Microwave Sounder Scan Bias Analysis from AIRS/AMSU Observations

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Abstract: The Atmospheric Infrared Sounding (AIRS) instrument suite, which includes the Advanced Microwave Scanning Sounder Unit A (AMSU-A) as well as a near-copy of the AMSU-B - the Humidity Sounder for Brazil (HSSB), was launched on the NASA Aqua satellite in May 2002. During the on-orbit checkout it became apparent that the microwave instruments, in particular AMSU-A, exhibit a significant scan angle dependent bias. This phenomenon has also been noticed in the AMSU instruments operated by NOAA on NOAA-15 through NOAA-17 and is expected to also be a feature of the next series of AMSU instruments, on NOAA-N and NOAA-N' as well as on equivalent European satellites. The Advanced Technology Microwave Sounder (ATMS), to be launched first in 2006 on the NASA NPP satellite and thereafter on a number of NPOESS satellites, is also expected to have significant scan bias. This bias is a major hindrance to the effective use of the microwave observations, both operationally and in atmospheric research, and much effort has been devoted by NOAA as well as NASA to analyze it, with a view toward correcting the measurements on an objective basis from first principles. These efforts have not yet been entirely successful, and many data users have resorted to making empirically derived corrections instead. While that may be satisfactory for operational use, it is not desirable for climate research and similar applications. The effort to model the bias therefore continues. In this paper we report on work that has been done at the Jet Propulsion Laboratory in this regard, including some progress in modeling the bias.

Background

Observations:
• Substantial scan bias in the observations; Asymmetric w.r.t. nadir; Magnitude varies along the orbit

Remedial action by AIRS:
• Preliminary analysis to characterize the behavior - not yet fully modeled, but results are promising
• In the meantime: empirical “bias tuning” is applied instead as part of the retrieval processing

Ongoing effort:
• Fully characterize the scan bias & model the effect from physical principles
• Determine modeled bias corrections, to be applied at the calibration processing stage
• Result is to convert earth scene “antenna temperatures” to “brightness temperatures”

Examples: Obs(AIRS/AMSU) - Calc(ECMWF)

Viewing geometry

Computed antenna efficiencies

Observed & predicted scan bias vs. scan angle - Ch. 8

AMSU vs. AIRS or ECMWF

How good is the “Truth”

Bias = Obs(AIRS) - Calc(truth): What is best “truth”?

• Truth #1: Forecast fields (ECMWF etc.)
• Truth #2: Radiosondes etc.
• Truth #3: AIRS retrievals

AMSU vs. AIRS or ECMWF

Step 1: Find AIRS channels with weighting functions matching AMSU’s

Step 2: Compare bias (AIRS-ECMWF) with bias(AIRSM-AMSU)

Empirical bias correction

Currently most used approach

• Compute obs-calc(ECMWF) for many cases
• Fit mathematical/regression model
• Determine bias corrections coefficients

Method described here
• Step 1: Compute obs-calc(ECMWF)
• Step 2: Compute obs-calc(AIRS)
• Step 3: Use shape from Step 1; offset from Step 2

Future work

Work continues on AIRS/AMSU, to replace empirical with modeled bias corrections

Model S/C environment more accurately

This is pursued for NPP/AMSS; the “climate” component of mission requires non-empirical corrections

A method to measure antenna efficiencies (T_a) directly on the ground has been proposed

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Empirical bias correction: Results

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