Ongoing and Planned Activities Concerning Assimilation of ATOVS Data At SMHI Sweden

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Abstract

AMSU-A radiances are soon to be operationally assimilated at SMHI. The effects of how careful data are selected for bias correction are therefore important to study. We will present some experiments where the effects of screening out data not in the vicinity of soundings have been studied. A further development in the use of AMSU-A data is to assimilate radiances over ice and land. Due to the importance of the non linear properties of surface skin temperature and surface emissivity, we will perform tests where these variables are included in the control vector. We also plan to assimilate AMSU-B, first only over oceans but then do research on how to use it over ice.

The HIRLAM model and ATOVS at SMHI

At SMHI the HIRLAM model is used for operational forecasts up to +48h four times a day. Two domains are used, one large with 44km resolution and one smaller domain with 22km resolution, figure 1. A 3DVAR system is used for the analysis with a 2h cut of time. The large domain uses ECMWF forecasts as boundaries, and the small (22km) area uses HIRLAM44.

ATOVS in HIRLAM at SMHI

In order to gain as much as possible from AMSU-A data we need, due to the short cut of time, fast access to AMSU data from the Atlantic where conventional observations are sparse. Therefore it was not until the EARS (EumetsAt Retransmission Service) became operational that we could really benefit from ATOVS data in the Swedish HIRLAM. We are collecting AMSU-A data from noaa15 and noaa16 and run them in passive mode for producing statistics for bias correction. The coverage of received EARS data during one day (2:nd of October 2003) are shown in figure 2. From there it can be seen that we get a good amount of data from the Atlantic but also that the data sample varies a lot from forecast to forecast.

Bias correction of AMSU-A radiances

We use the bias correction scheme presented in (B.A Harris,) with 7 predictors:

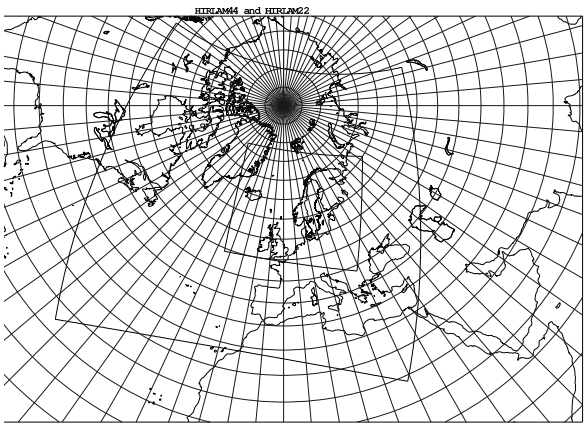

Figure 1: Operational HIRLAM domains at SMHI

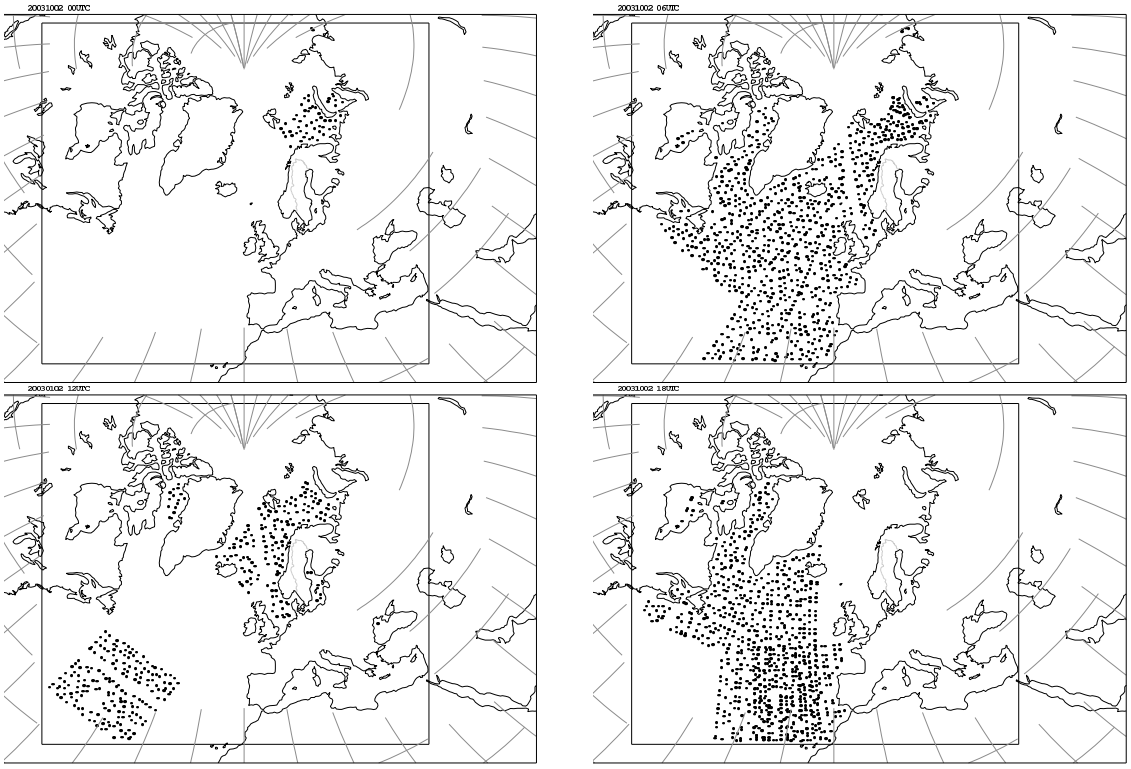

Figure 2: Available AMSU-A data from noaa15 and noaa16 for different HIRLAM forecasts on the 2:nd of October 2003. The figures show data available for minimization, i.e cloud cleared, land/ice contaminated obs screened out and thinned data

1. A constant displacement
2. A measure of the mean forecast temperature between the 1000hPa and 300 hPa pressure levels
3. A measure of the mean temperature between 200 hPa and 50 hPa
4. The surface temperature (here analyzed sea surface temperature values)
5. The integrated water vapor content per area from the surface up to the top of the atmosphere
6. The square of the observation zenith angle
7. The observation zenith angle

When using the model for bias correction as we are doing here it is important not to include model biases in the calculation of the regression coefficients. We have done some experiments where the data samples used for calculation of the coefficients have been selected in different ways. Figures 3 - 5 shows time series of daily bias (obs-first guess) and (corrected obs - first guess), i.e a 24 hour mean.

1. A dataset of 2 months where land/ice and cloud contaminated obs have been screened out. Figure 3
2. For every day, update the coefficients with a 30 day data set with land/ice and cloud contaminated obs screened out. Figure 4
3. A dataset of 2 months with land/ice and cloud contaminated obs screened out. Only data in the vicinity of soundings are used. Figure 5

From figures 3 - 5 it seems like screening out data not in the vicinity of soundings reduces most of the bias in the observations. For now, we will use those coefficients as long as they produce reasonable statistics. Bias correction in limited area models still remains an open issue though.

Research

In order to improve the analysis over the Arctic region, we participate in project called IOMASA. The purpose of the NWP part of this project (met.no and SMHI) is to assimilate radiances from AMSU-A and AMSU-B over ice. In that case the surface skin temperature T_{skin} and surface emissivity ϵ_{surf} become important. If T_{skin} and ϵ_{surf} are not allowed to vary during the minimization it may be difficult to achieve convergence towards the optimal solution. We will therefore perform tests where these variables are included in the control vector x, in the J_o term in equation 3, and adjusted by the minimization procedure.

We will only use AMSU-B where we have AMSU-A information to help us with quality control, cloud clearing etc. We therefore need some tool to map the AMSU-B footprint onto AMSU-A.

$$x = \begin{pmatrix} u \\ v \\ T \\ q \\ lnp_s \end{pmatrix} \longrightarrow J_b = (x - x_b)B^{-1}(x - x_b) \tag{1}$$

$$x = \begin{pmatrix} u \\ v \\ T \\ q \\ lnp_s \\ T_{skin} \\ \epsilon_{surf} \end{pmatrix} \longrightarrow J_o = (y - Hx)O^{-1}(y - Hx) \tag{2}$$

$$J = J_b + J_o \tag{3}$$

References

B.A Harris, G. K. A satellite bias correction scheme for data assimilation. *Quaterly Journal of the Royal Meteorological Society*, 127:1453–1468.

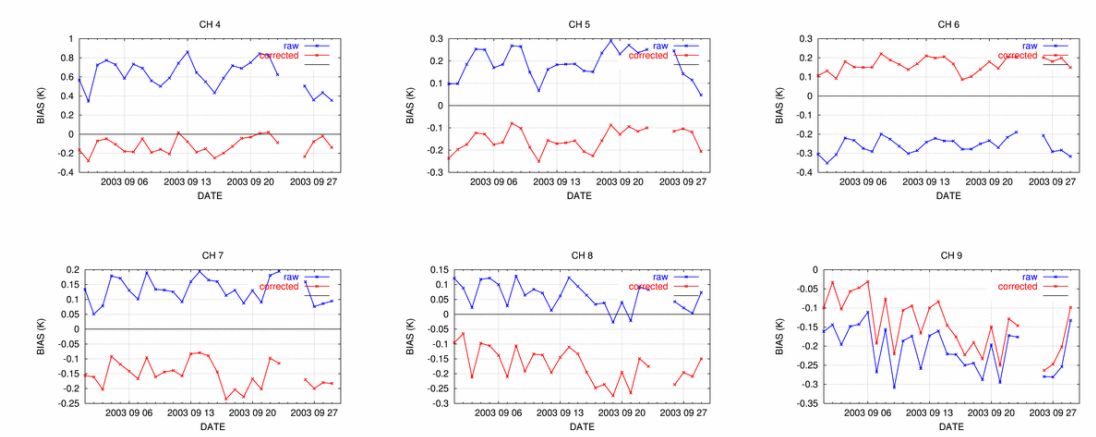

Figure 3: Red curve: bias corrected observations. Blue curve: raw data. All obs used for calculation of the coefficients

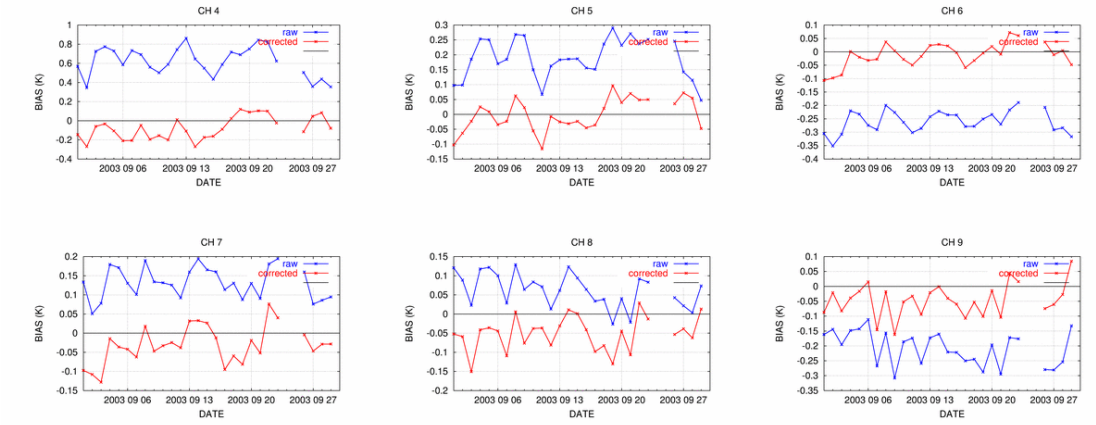

Figure 4: Red curve: bias corrected observations. Blue curve: raw data. Coefficients updated every day

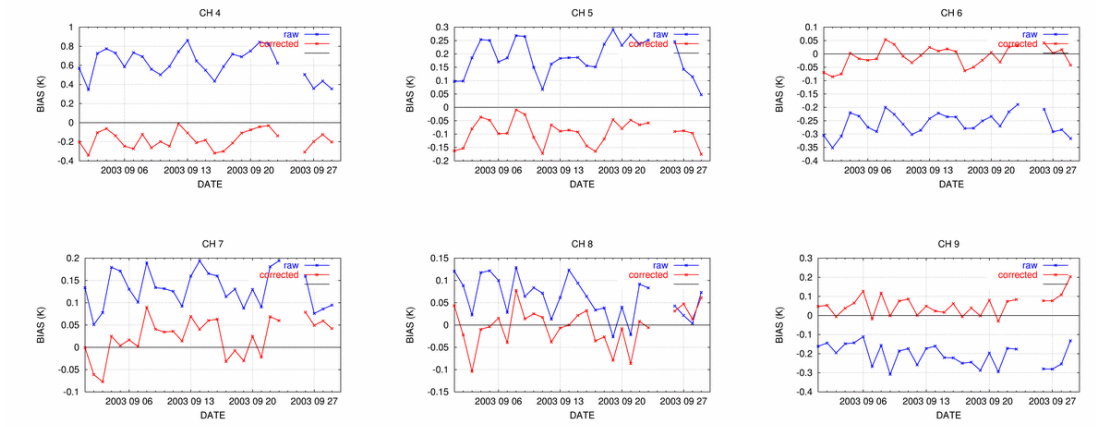

Figure 5: Red curve: bias corrected observations. Blue curve: raw data. Only data in the vicinity of soundings are used for calculation of the coefficients.