Assimilation of ATOVS Data at SMHI, Sweden

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The HIRLAM Model Setup at SMHI

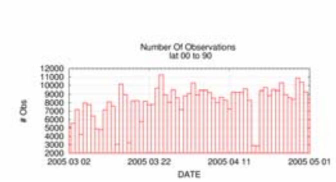
General
22 km horizontal resolution 306x306 gridpoints
40 vertical levels, model top at 10hPa
SLSI dynamics

Physics:
Rasch-Kristjansson (stratiform)
Kain-Fritsch (convective)
CBR (turbulence)
ISBA (surface)

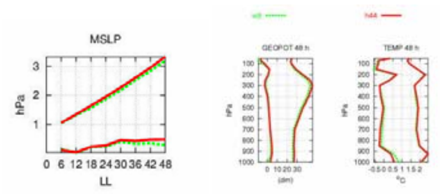
3DVAR analysis
6h assimilation cycle
48h forecasts made 4 times a day: 00,06,12,18 UTC
2h cut off for observations

Operational Use of ATOVS

- Cloud cleared AMSU-A radiances over sea are used
- Ch 5-10 are assimilated
- Ch 11-14 are not used because they peek over the model top
- Data is collected via EUMETSAT ATOVS Retransmission Service (EARS)
- The use of AMSU-A has a positive impact on especially MSLP and T



Number of received AMSU-A observations per day from NOAA16



Verification from a 2 week period of Dec 2003. Plots show RMSE and systematic error, BIAS.
Red: reference, no AMSU-A data is used
Green: AMSU-A data is assimilated

Bias Correction

Bias correction of AMSU-A radiances is performed with linear regression and the following predictors:

- Mean temp between 1000-300hPa
- Mean temp between 200-50hPa
- Surface temperature
- Integrated water vapor content
- Square of observation zenith angle
- The observation zenith angle

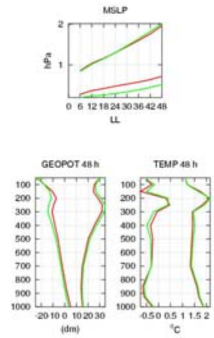
The coefficients are calculated from a reference dataset, usually a couple of months which gives about 2-400 000 observations. The coefficients are recalculated if the monitoring shows that it is necessary.

The Effect of Bias-correction

Does the bias correction do good?
The best way to test this is to examine the effect on forecast verifications.

The results on the right is from an experiment between 10:th Aug 2004 to 11:th Sep 2004, i.e. approximately 1 month.

The forecast scores shows a larger error if the radiances are not bias-corrected before assimilation.



Verification from a period of 1 month. Plots show RMSE and Systematic error, BIAS.
Red: reference, AMSU-A is assimilated.
Green: AMSU-A is assimilated without bias-correction.

AMSU-B Over Sea

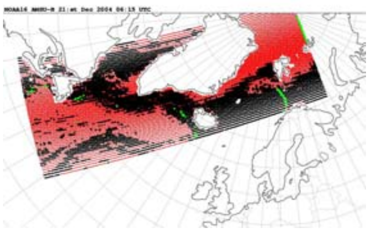
Quality Control

AMSU-B radiances are 'contaminated' by rain and cirrus clouds. We have, as a temporary solution, used indexes from the AAPP code to spot and screen out such observations: PPASCAT, PPACIRR. PPASCAT seems to be the most important One to use.

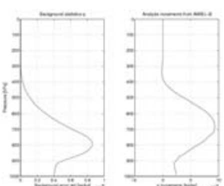
PPASCAT and PPACIRR are however difficult to apply outside the AAPP code. Suggestions to alternative algorithms for especially PPASCAT are welcome!!

General Assimilation Considerations

- Since the AMSU-B response functions depends on the water vapor amount they are not constant. Therefore the assimilation should use **inner/outer loops with intermediate re-linearizations** to assure convergence towards the most optional solution.
- Due to the varying response-functions, the ground will influence the analysis in dry cases. Therefore **T_{skin} must be included in the control vector and adjusted during minimization**. This also allows for AMSU-A CH4 to be used. An alternative solution would be to analyze T_{skin} before the assimilation: 1DVAR.

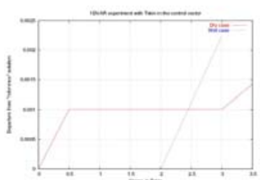


AAPP indexes PPASCAT and PPACIRR applied on AMSU-B data from NOAA16 (EARS data).
Red: observations flagged as contaminated by PPASCAT (89GHZ scattering test)
Green: Observations flagged by PPACIRR (cirrus test)



Single obs experiment with AMSU-B
Right: A profile of the analysis increments on q at the observation point.
Left: The background error standard deviation for q.

If an observation has no information about the vertical distribution, then the analysis increments would be determined by the background statistics. This plot show that AMSU-B can add some extra information about the vertical distribution of moisture.



1DVAR experiment with T_{skin} in the control-vector
Several analyses are done with different σ_b for T_{skin}. σ_b =0 means that T_{skin} is not allowed to vary during minimization, and the analysis for that case is referred to as the "reference solution". As σ_b is increased, T_{skin} is allowed to be adjusted by the assimilation system.
If it is dry (red curve), a new solution is found.
If it is wet (blue curve), the analysis is more insensitive to the ground characteristics.

Cloud mask for AMSU-A and AMSU-B

For AMSU-A over open water the NOAA/NESDIS algorithm for CLW is used as a cloud mask. In order to use AMSU-A and -B also over ice and land we would like a method that is independent of the AMSU window channels.

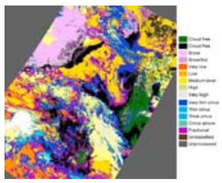


Figure 1: The OSI-SAF cloud mask

One idea is to use cloud type information from the OSI SAF cloud mask based on AVHRR, see fig. 1. Probably AVHRR will soon be included in the EARS data service.

By comparing ob-fg statistics from cloudy and cloud free classes we have decided which cloud types to include in the cloud mask. Fig. 2 shows an example where AMSU-B data (open water) from June 2004 was bias corrected and cloud cleared using this mask.

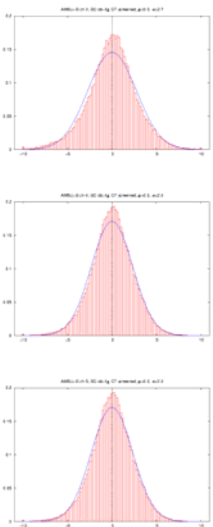


Figure 2: y-Hx_b statistics for AMSU-B