Meteorologisk institutt
met.no

ALADIN-HARMONIE/Norway and its assimilation system

Roger Randriamampianina and Andrea Storto

Acknowledgement: Alena Trojáková, Gergely Bölöni, Sándor Kertész, Andrew Collard,

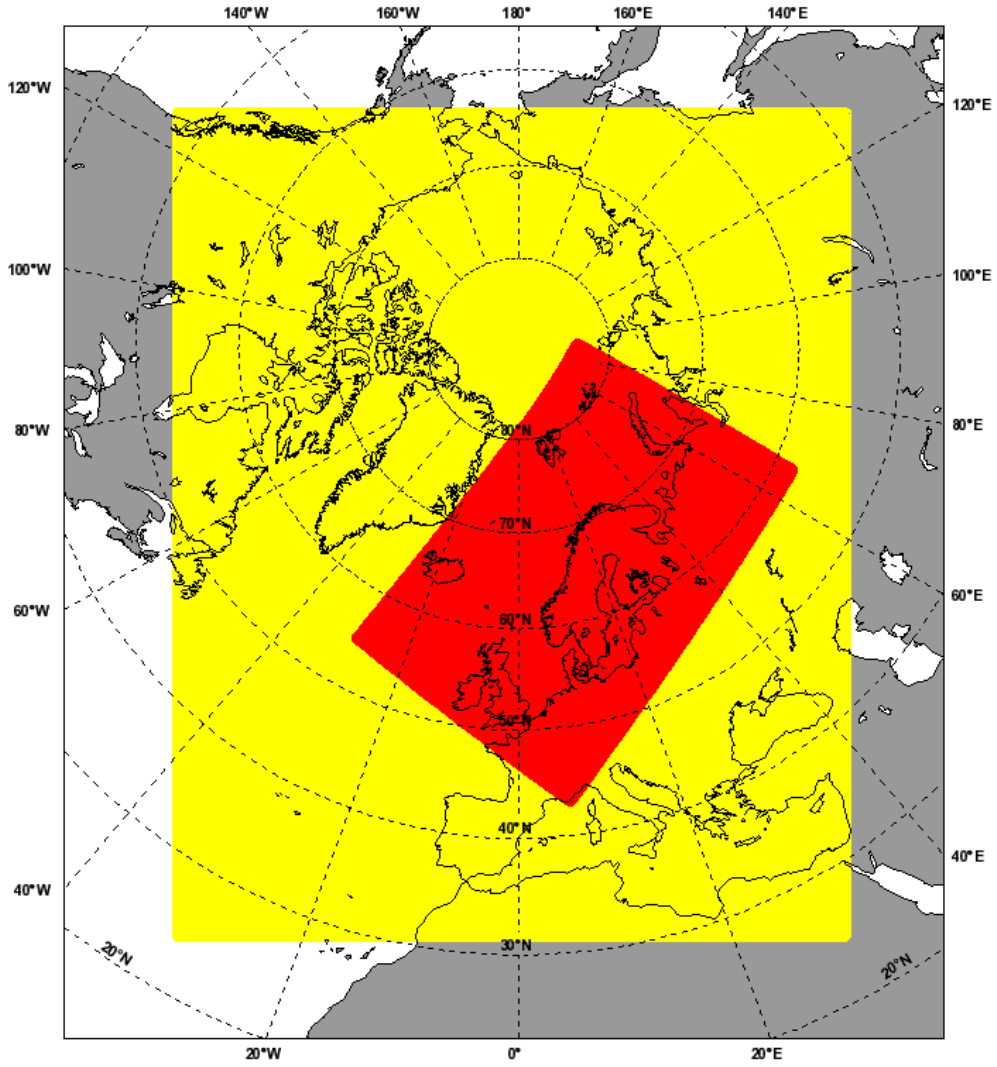
Lars Isaksen, Elisabeth Gérard, Patrick Moll, Loik Berre, Bernard Chapnik, Vincent Guidard, Pierre Bénard …

THORPEX-IPY/Norway and ABC project

Outline of the presentation

- The Model - Choice of Domain
- The forecast system
- The assimilation system
- System evaluation
- Conclusions

Choice of the domains



Small domain: rotated Lambert pr.
Dx=dy= 11 km, 60 vertical levels
up to 0.2 hPa

Big domain: polar stereographic pr.
Dx=dy= 16 km, 60 vertical levels
up to 0.2 hPa

The forecast system

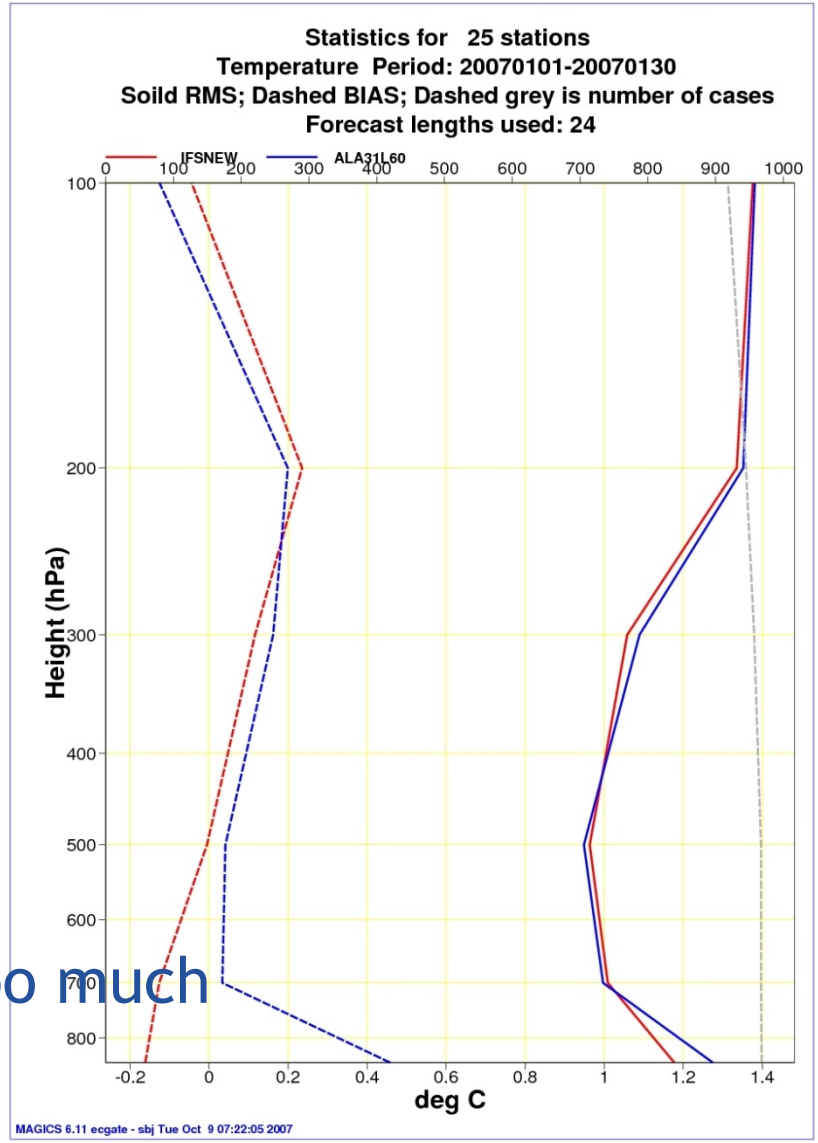
The CY31 was tested during one month:

→First run using ECMWF analysis as initial file:

→ ECMWF as coupling files

- At the beginning we observed problem related to orography in the coupling files

- Larger bias near the surface



Surface blending did not help too much

Type of observations

Conventional Observations

→ Surface data:
- Synop, Ship
- Bathy, Tesac
- Buoy

→ Upperair data:
- Airep, Amdar, Acar
- Temp, Temp-ship, Temp-mobil, Temp-drop
- Pilot, Pilot-ship, Europrofil, Profiler
- Satob, Satgeo, geowind (METEOSAT and MODIS)

Satellite Observations

→Meteosat:
- SEVIRI

→ NOAA Atovs:
- Hirs, Amsua, Amsub, Mhs

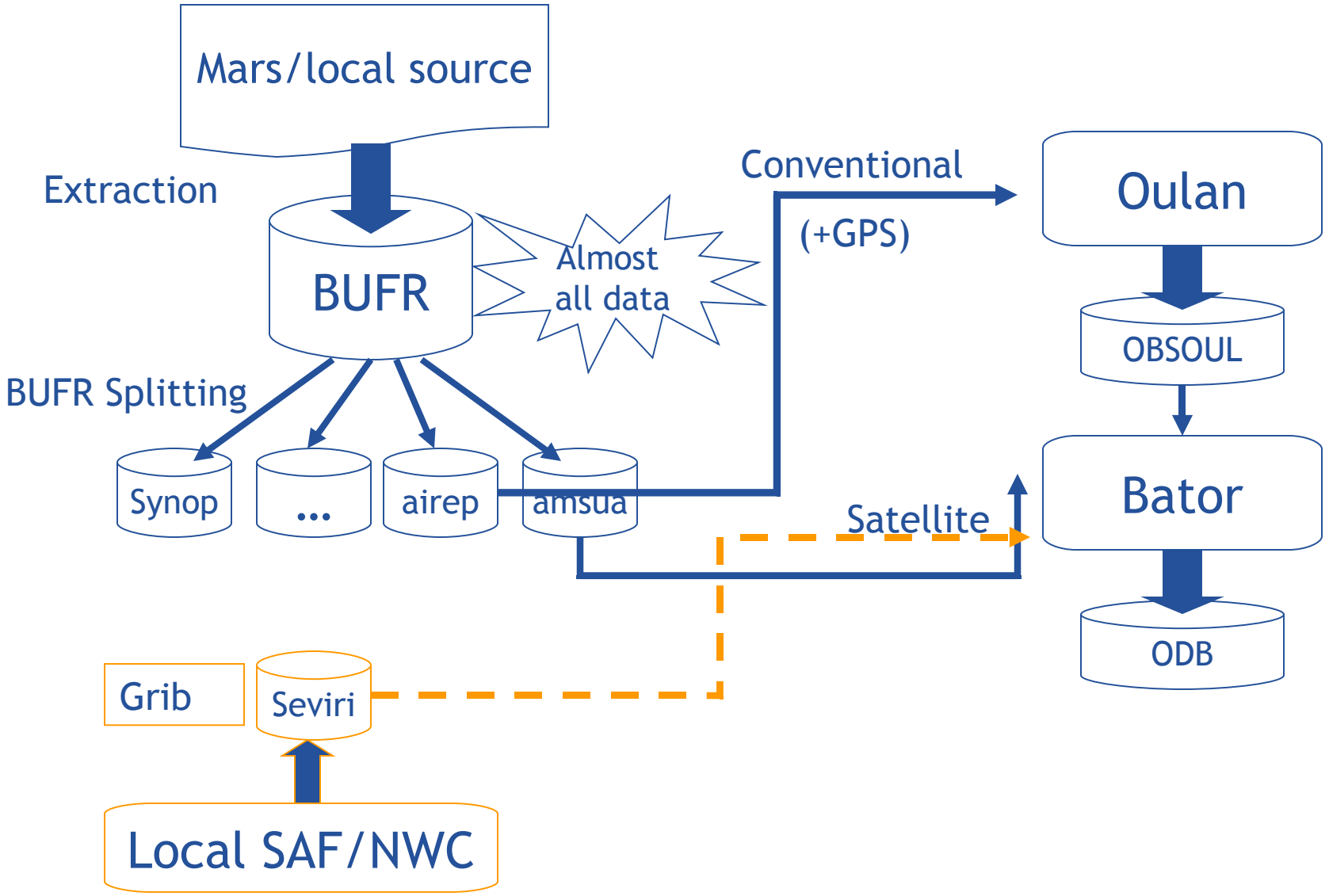
→ DMSP:
- Ssm/I

→ AQUA:
-Airs

→ Metop:
- Amsua, Amsub, Mhs, Iasi

→ GPS:
- ZTD

Data pre-processing



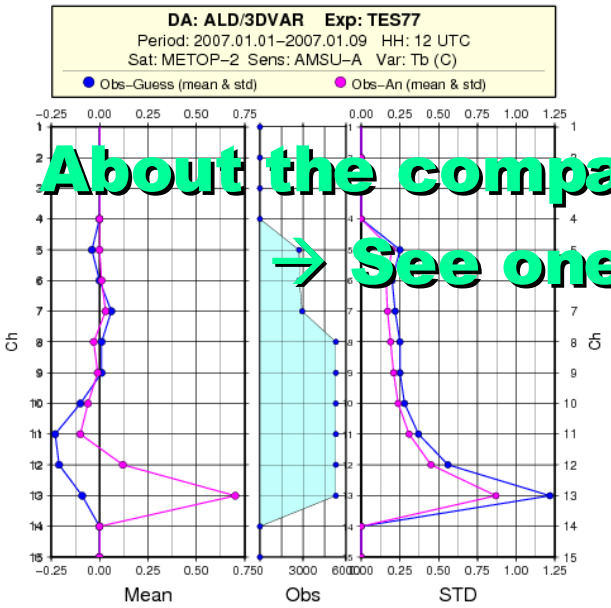
Radiance bias correction

Off-line method (Harris and Kelly, 2001) :

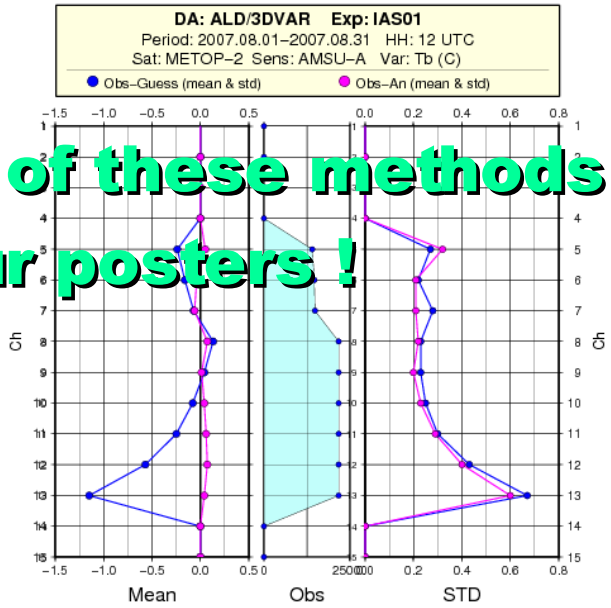
For ATOVS: → Bias varying along latitude bands
For Seviri: → Bias is estimated in one band for wall domain

Variational bias correction (Auligné et al, 2007):
Tested for ATOVS and IASI data

About the comparison of these methods
→ See one of our posters !



Off-line bias correction



Variational bias correction

NMC background error statistics

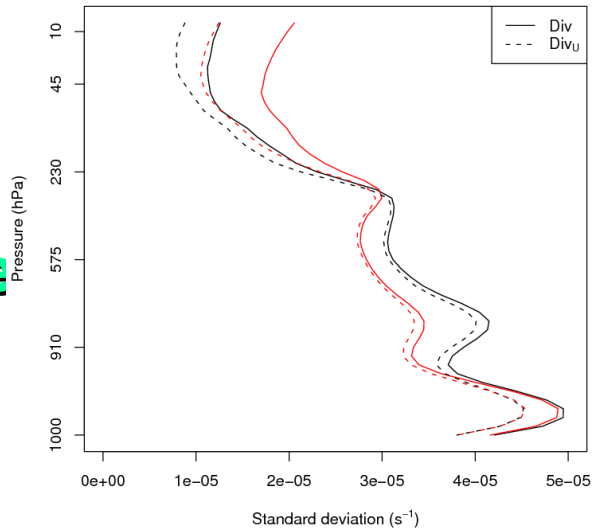
For the small domain:

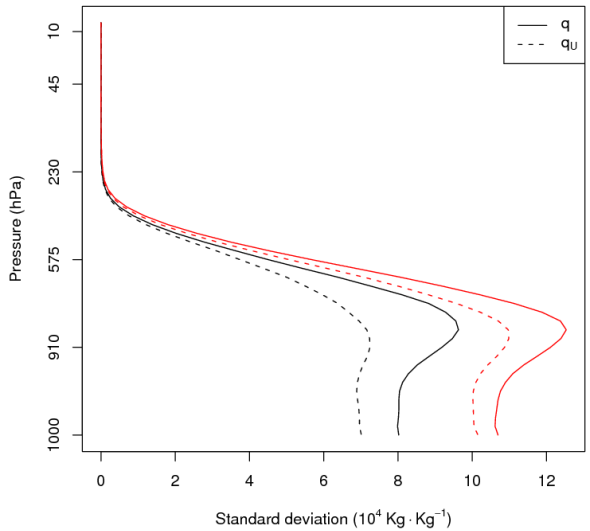
- Two matrices were estimated using winter and summer periods

For the large domain:

- So far, one matrix was estimated using summer periods

For e



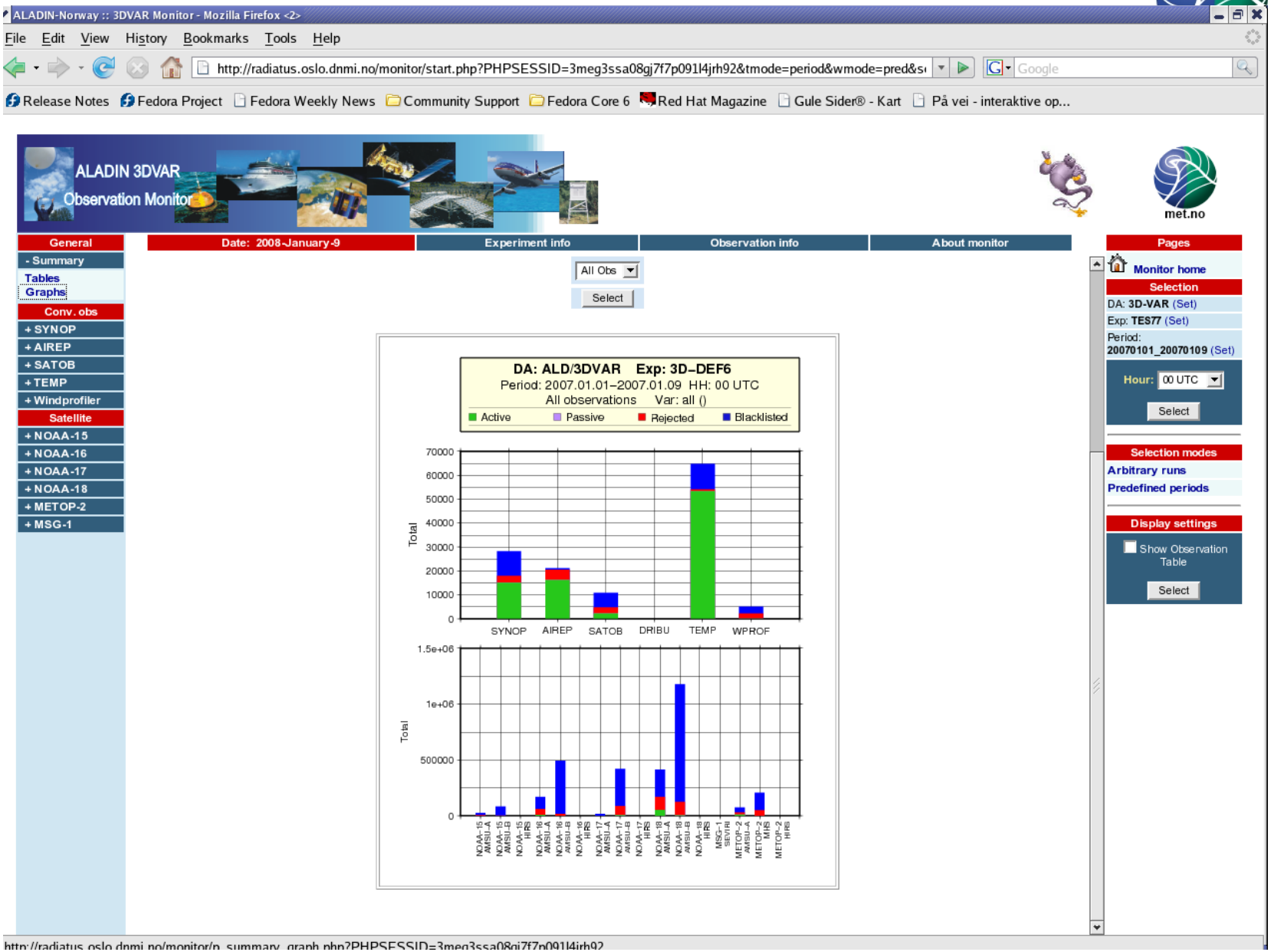


tistics

Winter: Small Background errors

Summer: Large Background errors

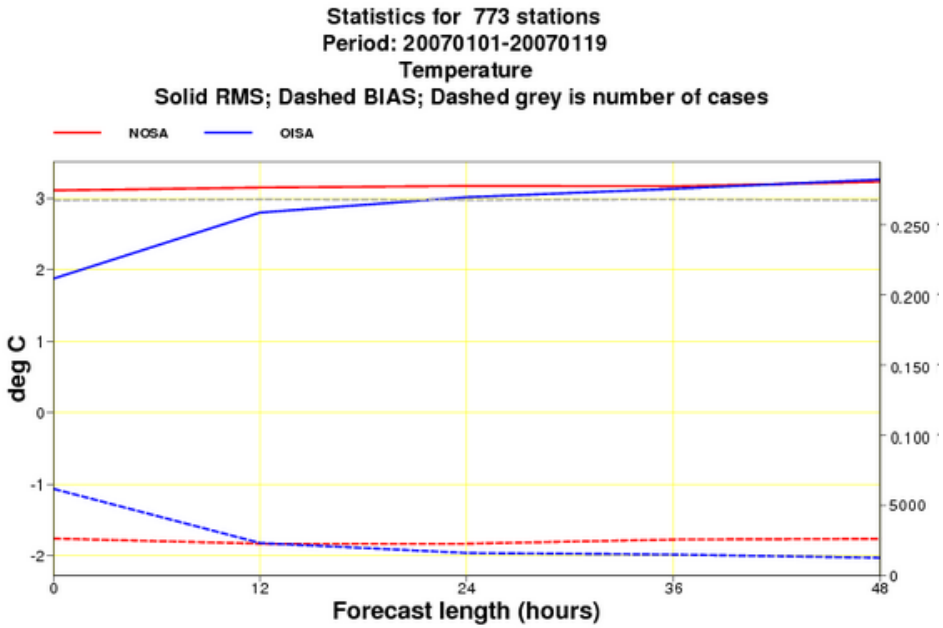
The assimilation system
Web based monitoring system



System evaluation

Impact of CANARI:

-- Old analysis (black)
-- New analysis with CANARI (blue)

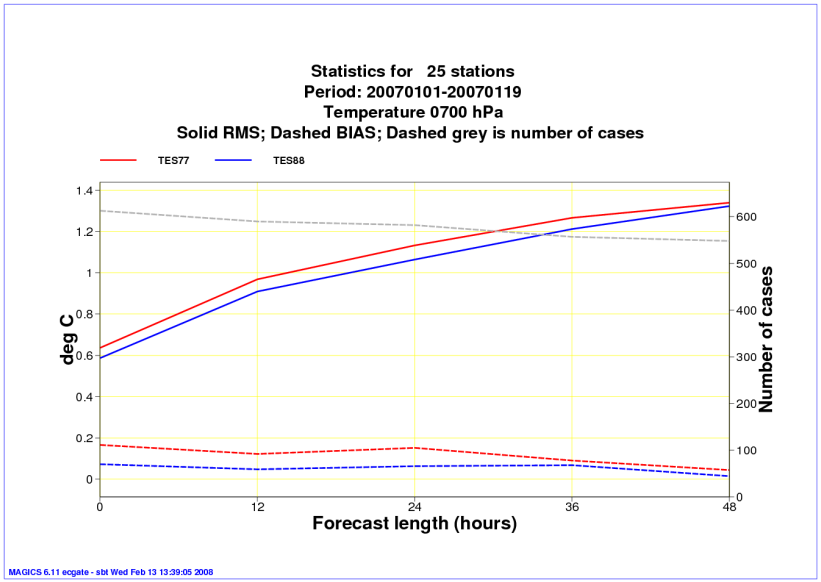


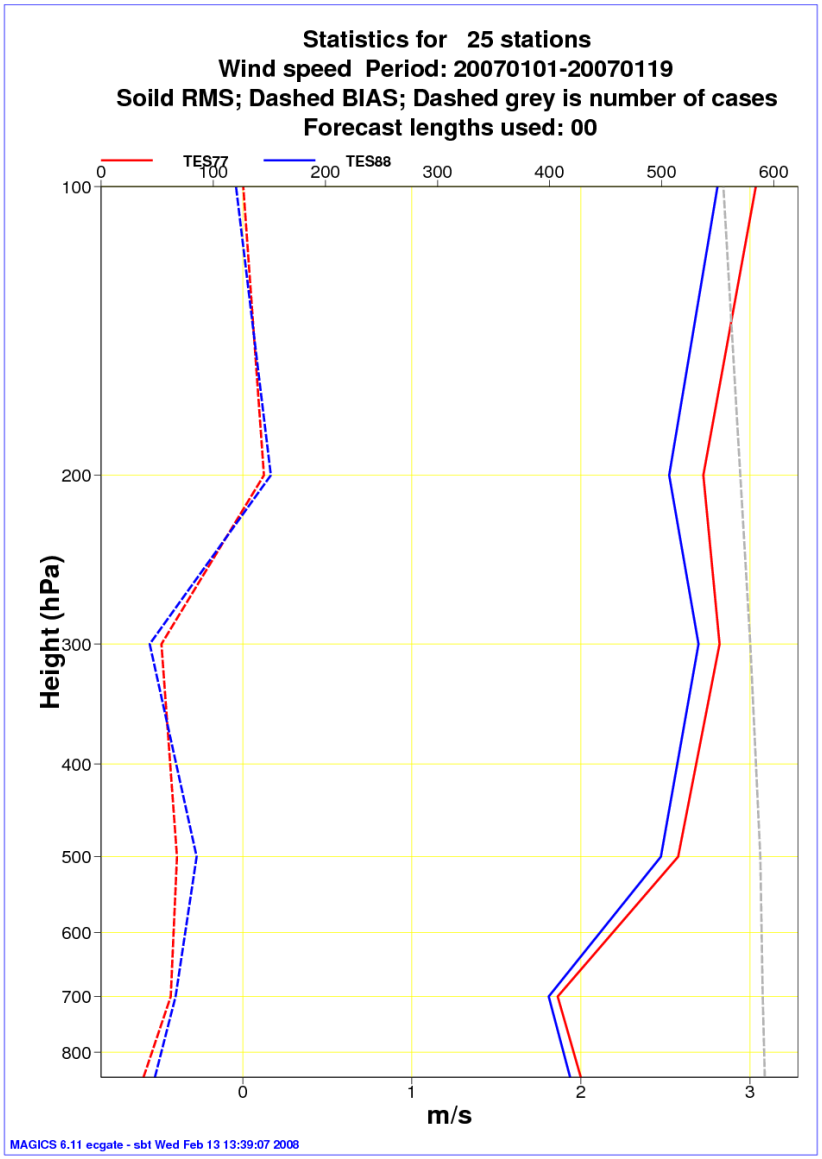
System evaluation

NMC seasonal B tested during winter

→ Better analyses and forecast with Wint. B

-- Run with summer B (red)
-- Run with winter B (blue)





Impact of observations on analysis

• **Degrees of Freedom for Signal (DFS)** evaluate the sensitivity of the analysis (in observations space) with respect to the observations, for each observation group, i.e. the information content of the observations brought into the analysis;

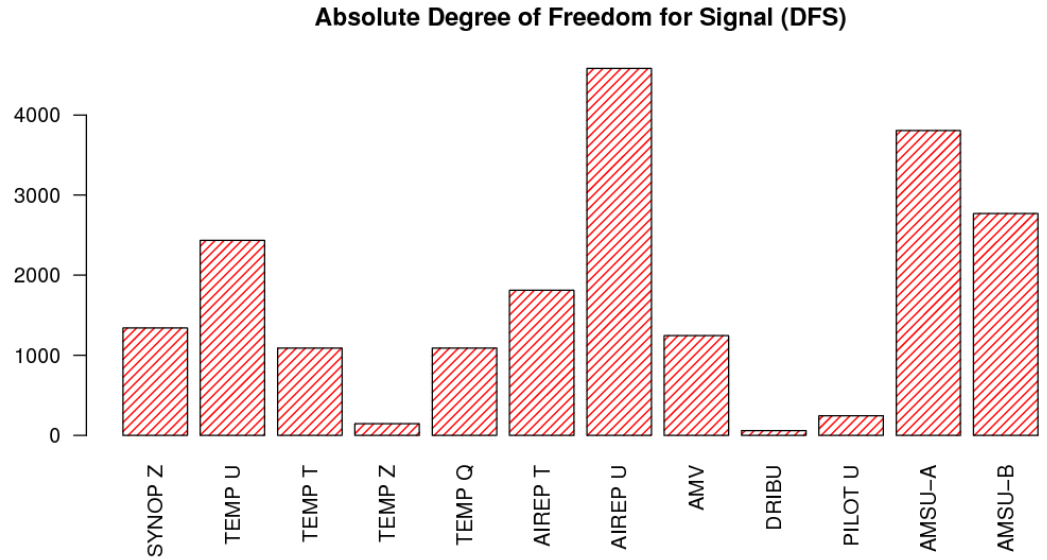
$$DFS_i = \frac{\partial H x_a}{\partial y_i} \approx \left(y_i - \tilde{y}_i\right) R^{-1} \left(H x_a - H \tilde{x}_a\right)$$

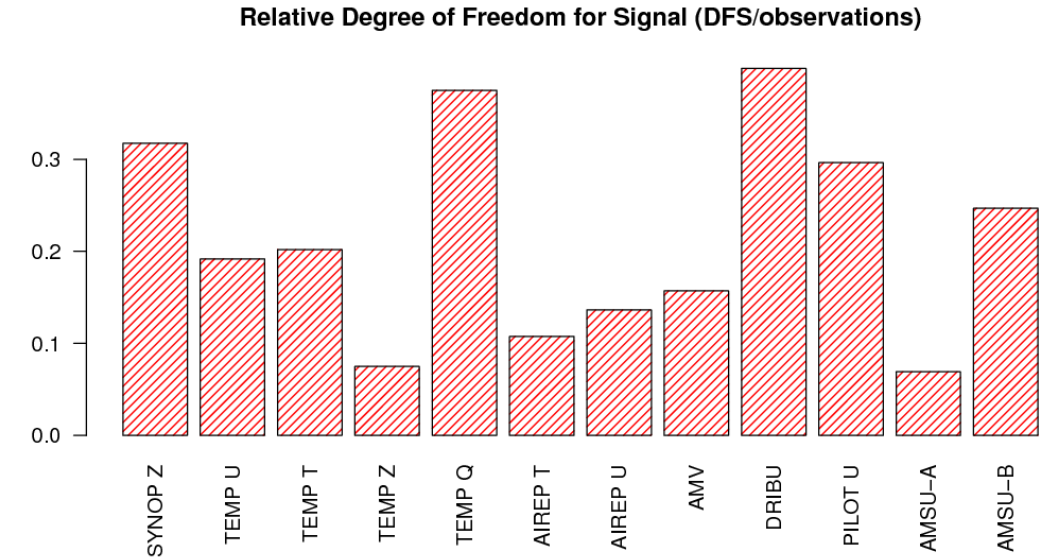
• It is calculated out by perturbing all the observations and studying the respective variation of the analysis in observation space. Such a procedure has to be repeated a number of assimilation cycles in order to ensure ergodicity and represent different meteorological situations and observations dataset. Perturbation must be done after screening to keep the same observations dataset in both minimizations.

• A winter NMC-based B has been used.

• We have results of 5 assimilation cycles (4 days and 6 hours distant each other).

Impact of observations on analysis





The ABSOLUTE value is the actual impact (a sort of index of amount and importance of obs) in the observing system, while the RELATIVE value gives the idea of importance of 'single observations'.

AIREP-U, AMSU-A and B, are the obs with the biggest impact.

Datum on DRIBU: only very very few in areas not-densely observed.

Impact of observations on forecasts

Evaluation of the impact of observations is made by perturbing observations, and defining a proper cost function to evaluate the sensitivity and the change in quality of forecasts:

$$SOF_i = \frac{\partial J}{\partial x_a} \cdot \frac{\partial x_a}{\partial y_i} = \frac{\partial J}{\partial y_i}$$

As cost function, the variation of RMSE of forecasts against analysis valid at same time with respect of RMSE of reference experiment (the one with all the observations unperturbed);

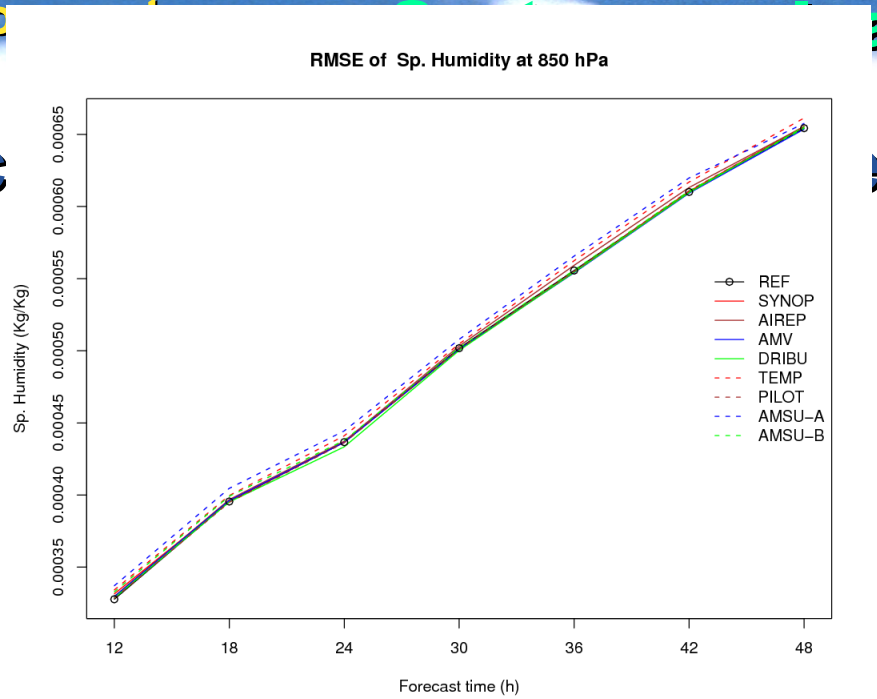
$$J = \frac{\overline{RMSE}_i - RMSE_{ref}}{RMSE_{ref}}$$

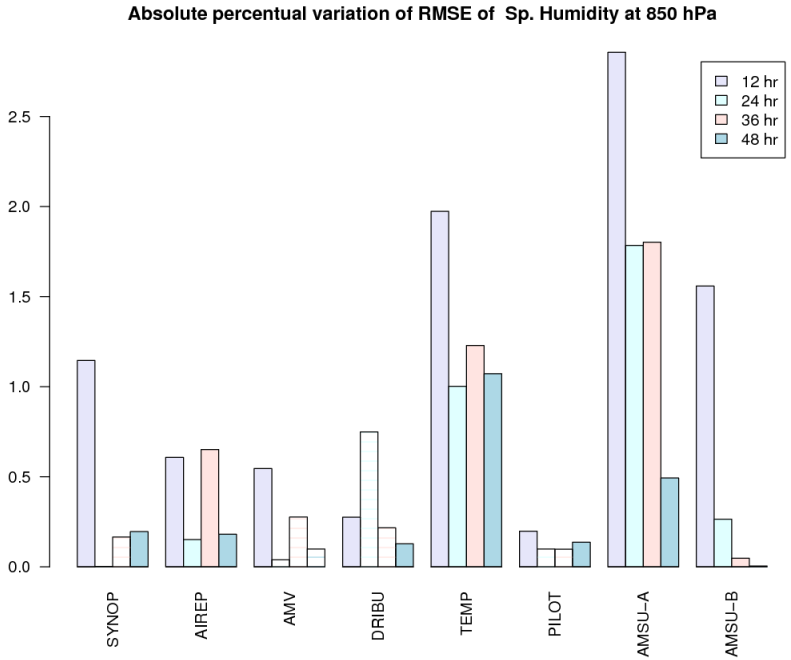
This is done in practice perturbing all the observations of a group, rerunning 3DVAR and forecasts as many times as the observations groups to evaluate: simplified way of study the impact of observations trough ensemble analysis.

- Number of assimilation+forecasts cycles has to be large enough (now only with 4 cases);
- Expensive method, but much cheaper than OSEs; the use of "variation of RMSE" provides an indication of both impact on forecasted fields (the analysis from which RMSE are computed are the same for all obs groups) and quality (the bigger the RMSE variation, the more positive impact that observation group has on the forecasts);

The assimilatio ation

Impac ecasts





Concluding remarks

- Good and flexible script system was created for running different configurations/steps of the analysis and forecast system.
- We built a preprocessor (oulan) working with BUFR format.
- We showed the importance of the seasonal background error statistics.
- We evaluated the sensitivity of the analysis system to different type of observations using DFS.
  - → Importance of 'single observations'.
  - → AIREP, AMSU-A, AMSU-B/MHS and TEMP have the biggest impact.
- SOF - AMSU-A have the biggest impact on the forecasts for almost all the parameters, followed by TEMP, whose impact is very strong in the high atmosphere. AIREP observations seem very important for short-range forecasts, especially for temperature fields, while AMSU-B influences mostly for low and high level humidity
- Please, do not forget to visit our posters
  - → Assimilation of superobs derived from CloudSat cloud measurements.
  - → Assimilation of Zenith Total Delay data from GPS measurements.
  - → Development related to the assimilation of IASI data.

Thank you for your attention!