CALIBRATION AND IN-ORBIT PERFORMANCE OF AMSU-B

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Summary: This paper discusses the calibration issues relevant to the AMSU-B on NOAA-15, and in particular the removal of RFI-induced bias. Some comparisons with AMSU-A channel 15 are also presented.

1. INTRODUCTION

AMSU-B is a 5-channel microwave radiometer intended for humidity sounding as part of ATOVS. The first AMSU-B flight model was launched on NOAA-15 on 13th May 1998. A functional description of AMSU-B is given by Saunders et. al. (1995), while an initial assessment of the in-orbit performance is given by Atkinson and McLellan (1998). This paper reviews the instrument performance to date and discusses the main problem associated with the instrument – radio frequency interference (RFI) from spacecraft transmitters. It also briefly presents some results of studies on navigation accuracy, using comparisons between the 89 GHz channels on AMSU-B and AMSU-A.

2. SCAN-DEPENDENT BIAS PROBLEMS

Functionally AMSU-B performs within its specification (e.g. channel noise levels). However, all channels are susceptible to RFI from the various spacecraft transmitters in the 1.54 to 1.71 GHz range. This resulted initially in scan-dependent biases of up to 40K. A correction scheme was devised, in conjunction with NESDIS, with the aim of restoring AMSU-B accuracy levels. However, in September 1998 a sudden degradation appeared in one of the spacecraft transmitters, which resulted in a dramatic increase in bias (up to 100K). Continuing erratic behaviour of the transmitters meant that AMSU-B could no longer be considered reliable enough for use in NWP, though the imagery continued to be useful for some applications, and a bias correction scheme was distributed as part of AAPP.

In March 1999 the high-gain transmitter that broadcasts HRPT (STX-1) had degraded to the point where HRPT could not be received reliably by users with small-dish antennae. The other two high-gain transmitters (STX-2 and STX-3) had also degraded. NOAA therefore considered alternative transmission scenarios in order to try to maintain both HRPT and the global data dumps. Eventually, in late September 1999 the following combination was adopted operationally:

- HRPT switched from STX-1 high-gain (1.698GHz) to STX-2 omni-directional antenna (1.7025GHz).
- Global data dumps moved to STX-4 omni-directional antenna (2.2475GHz). (No effect on AMSU-B)

As well as restoring HRPT, this combination has the advantage that AMSU-B biases are once again stable. Only two transmitters now interfere with AMSU-B – the STX-2 'omni' and the Search and Rescue Repeater (SARR). Since these transmitters are normally radiating continuously, a special test must be performed in order to determine the AMSU-B bias levels.

3. AMSU-B BIAS 'TRENDING TESTS'

These tests are conducted approximately every two months in order to quantify and monitor the RF-induced biases on each AMSU-B channel. Each active transmitter is turned off for a brief period (30 seconds), over an area of uniform surface characteristics (e.g. ocean or desert). By examining the step-changes in each channel as the transmitter is turned off or on, an absolute measurement of the bias is obtained. Fig. 1 displays the results of a recent test (conducted on 6th October 1999), and compares the results with those expected from previous tests. In this case, the 'previous' results are from May 1999 for SARR and July 1999 for STX-2 omni; these form the basis of the current AAPP bias correction tables.

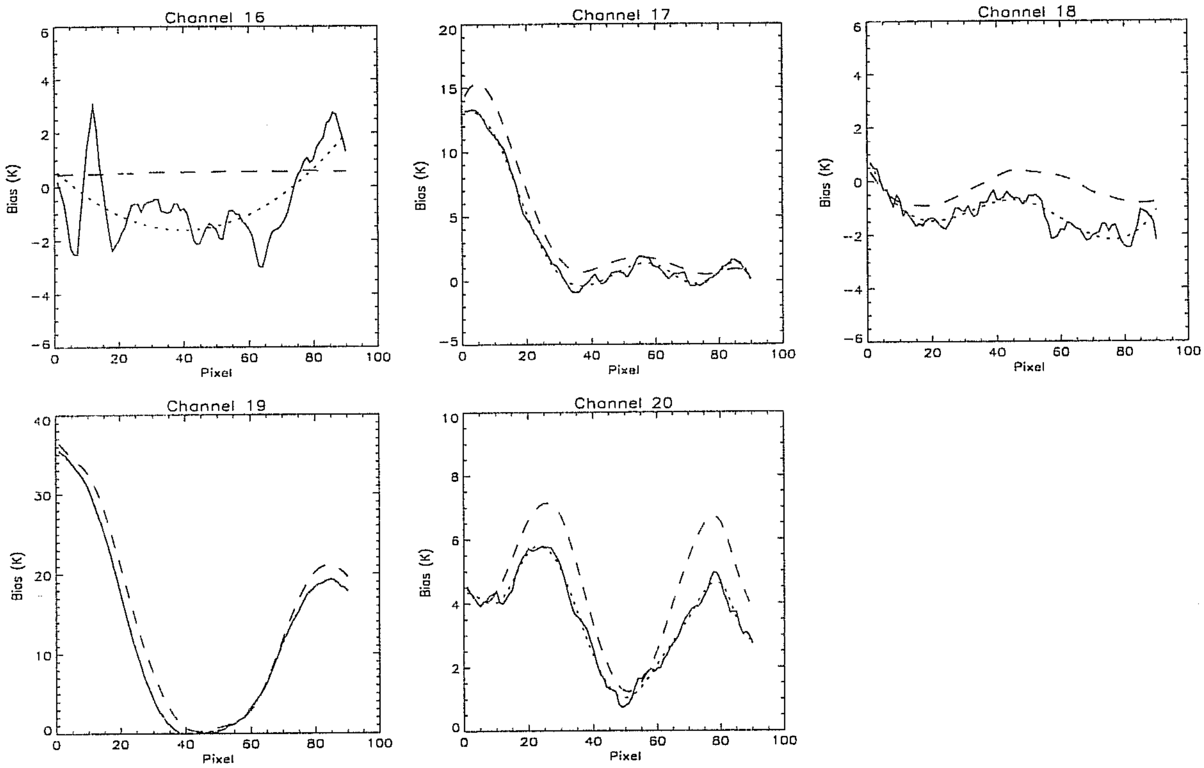


Fig 1: AMSU-B biases (STX-2 omni + SARR) deduced from October 1999 trending test. Solid: raw data from trending test; Dotted: least-squares fit through data; Dashed: Existing AAPP correction tables.

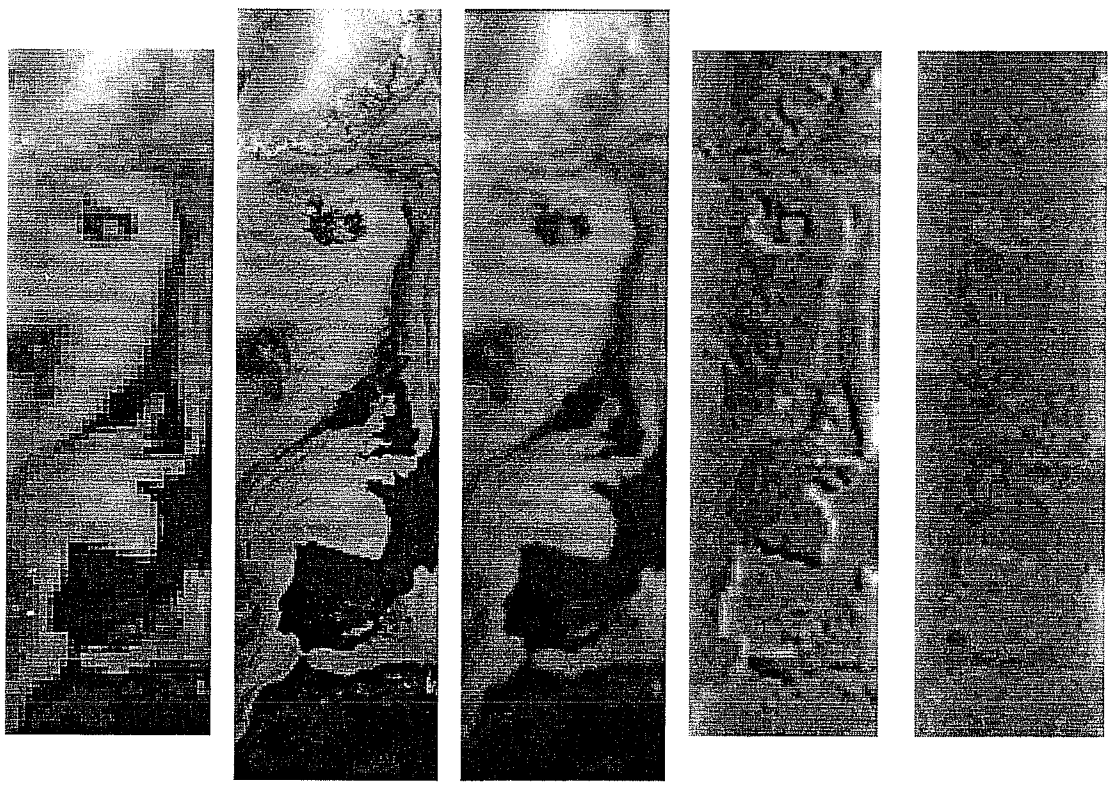
It can be seen that the existing correction tables are correct to within approximately 2K worst-case. It is planned to issue an update to these correction tables. Note that this method is not reliable for channel 16, because of surface variability effects: section 4 demonstrates an improved technique for channel 16.

4. COMPARISON BETWEEN AMSU-B AND AMSU-A 89GHz CHANNELS

Since AMSU-B and AMSU-A each have a channel centred on 89GHz, a detailed comparison between these channels can provide information on absolute radiometric accuracy, beam-pointing accuracy and noise. However, because of the very different beam-widths of the two instruments, some image processing is required in order to perform a sensible comparison. This may be achieved using Fourier Transforms.

Fig. 2 illustrates the technique. An AMSU-B scene is Fourier transformed, manipulated to attenuate high spatial-frequencies, and returned to the image domain. This gives a quasi-continuous image corresponding to an instrument of AMSU-A beam-width but highly over-sampled (Fig. 2 (c)). On re-sampling at the nominal AMSU-A sample positions it is clear that the difference image (Fig. 2 (d)) shows artefacts due to misalignment (e.g. the 'shadowing' on the west and north coasts of Spain). Re-sampling with an offset of +0.24 AMSU-B samples in the cross track direction and +0.15 samples along-track removes these artefacts.

The same technique may be used to determine RFI biases in AMSU-B channel 16, by examining the imagery obtained during a trending test. The scan-dependent differences between AMSU-B and AMSU-A are quantified during a period when all transmitters are off; these are taken to be 'truth' and may be compared with the scan-dependent differences obtained when the transmitters are on. It is not necessary to eliminate biases between channels 16 and 15, since other instrumental effects may be present; rather, AMSU-A is used as a transfer standard in correcting AMSU-B.



(a) (b) (c) (d) (e)

Fig. 2 Comparison between AMSU-A channel 15 and AMSU-B channel 16.
(a) AMSU-A Channel 15 scene (30 pixels wide). Scale: 164K (white) to 290K (black).
(b) AMSU-B Channel 16 scene (90 pixels wide). Same scale as (a).
(c) AMSU-B scene degraded to AMSU-A beam-width. Same scale as (a).
(d) Difference between AMSU-B and AMSU-A when AMSU-B scene is re-sampled at the nominal AMSU-A sample locations. Scale: -11K (white) to +5K (black)
(e) Difference between AMSU-B and AMSU-A when AMSU-B scene is re-sampled with an offset of 0.24 AMSU-B samples cross-track and 0. 15 AMSU-B samples along-track. Same scale as (d).

5. REFERENCES

Saunders, R.W., T.J. Hewison, S.J. Stringer and N.C. Atkinson, 1995: The Radiometric Characterization of AMSU-B. IEEE Trans. on Microwave Theory and Techniques, Vol 43, No 4, April 1995.

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