Preliminary results and tuning of Météo-France's pre-operational ALADIN 3D-Var

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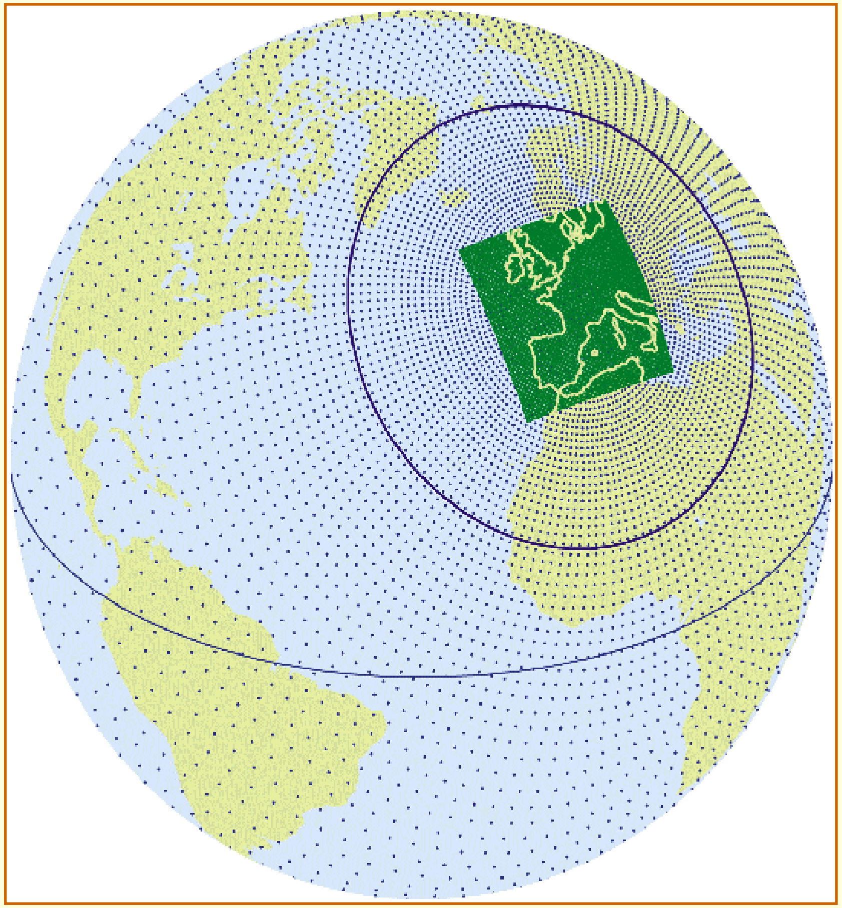
ALADIN France :

- A spectral Limited Area Model covering Western Europe, coupled with ARPEGE
- **Simulation Domain:** 2740 km^2, centered over ARPEGE's gridpoint that has the maximum horizontal resolution
- 3DVar version pre-operational since 20th of march, 2005



General algorithm :

Ensemble Jb : Background error covariances are sampled from an ensemble of Aladin forecasts, with initial conditions from an ensemble of ARPEGE analyses (Stefanescu et al, 2005)

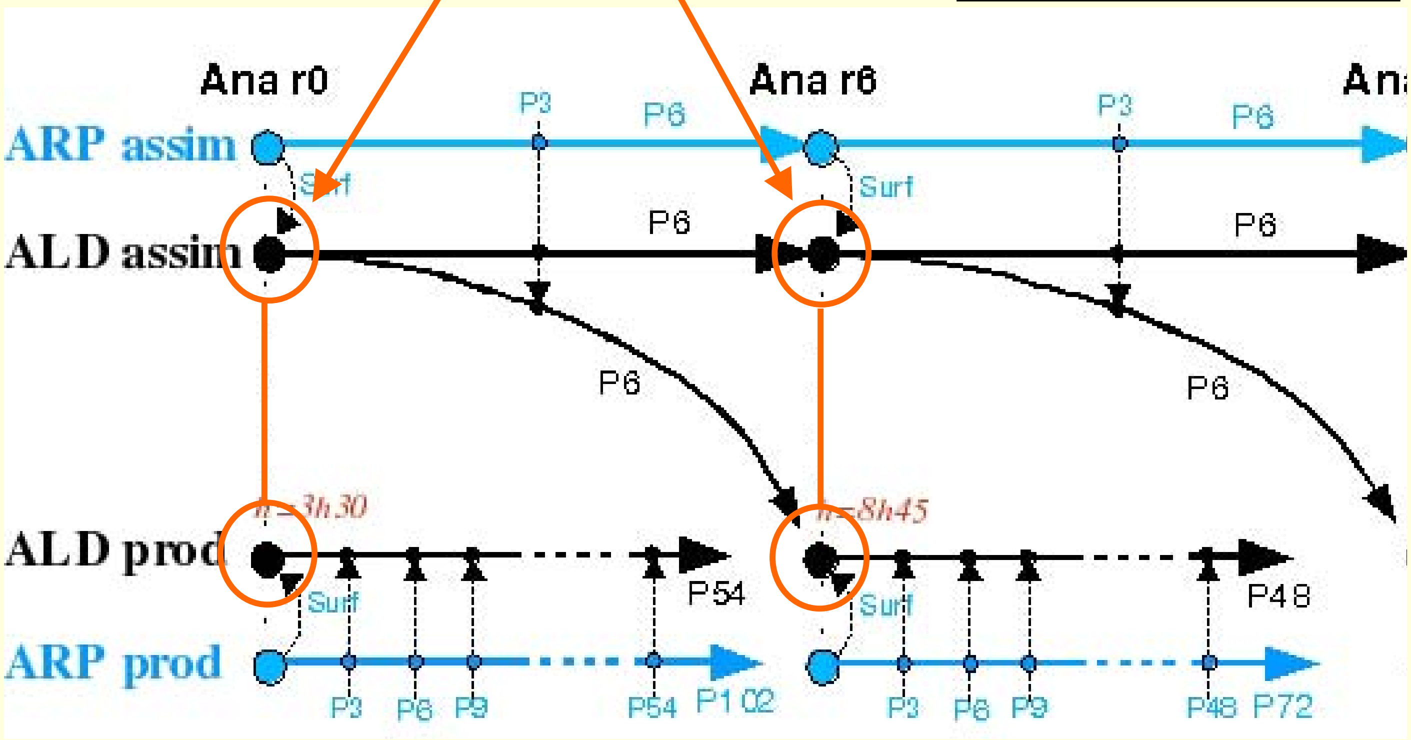
Incremental 3D-VAR, using 80-90 % of the common Arpège/IFS code

Observations are those that enter the ARPEGE assimilation (cf Florence Rabier's talk)

+ Met-8/SEVIRI radiances

Continuous assimilation cycle, 6 hour frequency, coupled with ARPEGE

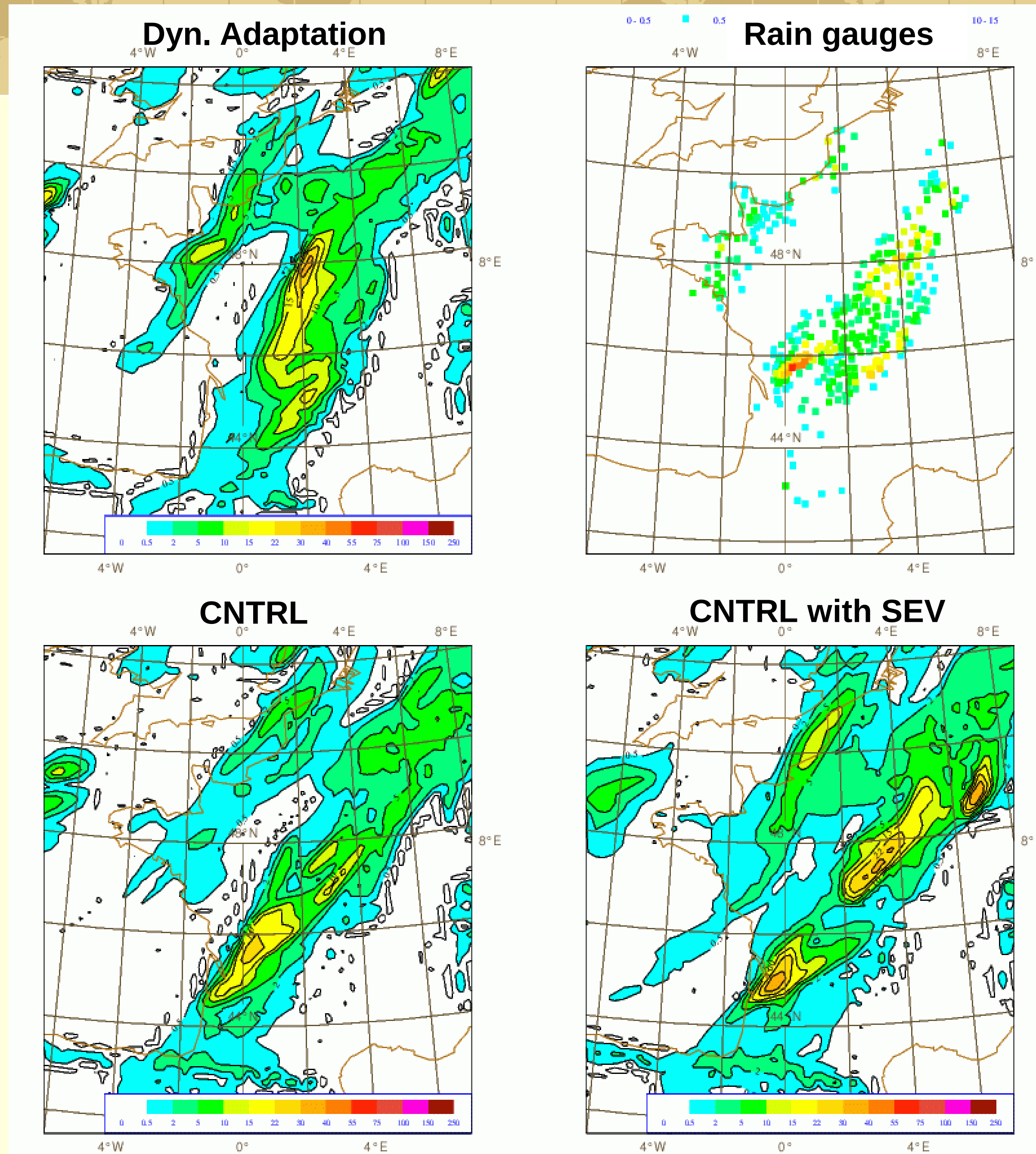
Production started from the assimilation cycle guess, coupled with ARPEGE



Test period : july 2004

Example of total rain forecast (P12 – P6)

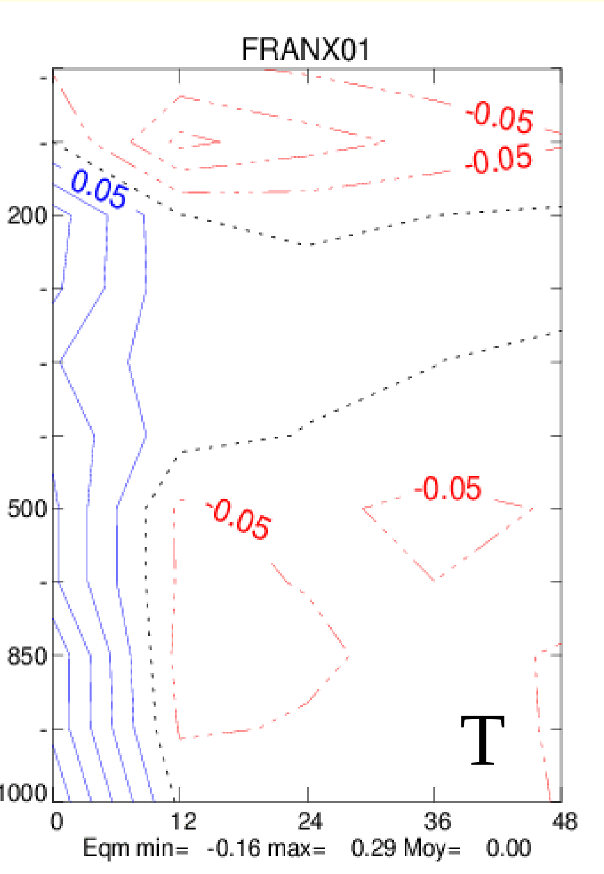
Known drawback : positive bias for the precipitation forecast

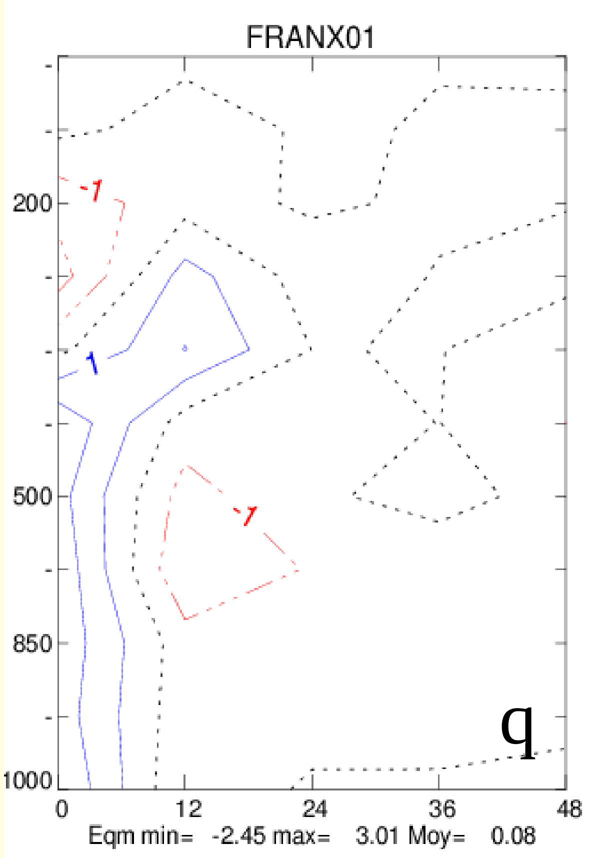


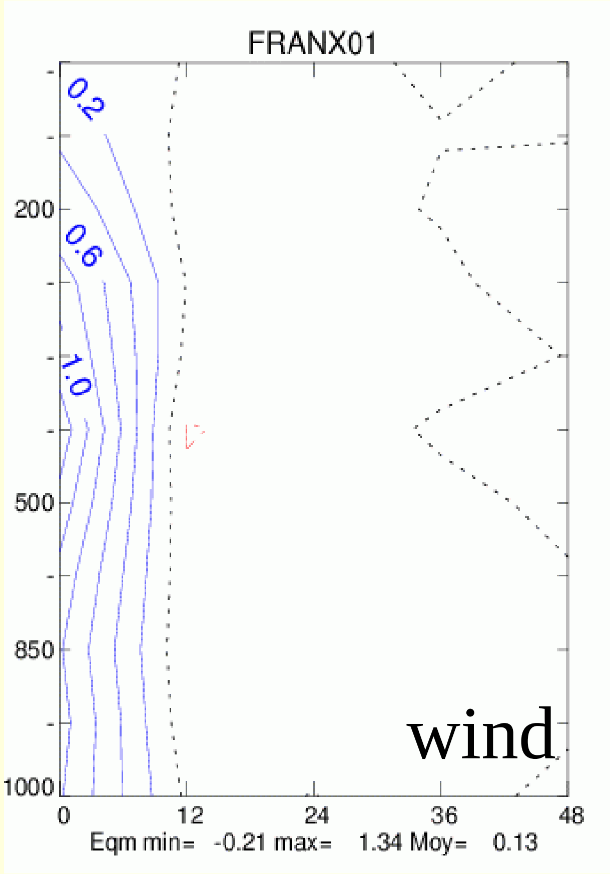
Scores of the pre-operational suite :

22nd of march -> 15th of june 2005

rms error (Dyn. Adap / TEMP) – (Oper/TEMP)







⇒ Reduction of the variances before 12h of forecast, neutral afterwards except for T and q which show a weak degradation of the mid-tropospheric bias

Scores of the pre-operational suite :

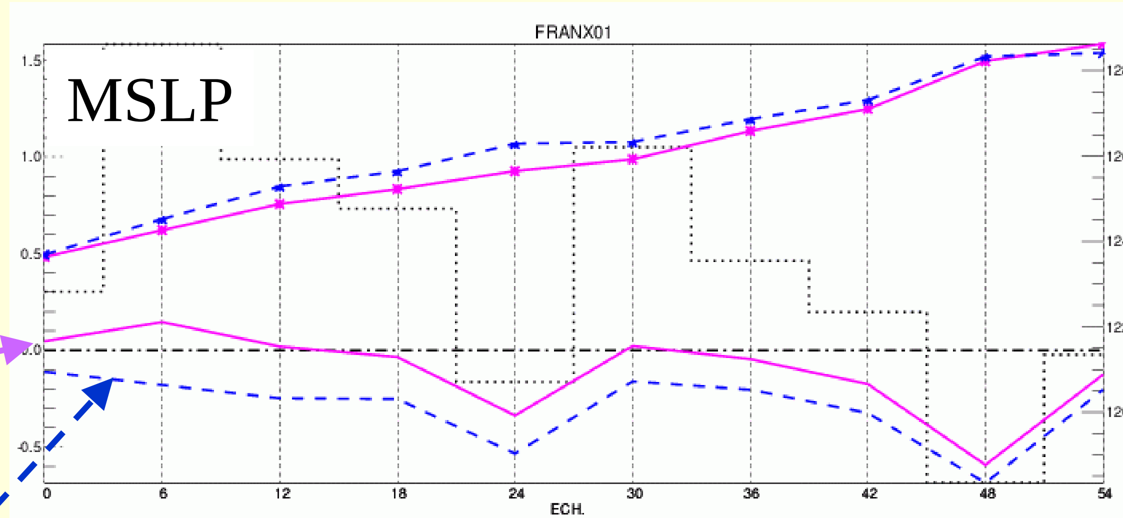
22nd of march ->

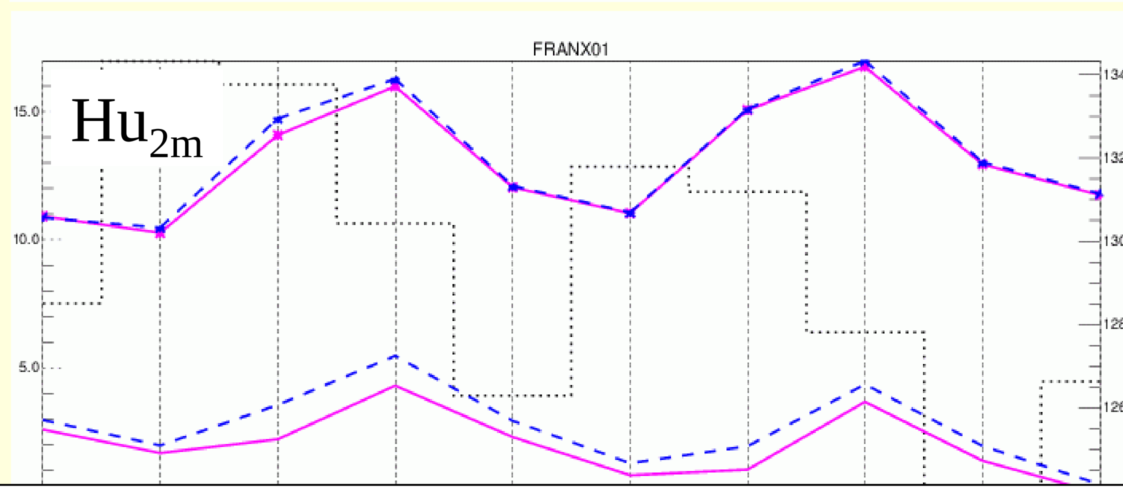
15th of june 2005

Bias + RMS compare to SYNOP

Dyn. Adap

Oper





⇒ Strong MSLP and Hu_{2m} biases in the analysis : balance problem due to badly tuned and/or biased observations ?

Tuning

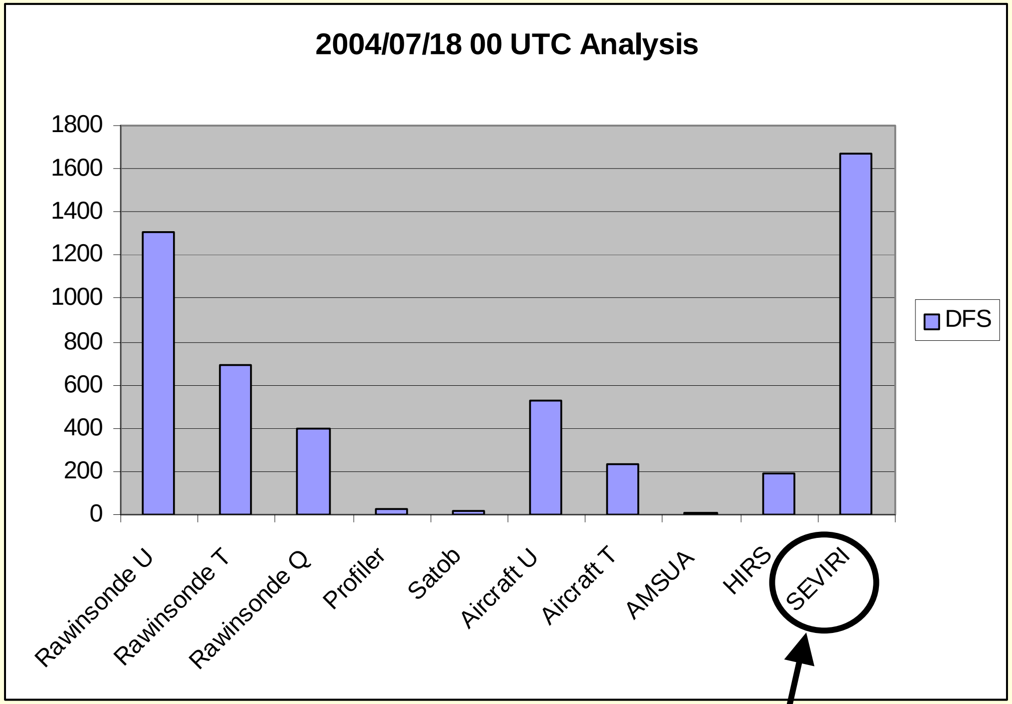
Sensitivity of the analysis to observations :

The DFS ("Degrees of Freedom for Signals" has been computed :

$$\mathbf{DFS} = Tr\left(\frac{\partial \mathbf{Hx_a}}{\partial \mathbf{y}}\right) = Tr(\mathbf{HK})$$

Where $\mathbf{x_a}$ denotes the analysis vector, $\mathbf{H}$ the observation operator linearized in the vicinity of the background state (composed of an interpolation operator and RTTOV-8 fast radiative transfer model for the radiances), and $\mathbf{K}$ the Kalman gain matrix ($\mathbf{K} = \mathbf{BH}^{\mathrm{T}}(\mathbf{HBH}^{\mathrm{T}} + \mathbf{R})^{-1}$).

$Tr(\mathbf{HK})$ is computed following a Monte Carlo method



⇒ **DFS is very high for SEVIRI** which denotes a (too ?) high impact in the analysis

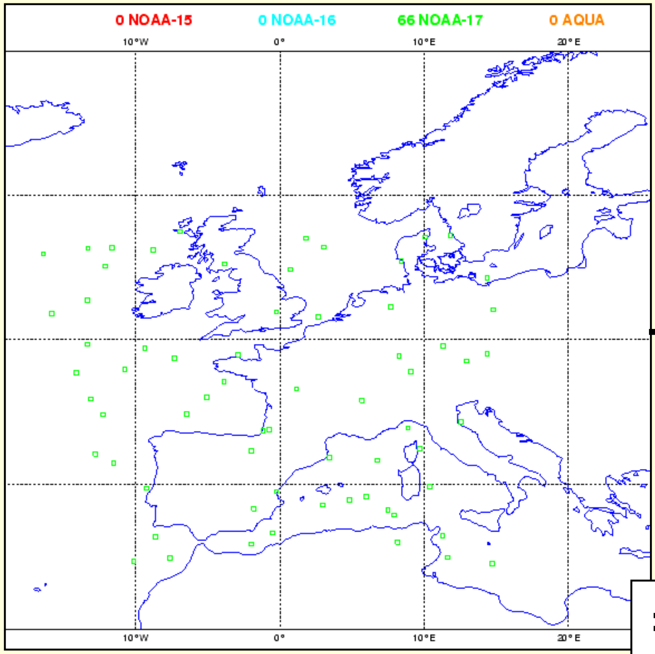
⇒ σ_o **have been increased for SEVIRI**

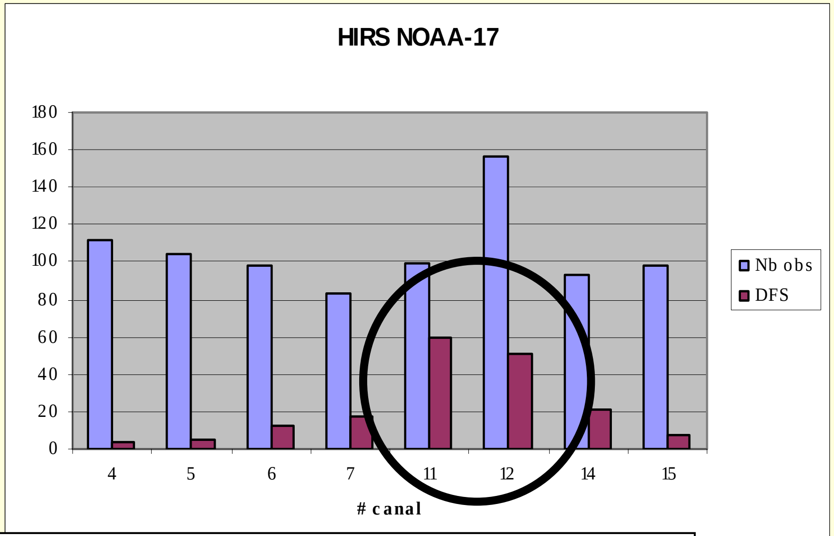
2005/05/16 00 UTC

Active data

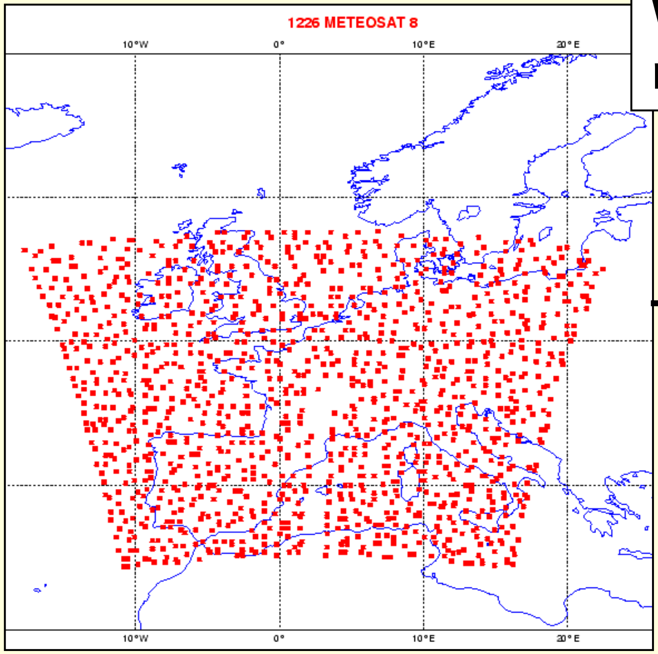
DFS/Channel

HIRS

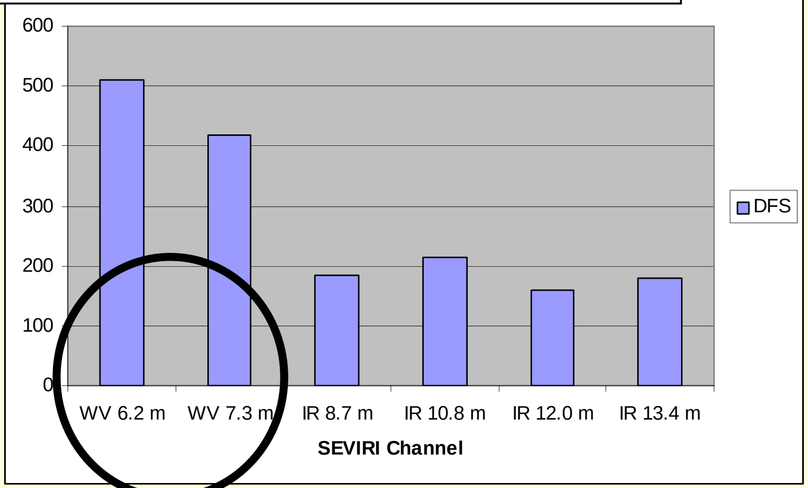




SEVIRI



=>Channels 11 and 12 for HIRS and WV channels for SEVIRI are the most informative



Tuning

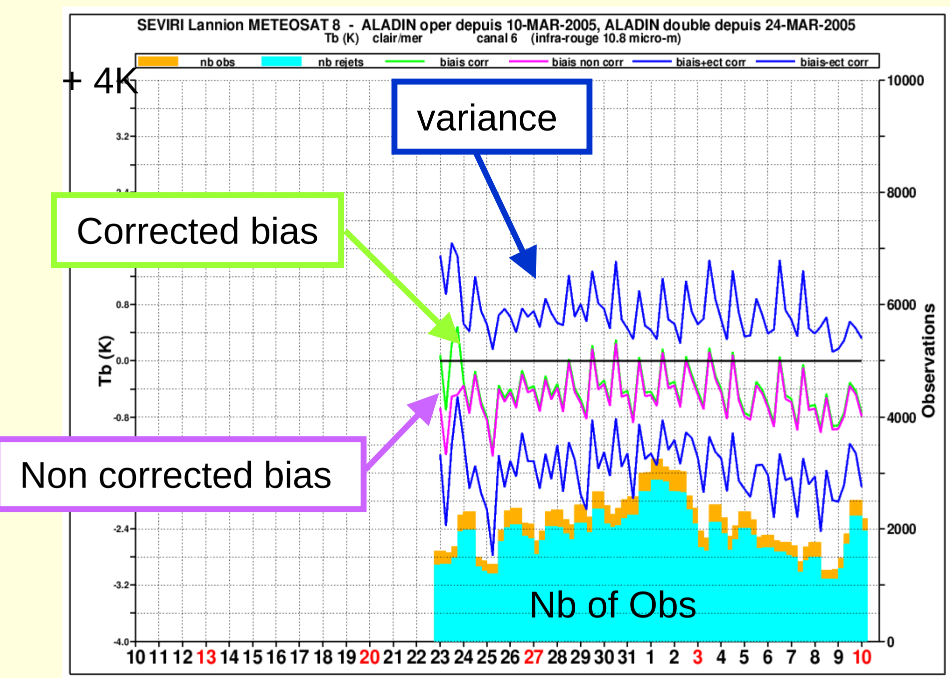
• Tuning of the background error variances :

Use of *Desroziers et Ivanov* (2001) algorithm $\mathbf{B}_{true} = s_b\, \mathbf{B}$ with

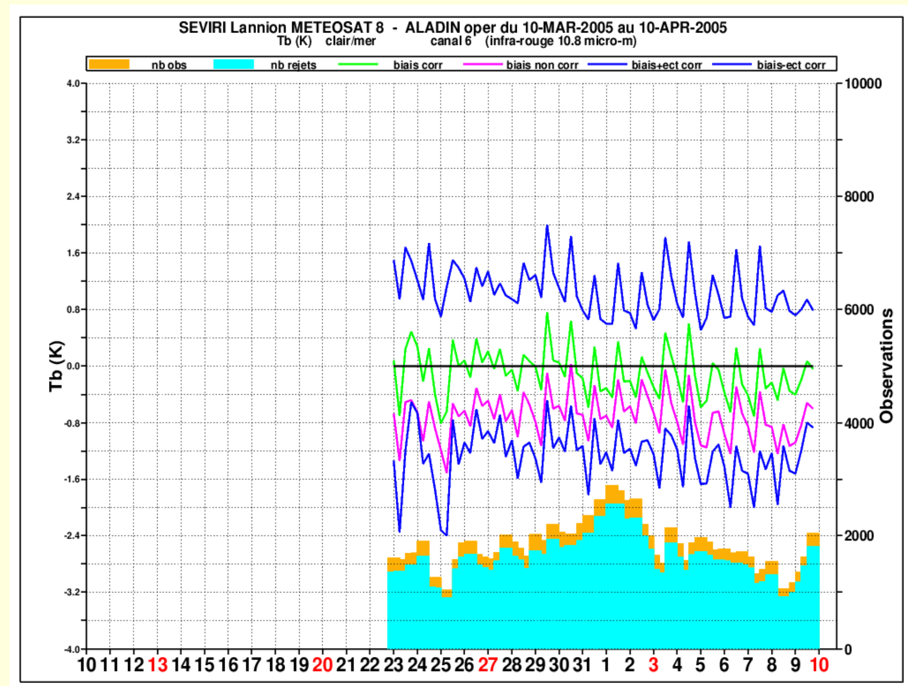
$$s_b = \frac{2J_b(\mathbf{x_a})}{Tr(\mathbf{KH})}$$

gives $s_b = 0.7$ => The fit to the observations has been reduced by decreasing σ_b

• Computation of the bias for SEVIRI :



Flat bias tuned on the july 2004 period

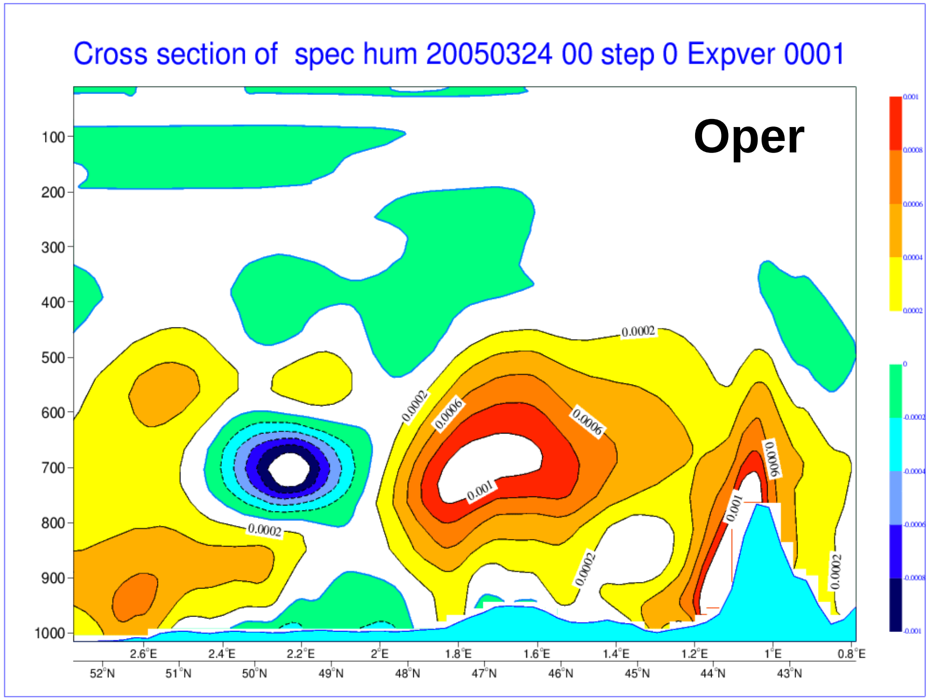


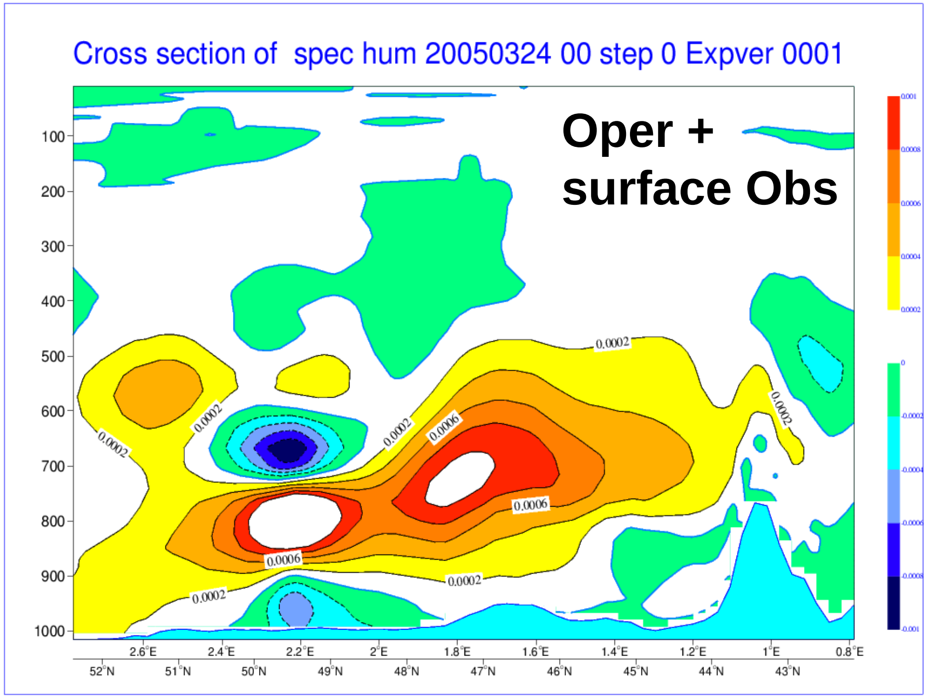
Biases computed using *Harris and Kelly* (2001) method

Addition of surface observations (P, T_{2m}, Hu_{2m}) (L. Auger):

Prevent mid-tropospheric analysis increments due to radiances assimilation to spread out into the boundary layer

⇒ **More realistic initial conditions** that reduce the positive bias in precipitations forecast





Vertical cross-sections of humidity increments

Scores after the tuning and the addition of surf. Obs

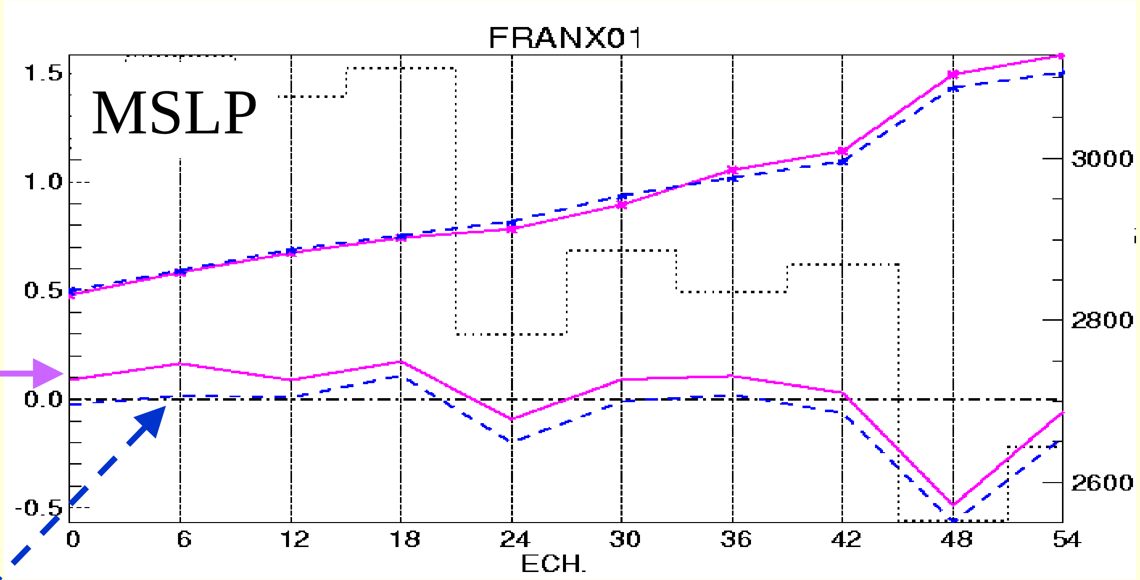
23rd of march ->

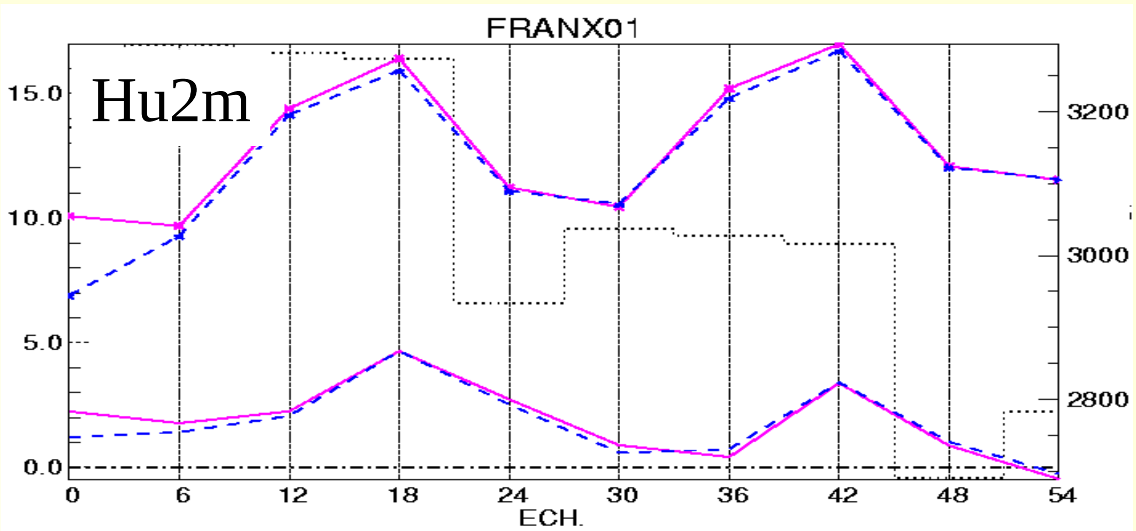
4th of april 2005

Bias + RMS

Dyn. Adap

Oper v2





⇒ **Important improvement** compare to the pre-operational suite

⇒ Reduction of the mid-tropospheric T and q biases

Conclusions

The ALADIN 3DVar is run pre-operationally at Météo-France since march

First evaluations show obvious tuning problem :

• DFS have been computed for each type of observations and each channel of ATOVS and SEVIRI radiometers

$\Rightarrow$ DFS show that analyses are too sensitive to SEVIRI radiances : their σ_o have been increased in consequence

• the s_b coefficient has been estimated in order to tune the background error variances (σ_b)

• Flat biases initially used for SEVIRI have been replaced by air mass dependent biases

Conclusions

Surface observations have been introduced in the variational process:

• Increment patterns show good complementarity with SEVIRI WV radiances

• Positive bias in precipitation forecast has been reduced

All these modifications notably improve forecast scores

⇒ This new version will become operational after validation at the end of june

Perspectives

3DFGAT, J_k (variational term of relaxation towards large scale), revisit the formulation of humidity analysis, impact of denser data (ATOVS, Quikscat)

Seviri in Aladin 3DVar

1st configuration :

- **Use of 1 pixel over 5** (~25 km horizontal resolution over France)
- Thinning within 66 km^2 boxes
- Channels 3.9μ and 9.7μ (Ozone) blacklisted
- **Flat bias** for each channel
- Empirical σ_o

Seviri in Aladin 3DVar

- **Use of the cloud classification for the channel selection** :

i) Channels IR 8.7μ, 10.8μ and 12μ only in clear air
ii) 13.4μ keeped above low clouds
iii) WV 6.2μ and 7.3μ keeped above mid-level clouds

- **Test Runs 6 to 22 july 2004** (4 cycled assimilations per day)

CNTRL uses (as shown by Claude Fischer) :

i) a B matrix deduced from an ensemble of ARPEGE/ALADIN assimilation/forecasts (as shown by Simona Stefanecsu)

ii) Complete set of observations (conventional data, IR radiances from HIRS and AMSU-A) within a +/- 3 h assimilation window.

SEV : CNTRL with SEVIRI data

Conclusions

- A lot of information coming from SEVIRI radiances is taken into account in the analysis through the 3DVar, producing realistic mesoscale increments
- The cloud type classification is very useful to keep only data non contaminated by clouds in the variational process
- Results deduced from the 15 days test period are encouraging, notably for short term (i.e < 12h) precipitation forecast

Perspectives

- QPF scores show however that SEV produces too much precipitations (i.e better ETS and POD but worse FAR and FBias) + relative weight of SEVIRI data is important in the analysis : should the fit to observation be relaxed ?

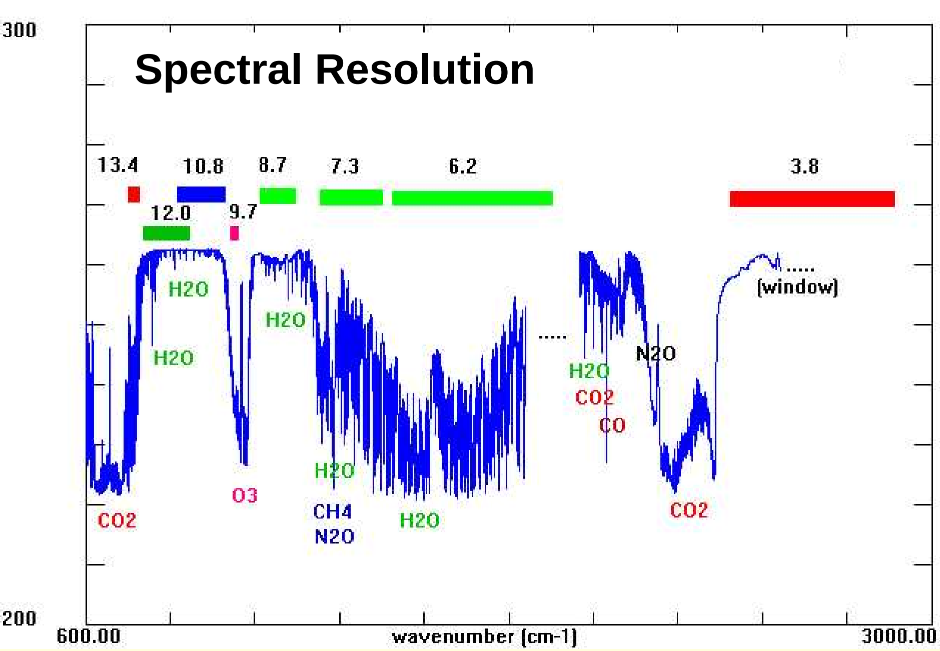
⇒ **Tunning of the error statistics** (B. Chapnik) and of the thinning

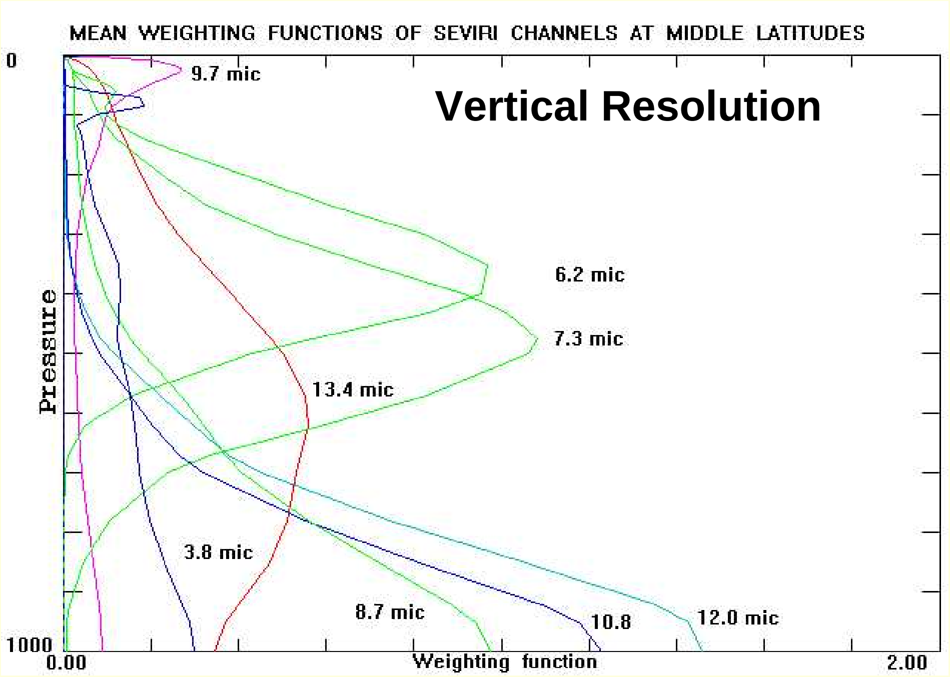
- **Assimilation of proxy humidity profiles** for convective clouds (see the poster of M. Nuret), computed from the cloud top pressure and a convection detection algorithm.

- Monitoring as soon as ALADIN 3DVar becomes operational

Seviri in Aladin 3DVar

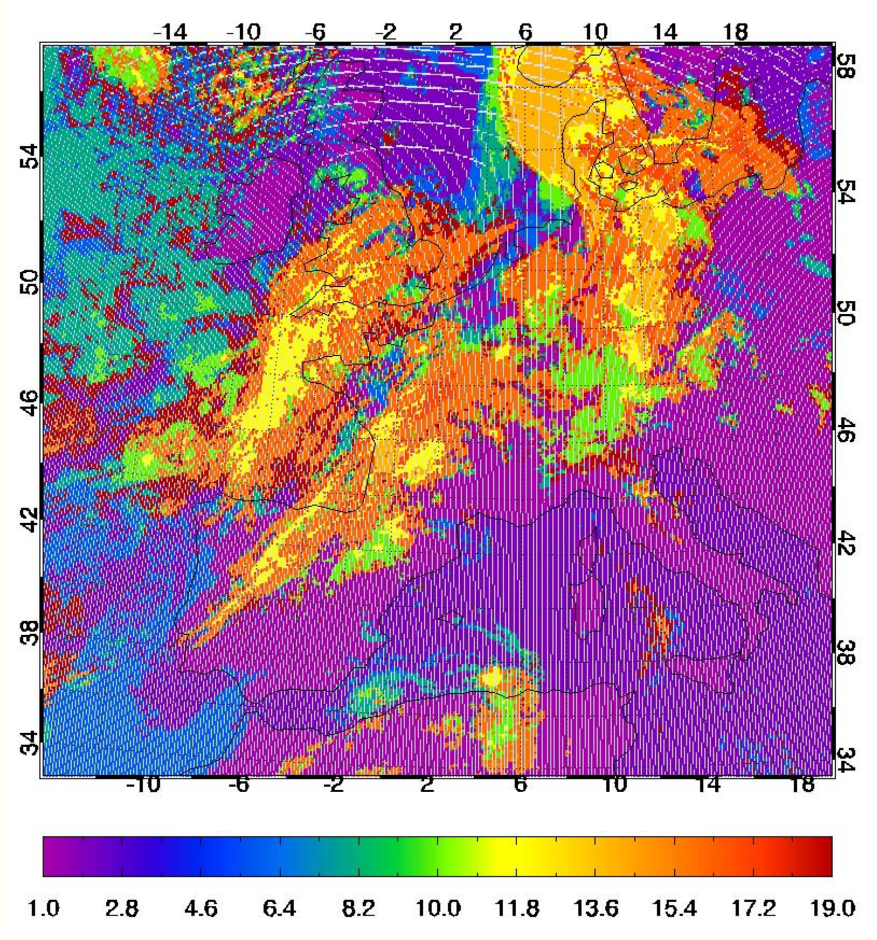
SEVIRI radiometer onboard MSG (henceforth called Meteosat-8):



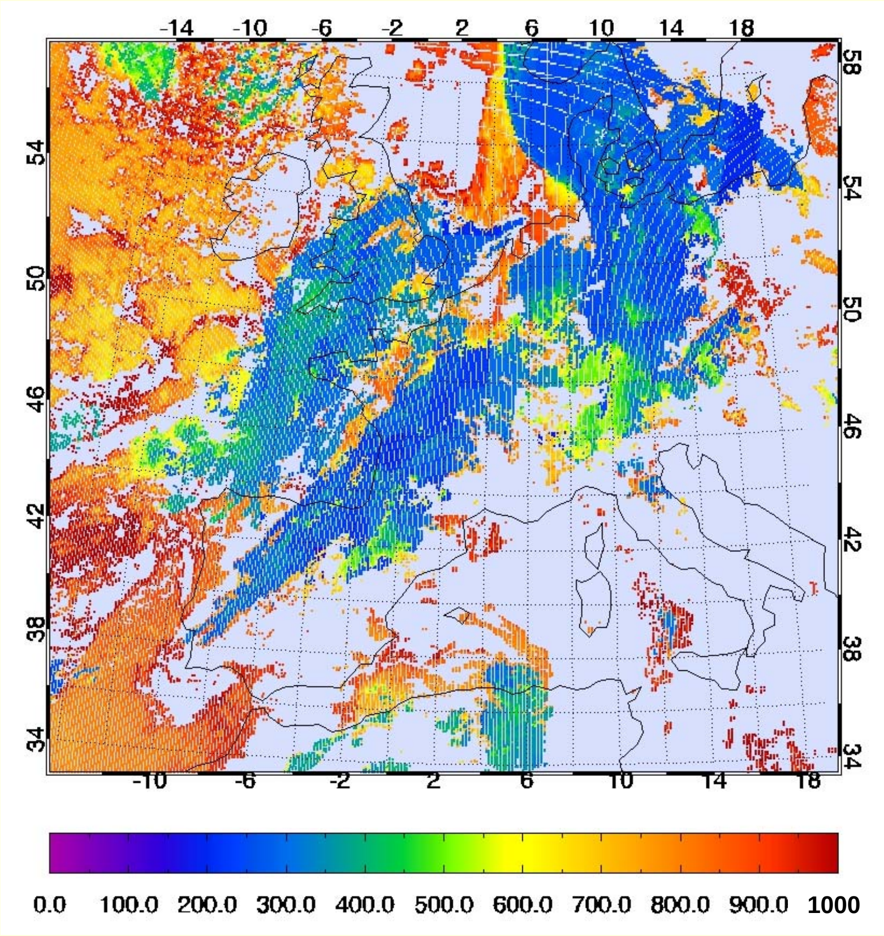


=> Information about the variation rates of T and q fields at high spatial and temporal resolutions (complete image every 15 min)

18/07/2004 00UTC



Cloud Types



Cloud Top Pressure

Seviri in Aladin 3DVar

Cloud types :

(computed by CMS in the SAF/NWC MSG framework)