A SEMI-DECADAL MULTI-SENSOR GRIDDED DATA RECORD OF OUTGOING
LONGWAVE RADIATION (OLR) FROM AQUA

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ABSTRACT
Launched on May 4, 2002, Aqua carries two well calibrated independent infrared (IR) instruments, Atmospheric Infrared Sounder (AIRS) and Moderate Resolution Imaging Spectroradiometer (MODIS), which together could provide a precise decadal measurement across the IR electro- magnetic spectrum from 3.7um to 15um to form a fundamental climate data record. According to the National Academy of Science – Nation Research Council report [1], the notion of a fundamental climate data record (FCDR) is defined as “a time series of measurements of sufficient length and continuity to determine climate variability and change from sensor data (e.g., calibrated radiances, brightness temperatures (BT), radar backscatter) that have been improved and quality controlled over time.” AIRS and MODIS have been continuously returning upwelling IR spectral radiance measurements while maintaining a nominal grid precision of ~0.2 - 0.4 K BT [2] with quality controlled calibration improvements for more than five years. Based on the Aqua senior Project Review [2] of available flight fuel, power and orbital maneuvers, the assessed life span of the satellite Aqua is estimated to be 2013. AIRS and MODIS instrument teams also expect their passive radiometers to continue providing self-calibrating measurements with the same precision through the year 2013. With these assumptions, we show in this paper that with these two independent sensors on the same platform with on orbit relative validations, this data record would be of sufficient length and continuity to meet the FCDR definition to observe and determine the decadal variability of seasonal to inter-annual climate processes. In addition, NPOESS preparatory project will launch satellite systems carrying instruments similar to AIRS and MODIS which will enable production of an FCDR record for additional decades. An FCDR requires stable and consistent measurements throughout the entire period of observation. We have implemented the Service Oriented Atmospheric Radiance (SOAR) system [3], featuring gridded datasets and analysis capabilities for inter-comparisons of gridded AIRS and MODIS spectral radiances. SOAR can establish the stability and consistency of these measurements over their entire 5 year flight history. In particular, a dataset is available on a lat–lon grid of averaged AIRS radiances over 5 years at a grid resolution of 0.5 X 1.0 degrees from 2005 through 2007. The SOAR system will also produce 5 years of gridded MODIS radiance data at the same resolution from 2002 through 2007. In addition to the averaged radiances for AIRS and MODIS available online, SOAR also provides maximum and minimum radiances for ascending and descending orbits.

Figure 1 shows a plot produced by SOAR of AIRS and MODIS gridded radiances across all their measured IR spectral channels for a given day October 1 2007, five years after launch. The plot of the radiances of these two instruments show that the relative measurements of the IR OLR for each of the MODIS spectral channels are consistent with AIRS with the same relative accuracies. We ascribe this consistency to the fact that both instruments have been fully ground calibrated at NIST with the black body instruments, in orbit traceable to the NIST black body calibration.

Figure 2 shows a three year average of monthly radiances for February for the years, 2005, 2006 and 2007. Figures 2B, 2C and 2D show AIRS gridded radiances can distinguish the spatio-temporal monthly anomalies arising from the three year annual radiance cycle (i.e. brightness temperatures). Thus, if the current projected performance of these instruments is maintained through 2013, then a fundamental decadal data record of IR spectral radiances should be available with sufficient accuracy to detect climate process changes in this 10 year climate data record. Results will be presented of studies of inter-annual processes such as the MJO, ENSO, QBO and inter-annual global radiances observed in the data record over the past five years.

In order to ensure that the fidelity of these observations meets the requirements of an FCDR, SOAR provides a number of scientific statistical services to enable scientists to invoke detailed analytical services on demand.
These statistical services consist of conducting spectral convolutions, limb scan adjustments, root mean square differences, correlation anomalies, and simulating AIRS and MODIS radiances from analysis and model outputs. To validate the detection of climate signals in the AIRS and MODIS radiance data sets, results are compared with model radiance outputs from the National Centers for Environmental Prediction (NCEP) analysis and selected model simulation outputs stored in the Intergovernmental Panel on Climate Change (IPCC) archive.

If the current projected performance of the AIRS/MODIS instruments is maintained through 2013, then a FCDR of IR spectral radiances should be available with sufficient accuracy to detect climate process changes in this 10 year data record and beyond.

Figure 1. Plot showing agreement in average radiance values between 324 operational AIRS channels (green), and 16 MODIS channels (red) for all radiances on October 1, 2007 in region 20N-20S 180W-90W

Figure 2. (a) 3 Mean AIRS brightness temperatures of Feb 05, 06, and 07 for super-window channel in the 3.7 micron region. (b) AIRS brightness temperature difference between Feb 05 and 3 year mean. (c) AIRS brightness temperature difference between Feb 06 and 3 year mean. (d) AIRS brightness temperature difference between Feb 07 and 3 year mean.

REFERENCES