Impact of observation density in data assimilation: A study with simulated observations

(QJRMS, 2003, October)

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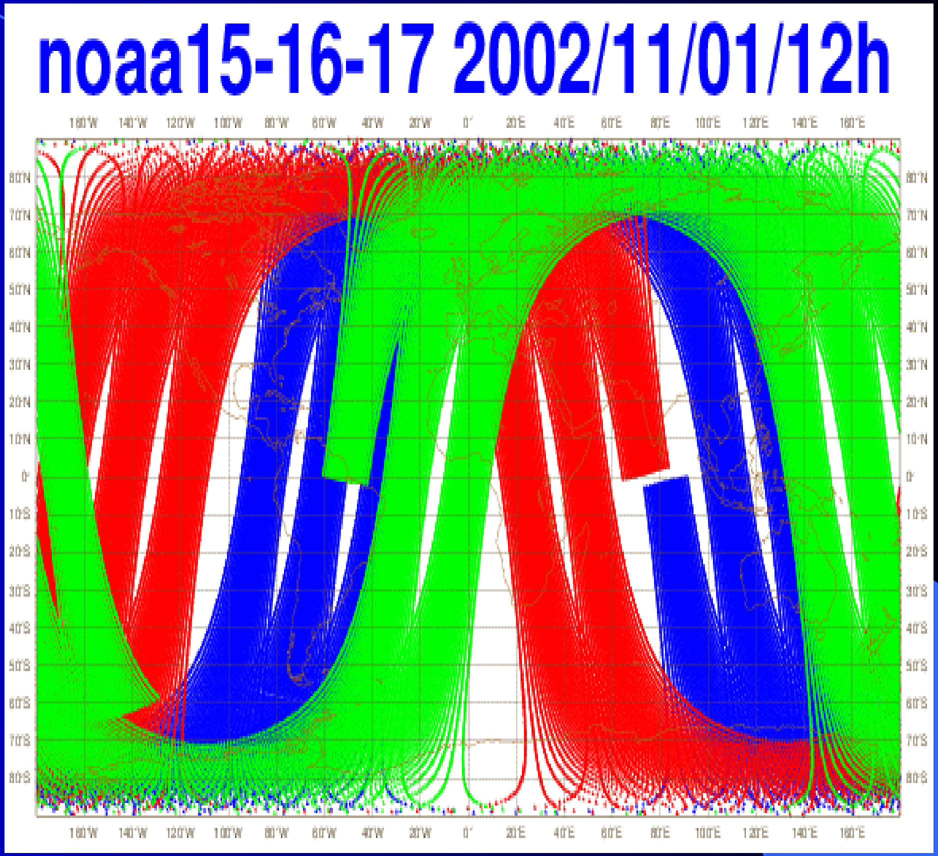
Rationale

- Increasing number of satellite data. But only 10% ~ 20% are used by QC and sampling of data.

- Question: How to determine an optimal sampling distance?



Conclusions of a 1D-study (Liu and Rabier, QJRMS, 2002)

- For uncorrelated obs error, increasing the obs density improves the analysis
- For correlated obs error
  - Increasing the obs density yields little improvement beyond a given threshold, even with an optimal DA scheme
  - It can even degrade the analysis for a suboptimal scheme not taking into account correlations
  - An optimal sampling can extract most of the information contained in the data

3D-study

- ARPEGE, 6h-4DVAR Multi-incremental
- Resolution T199C3.5L31/T42-63-95C1.0L31
- Interesting synoptic cases, including:
  - The second french storm (27/12/1999)
- Simulated Observations (OSSE).
- Impact of obs density with or without correlation on analysis and forecast. The current DA system does not take into account obs error correlation.

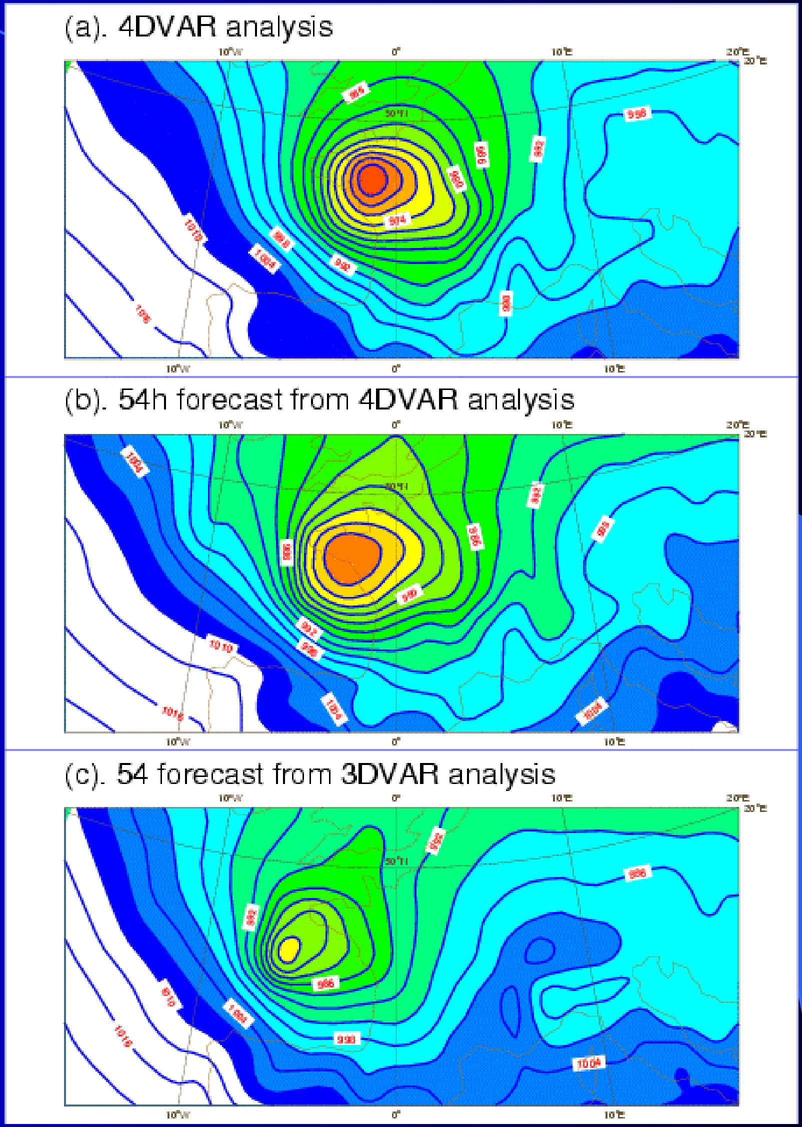
The storm: 27/12/1999, 18Z

4DVAR analysis

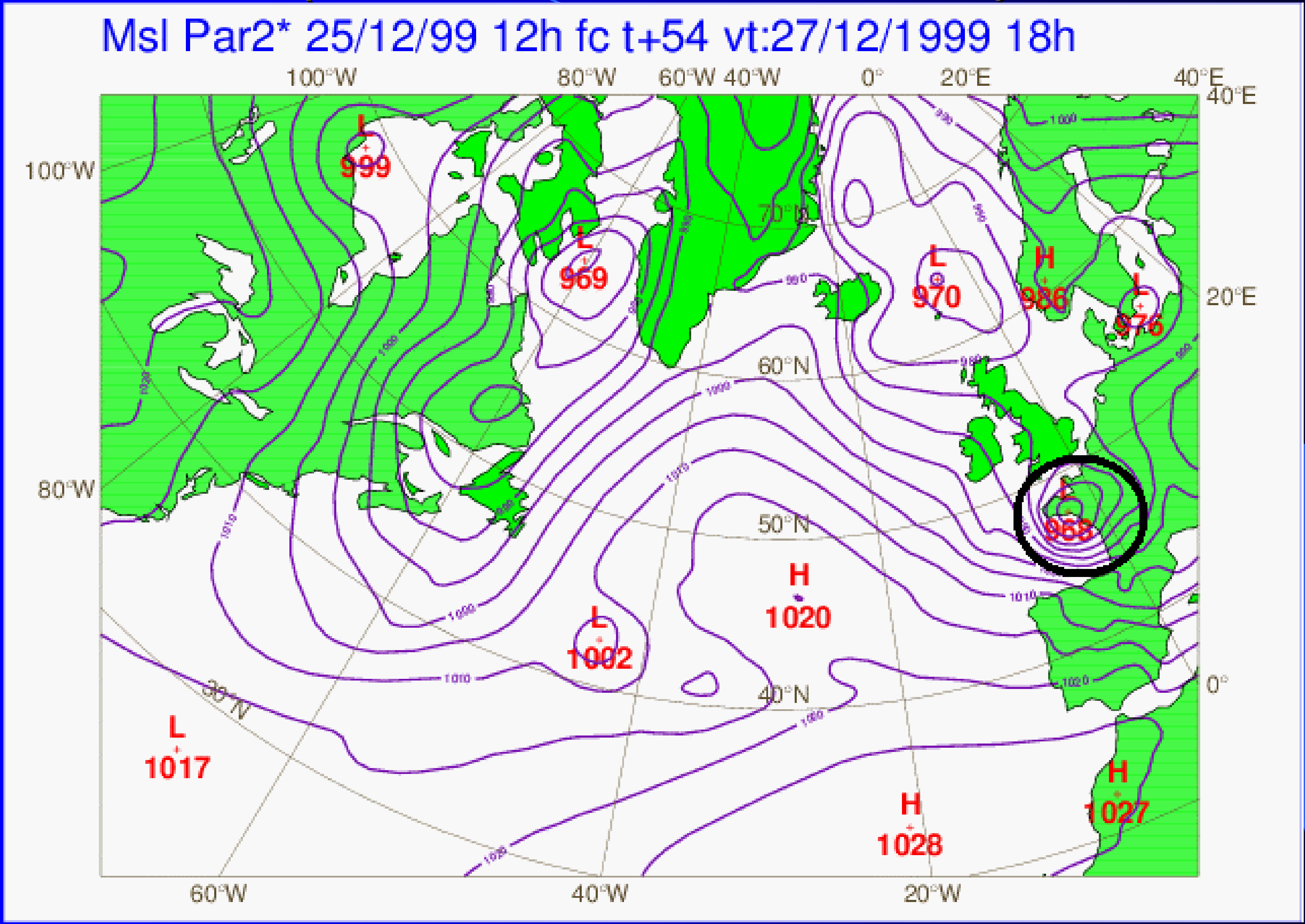
962hPa

54h 4DVAR 968hPa
« truth»

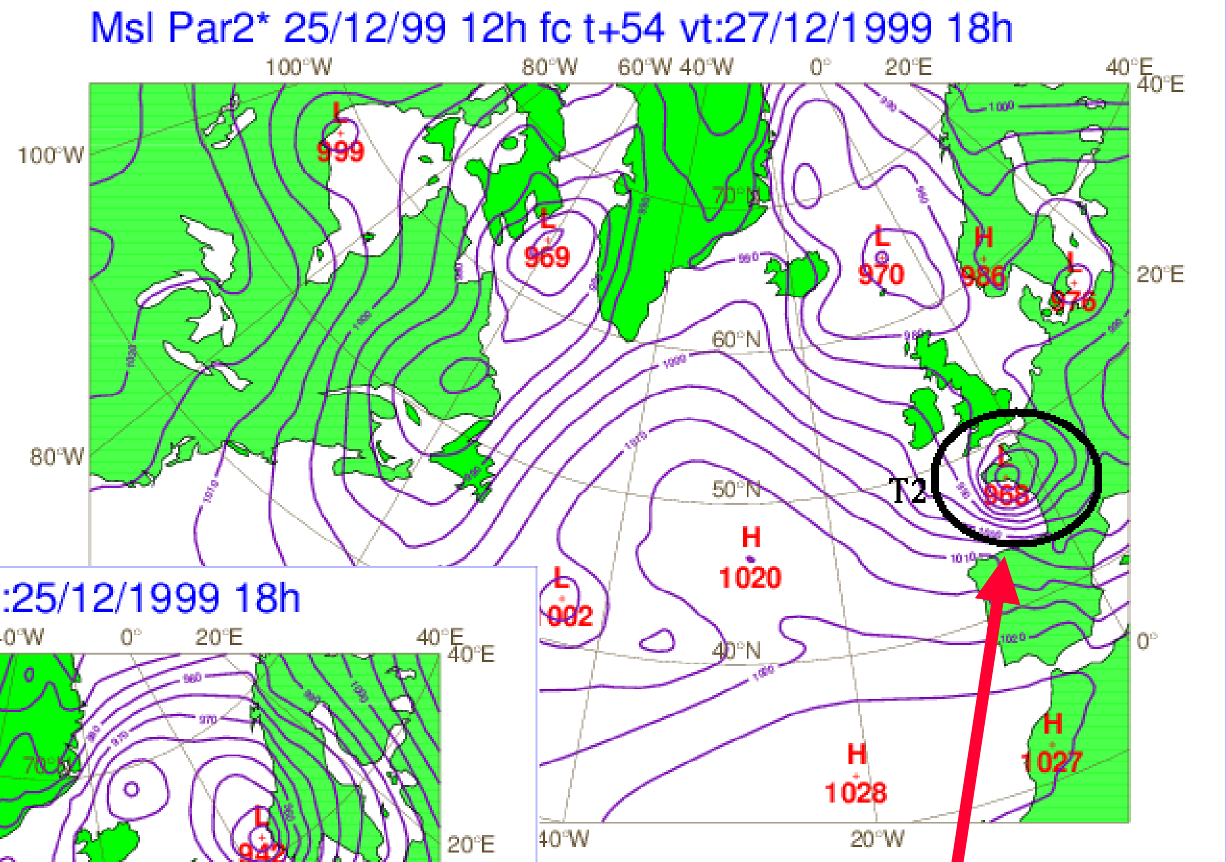
54h 3DVAR 975hPa
« background »

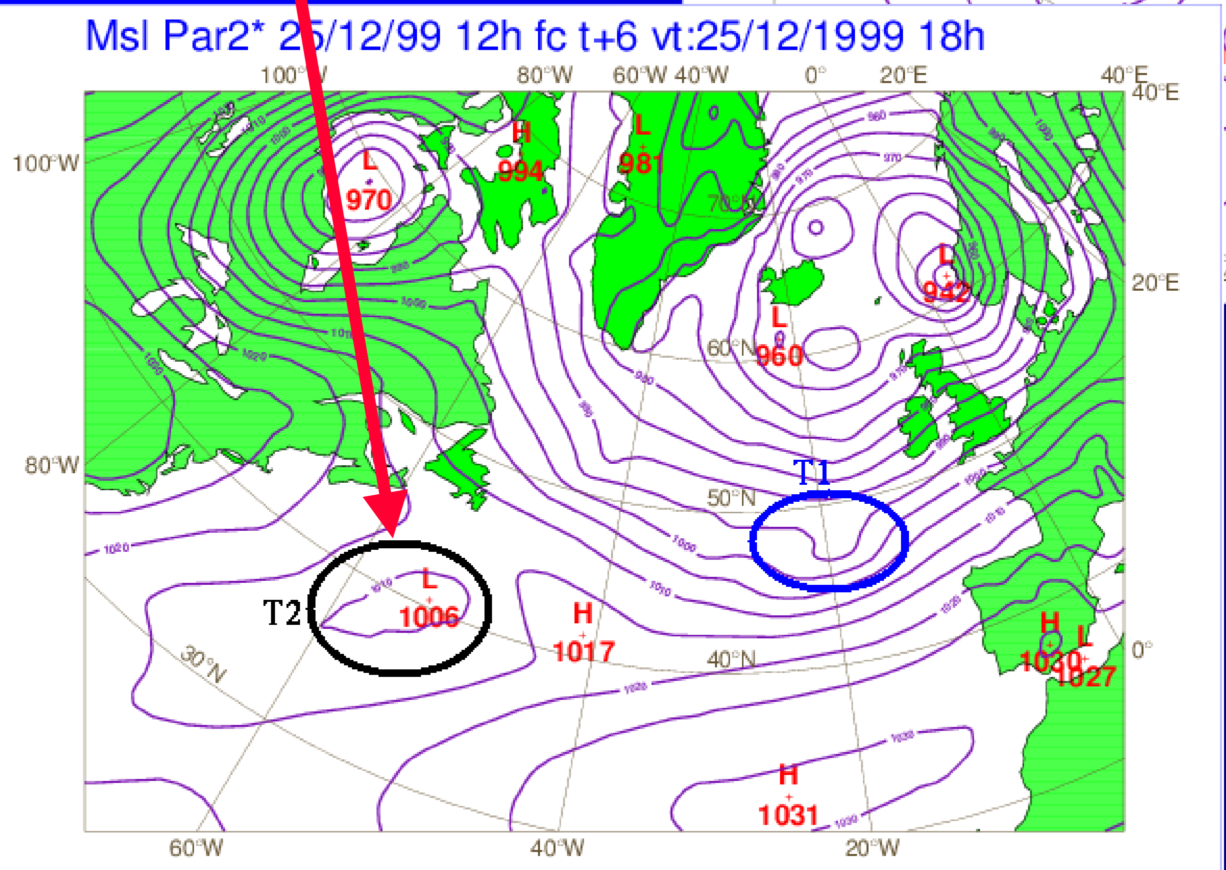


Movie of the two storms
(12Z/25/12/99 ~18Z/27/12/99)



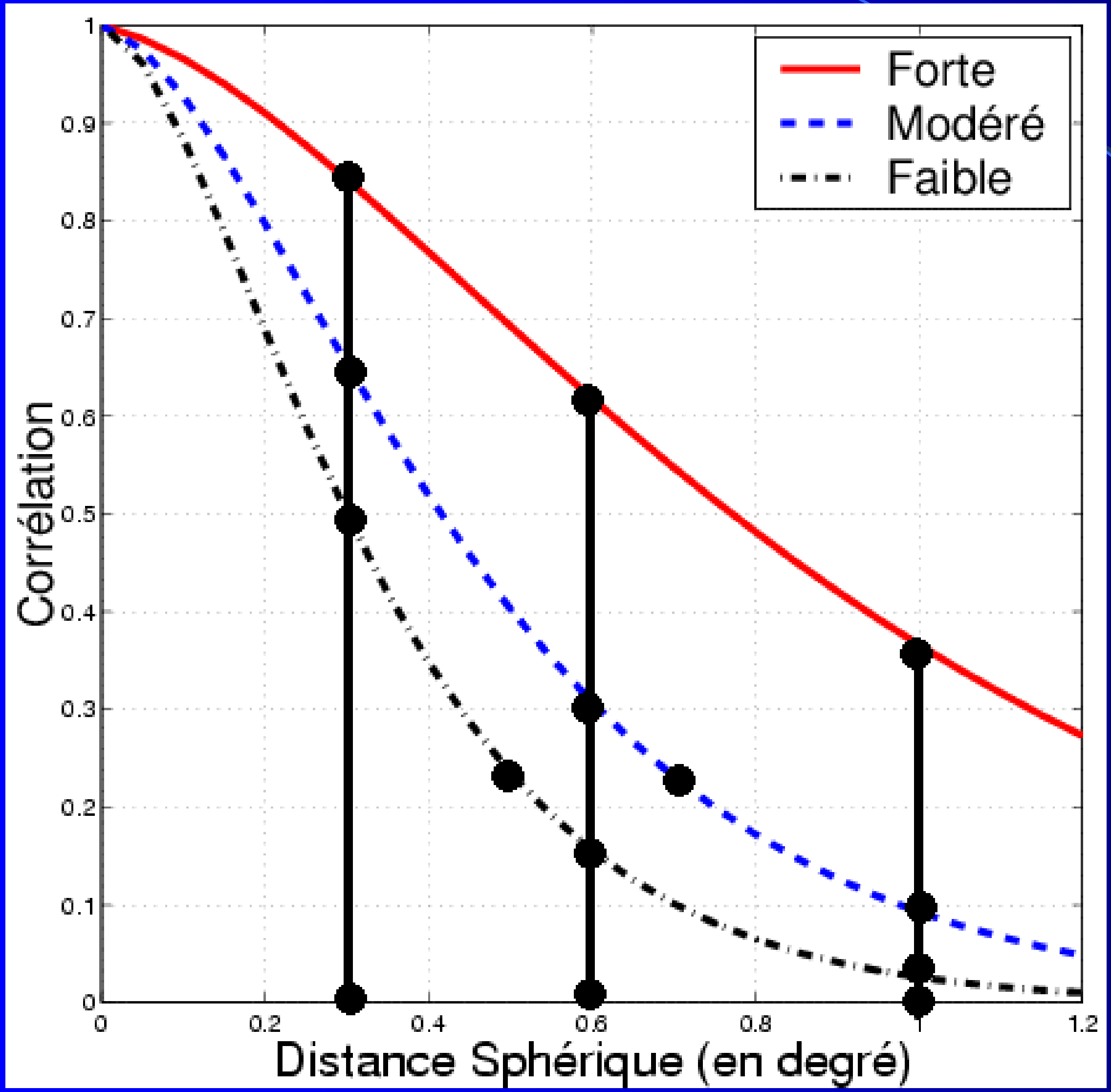
Obs simulated in the sensitive area 48h before the storm (using adjoint computations)





Area of interest

Simulated obs error correlation model



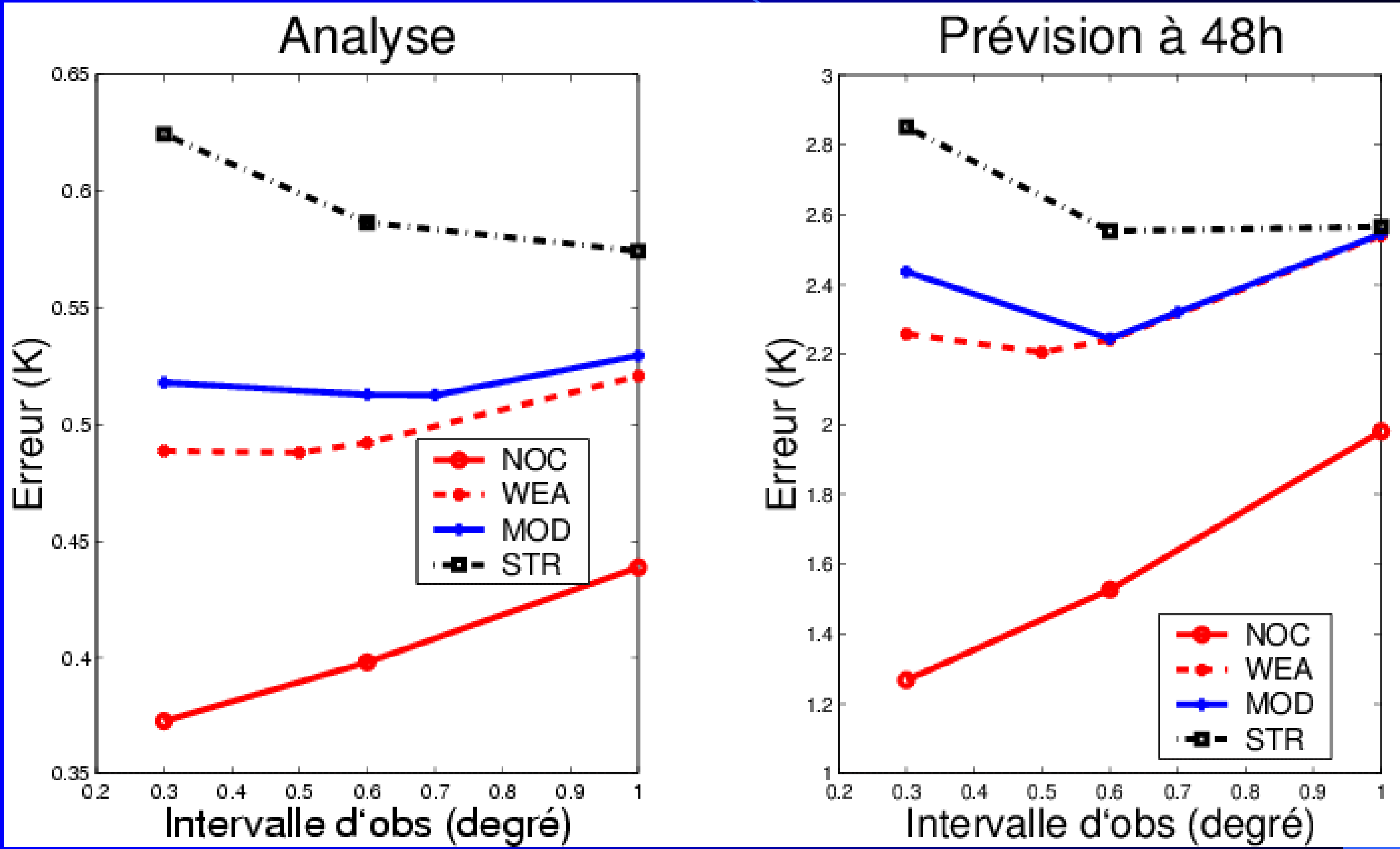
1. T (31levels) + Ps

2. Only in the sensitive area (3066 gridpoints)

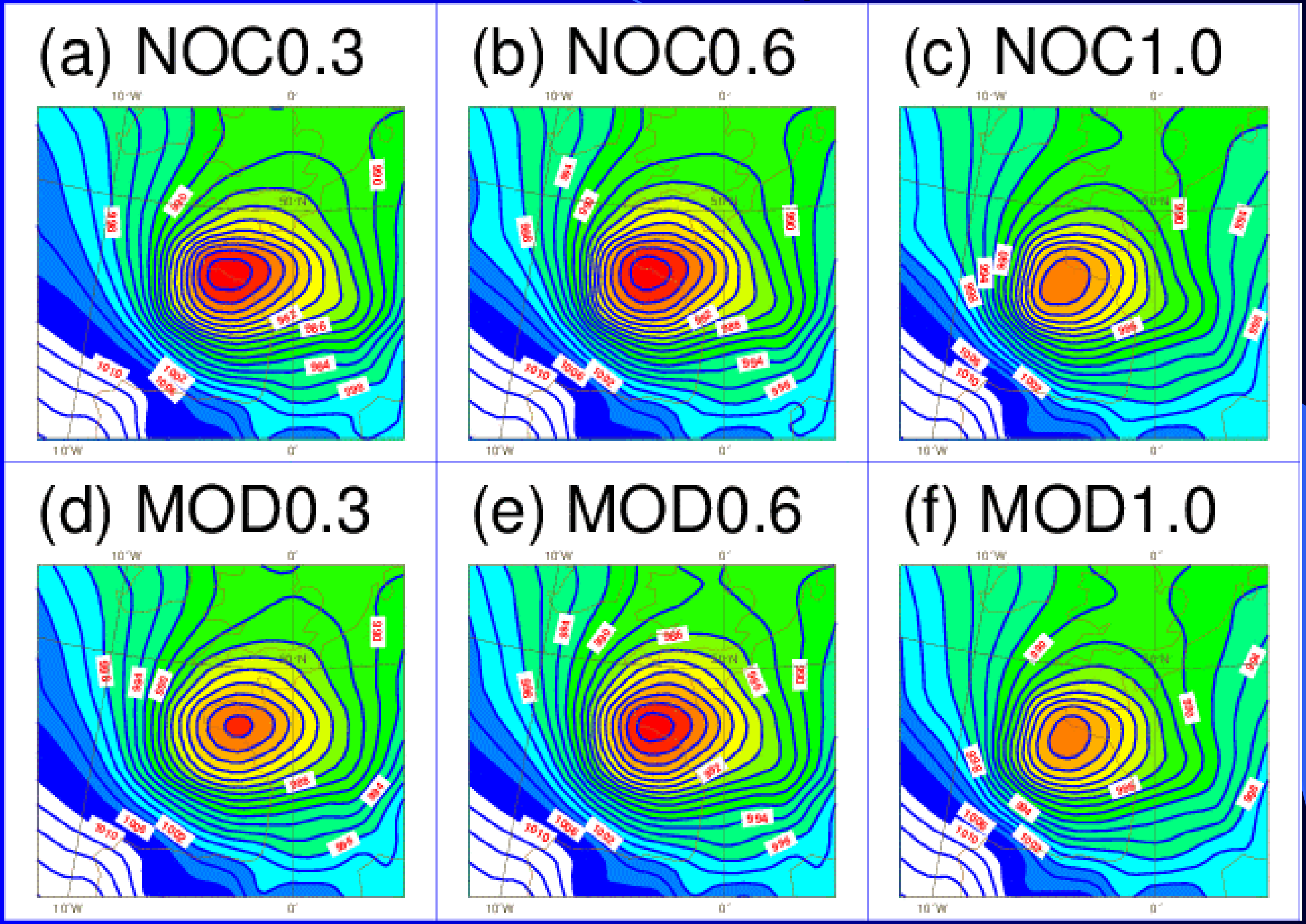
3. Isotropic Correlation

4. 14 experiments with 10 random realisations each

Averaged T error
(all levels, 10 realisations)



Forecasts for 6 experiments (mean over 10 realisations)



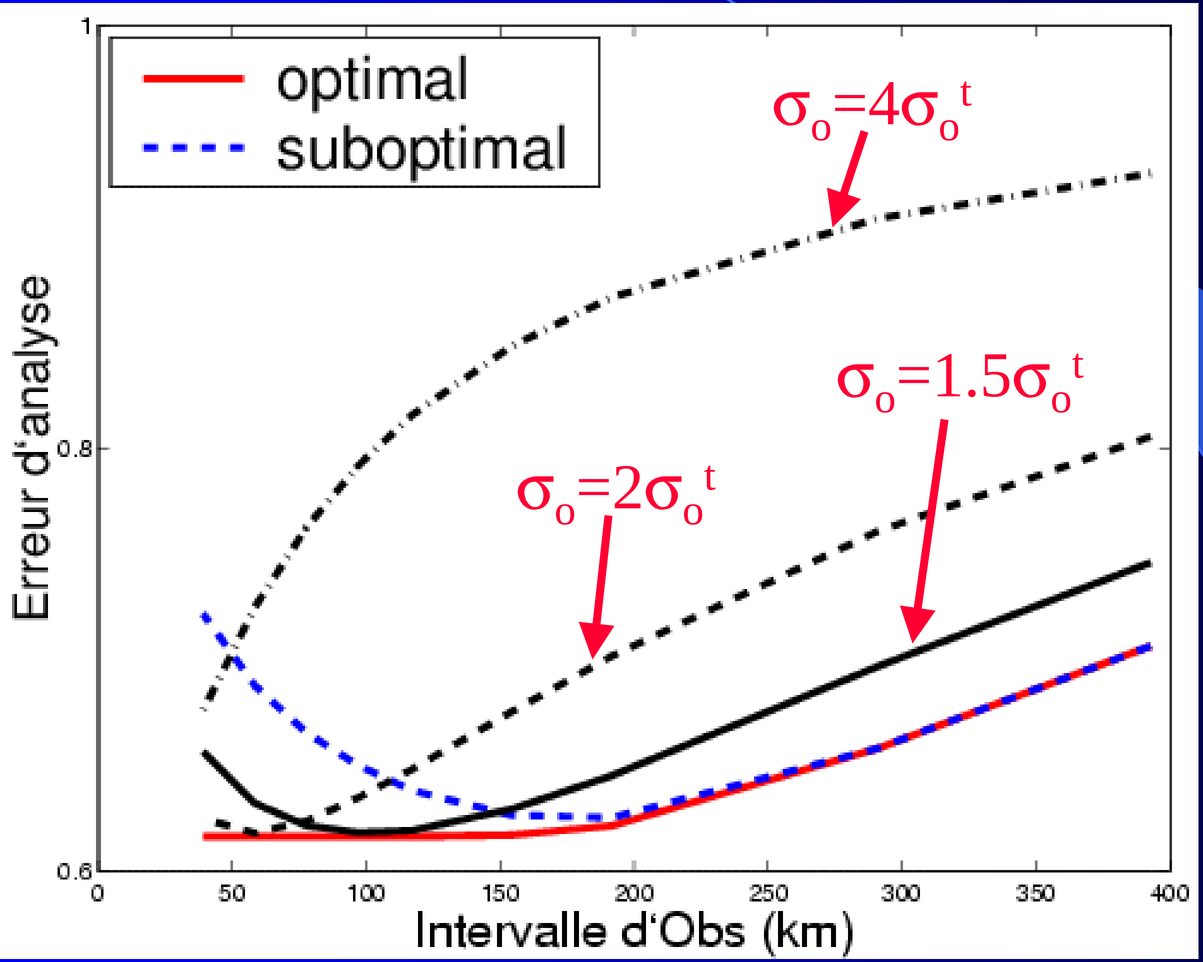
Conclusions

- Confirmation of the 1D results. A correlation around 0.2 could provide an optimal sampling.
- High density data in sensitive areas are important for the forecast. There does not seem to be a limit set by L_b or Δx.
- A low vertical resolution does not prevent the use of high horizontal density data.

Other options for using the correlated obs

- Sampling or averaging obs?
- Modelling obs error horizontal correlation
- Inflating obs error σ_o specified in the obs error covariance matrix.

Inflating obs error



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