Spatially varying (mean or daily) sigmab's in Aladin

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Introduction

- background errors in Aladin specified in spectral space: scale dependence, but no spatial dependence (except for nonlinear and omega balance effects)
- spatially varying errors successfully tested in Arpege, computed from ensemble of assimilations
- the same strategy applied to Aladin 3d-Var
- Aladin spectral error specification, modified by climatological or daily spatial patterns
- test of the background - dependent specific humidity errors, as in Arpege

Sigmab's - reminder

- sigmab = standard deviation of background error
- control variable: $\chi = \mathbf{B}^{-1/2}\,\delta x$, $\mathrm{avg}(\chi\chi^{T}) = I$,
  $\mathbf{B}$ – background error covariance matrix
- minimization in control space: transformation $\mathbf{B}^{1/2}$ needed for J_o calculation in model space
- $\mathbf{B}^{1/2} = \mathbf{K\,F\,S\,F}^{-1}\,\mathbf{D\,V\,W}$

horizontal and vertical auto-correlations:

define increment shapes

cross - correlations:

balances between variables ζ, η, T, P_s, q

sigmab's:

computed in grid-point space using two Fourier transforms

Ensemble spatial sigmab's

- sigmab’s calculated using an Arpege ensemble (works well even using a few members)
- only ξ sigmab's are used (directly aplicable - ξ not divided into balanced and unbalanced parts)
- adjustment from global to limited area (rescale using mean Aladin spectral averages)

Sigmab's of specific humidity

- specific humidity sigmab's computed from a study of statistics of radiosonde observations minus background
- dependence on background temperature and relative humidity
- Undén's formula (Rabier et. al., 1998)

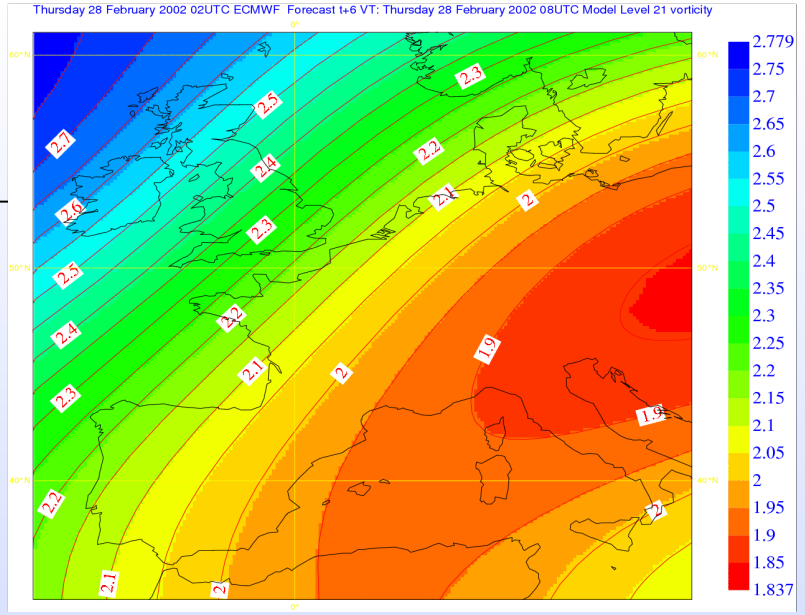
$$\sigma_b = -0.002T_b - 0.003(T_b - 273) + 0.35(RH_b - 0.4) + 0.70$$

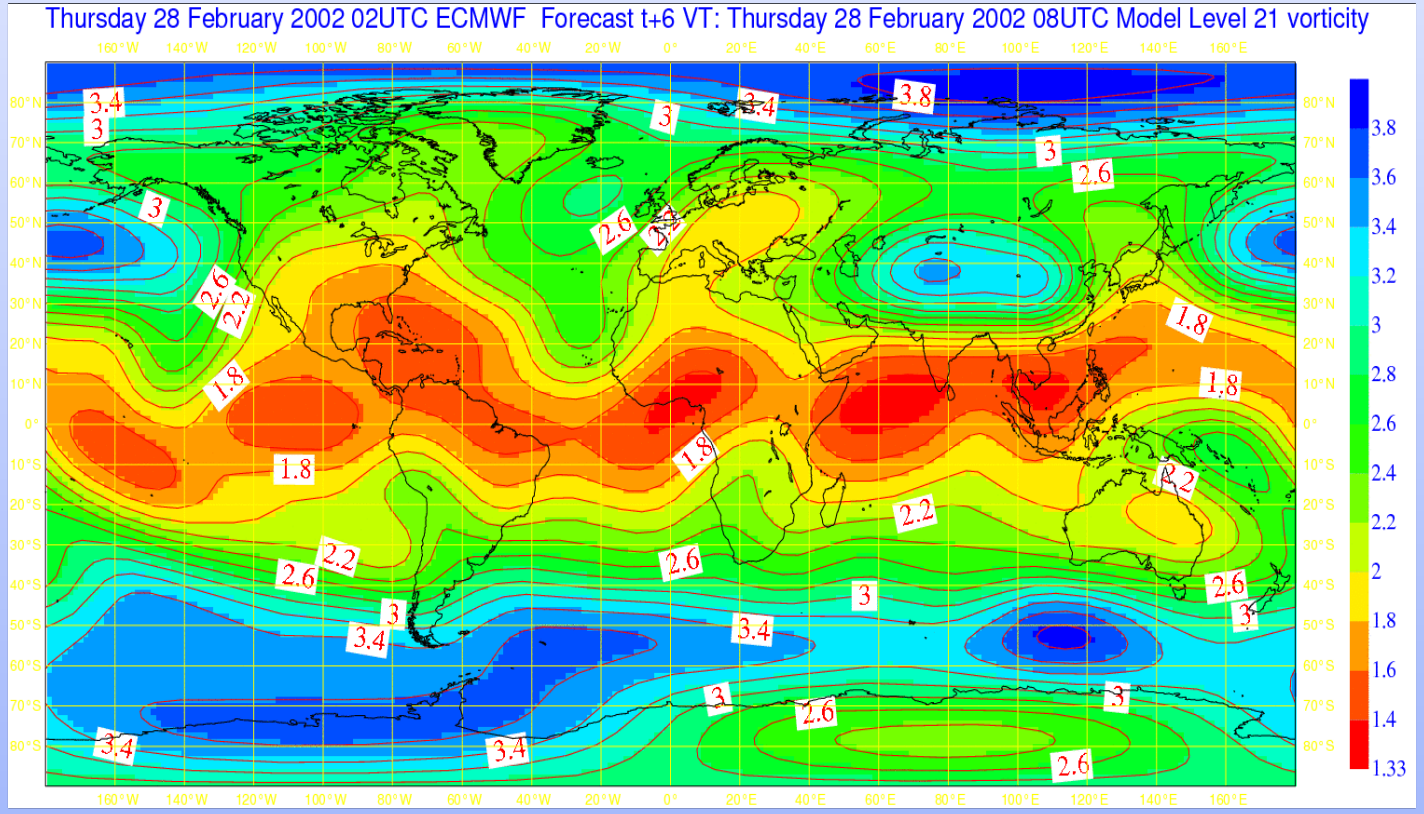
$$0.06 < \sigma_b < 0.18$$

- simple transformation from sigmab (RH) to sigmab (q), further adjustments near the surface

Climatological ξ sigmab's

- Sigmab's, computed using Arpege as a time average over the period of February and March 2002
- reflect natural variability and observational data density

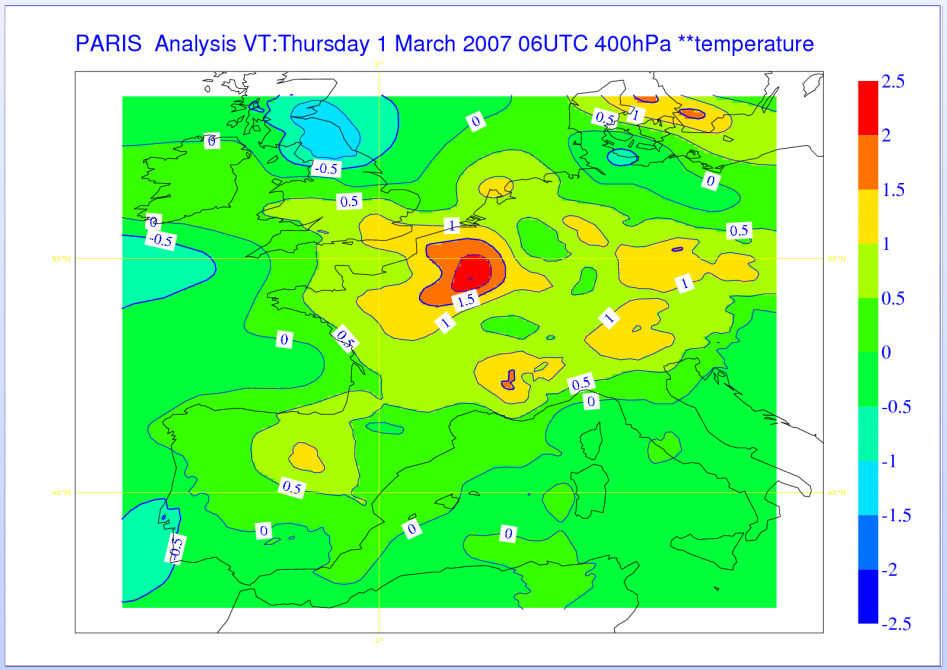




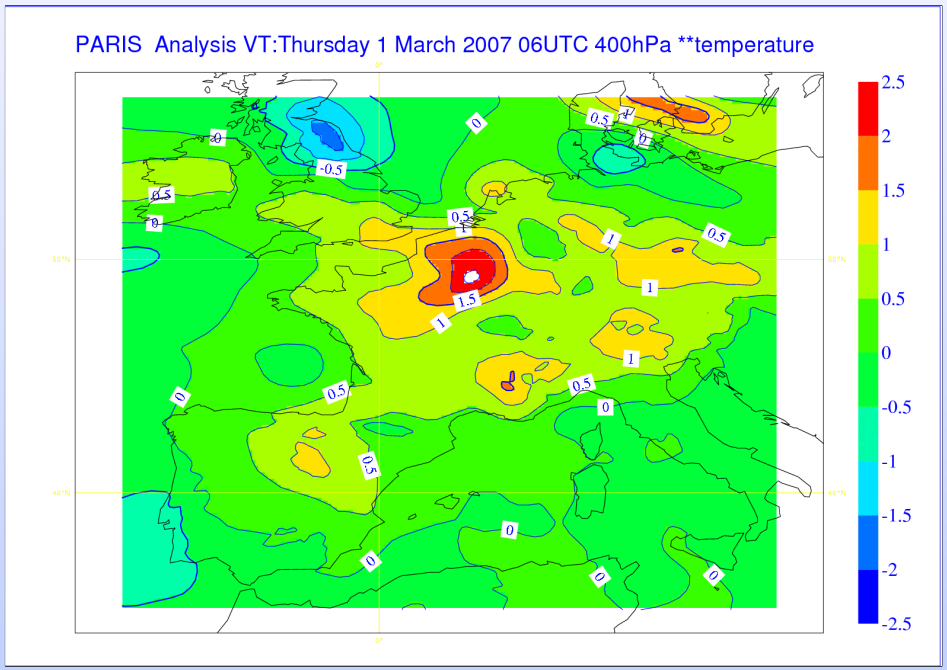
relative vorticity at level 21 / 41

(~ 500 hPa)

Effects of horizontal variations of sigmab's



horizontally uniform σb's



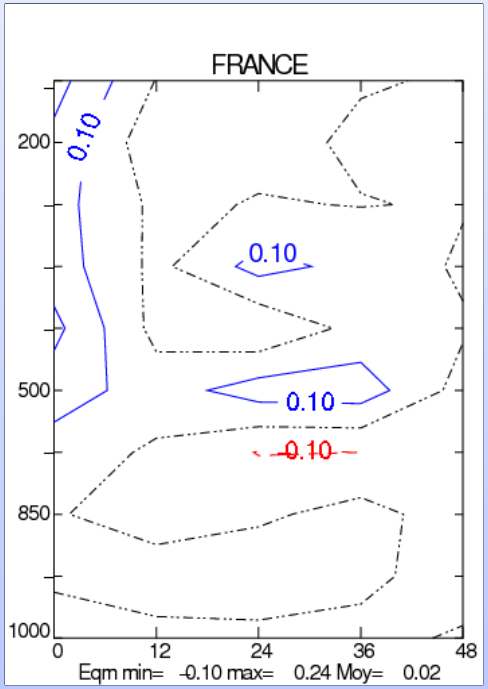
horizontally varying σb's

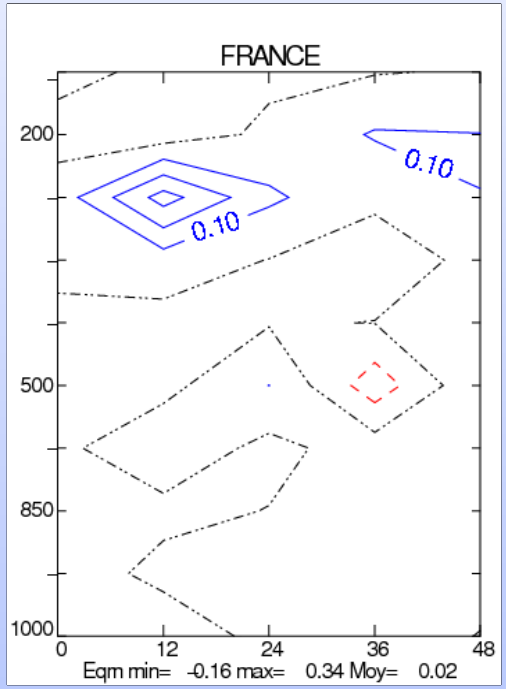
T 400 hPa
March 3th 2007
06 UTC

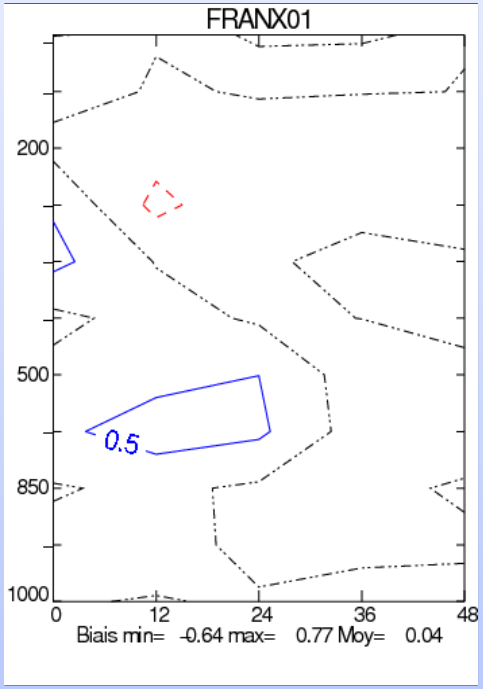
- T analysis increments are larger over areas with large sigmab's (Northern UK, Danmark)

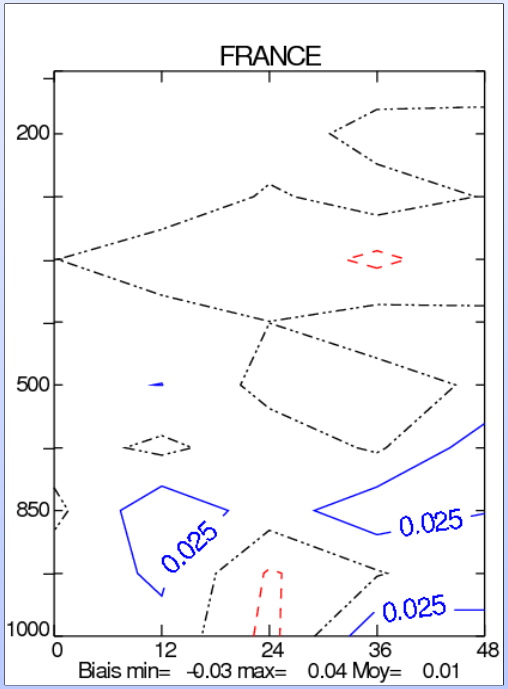
Climatological ξ sigmab's - scores

- winter experiment (7th January – 2nd February 2007)
- summer experiment (18th July - 16th August 2007)









RMSE wind winter

RMSE wind summer

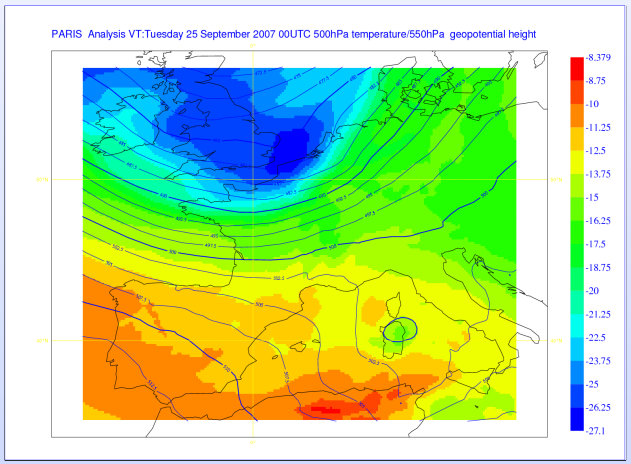
bias RH winter

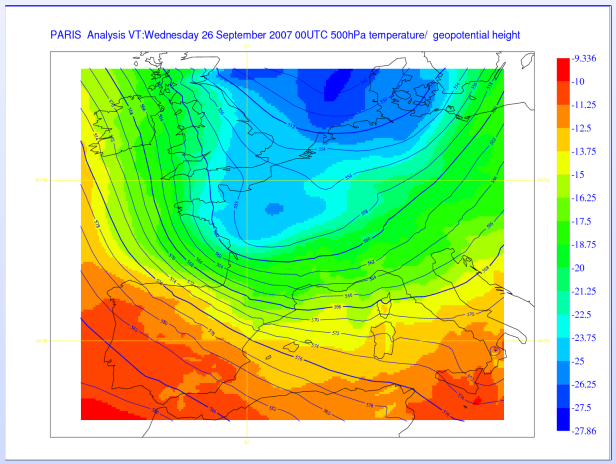
bias T summer

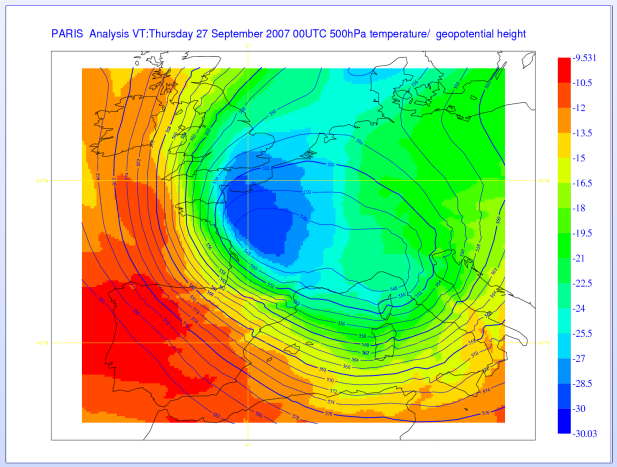
- slight positive impact on wind RMSE, and on T/RH bias.

Sigmab's "of the day"

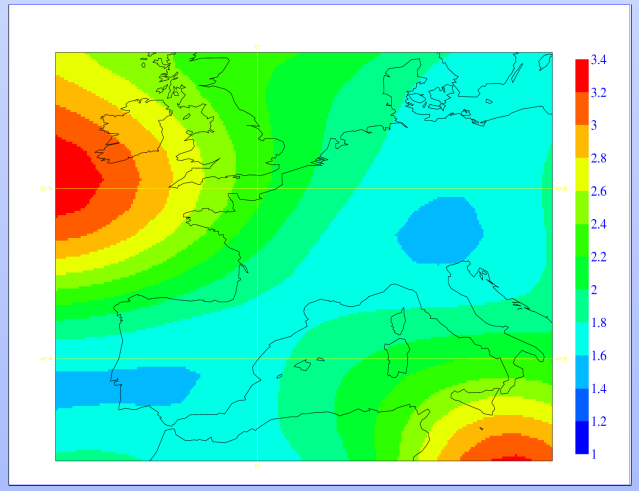
- cold cut-off over Europe: 25 -27 September 2007

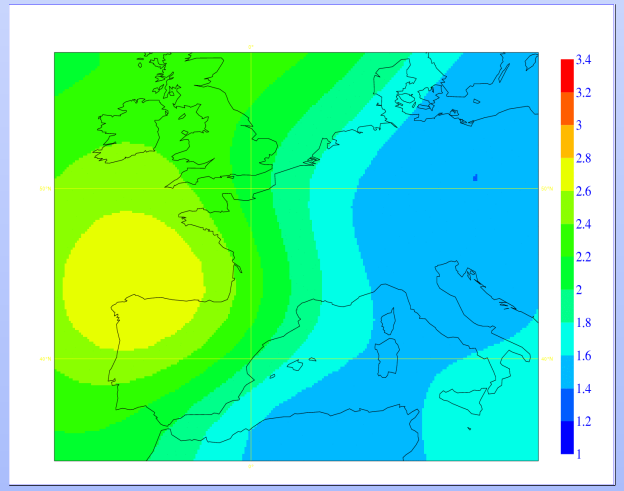


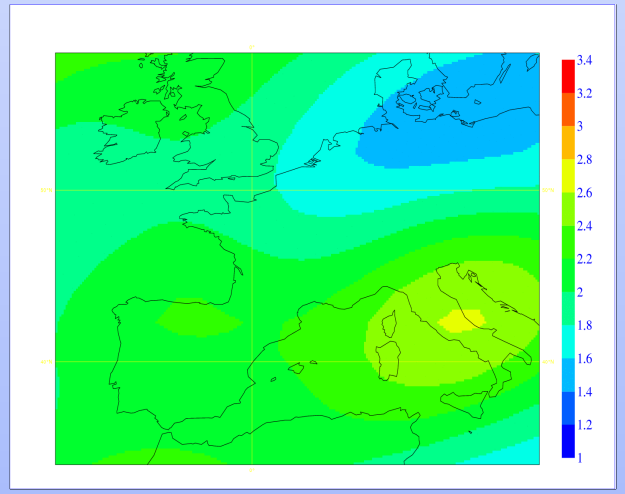




→ maximal sigmab's following the sharpest pressure gradients →



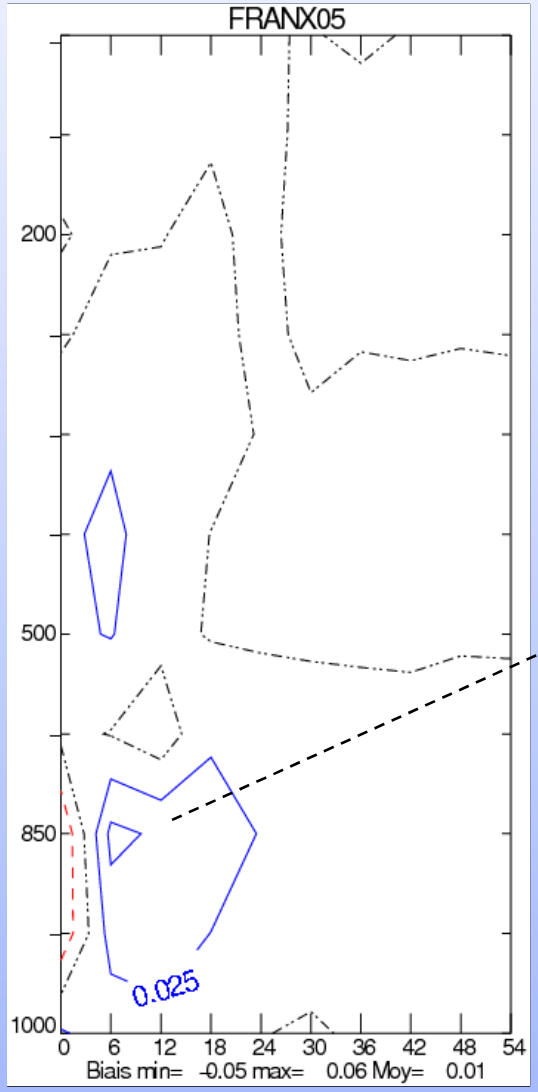




→ magnitudes of sigmab's decreasing with time →

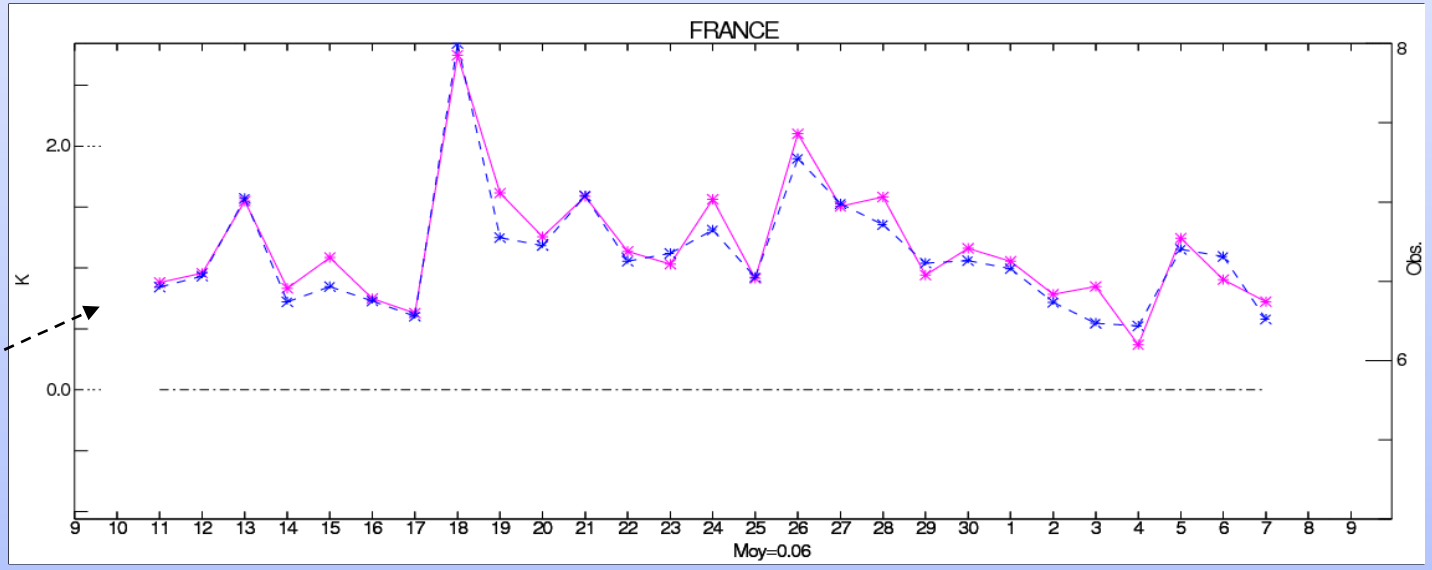
Sigmab's "of the day" - scores

bias T vs. ECMWF



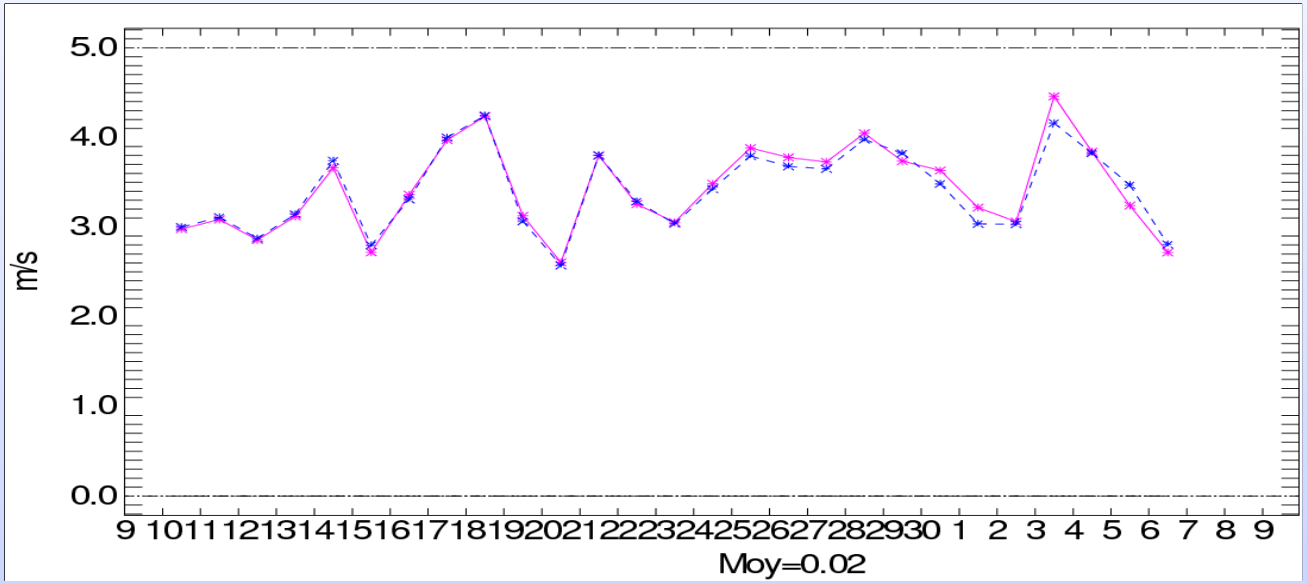
- σb's "of the day" experiment (8th September – 5nd October 2007), 27 days

+12h T 850 hPa bias vs. TEMP

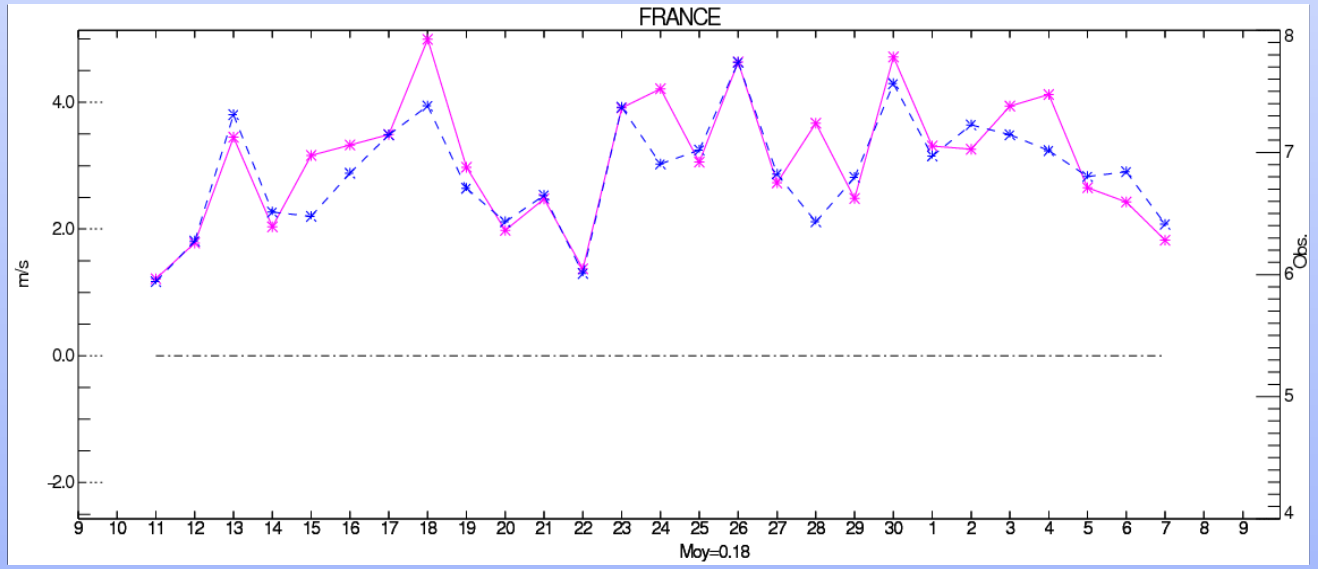


- +12h temperature low level bias improved

Sigmab's "of the day" - scores



+ 36h 850 hPa wind RMSE vs. ECMWF

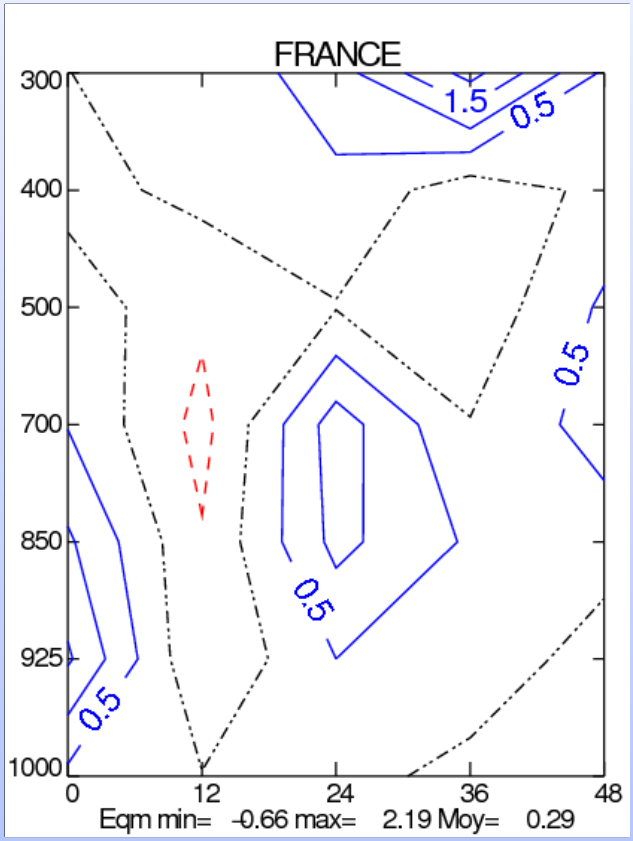


+ 48h 700 hPa wind speed RMSE vs. TEMP

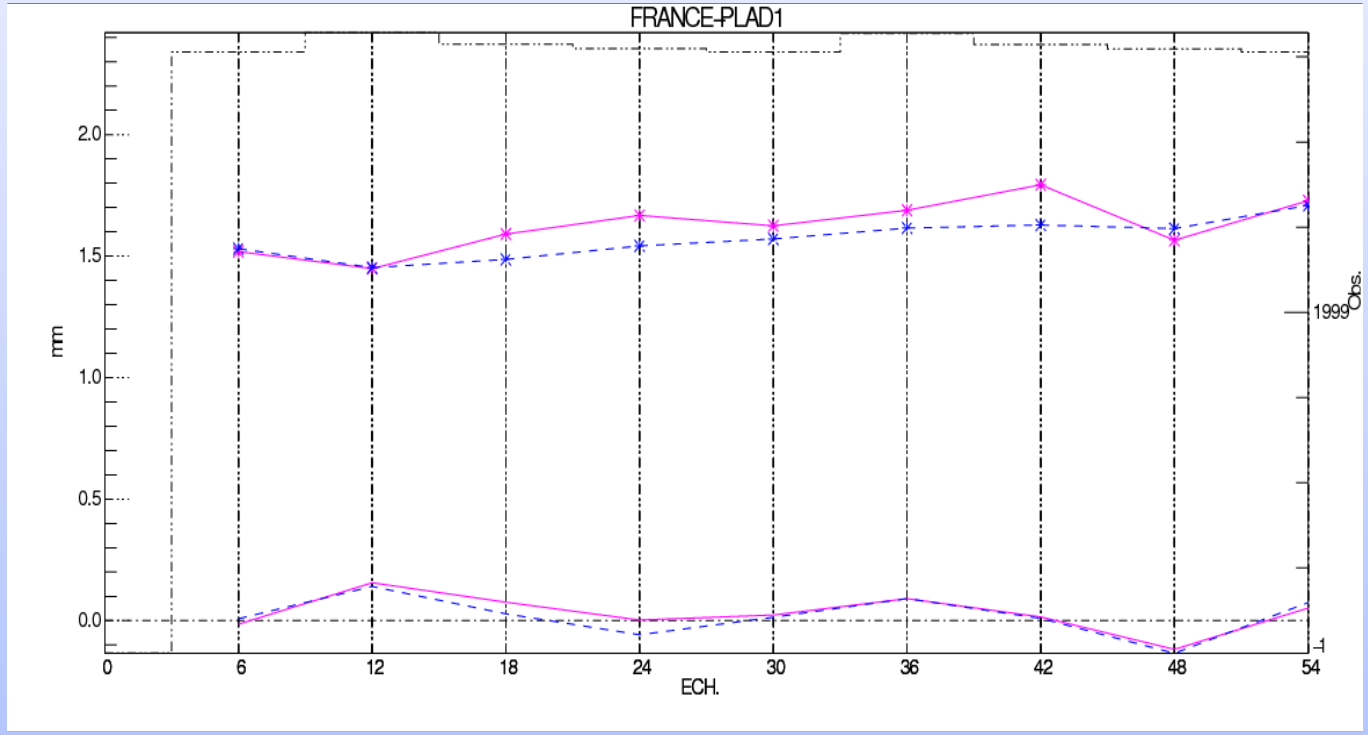
- observable improvements in wind found for some cases

Sigmab's "of the day" - scores

RMSE RH vs. TEMP



RMSE precipitation vs. SYNOP



- improvements in humidity, leading to improvements in precipitation

Conclusions (1)

- spatially varying sigmab's have been implemented and tested in the Aladin 3D-Var
- compared to spatially uniform (climatological) sigmab's, spatially varying (climatological) sigmab's enable local data density effects to be represented
- compared to climatological sigmab's, ensemble sigmab's "of the day" enable both data density and flow-dependent effects to be represented

Conclusions (2)

- clim vorticity sigmab's + Undén's humidity sigmab's:
  - nearly neutral impact globally, but with some predominant positive impacts on wind and humidity forecasts
- flow-dependent ξ sigmab's + Undén's humidity sigmab's:
  - nearly neutral impact globally, but with some predominant positive impacts on +12h low-level T bias, +36h/+48h low-level wind/T and also humidity + precipitation forecasts

Perspectives

- consider the operational use of these two approaches, and in particular the second one to account for flow – dependencies
- consider a later extension of flow-dependent ensemble sigmab's to humidity
- extensions to flow-dependent ensemble horizontal and vertical correlations

Thank you for attention!