Abstract Planning for the next European Polar System (post-EPS) is underway and a microwave sounder will be an important component of the mission payload. As part of an ESA-funded study, a number of observing system experiments (OSEs) were carried out at the Met Office and ECMWF. They aim at establishing the sensitivity of forecast accuracy to radiometric performance for a microwave sounding mission using AMSU-A data and noise degraded AMSU-A data. The results show measurable degradation in the impact of MWS data if the noise performance (NE5) of AMSU is degraded from 0.1 K to 0.2 K. For remapped data, with Southern Hemisphere forecast impacts reduced by ~10–15%.

The process of defining the mission requirements for the next generation series of European meteorological polar orbiting satellites (European Polar System, or post-EPS), to operate post-2018, is underway. Microwave sounding data has in the past provided very significant benefit in NWP systems and recent observing system experiments have shown that microwave soundings provide significant benefit, even in the presence of advanced infrared sounders (AIRS and IASI), as shown in Figure 1. A microwave sounding instrument (MWS) will therefore be an important component of post-EPS.

The radiometric requirements for such a sounding mission have a significant bearing on the type of instrument chosen for the MWS. For example due to the longer integration times possible with cross-track radiometers NE5% are generally lower, relative to conical scan geometries. Recent studies on the on-orbit performance of SSMIS have also shown that conical scanners can be more prone to complex systematic biases that limit their impact in NWP DA systems (Kunkee (2008) and Bell (2008)).

Radiometric requirements for temperature sounding channels are particularly stringent as background is low. T+6 hour forecast fields are generally of very high quality in NWP models (H945 – 0.1 K for tropospheric sounding channels). Figure 2 shows the observation minus fit test departures for AMSU channel 6 at 54.4 GHz. Measured radiance therefore need random noise performance (NE5%) and residual systematic biases below 0.3 K to improve analyses and forecasts.

This poster presents a series of observing system experiments (OSEs) carried out at the Met Office and ECMWF, funded by ESA, aimed at assessing the impact of degraded radiometric performance on forecast accuracy achieved by current global NWP models.

Conclusions
The OSEs reported here show that there is a measurable and significant reduction in forecast improvements (~10–15% for SH forecasts) provided by a single AMSU if the noise performance of the instrument is degraded to 0.2 K. The consistency of the independent tests at the Met Office and ECMWF suggest the sensitivities derived are robust.

The results reported here are relative to a baseline configuration which represents the most realistic simulation of the post-EPS observing system that can be achieved at present. Nevertheless, there is likely to be developments in NWP systems between now and 2018 that influence the significance of these results, including:

- The development of more intelligent averaging and thinning schemes
- More optimal use of MWS and IR data over land and sea
- More widespread use of MWS and IR data in cloudy and precipitating regions
- More optimal observation and background error definition, improved bias correction and quality control of data.

Met Office OSEs The global observing system in the post-EPS era is likely to include at least two advanced infrared sounders (of AIRS / IASI class) and therefore the Met Office OSEs employed a baseline configuration (NO-MWS) which included all observation types (including AIRS and IASI) used operationally but which withheld all microwave temperature and water vapour sounding channels (from N16, -18, MetOp-A AMSU-A/B and F16 SSMIS).

The two test experiments introduced:

- Data from MetOp-A AMSU with nominal noise performance (NE5%) – 0.1 K for channels 5–9, as Met Office AMSU data are remapped to the HRIS grid.
- Data from MetOp-A AMSU with synthetic noise added, to achieve NE5% – 0.2 K.

The experiments were run over a 30-day period covering 24 May – 24 June 2007. Figure 3 shows the impact of adding normal and noisy AMSU-A to the NO-MWS baseline, relative to a range of observation- and analysis-based verification measures. A single AMSU improves forecasts by 5–10% in both the Northern and Southern Hemisphere. The impact is weaker, but still positive, in the Northern Hemisphere at ~2–3%. The impact of adding noise is to reduce the impact of the data by ~10%. This is shown more clearly in Figure 4, which shows the effect of adding a range of 125% of verification measures in the NH, tropics and SH.

ECMWF OSEs A set of OSEs were run at ECMWF for the same period. In a first reference experiment only conventional observations and atmospheric motion vectors were included in the assimilated observations.

In a second experiment, a single AMSU-A (NOAA-18) was added to the ‘poor’ reference system, therefore allowing the evaluation of the (positive) impact of the new instrument. A third assimilation experiment differed from the previous only in having synthetic noise added to the AMSU-A observations. A fourth experiment was run with the full observing system as a control, i.e. to evaluate the forecast errors of previous experiments as differences from the corresponding control analysis.

The impact of the increased noise levels on the forecast scores is shown in Figures 5 and 6. Here, the RMS errors are normalized to those of the reference, and plotted as function of the forecast range. Black curves are for the experiment where original AMSU-A observations are assimilated, while red ones are for the experiment with augmented instrument noise. Vertical bars along each curve indicate 50% confidence intervals. Figure 5 shows the forecast error for geopotential height at four pressure levels (from top to bottom), separately for the Southern Hemisphere (left panels), Tropics (central panels) and Northern Hemisphere (right panels). In the Southern Hemisphere, a degradation of the forecast skill of ~15% is evident from Day 1 to Day 4 at all pressure levels. In the Tropics and in the Northern Hemisphere the degradation is smaller and still within the confidence bars, but is still evident. Normalized rms forecast errors are reported in Figure 6 for the mean surface level pressure. Again, in SH, where AMSU-A data are more important for an accurate analysis, the degradation at Days 1 to 4 ranges from 14% to 20%.

References


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Post-EPS planning process
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