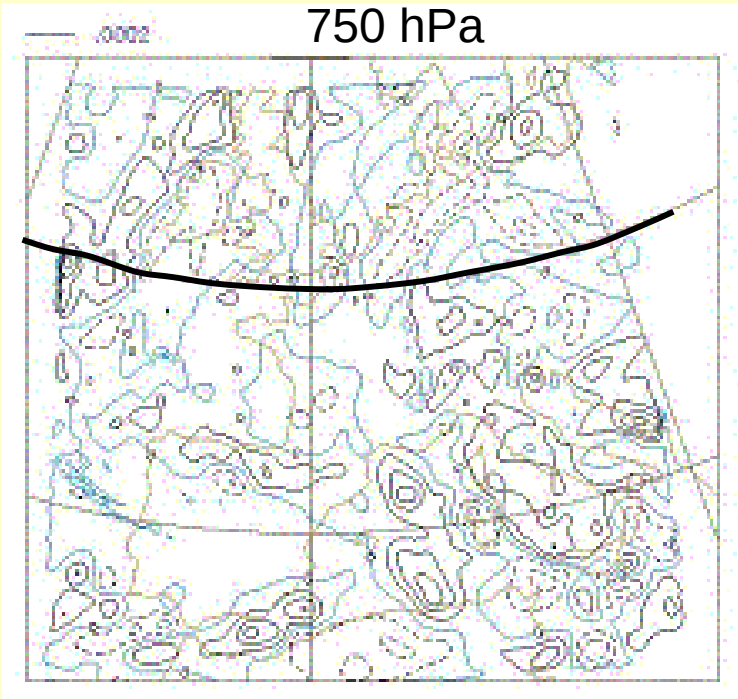


⇨ More information coming from the 2 WV Channels is taking into account in the assimilation process than the IR channels.

Impact on the humidity analysis: Increments

- **Spatial distribution of humidity increment** $\delta x = x_a - x_b$

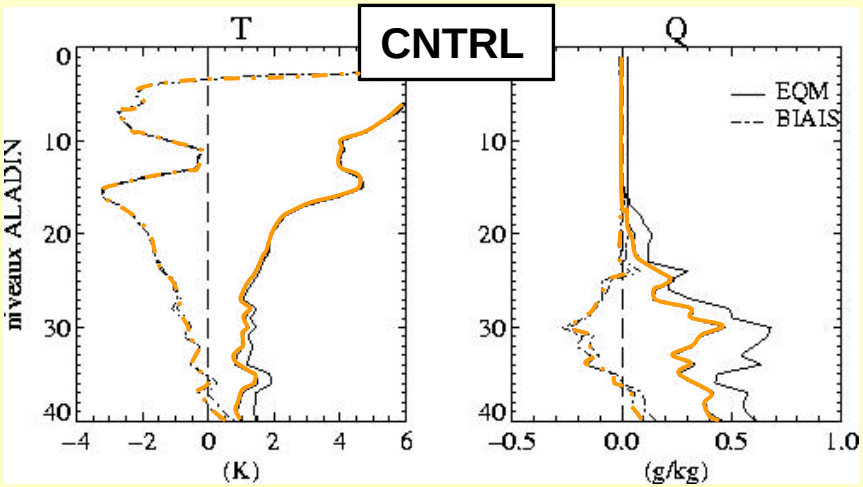


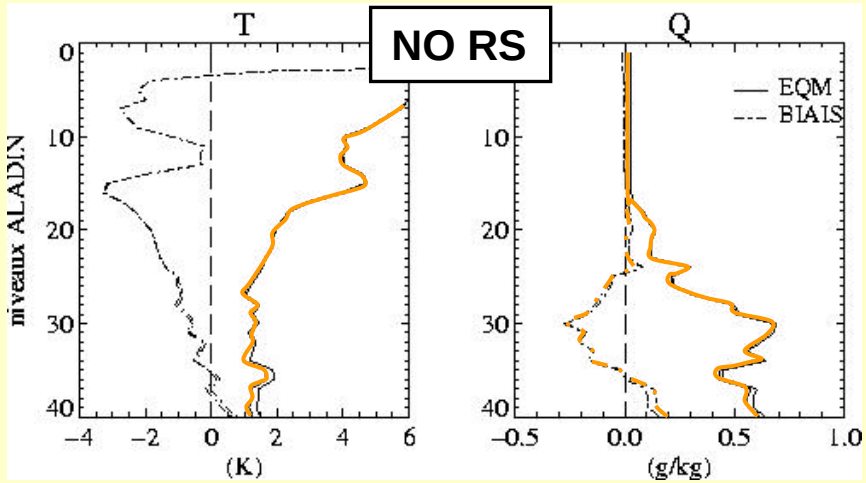


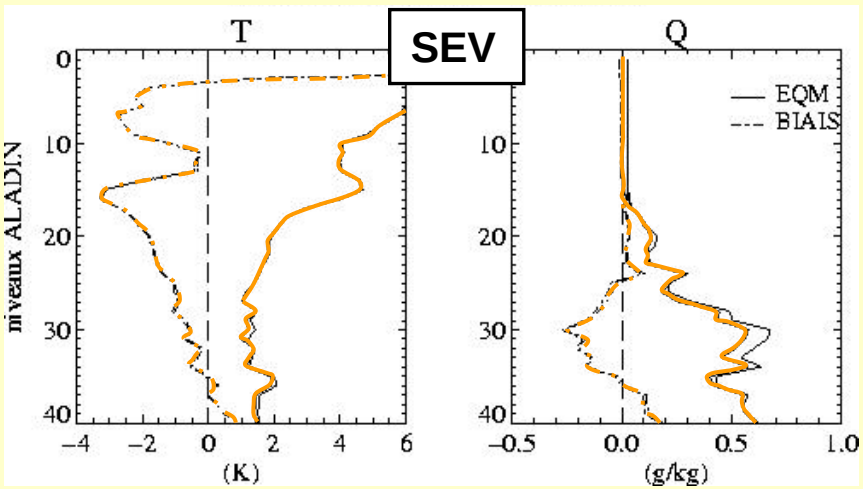
- Max > 0.6 g/kg ⇨comparable to increments obtained after RS assimilation
- Large impact in mid to high Troposphere
- Impact on other control variables due to the multivariate behaviour of the structure functions that compose **B**

Impact on the humidity analysis: Impact

- **Comparisons with 18 radiosondes**







— Background $\mathbf{x_b}$

— Analysis $\mathbf{x_a}$

⇨Reduction of the background error in mid-troposphere for the humidity

⇨Very weak impact in low troposphere for the temperature analysis

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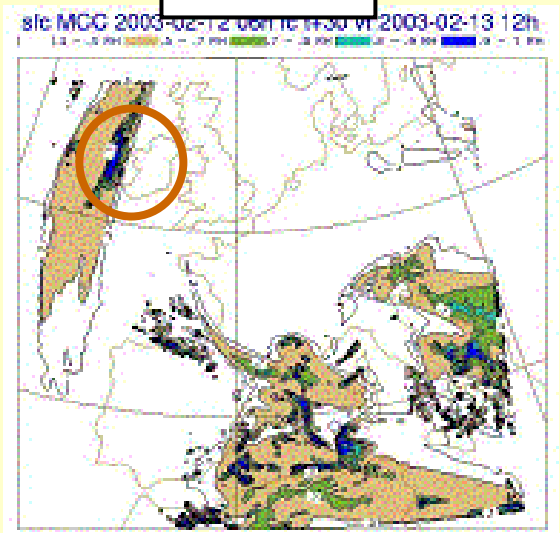
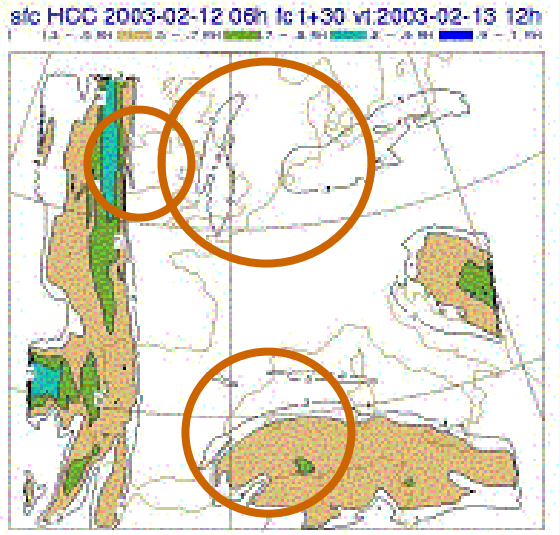
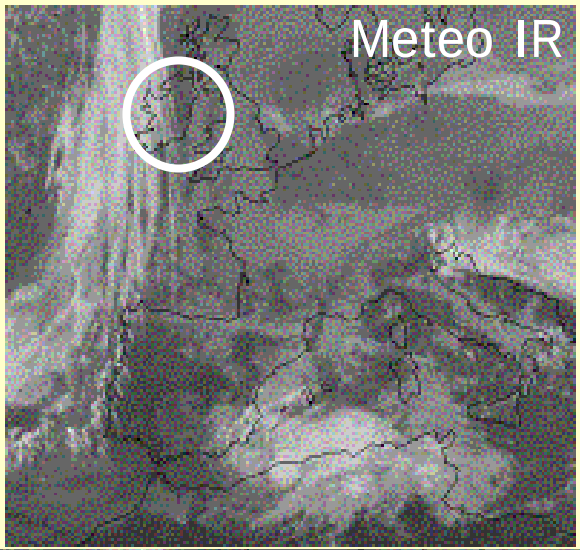
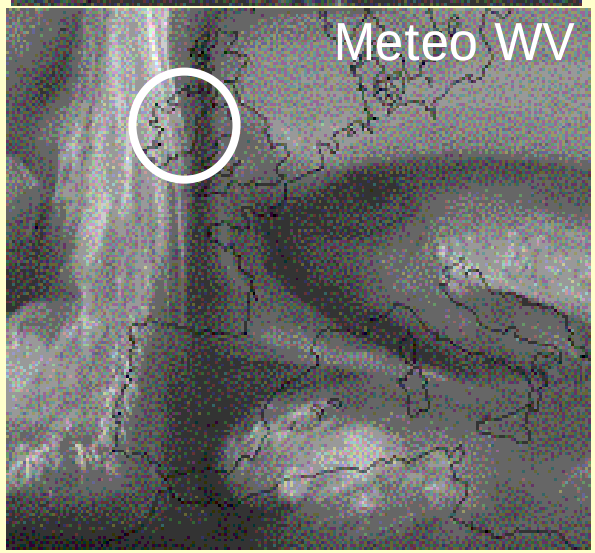
Impact on short term forecast of cloud cover

CNTRL

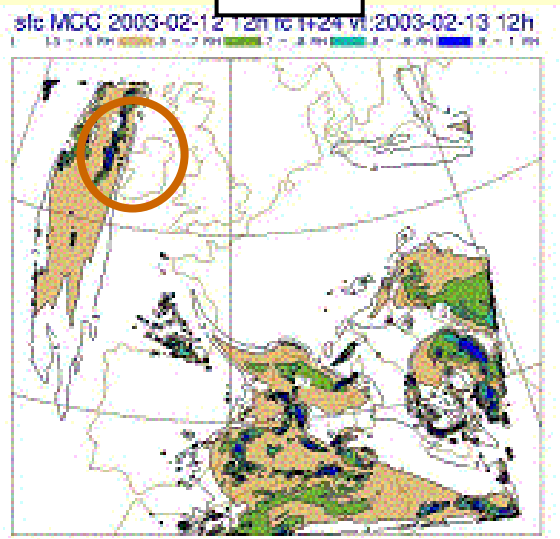


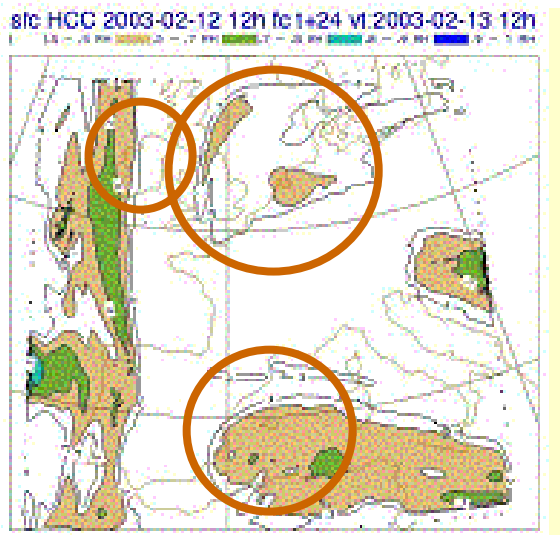






SEV





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Conclusion

- **SEVIRI observations coming from the 12th February 2003 case have been:**
- Corrected from air-mass dependent bias coming from the RT model
- Screened using cloud detection and quality control algorithms
- Assimilated in the 3D-Var of the regional NWP model ALADIN

- **Impact of their assimilation:**
- reduction of humidity error in mid to high troposphere mainly due to the information carried out by WV channels
- Negligible impact on the temperature analysis
- Humidification and drying of some areas that leads to more realistic mid to high level cloud cover prediction

Conclusion

Perspectives :

- Improving the **B** matrix to take into account meteorological phenomena at mesoscale (position of a front, inversion in the boundary layer...)
- To run the 3D-Var ALADIN operationally with the same observations than ARPEGE and with SEVIRI data over Europe
- To perform OSSE with various available satellite data (AMSU-B, HIRS, AIRS, SEVIRI), testing different assimilation cycles per day and different cut-off times

⇨ **Impact of the high temporal resolution of SEVIRI vs. higher spectral resolution for short-term regional forecast**