A diagnostic study of

time variations of regionally-averaged background error covariances

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Overview

1. Introduction
2. Seasonal variation of covariances
3. Day-to-day variation of covariances (winter)
4. Diurnal cycle variation (summer)
5. Conclusions

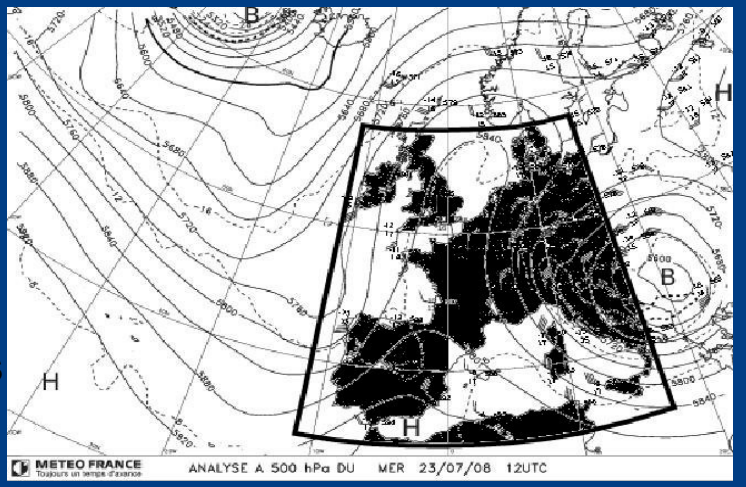
Introduction

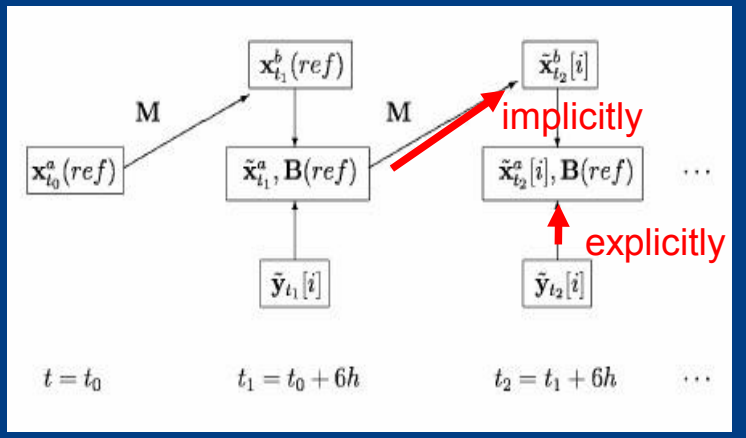
Motivation: *relaxation of stationarity assumption (flow dependency)*

Experimental framework:
ALADIN/France domain (60 levels)

Two REnDA were considered *per season (W1, W2, S1 and S2),*
to check the robustness of covariance estimates:
- 6 members
- different (explicitly) independently perturbed observations sets
- 6 hour (implicitly) perturbed forecasts as background
- perturbed coupling files from AEARP

Two periods (30 days):
- Winter (2008): 12 Feb->13 March
- Summer (2008): 3Jul->2 Aug





Introduction

Diagnostic parameters:

Standard deviations and spectral decomposition of variance

horizontally-averaged standard deviation of background error, $\sigma_b(z)$

horizontally-averaged background error variance spectra, $v_b(K^*, z)$

Horizontal and vertical correlations

horizontal length-scales of background errors, $\mathcal{L}_z$

vertical auto-correlations of background errors, $\rho(z,z')$

Model variables:

specific humidity, temperature, divergence, vorticity

Seasonal variation

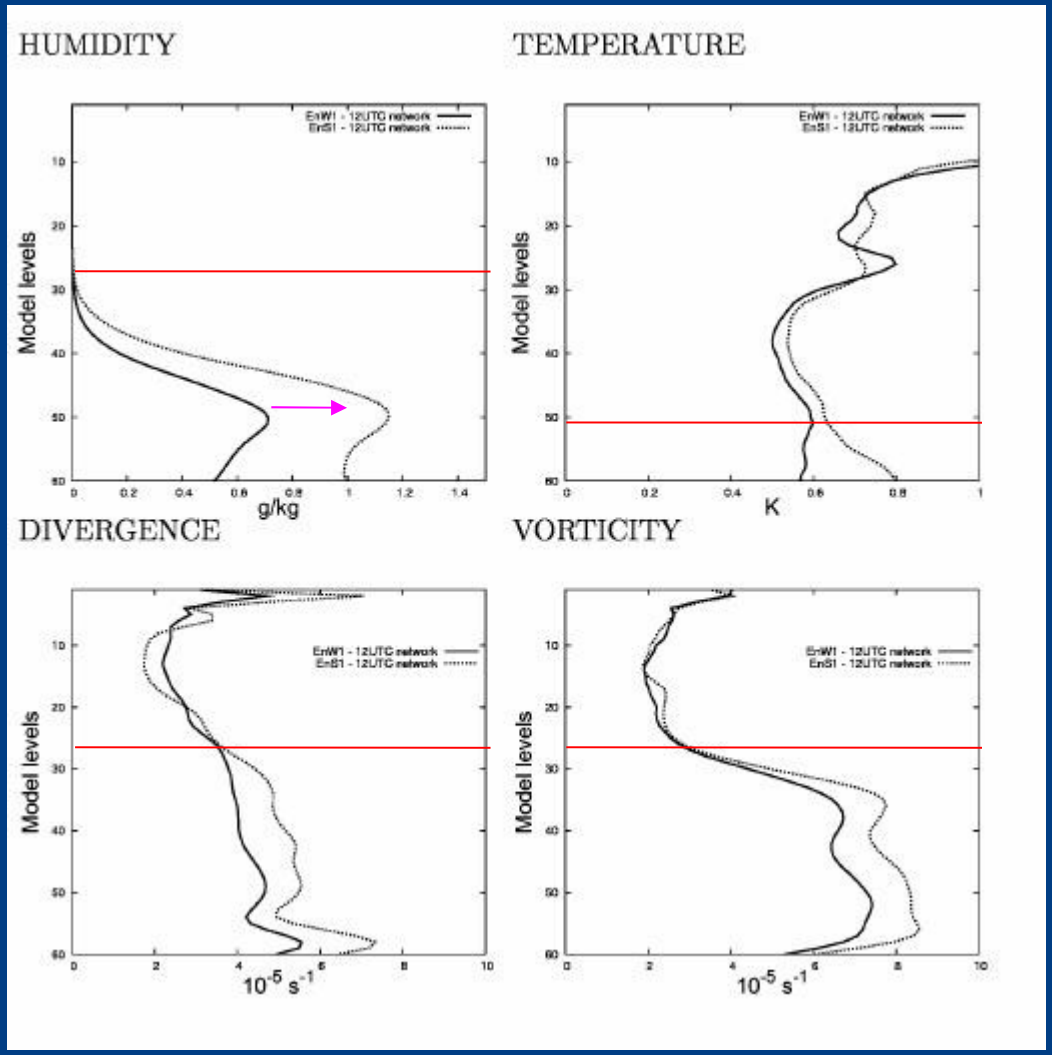
Profiles of horizontally-averaged

STANDARD DEVIATIONS

ALADIN/France 6 hour forecast errors (issued from the 12UTC network, and valid at 18UTC)

→ first ensemble in WINTER (full)

→ first ensemble in SUMMER (dashed)



Seasonal variation

Top panels:

500hPa horizontal VARIANCE SPECTRA

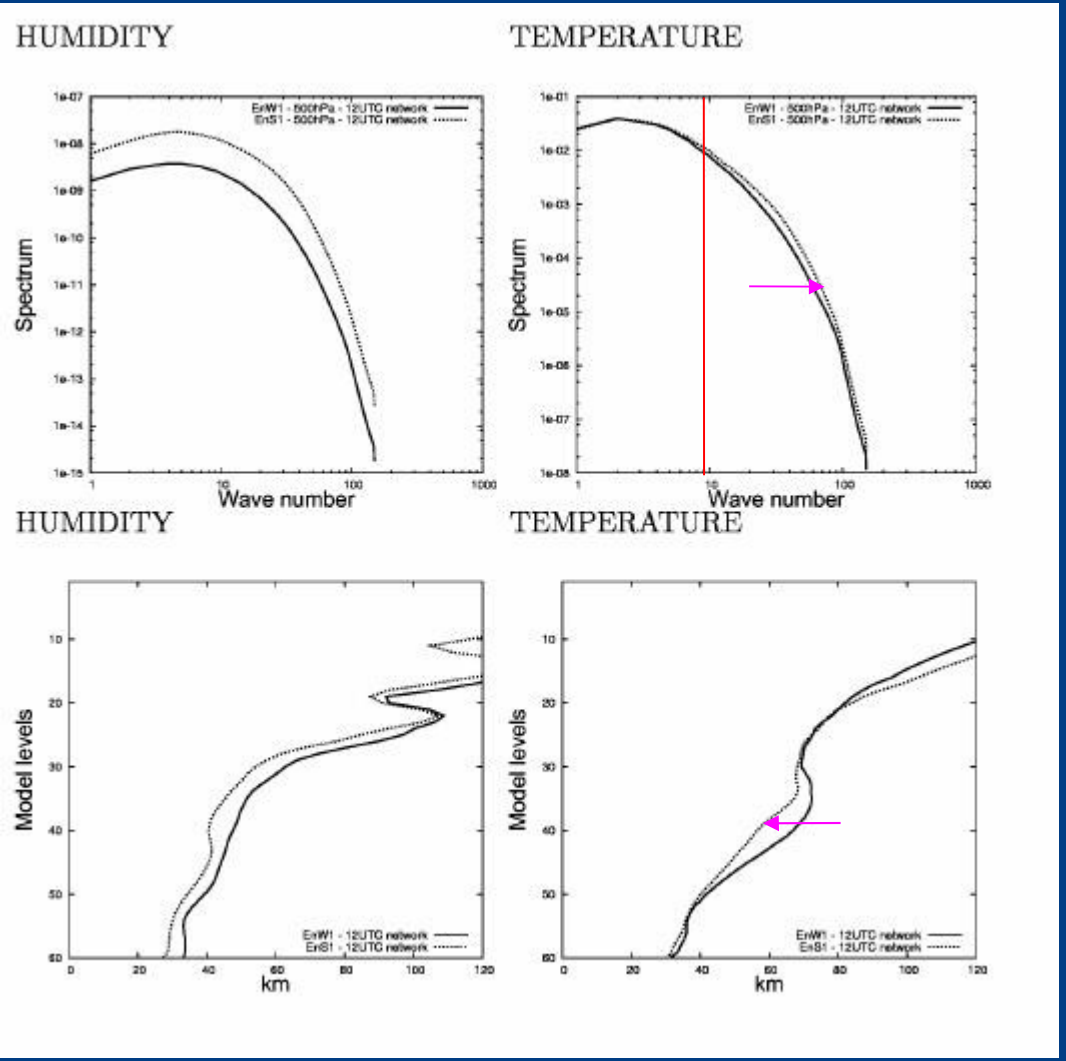
Bottom panels:

Profiles of horizontal LENGTH-SCALES

ALADIN/France 6 hour forecast errors (issued from the 12UTC network and valid at 18UTC)

→ first ensemble in WINTER (full)

→ first ensemble in SUMMER (dashed)



Seasonal variation

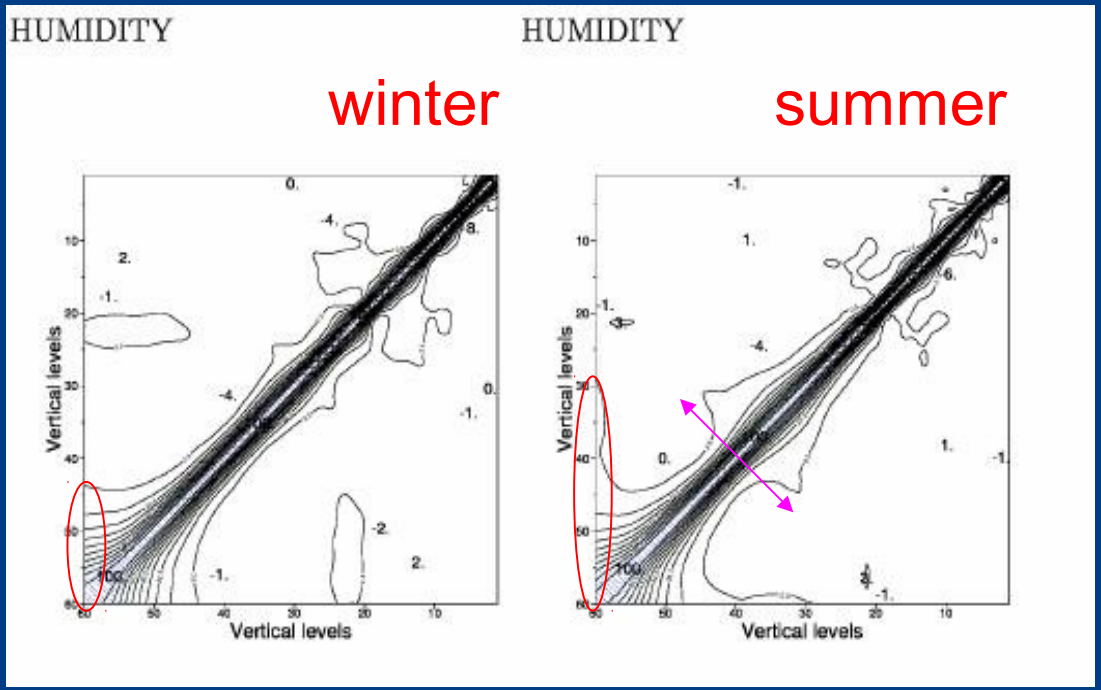
VERTICAL AUTO-CORRELATIONS (specific-humidity)

ALADIN/France 6 hour forecast errors (issued at 12 UTC and valid at 18UTC)

→ first ensemble WINTER (left)

→ first ensemble SUMMER (right)

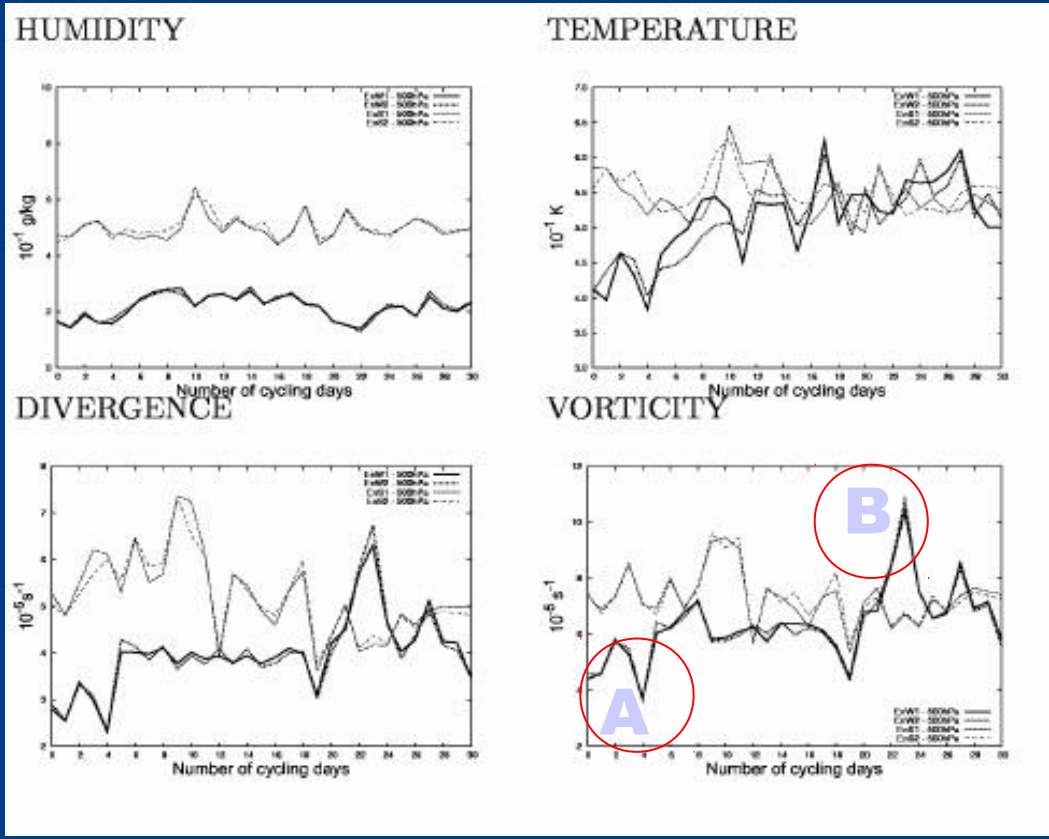
The isoline spacing is 10%



Day-to-day variation (winter)

Time evolution of 500hPa horizontally averaged STANDARD DEVIATIONS

ALADIN/France 6 hour forecast errors (issued from the 12UTC network and valid at 18UTC)



→ **W1, W2 for WINTER (full)**
→ **S1, S2 for SUMMER (dashed)**

Two contrasting cases were studied using two independent ensembles per season:

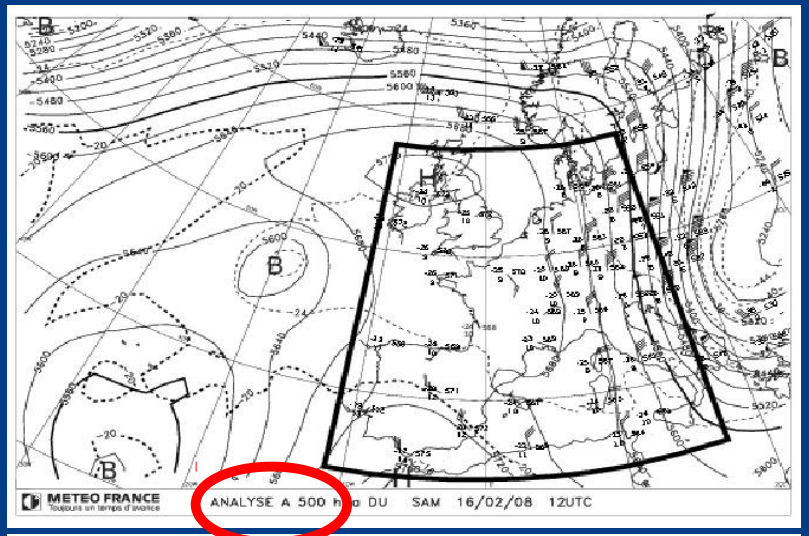
A. WINTER – day 4: *smallest variance values of wind and temperature*

B. WINTER - day 23: *standard deviation is even larger than in summer days (due to a winter cut-off low)*

Day-to-day variation (winter)

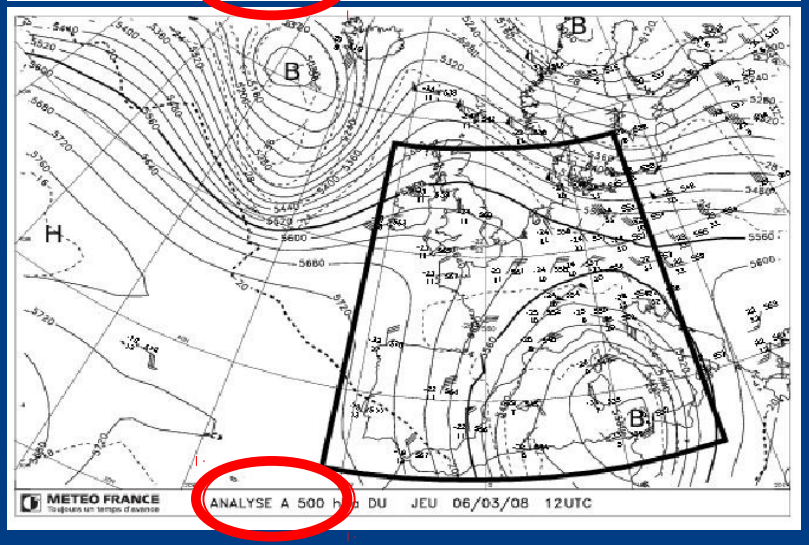
CASE A (WINTER – day 4)

16th Feb 2008: stable anticyclonic situation



CASE B (WINTER – day 23)

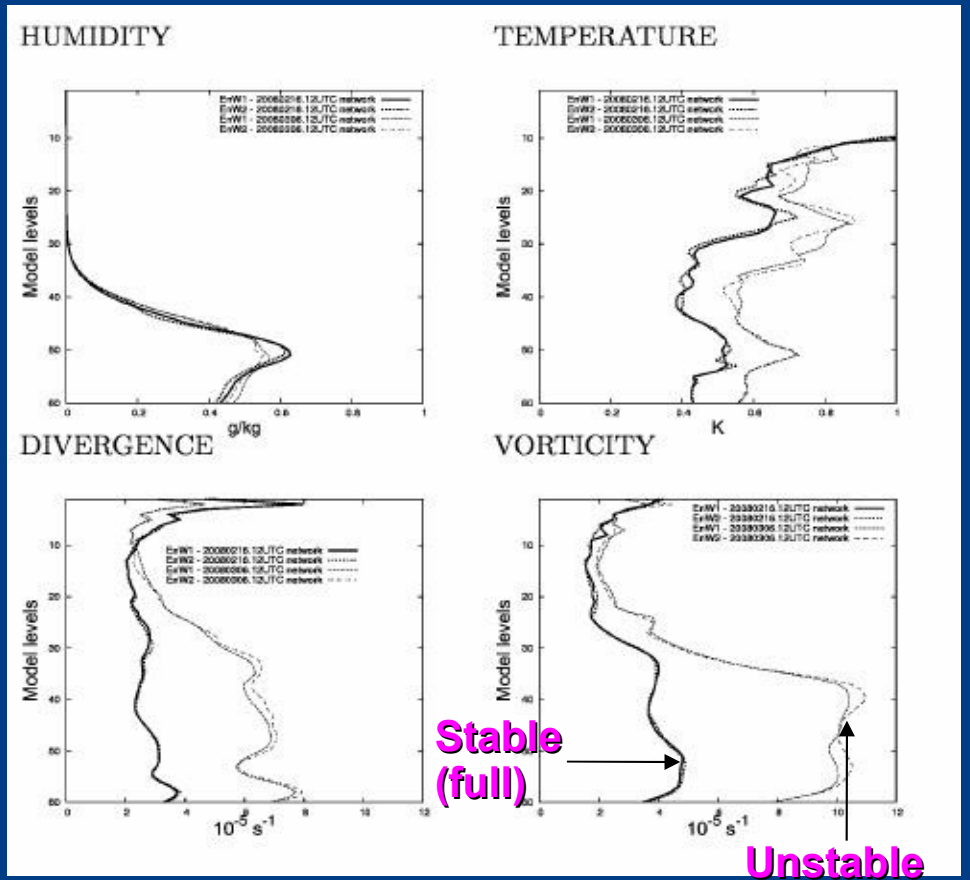
6th of March 2008: unstable high cut-off low



Day-to-day variation (winter)

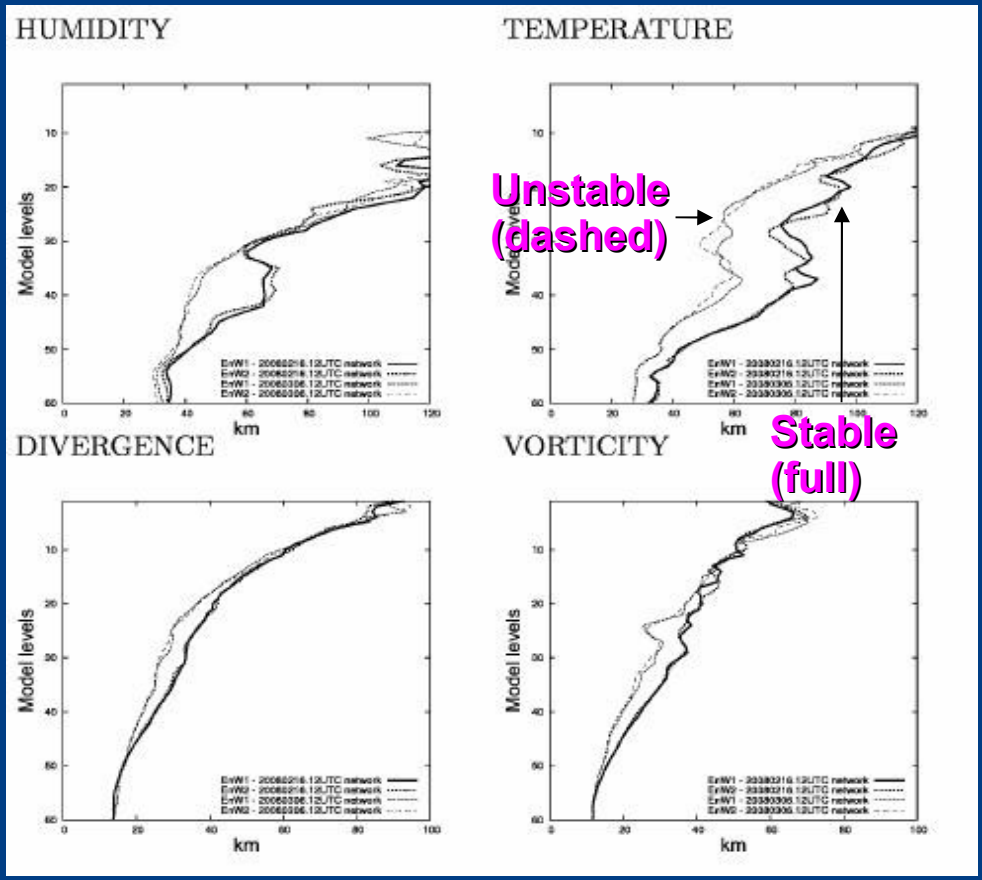
Profile of horizontally-averaged

STANDARD DEVIATIONS



Profile of horizontal

LENGTH-SCALES



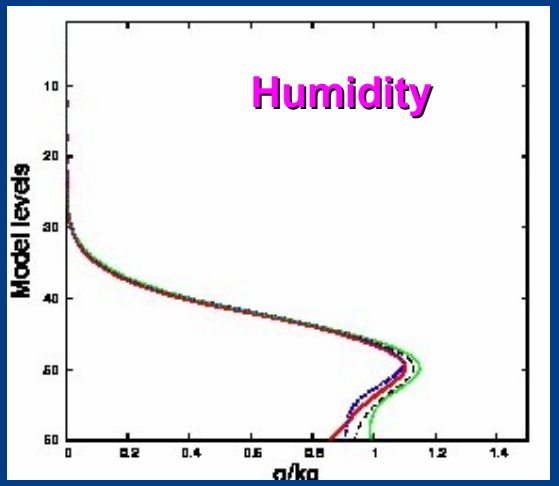
Diurnal variation (summer)

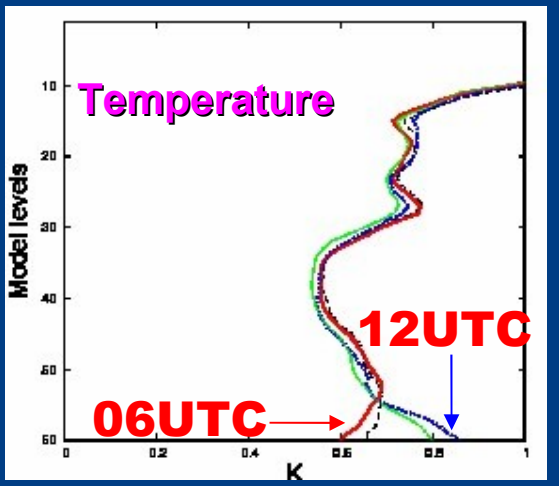
Profiles of horizontally-averaged STANDARD DEVIATIONS over a seasonal period

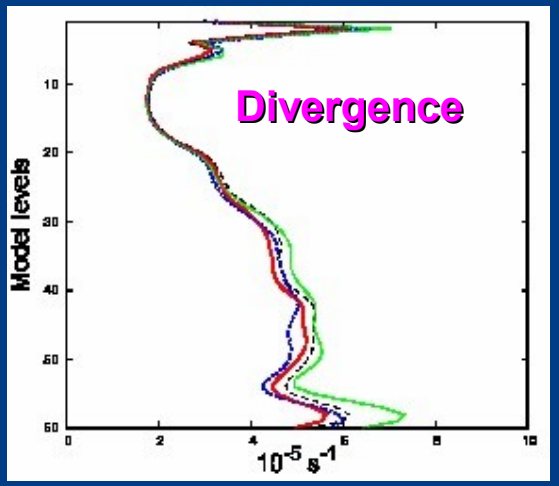
ALADIN/France 6 hour forecast errors

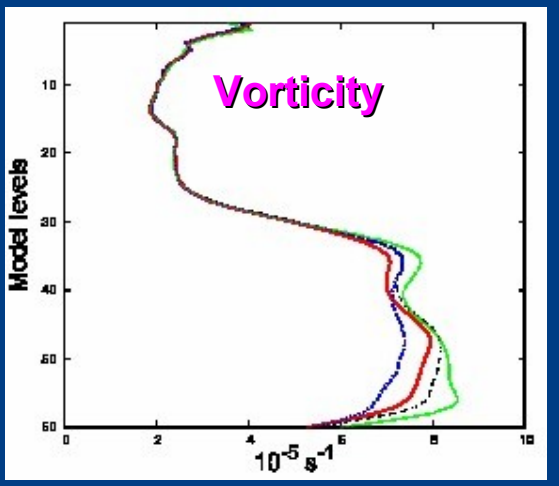
All networks (diurnal cycle):

→ valid at 00UTC
→ valid at 06UTC
→ valid at 12UTC
→ valid at 18UTC







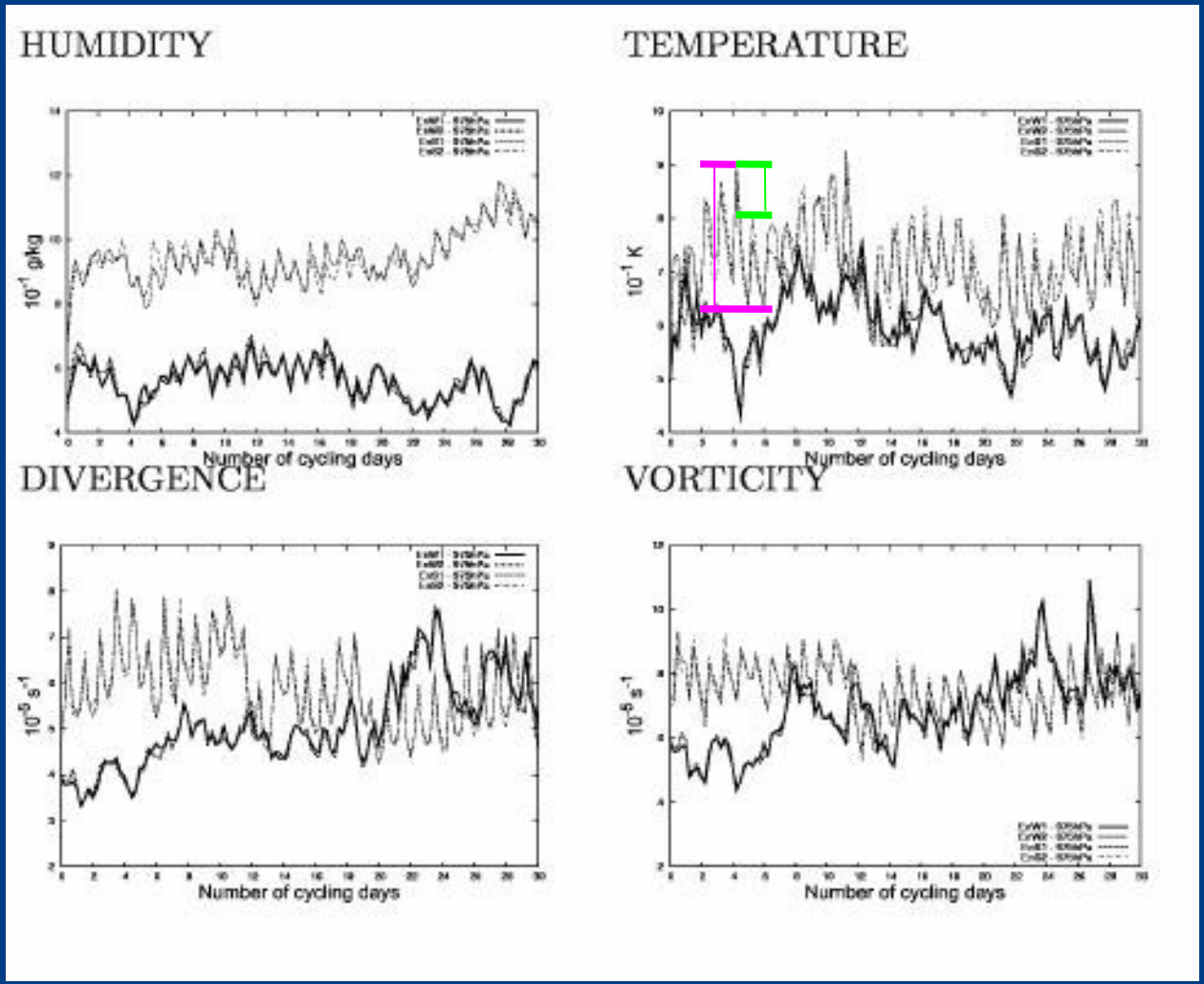


Diurnal variation (summer)

Time evolution of 975hPa (PBL) horizontally averaged STANDARD DEVIATIONS

→ **Diurnal** variation
→ **Day-to-day** variation

ALADIN/France 6 hour forecast errors (valid at all networks: 00UTC, 06UTC, 12UTC and 18UTC)

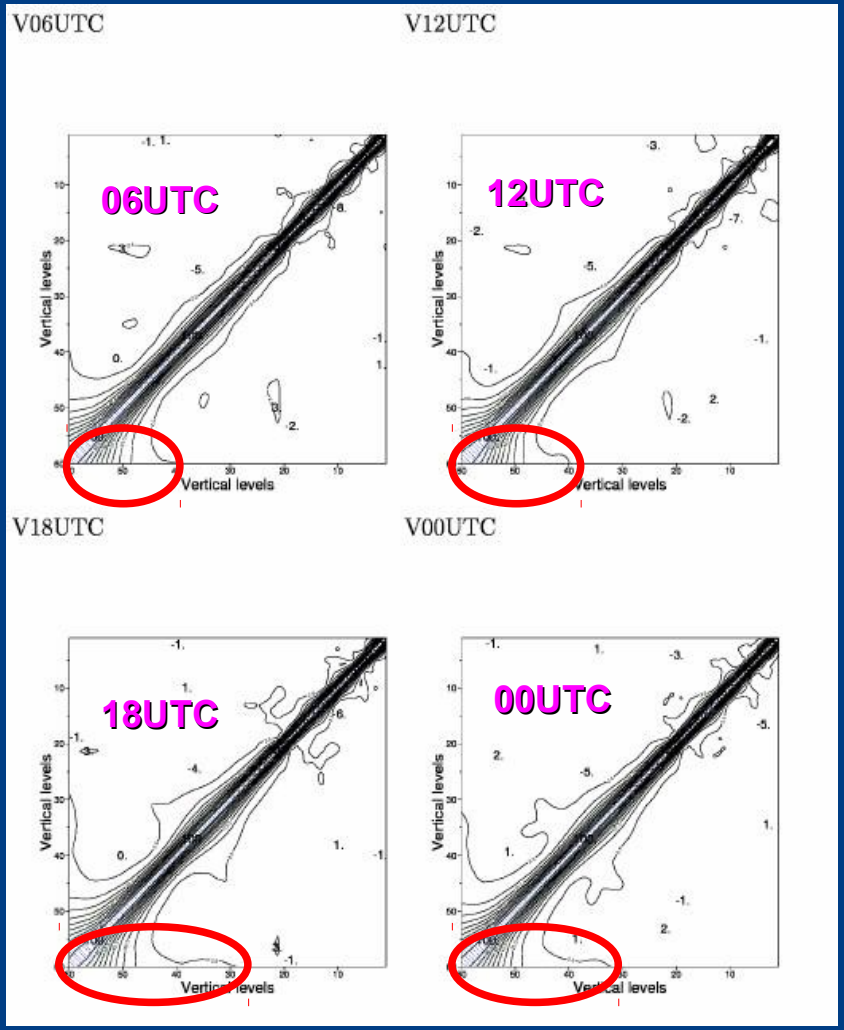


Diurnal variation (summer)

Seasonal averaged
VERTICAL AUTO-CORRELATIONS
(specific-humidity)

ALADIN/France 6 hour forecast errors valid at specified hour

The isoline spacing is 10%



Conclusions

Error covariance variations have been found:

- **Season: winter → summer** *variances are larger and length-scales are smaller; this feature reflects implications of increased convective activity in summer*
- **Day: in connexion with the synoptic situation** *variances are larger and length-scales are smaller in the cyclonic situation (versus anticyclonic); and can be even more pronounced than seasonal variations*
- **Hour: related to diurnal cycle** *mainly in the boundary layer during summer in accordance with expected effects of convective activity in the afternoon*

Besides, **all these time-dependent covariance estimates appear to be robust with a 6-member ensemble** *therefore these results support the idea to represent these time variations by using a real time ensemble data assimilation system*

Conclusions

Foreseen work:

- **Impact studies by representing these time variations on the reference data assimilation system**
- **To extend this study of time variations to heterogeneous covariance estimates, provided by a wavelet formulation for instance**