

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

(QJRMS, 2003, October)

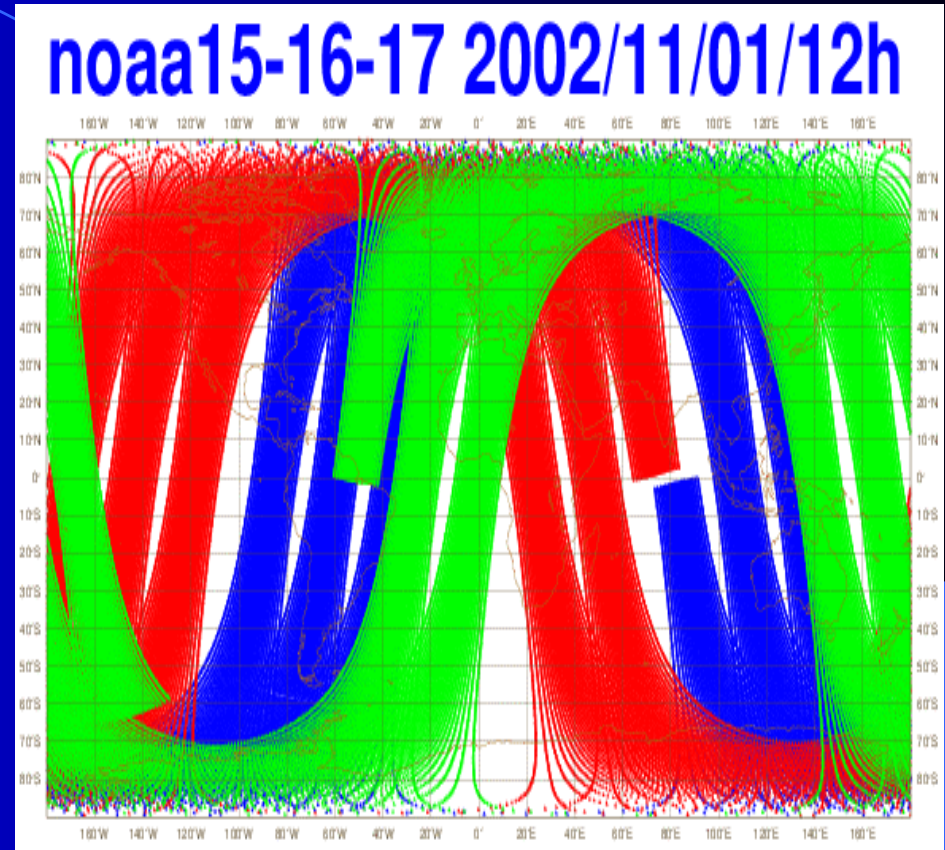
Zhiquan Liu*, Florence Rabier

Météo-France

*: Now at National Satellite
Meteorological Center, Beijing, China

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

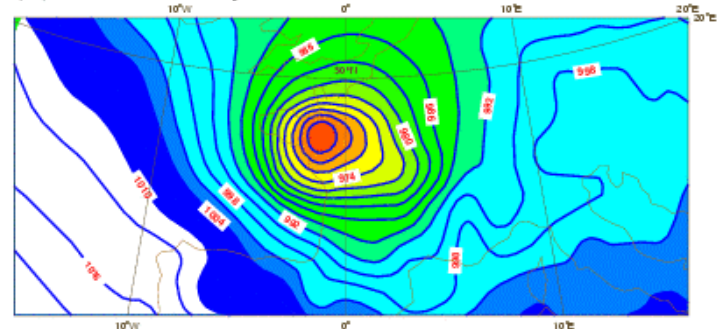
4DVAR analysis

962hPa

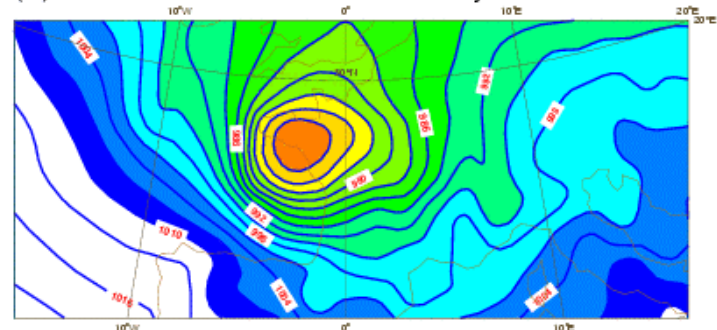
54h 4DVAR 968hPa
« truth »

54h 3DVAR 975hPa
« background »

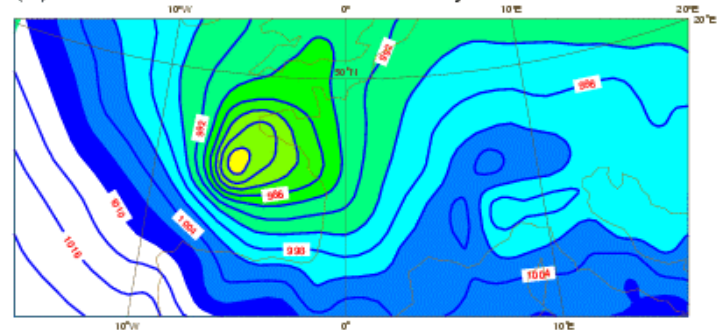
(a). 4DVAR analysis



(b). 54h forecast from 4DVAR analysis

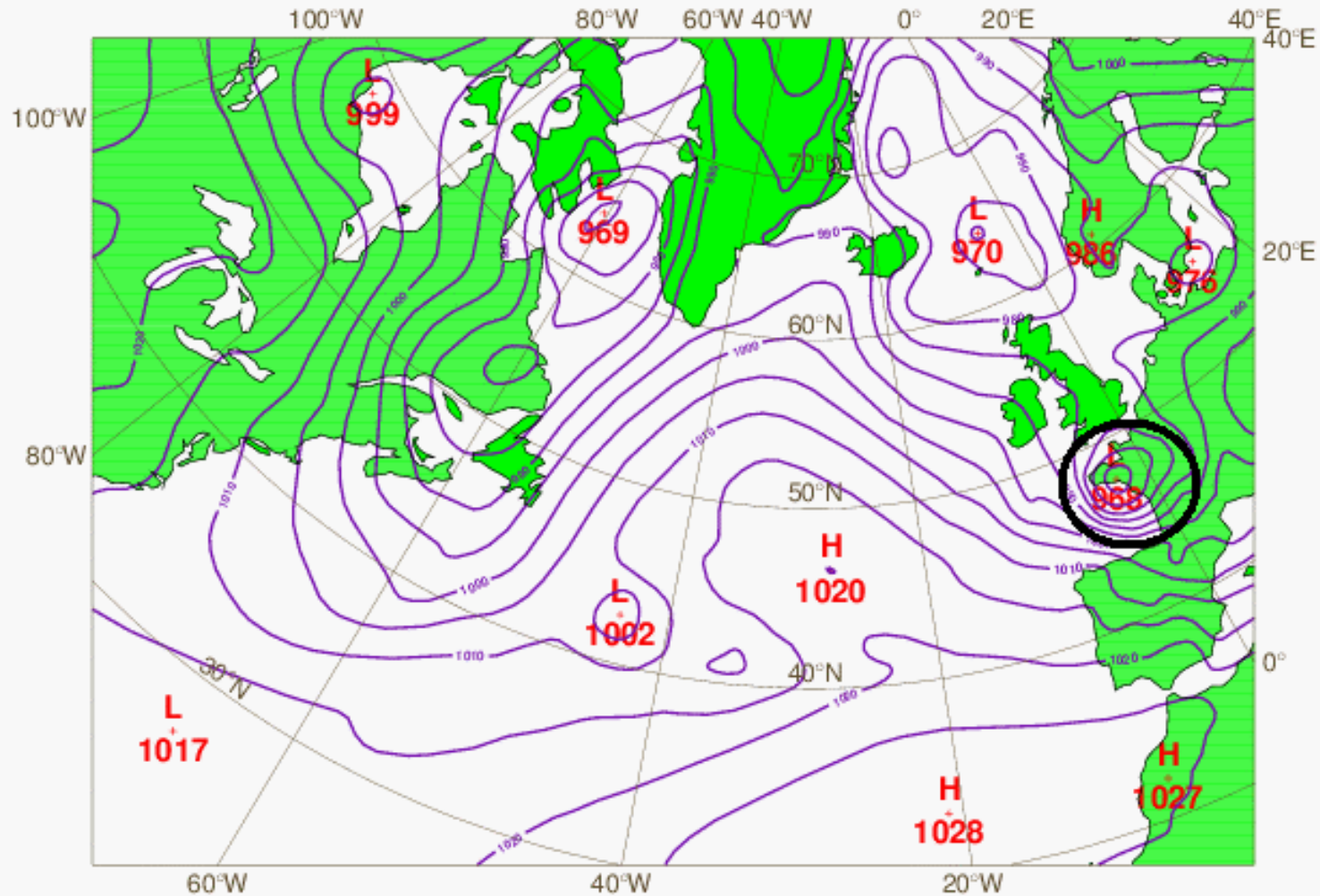


(c). 54 forecast from 3DVAR analysis



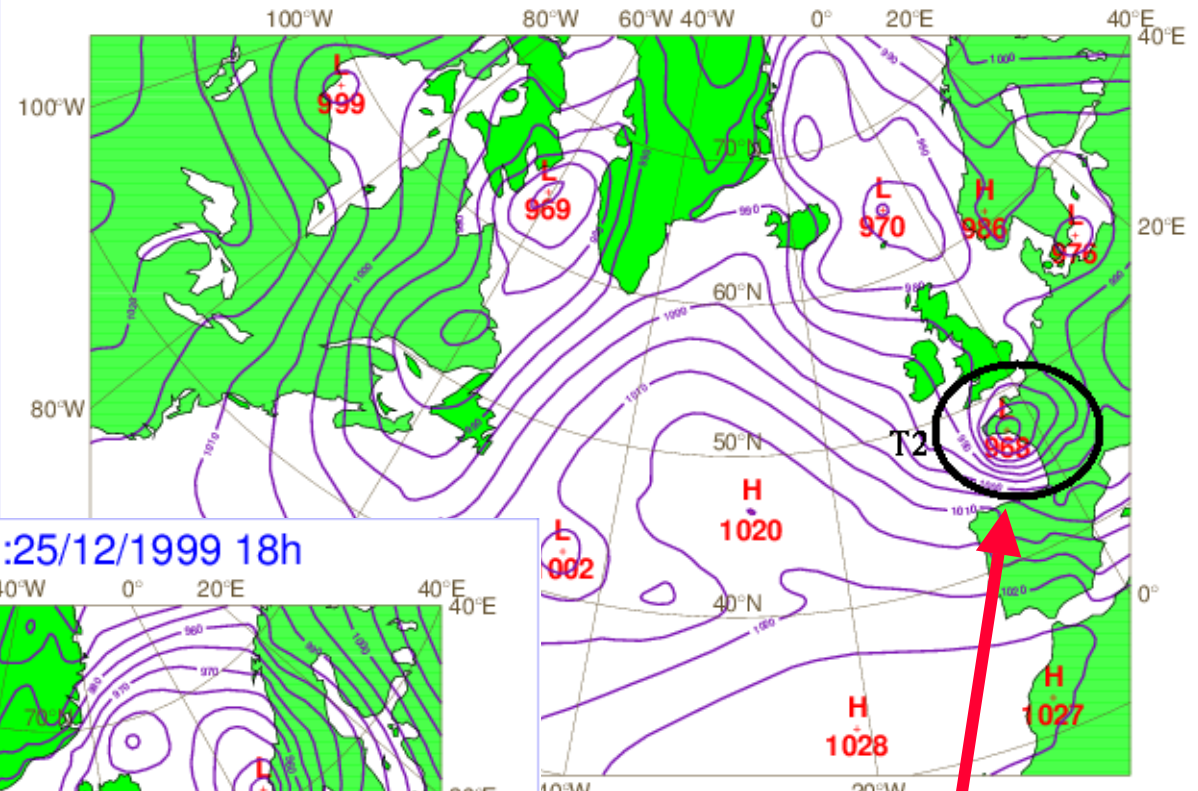
Movie of the two storms (12Z/25/12/99 ~ 18Z/27/12/99)

Msl Par2* 25/12/99 12h fc t+54 vt:27/12/1999 18h

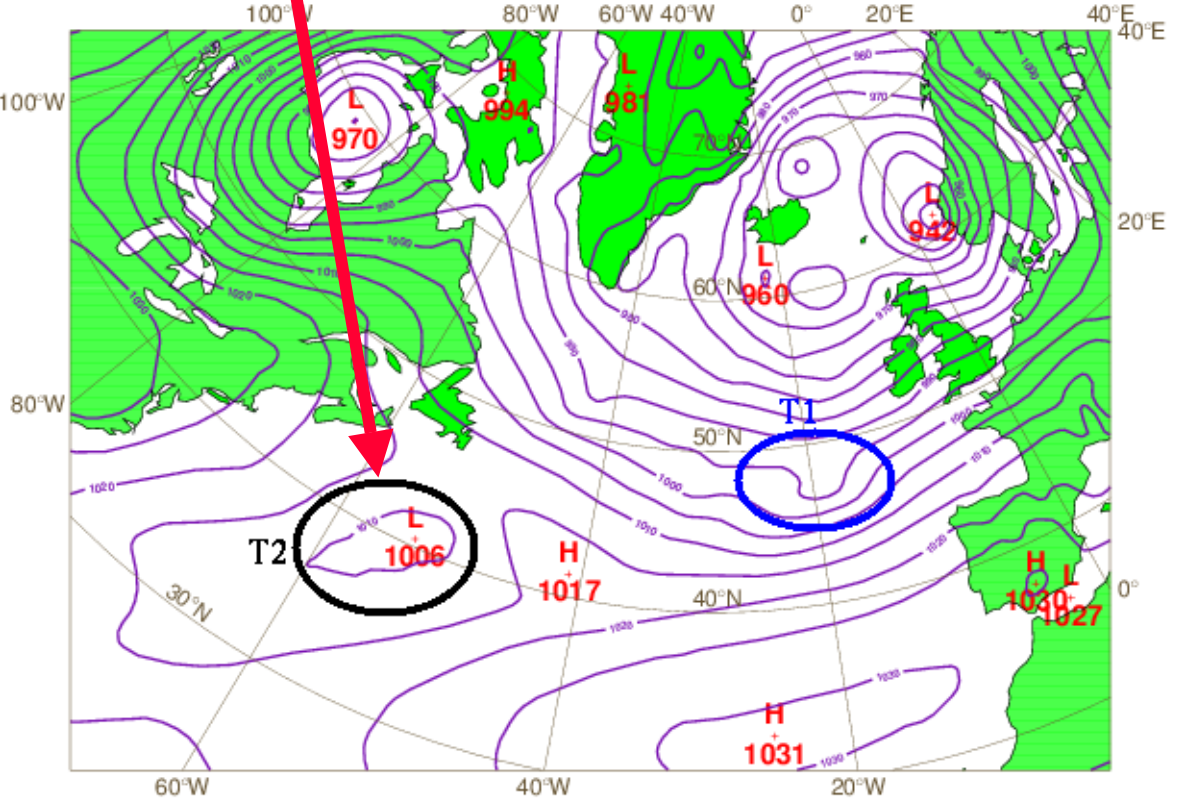


Obs simulated in the sensitive area 48h before the storm (using adjoint computations)

Msl Par2* 25/12/99 12h fc t+54 vt:27/12/1999 18h

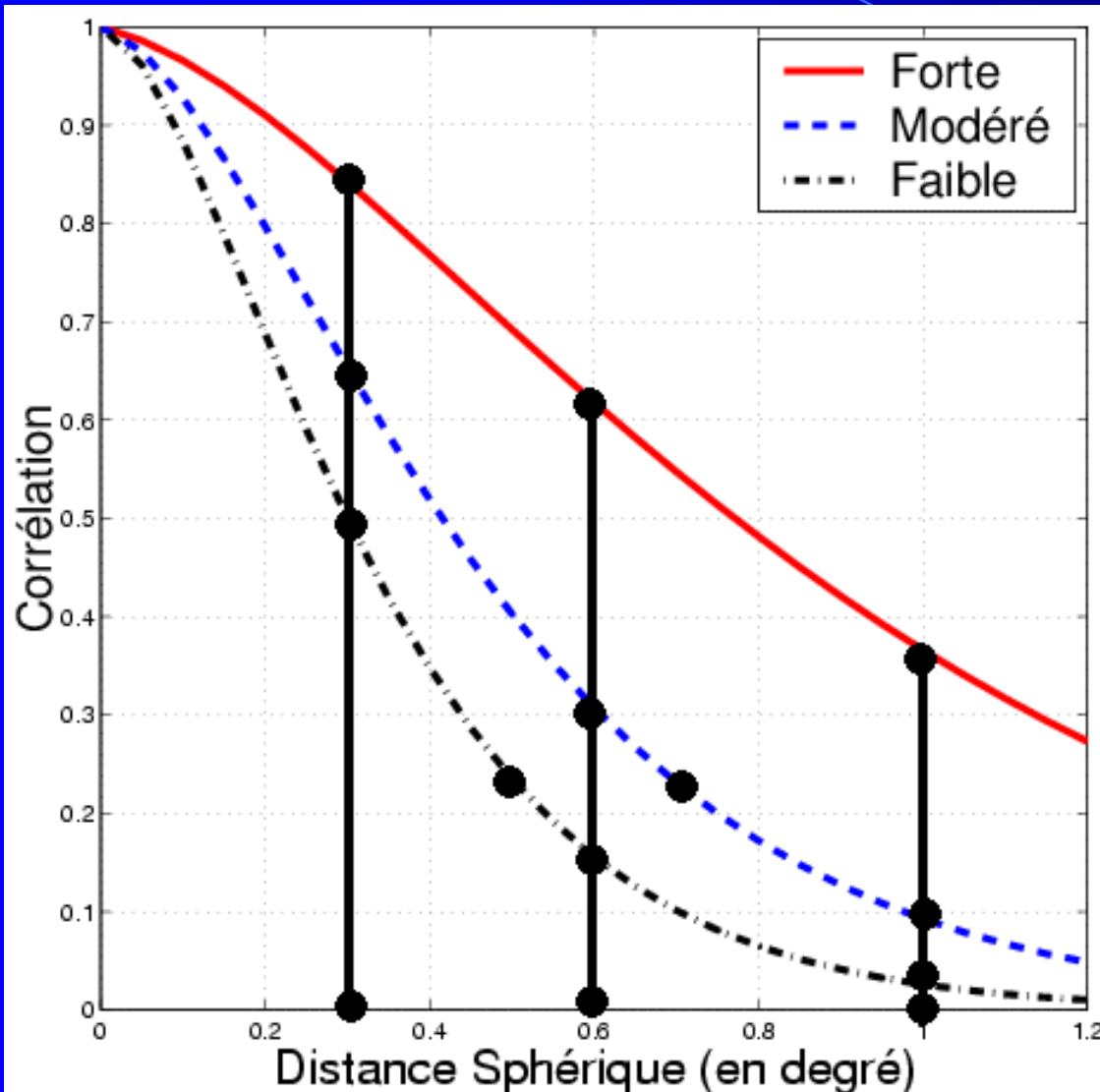


Msl Par2* 25/12/99 12h fc t+6 vt:25/12/1999 18h



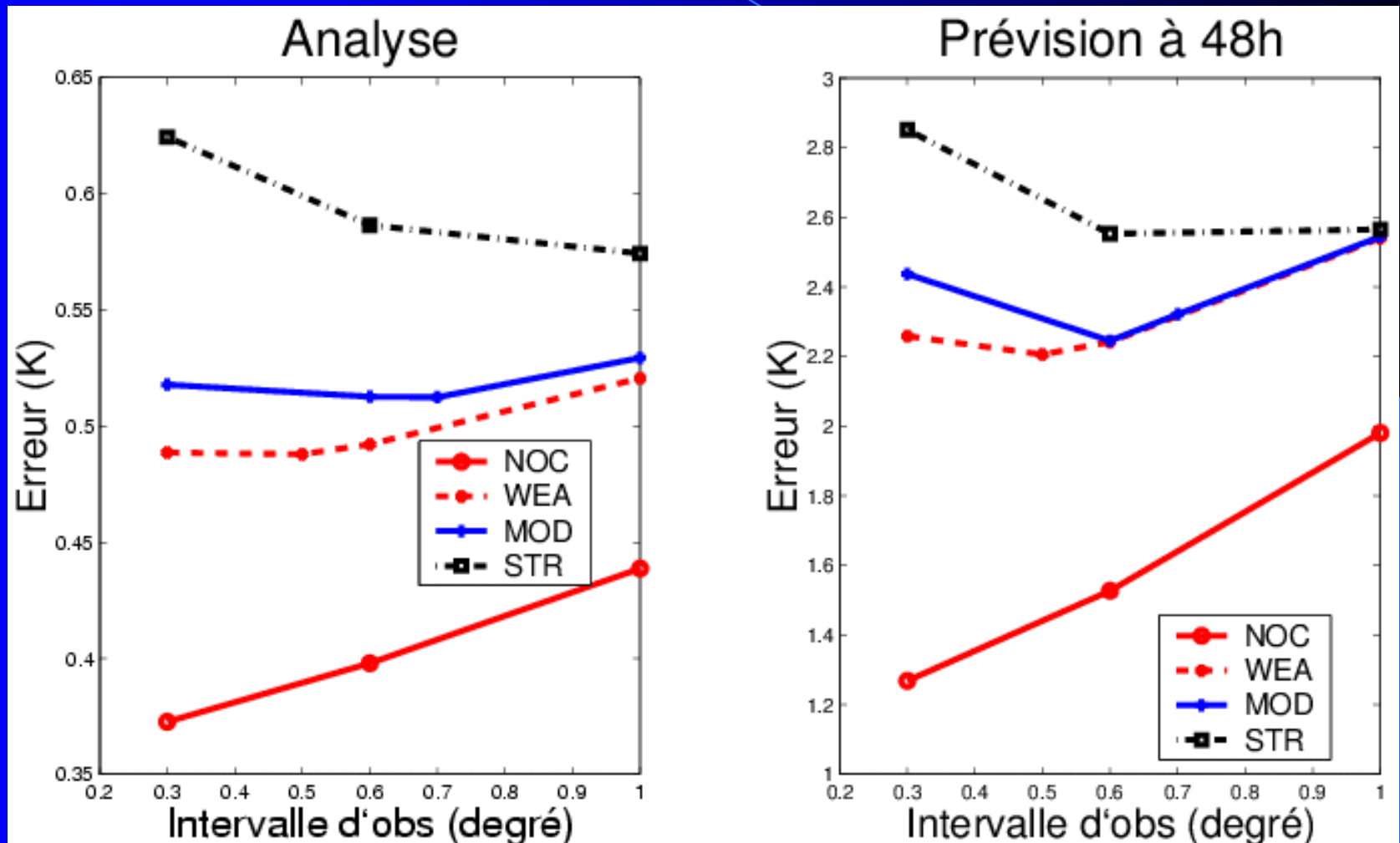
Area of interest

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)



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

