Evaluation of AIRS, MODIS, and HIRS 11 micron brightness temperature difference changes from 2002 through 2006

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ABSTRACT

In an effort to validate the accuracy and stability of AIRS data at low scene temperatures (200-250 K range), we evaluated brightness temperatures at 11 microns with Aqua MODIS band 31 and HIRS/3 channel 8 for Antarctic granules between September 2002 and May 2006. We found excellent agreement with MODIS (at the 0.2 K level) over the full temperature range in data from early in the Aqua mission. However, in more recent data, starting in April 2005, we found a scene temperature dependence in MODIS-AIRS brightness temperature differences, with a discrepancy of 1-1.5 K at 200 K. The comparison between AIRS and HIRS/3 (channel 8) on NOAA 16 for the same time period yields excellent agreement. The cause and time dependence of the disagreement with MODIS is under evaluation, but the change was coincident with a change in the MODIS production software from collection 4 to 5.

AIRS and MODIS (Flight Model 1) are onboard the EOS Aqua spacecraft, launched into a 1:30 PM polar orbit on May 4, 2002. AIRS has 2378 infrared channels with high spectral resolution (1200) covering the 3.7 to 15.4 micron wavelength range, with a nominal spatial resolution of 13.5 km. MODIS has 36 relatively broad spectral bands with spatial resolution of 1 km for the LWIR bands. HIRS/3 is onboard NOAA-16 (L), launched into a 2:00 PM polar orbit on Sep. 21, 2000.

Keywords: AIRS, MODIS, HIRS, spectrometer, radiometer, validation

1. INTRODUCTION

Discussion of global temperatures at the 100 mK absolute level with changes at the 10-20 mK/year level[1] requires that the absolute accuracy and long tem stability of supporting climate data sets and their underlying instrumentation must be of at least this quality. While the capability to radiometrically validate at the 100 mK level has been demonstrated for individual instruments[2], doing so across multiple instruments and/or platforms is somewhat more problematic. In this paper, as part of a study to validate the accuracy and stability of AIRS data at low scene temperatures, we utilize Antarctic overpasses to provide a common cold reference for comparison of AIRS and MODIS, both on the Aqua platform, and AIRS and HIRS/3, the latter on NOAA-16 (L). The high spectral resolution of AIRS allows the synthesis of broader bandpass spectral response functions, while differences in spatial resolution can be handled by either matching footprint centers without regard to spatial resolution, by averaging higher resolution footprints to create equivalent coarser sized footprints, or utilizing a combination – i.e., averaging to an intermediate resolution, and matching up with somewhat coarser footprints. Additionally, spatial uniformity and/or scan angle match-up constraints can be applied – but we chose to apply no additional constraints beyond a nearness criterion. This relatively straightforward approach appears to work well, resulting in agreement at the 0.2 K level. It is expected that the approach could be extended to other instruments/platforms, such as MODIS on Terra, IASI, as well as the CrIS and VIIRS on the NPOESS platforms.

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NOAA polar orbiters are not maintained at a constant ascending node. Aqua-MODIS band 31 has a central wavelength of 11.03 microns and HIRS/3 channel 8 has a central wavelength of 11.11 microns, both with bandwidths on the order of 0.5 microns.

6. SUMMARY

A method of inter-instrument, cross-platform calibration/validation at the stressing calibration point of 200 K using Antarctic scenes appears viable to the 0.2 K level, which is at the threshold level required to perform climate studies. When limiting comparisons to the Antarctic continent, no constraints other than a nearness criterion were required for either same-platform comparisons (MODIS-AIRS) or for cross-platform comparisons (HIRS-AIRS), when the nearest overpass in time was selected. The high spectral resolution of AIRS allowed the synthesis of broader bandpass spectral response functions such as those of MODIS and HIRS via a linear combination of selected AIRS channels. It is expected the approach used could be extended to other instruments/platforms, such as MODIS on Terra, IASI, as well as the CrIS and VIIRS on the NPOESS platforms