Use of satellite data in ALADIN/HARMONIE-Norway

Andrea Storto and Roger Randriamampianina
Norwegian Meteorological Institute
PO Box 43 Blindern, N-0313 Oslo, Norway
www.met.no
andrea.storto@met.no, rogerr@met.no .

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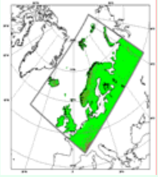

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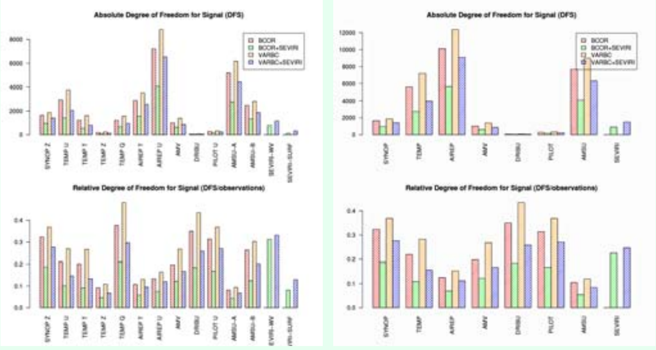

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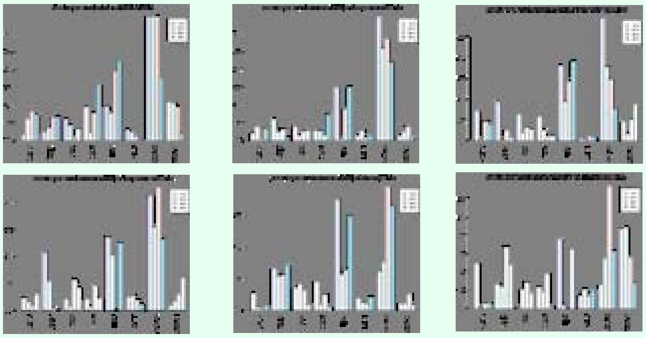
AMSU-A have showed the biggest impact on the forecasts for almost all the parameters, followed by TEMP, whose impact was very strong in the high atmosphere. AIREP observations seem very important for short-range forecasts, especially for temperature fields, while AMSU-B exercises have influence mostly on low and high level humidity.



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The evaluation of the ***impact of different observations*** on analysis and forecasts showed that the sensitivity of the analysis was particularly high with regards to wind measurements, especially from aircrafts, while humidity observations had a large information content but were not very dense if compared with other observed parameters.

According to our results, ***AMSU-A data*** have the most remarkable impact on forecasts, at all the forecast ranges.

A positive impact of ***CloudSat data*** – especially on the mass fields - was found against observations in a short period study.

Impact of ***SEVIRI data*** on humidity forecasts was found to be positive.

We concluded, that the use of background errors derived through ***ensemble techniques*** could contribute to the optimal assimilation of observations.

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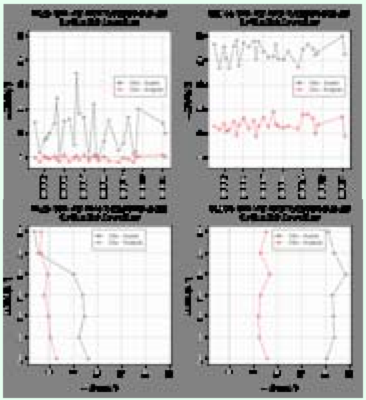

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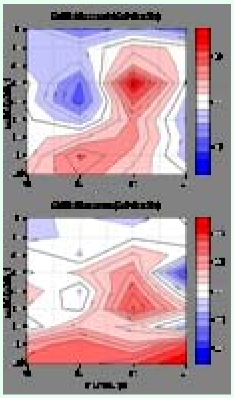

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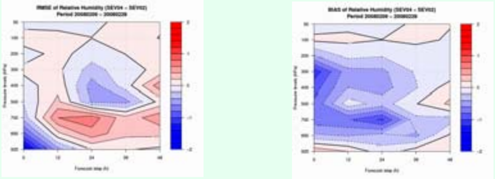

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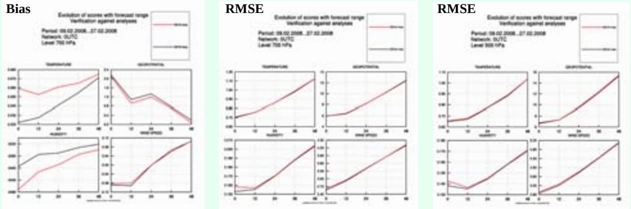

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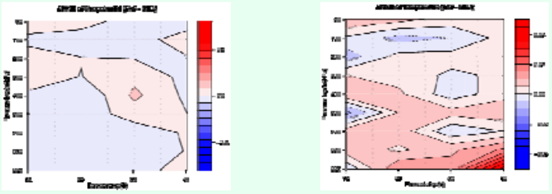

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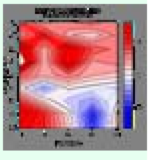

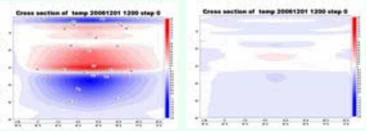

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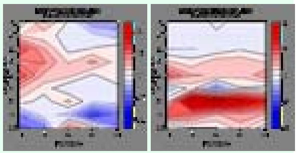

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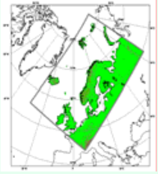

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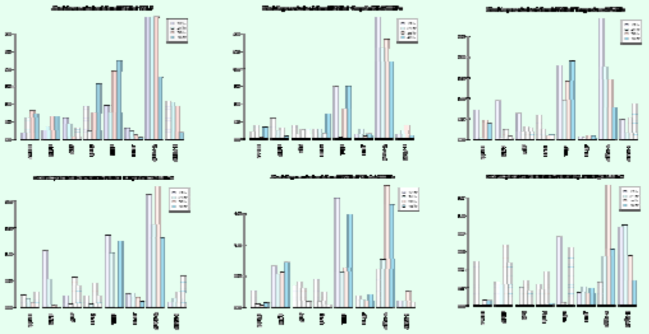

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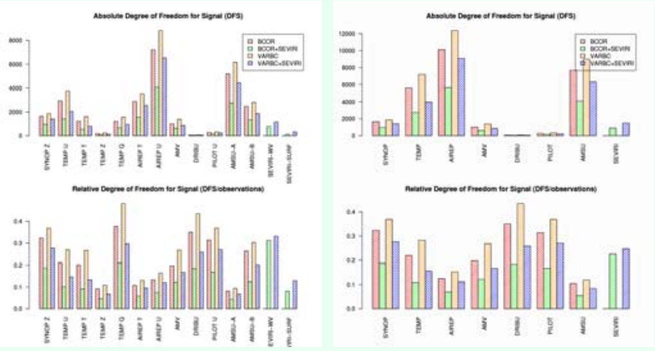

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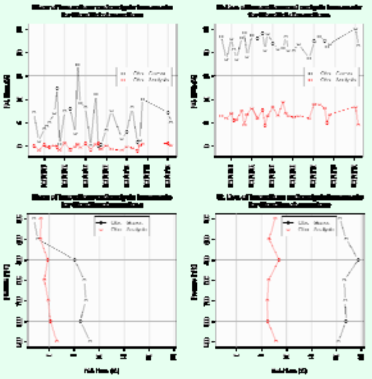

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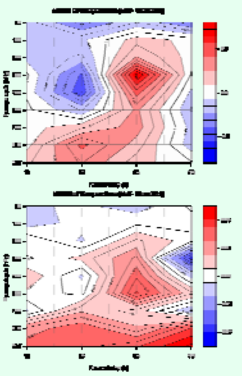

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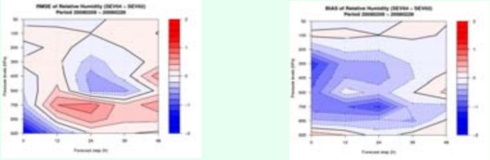

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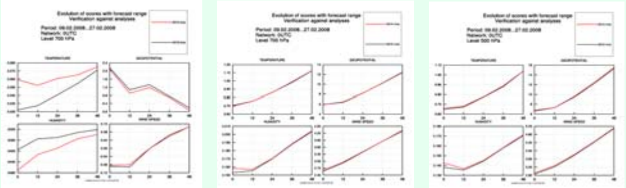

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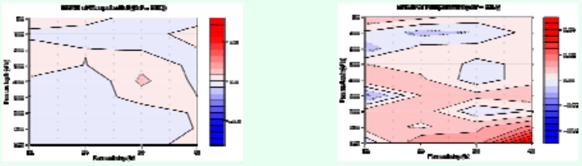

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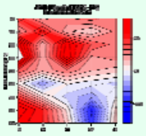

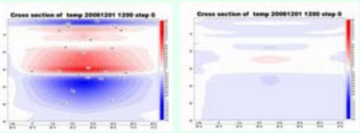

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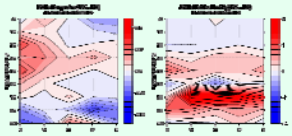

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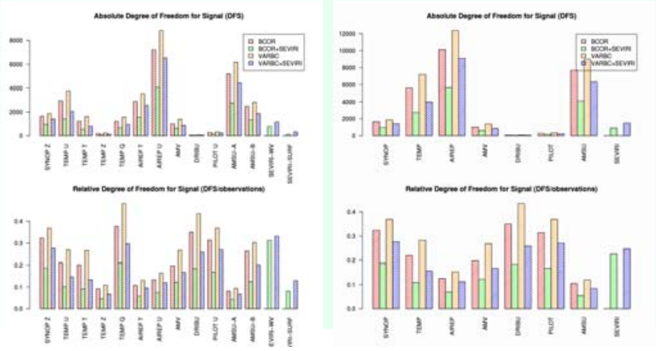

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The impact of observation types on forecasts have been studied perturbing each observation group, rerunning the assimilation and comparing the RMSE (between forecasts and analyses valid at forecast time using the reference system) from the reference experiment (all the observation in the above table) with the RMSE from the perturbed experiments. The bigger is the relative variation in RMSE, the more sensitive are the forecasts to the observations group. The perturbation and forecast has been repeated for 4 assimilation cycle, far enough in time from each other to ensure ergodicity of results. This test was done without observations under investigation.

AMSU-A have showed the biggest impact on the forecasts for almost all the parameters, followed by TEMP, whose impact was very strong in the high atmosphere. AIREP observations seem very important for short-range forecasts, especially for temperature fields, while AMSU-B exercises have influence mostly on low and high level humidity.

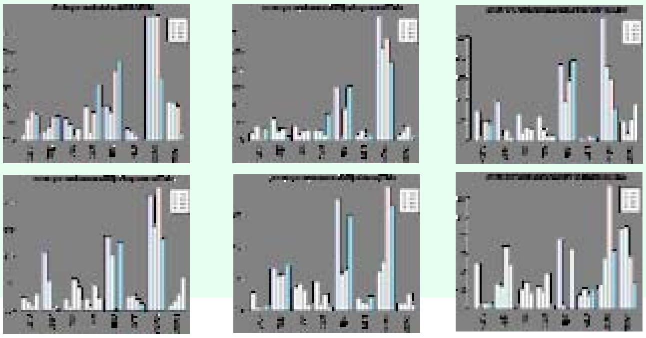

Figure 2. Absolute percentual variation of RMSE of different observation types

Conclusions

The use of ***variational bias correction technique*** to correct the bias of all radiances emphasises the information content of all the observations since they are better assimilated. This is true not only for satellite data but also for conventional data.

The evaluation of the ***impact of different observations*** on analysis and forecasts showed that the sensitivity of the analysis was particularly high with regards to wind measurements, especially from aircrafts, while humidity observations had a large information content but were not very dense if compared with other observed parameters.

According to our results, ***AMSU-A data*** have the most remarkable impact on forecasts, at all the forecast ranges.

A positive impact of ***CloudSat data*** – especially on the mass fields - was found against observations in a short period study.

Impact of ***SEVIRI data*** on humidity forecasts was found to be positive.

We concluded, that the use of background errors derived through ***ensemble techniques*** could contribute to the optimal assimilation of observations.

Assimilation of other remote-sensed observations types is very promising, although more work for the assessment of their best use has still to be completed

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Experimental observations

Superobservations derived from CloudSat data: In this section we present recent results for a number of new observations type whose assimilation is under evaluation. A strategy for the assimilation of CloudSat CPR observations have been assessed. It consists of a Bayesian analysis able to produce super-observations of relative humidity, exploiting the ability of CloudSat to detect single and multi layer clouds at very high resolution, both on the vertical and along the satellite track. NWP data to define the "a priori" knowledge of humidity fields come from ECMWF short-range forecasts. A Monte Carlo approach is then used to calculate the errors of the super-observations, simulating the Bayesian analysis' errors. 3DVAR correctly assimilates these observations, and a positive impact was found, especially on mass fields. However, the verification period was rather short, hence, the impact of CloudSat observations over a longer period is under evaluation.

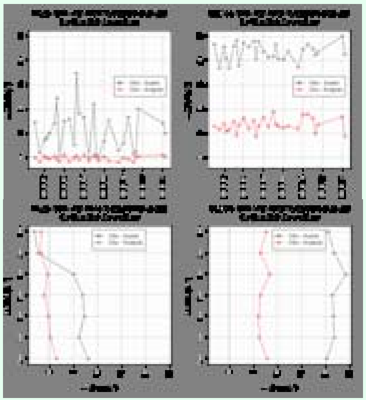


Figure 3. Innovations and residuals statistics for CloudSat observations (mean on the left, st.dev. on the right) calculated by day (top) and by vertical level (bottom). The plots show that the residuals are unbiased and that the weight given to the CloudSat observations is large.

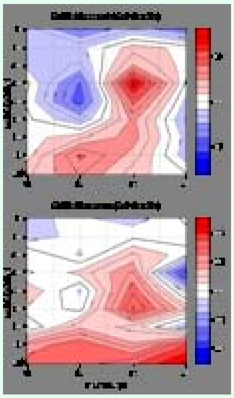


Figure 4. Radiosonde verification scores against experiment with all observations in Table 1 but without CloudSat assimilation.

SEVIRI data: First assimilation trials have also been run with SEVIRI Infrared radiances (channels 5, 6 in clear-sky or above mid-level clouds conditions, channels 7, 9 and 10 in clear-sky above sea). An air-mass bias correction scheme was used, not varying latitudinally. provides reasonable analysis increments for WV channels (5 and 6) but not for the window channels. Impact is promising, especially at low and middle-level atmosphere. ***Note, that SEV04 refer to reference runs, while SEV02 to the run with SEVIRI data.***

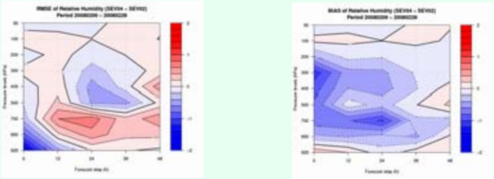


Figure 5. Impact of SEVIRI data against observations

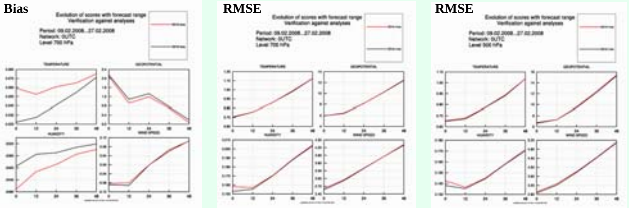


Figure 6. Impact of SEVIRI data against analyses

GPS ZTD data: A feasibility study for the assimilation of GPS Zenith Total Delay has been carried out trough the creation of a dataset of reliable GPS stations and data processing centre. This approach leaded to 52 assimilable stations over the Norwegian domain. Trials experiment, that used an overestimation of the delay errors trough the observations minus guess standard deviations have been performed over one month (Feb. 2008).
A flat bias correction is used. Impact on verification against TEMP is small for all the parameters except for temperature, where it is positive in general.
A more rigorous formulation of observations errors is under evaluation.

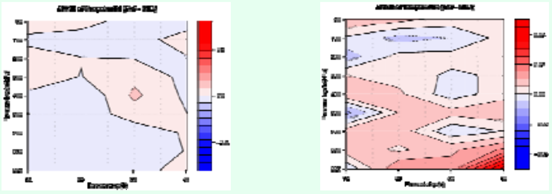
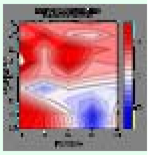


Figure 7. Impact of GPS ZTD data on forecast of geopotential and temperature

B covariances from downscaled ensemble analysis

In order to exalt background covariances typical of small scales, ensemble analysis generated at ECMWF (kindly provided by Lars Isaksen) by perturbing observations in the assimilation, have been used after downscaling as initial and lateral boundary conditions for ALADIN/HARMONIE-Norway 6 hours forecasts. The experiment used all the original 10 members, for a period of 1 month (two daily runs), and differences between the true state of the atmosphere and the model forecasts have been simulated as differences between the ensemble mean and the forecasts coming from each of 10 members initial conditions. Background error covariances follow Loik Berre's formulation. Results have been extensively compared with background error covariances obtained through the "NMC" method, for a winter three-months dataset of differences between 48 and 24 hours forecasts. The use of ensemble analysis produced much shorter correlations, especially on the vertical correlations and at large horizontal scales. Variances and cross-covariances present a very similar structure in the two B statistics. Analysis initialized by 3DVAR using ensemble-derived statistic result closer to the background, and the forecasts show a better verification scores after day 1. The two cross-sections on the left show different analysis increments for a 2 K single-obs innovation (brightness temperature for the channel 9 from NOAA-18), NMC B (left) against Ensemble B (right). Differences in analysis increments are very big. Verification (right side) compare an NMC-based experiment against an Ensemble-B experiment.



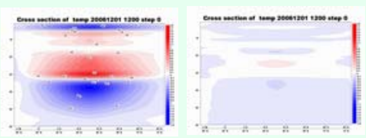


Figure 8. Analysis increments for a 2 K single-obs innovation (brightness temperature for the channel 9 from NOAA-18)

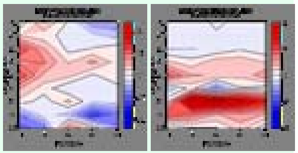


Figure 9. Comparison of an NMC-based experiment against an Ensemble-B experiment

International TOVS Study Conference, 16th, ITSC-16, Angra dos Reis, Brazil, 7-13 May 2008.
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