Calibration Status of the Atmospheric Infrared Sounder (AIRS) on Aqua

Steve Gaiser

Jet Propulsion Laboratory,
California Institute of Technology
4800 Oak Grove Avenue, Pasadena, CA 91109
AGENDA
AIRS Calibration Status

- Radiometric status
- Spectral Status
- Spatial Status
- Vis/NIR Status
- Summary
RADIOMETRIC APPROACH
AIRS Calibration Status

Based on 2-point in-orbit calibration, with corrections for polarization and non-linearity (each < ~1.5%)

\[
N_{sc,i,j} = \frac{a_o(\theta_j) + a_{1,i}(dn_{i,j} \cdot dn_{sv,i}) + a_2(dn_{i,j} \cdot dn_{sv,i})^2}{1 + p_r p_t \cos 2(\theta_j \cdot \theta_i)}
\]

\[
a_o(\theta_j) = P_{sm} p_r p_t [\cos 2(\theta_j \cdot \theta_i) + \cos 2 \theta_j]
\]

\[
a_{1,i} = \frac{N_{OBC,i}(1 + p_r p_t \cos 2 \theta_i) \cdot a_o(\theta_{OBC}) \cdot a_2(dn_{OBC,i} \cdot dn_{sv,i})^2}{(dn_{OBC,i} \cdot dn_{sv,i})}
\]

\[
d_{n_{ij}} = \text{Raw Digital Number in the Earth View}
\]

\[
d_{n_{sv,i}} = \text{Space view counts offset.}
\]

\[
a_o = \text{Radiometric offset. } a_{1,i} = \text{Radiometric gain.}
\]

\[
a_2 = \text{Nonlinearity}
\]

\[
p_r p_t = \text{Polarization Factor Product}
\]

\[
d = \text{Phase of the polarization}
\]

\[
N_{sc,i,j} = \text{Scene Radiance (mW/m}^2\text{-sr-cm}^{-1})
\]

\[
P_{sm} = \text{Plank radiation function}
\]

\[
N_{OBC,i} = \text{Radiance of the On-Board Calibrator}
\]

\[
i = \text{Scan Index, } j = \text{Footprint Index}
\]

\[
q = \text{Scan Angle. } q = 0 \text{ is nadir.}
\]
Simple radiometric transfer equations lead to exceptional accuracy: Pre-flight residuals < +/- 0.1K for >90% of channels
DETECTOR NOISE LEVELS
AIRS Calibration Status

- In-orbit special test data analyzed
- Consistent w/ pre-flight measurements
- Calculated for a 250K scene
- AIRS NEDTs look good in orbit

\[
NEN_{\text{scene}} = Gain \sqrt{N_{\text{scene}}/N_{\text{obc}}} \left( DN_{\text{obc}}^2 + DN_{\text{sv}}^2 \right) + DN_{\text{sv}}^2
\]
• Icing observed early in mission

• Detector responsivities are now stable (< 0.3% change/month)
SPECTRAL CHARACTERIZATION
AIRS Calibration Status

SRF shapes well characterized pre-launch

SRF centroids accurately determined pre-launch
The AIRS spectrometer has a 23-hour thermal time constant, measured pre-flight.

In-orbit spectral calibration provides the most sensitive measurement of instrument stability.

AIRS is extremely stable spectrally: < 0.03%/month shift.
SPECTRAL STABILITY
AIRS Calibration Status

Five Months of Spectral Stability

- Calculated position of every 6-minute granule
- Daily mean shifts

Date

AIRS Science Team Meeting, Feb. 25-27, 2003, Camp Springs, MD
SPECTRAL ACCURACY
AIRS Calibration Status

- SRF centroids known to 0.5% FWHM based on the pre-flight model
- Validated to ~1.5% in all bands except M5
- Stability not in question for M5
GEOLOCATION ACCURACY
AIRS Calibration Status

- Done by Dave Gregorich, based on MODIS approach
- Method is described in TGRS special issue
- Finds apparent shift of 2 km in cross-track direction
L1B and L2 products are in good shape, no significant liens.
Current activities:

- Coregistration. An area-matching technique (comparing cloud patterns in ocean granules) is being used to assess the relative alignment of IR and Vis in instrument coordinates (line/sample).
- Geolocation. Similar area matching techniques will be applied in an earth-based coordinate system (lon/lat), allowing comparisons to AMSU, HSB, MODIS, MISR, and USGS data sets. This follows up on work reported previously by UCSB.
- Additional validation of cloud flags. UCSB reported excellent agreement between MODIS and AIRS-Vis/NIR cloud flags. Will now compare Vis/NIR to lidar results.
- Vis/NIR global surface maps. Refine data selection and smoothing criteria when generating global maps of surface-type. These maps are currently used in cloud detection, and to provide NDVI information in L1b files.
SUMMARY
AIRS Calibration Status

- AIRS IR radiometric accuracy and precision are outstanding
- AIRS spectral stability is excellent
- Geolocation information is currently good to 1/5th an IFOV
- VIS/NIR is performing as expected