First experiences with RTTOV8 for assimilating AMSU-A data in the DMI 3D-Var data assimilation system

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Introduction

AMSU-A data has been used operationally at DMI since 2002. Impact studies (e.g. Amstrup (2003; 2004)) have demonstrated a clear positive impact in winter months. The radiative transfer model used in the analysis is RTTOV, available from the NWP SAF (Numerical Weather Prediction Satellite Application Facility). A newer version, RTTOV8 (subrelease 5), was made available in November 2004 and has been implemented in the HIRLAM variational data assimilation system (HIRFDA), including the updates since the original release. See Schyberg et al. (2003) for further details concerning the implementation in HIRFDA.

The main difference between the RTTOV7 and RTTOV9 packages used in this study is the use of FASTEM-3 instead of FASTEM-2 (see http://www.metoffice.com/research/interproj/nmapa/stm/rttov8-avr.pdf). The RTTOV7 optical depth predictors have been used to make the coefficient files that are available from the NWP SAF home page.

The current status is that we have made an impact study using the old operational DMI-HIRLAM set-up (see below). Results from this study are presented on this poster. It is likely that tests will be made with the current operational set-up in preparation for an operational implementation in the fall of 2005 and also for making a test including data from NOAA-N.

Set-up of the experiments

In the “Observing System Experiment” made here we used January 2005 with 3 hour data assimilation cycles (using the HIRLAM 3D-VAR system) and a 48 hour gridpoint forecast with the DMI-HIRLAM-G and DMI-HIRLAM-E models (Sass et al. (2002)). In the HIRLAM 3D-VAR system the following observation types (and observation quantities) were used: SYNOP, DRBU, SHIP (pressure), TEMP (temperature, wind and specific humidity), PILOT (wind), AIREP (temperature and wind), QuickSat (near surface wind) and Atmospheric Motion Vectors (AMV) from METOP. The data were screened using the following checks: 1) Bad reporting practices, 2) Black list check, 3) First guess check, 4) Multi-level check, 5) RBD check, and 6) Redundancy check. The final thinning for AMSU-A data in DMI-HIRLAM was 0.9%.

Statistics of observations against model first guess

The necessary statistics for bias correction (Harri-Kelly scheme used here) is derived using the available observations from locally received data and from EARS (EUMETSAT ATOVS Retransmission Service) for a 5.5 month period starting from June 1st 2003. The model derived data are made using archived first guess fields (3 hour forecasts) from the operational DMI-HIRLAM-G runs. The data used in the statistics are checked in the same way as in the model runs except with less thinning. The bias and rms statistics for NOAA16 AMSU-A channels 1-10 of observed brightness temperatures against model first guess derived brightness temperatures in 3 latitude bands are given in Figure 2. There are small differences of the statistics in the 3 bands, as was also seen in the original studies. This is the reason for having different bias-correction for data south of 45°N, for data north of 65°N, and for data in between. It is also seen that the statistics for channels 1-3 (“surface channels”) are quite different when using RTTOV7 than when using RTTOV8. This must be due to the differences between FASTEM-3 and FASTEM-2. For the other channels the statistics are much more similar. Note that the number of data used in the statistics are not the same. That is due to different cloud mask based exclusions when using RTTOV7 and RTTOV8. The cloud mask (see Schyberg et al. (2003)) is based on a NOAA/NESDIS developed algorithm that uses observed and model derived AMSU-A channel 1 and 2 brightness temperatures.

Figure 3 shows the effect of bias correction on the statistics for RTTOV8 derived NOAA16 AMSU-A channels 4-10 data. The raw data have biases and the distributions are to some extend asymmetric. The distributions of the bias corrected data show very nice Gaussian behavior.

Results from model runs

The results from the two model runs are compared in different ways. A standard observation verification, where forecast results are compared to standard SYNOP and radiosonde observations using an EWGLAM (European Working Group on Limited Area Model) station list, is done (see Figure 4). The impact is basically neutral. Results of forecasted 12h precipitation against observations from SYNOP stations at 08 UTC and 18 UTC are given in terms of standard contingency tables (see Tables 2-4). The forecast precipitation events (rain amounts in mm): P1 = 0.2, P2 = 1.0, P3 = 5.0, P4 = 10 and P5 = 50. P is either P (forecast) or O (observation) in the tables. Only results for the DMI-HIRLAM-E (D1E with RTTOV7 and D1D with RTTOV8) models is given in the tables. The differences are fairly small except for D1D consistently having the better number in the O1/F1 (no or small amounts of precipitation) entries.

Conclusion

As expected the impact is fairly small by using RTTOV8 instead of RTTOV7 since the main change is the use of FASTEM-3 instead of FASTEM-2 and the “surface channels” are given very small weight in the data assimilation. The memory consumption is somewhat smaller using RTTOV8 compared to using RTTOV7 in our implementation (including some cleanup of the code when using RTTOV8). This is important when considering the future instrument types such as IASI. However, the CPU time speed in the RTTOV part of the code is much larger when using RTTOV8 on the DMI SX-6 vector machine. Future tests including data over sea ice and land, as well as tests with AMSU-B, HIRS and MHS (from NOAA-N when available), is under consideration.

References


