

Introduction

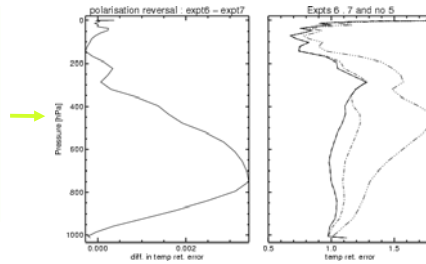
Microwave sounders such as AMSU-A, AMSU-B, MHS and SSMIS form a very important and mature part of the global observing system both for weather forecasting and climate science. Three possible modifications to the mature baseline system are considered here. In each, the value for weather forecasting is assessed using 1D-var and simulated observations. This research was funded by two EUMETSAT study contracts, EUM/CO/07/4600000409/CJA and EUM/CO/06/1577/PS.

Method

1. Create a simulated "truth" from Chevalier (2001) dataset and then calculate simulated noise-free observations using RTTOVSCATT (Bauer 2002).
2. Add simulated errors to the truth and the observations consistent with observation and background error covariance matrices to estimate background and noisy observations.
3. Run 1D-var assimilating the simulated noisy observations.
4. If testing cloud screening run 1D-var twice, using the first run to screen for cloud.

Question 1: Does polarisation matter?

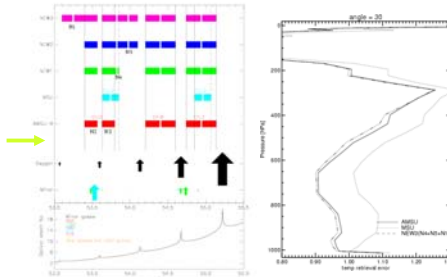
The polarisation measured by a cross track sounder varies as the angle of look changes across the scan. When looking at nadir, the channels either measure nominal vertical or horizontal polarisation. AMSU-A is QV (vertical at nadir) for channels 1 to 4, 7 and 15. AMSU-B is QV for all channels. Questions arise about which is the best choice for sounding, and does it matter if adjacent channels measure opposite polarisations?



- Horizontal polarisation for sounding channels (AMSU Ch.4-6) gives the lowest analysis error.
- The advantage is, however, tiny so the choice of polarisation is not critical.

Question 2: Does the unmeasured spectrum between 53 and 55 GHz contain useful information?

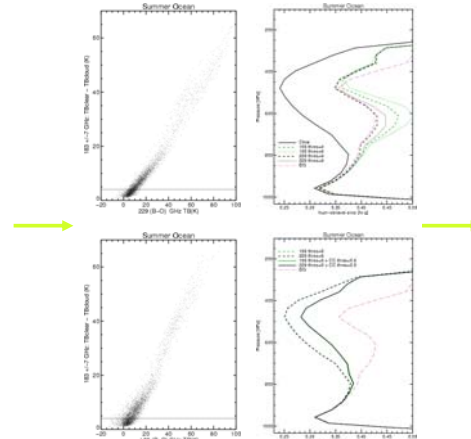
The figure to the right shows the spectral coverage of MSU and AMSU-A observations between 53 and 55.5 GHz. The absorption spectrum of oxygen is also shown as is the position of the main spectral lines (oxygen — black arrows; trace gases — coloured arrows). Despite primary protection for passive sounding under the radio regulations, not all of this band is used by current instruments. AMSU (red blocks) used more of the band than MSU (light blue blocks). Three options are tested. "New1" (green) added a missing part of the MSU-2 channel. "New2" (dark blue blocks) added a channel between AMSU Ch.5 and Ch.6. "New3" added a channel between AMSU Ch.4 and Ch.5. All channels use the space between strong oxygen lines.



- Adding channels at 53.097 to 53.396 GHz and 53.796 to 54.100 GHz gives significant useful new information (Sreerekha, English and Rayer 2008)
- The impact of the two new channels was found to be about a third of the impact of removing AMSU Ch.5.
- This is, however, a small fraction of the improvement which was found going from MSU to AMSU.

Question 3: Can a 229 GHz channel help identify cirrus in the wings of the 183 GHz water vapour line?

Scattering by ice hydrometeors increases rapidly between 89 and 229 GHz. The window channels at 89 and 166 GHz are only weakly sensitive to ice hydrometeors smaller than 200 μm and may be too weak to determine if the cloud is altering measurements in the wings of the 183 GHz water vapour line. In this study a 229 GHz channel was simulated following the same method as the first two studies. The figures to the right show that as expected the 229 GHz channel is much more sensitive to ice cloud than 166 GHz. The figures on the far right show that the negative impact on undetected cloud is much larger if 166 GHz is used for screening cirrus than if 229 GHz is used for screening cirrus. The top plot shows analysis errors for the cloudy dataset, where cloud is missed and degrades the analysis. The lower plot shows the impact on cloud-free cases.



- Cirrus cloud screening would be improved if a 229 GHz channel is added to MHS.
- Adding a 229 GHz channel would allow more weight to be given to 183 GHz data in data assimilation either by:
 - Eliminating the negative impact of undetected cloud when not screening using the 183 GHz channels.
 - Reduce the false alarm rate in cloud screening when the 183 GHz channels are used to "self screen".

Conclusions

- Polarisation choice has little impact on NWP.
- More temperature information can be extracted between 53 and 55 GHz .
- A 229 GHz channel would improve exploitation of the 183 GHz water vapour line.

References

- Pavelin E.G., S.J. English and J.R.Eyre. The assimilation of cloud affected infrared satellite radiances for numerical weather prediction. Accepted by QJR Meteorol. Soc.
 Chevalier, F., 2001: Sampled databases of 60-level atmospheric profiles from the ECMWF analysis, Technical report, SAF Research Report No.4, available from www.metoffice.gov.uk
 Bauer, P., 2002: Microwave radiative transfer modelling in clouds and precipitation, Part 1: Model description. Technical report, NWPSAF-EC-TR-005.
 Sreerekha TR, S.J. English and P.J. Rayer 2008 a: Report on oxygen sounding channel frequencies and polarisations. EUMETSAT Contract EUM/CO/06/1557/PSF.
 Sreerekha TR, A.M. Doherty, S.J. English, P.J. Rayer 2008 b: Report on The Potential of a Microwave Sounder 229GHz Channel. EUMETSAT Contract EUM/CO/07/460000409/CJA