Project: Towards a Consensus Historical AVHRR Reflectance Calibration

Personnel:

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Project Description

The Advanced Very High Resolution Radiometer (AVHRR) flying on NOAA and EUMETSAT polar orbiters has a long data record (1979-present); and with its global, daily coverage and moderately high resolution (1-4km) it can resolve many cloud and surface features. For this reason, the AVHRR has become a critical component in many satellite climate studies. Unfortunately, sensor degradation and lack of on-board calibration for channels 1 (red) and 2 (NIR) require post-launch calibration efforts in order for these data to be useful for detecting long term climate change. The spectral band passes of channel 1 and

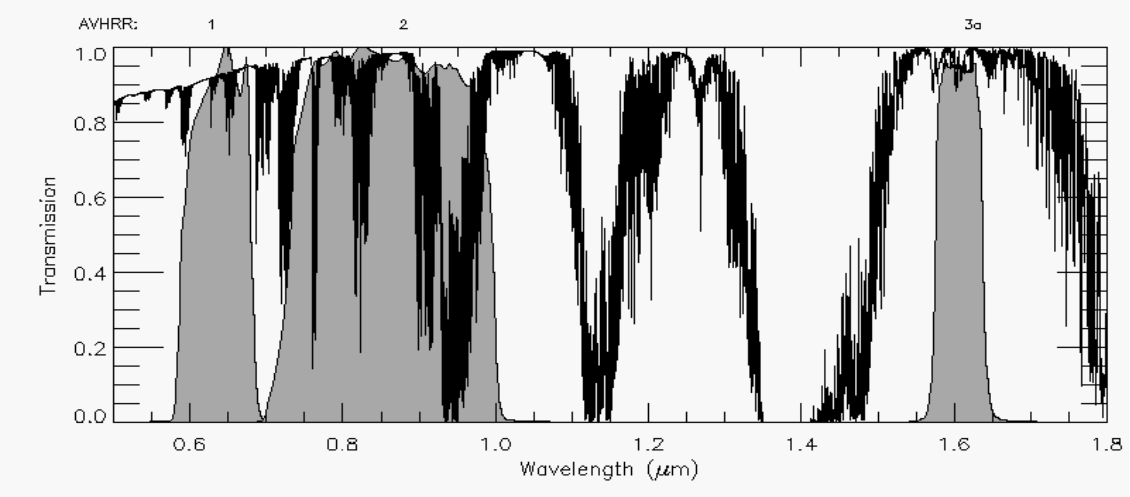

Figure 1 AVHRR spectral response functions overlaid onto a transmission spectrum for Tropical standard atmosphere.

Although calibration research has been conducted since the early days of the instrument, there is still quite a bit of disagreement among the various published calibrations – on the order of 10%. This goal of this project is to study past calibration efforts, bring together current AVHRR calibration researchers, and design a set of guidelines for calibration that will bring differing methodologies within a 3-4% consensus. To illustrate this, Figure 2 shows a

comparison of three of the available long-term AVHRR reflectance calibration data sets (ISCCP, LTDR and PATMOS-x). Figure 2 compares the mean channel-2 reflectance over a region of the Greenland Ice Sheet using the same raw AVHRR count values. ISCCP does not provide information on the channel-2 calibration. The results confirm that current calibration often disagree by upwards of 10% in a relative sense. This level of uncertainty is too large for many climate applications.

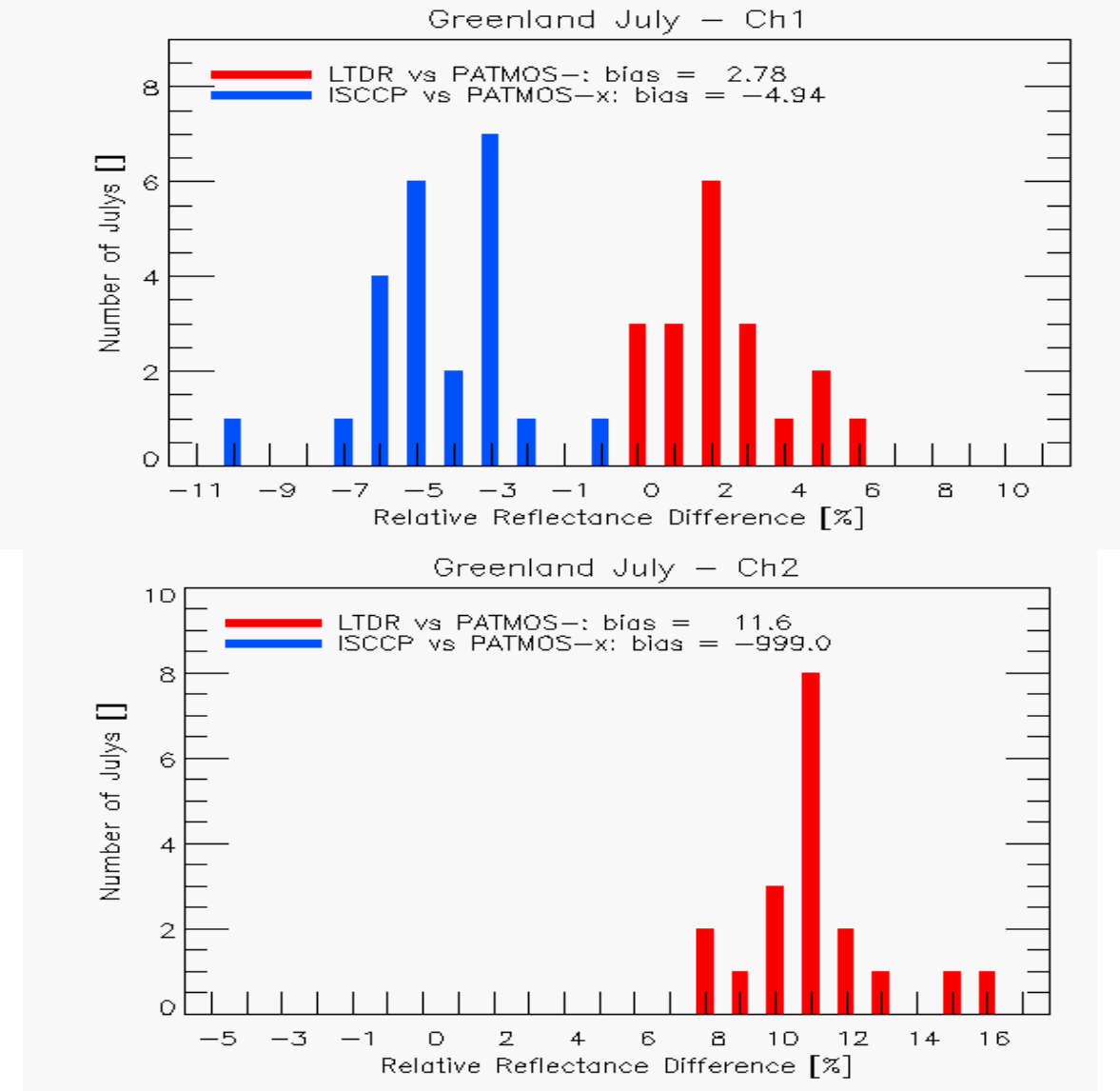

Figure 2 Analysis of the variation of the channel-2 reflectance over a region of Greenland due to calibration differences present in the ISCCP, LTDR and PATMOS-x calibration data sets.

Project Progress

During this year, we have developed a new set of calibration coefficients for each AVHRR instrument. Figure 3 shows an example of the calibration coefficient for Channel 1 of the AVHRR flown on NOAA-18. The points are generated from the Libyan Desert and DOME-C vicarious targets in addition to the direct comparison to MODIS during periods of simultaneous overpasses (SNO's). In addition, the AVHRR SNO values also provide a measure of the level of agreement among the other AVHRR sensors. These values are shown in green in Figure 3. The black curve shows a polynomial fit and represents the actual assumed variation of the calibration for the channel over the life of the instrument.

To that effort we have completed the following specific progress May 2008 - April 2009

- Completed the assembly of pre-launch plus 14 post-launch calibrations from the literature for AVHRR channels 1 and 2
- Extracted time series of channel 1 and 2 counts over selected targets, including Libya, Amazon, Southern Ocean
- Estimated range in differences among calibrations from all groups and active groups.
- Computed several types of calibration parameters over selected targets, including previously mentioned plus Dome C
- Organized AVHRR/HIRS CDR Workshop, NOAA Science Center, Camp Springs, Maryland November 17-19, 2008
- Computed simultaneous nadir overpasses between AVHRR/AVHRR pairs back as far as TIROS-N (1987-2008. Data prior to 1987 does not include afternoon/morning SNO due to bad data over SNO region) and AVHRR/MODIS pairs from 2000-2008.
    - Slope/intercept for each AVHRR/AVHRR SNO posted at http://cimss.ssec.wisc.edu/clavr/calibration/snocompare.html
    - Slope/intercept for each AVHRR/ MODIS SNO posted at http://cimss.ssec.wisc.edu/clavr/calibration/modis_avhrr/modis_sno.html

- Assembled an analysis of the integrated solar amount using various solar spectra for each AVHRR sensor. Data posted on http://cimss.ssec.wisc.edu/clavr/calibration/irradiance.html

- Created a calibration web site: http://cimss.ssec.wisc.edu/clavr/calibration/index.html

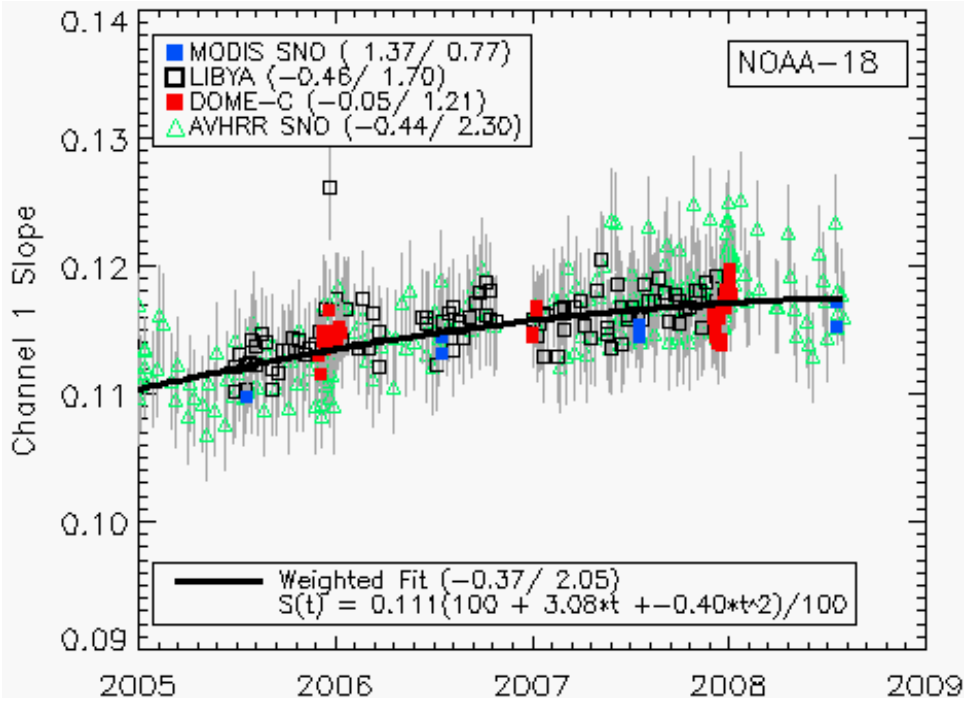

Figure 3. An AVHRR calibration for NOAA-18, channel 1, derived using constant target reflectances for Libya and Dome-C and simultaneous nadir overpasses between NOAA-18 and NOAA-15, NOAA-17, MetOp-A , Aqua-MODIS and Terra-MODIS. The large number of calibration points creates a statistically robust slope calculation.

Goals for Next Reporting Period

- Finish the new AVHRR calibration coefficient data-base.
- Conduct climate time series analysis to demonstrate the improvement of the new calibration data over the existing calibration data sets.
- Write a final report and provide the CEOS calibration working group.

Publications/Conference Presentations

Heidinger, A., Straka III, W., and Molling, C., 2008: Efforts toward a consensus Historical AVHRR reflectance calibration. Presented at AVHRR/HIRS CDR Workshop, NOAA Science Center, Camp Springs, Maryland 17-19 November 2008.

Heidinger, A., Molling C. and Straka III, W, 2008: Comparison of existing AVHRR reflectance calibration methods. Presented at EUMETSAT Satellite Conference, Darmstadt, Germany.

Heidinger A., Molling, C., 2008: Status of the NOAA-OGP funded effort to characterize and find consensus among existing AVHRR reflectance calibrations. CEOS Calibration Workshop, Ottawa, Canada.

Molling, C., Heidinger, A., Straka III, W., and Wu, X., 2009: Calibrations for AVHRR channels 1 and 2: review and path toward consensus. In preparation.