NOAA Agency Report to CEOS WGCV

- Cal/Val Activity Update

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NOAA/NESDIS/STAR(Center for Satellite Applications and Research)
formerly ORA (Office of Research and Applications)

CEOS WGCV 25
May 9-12, 2006, Budapest, Hungary

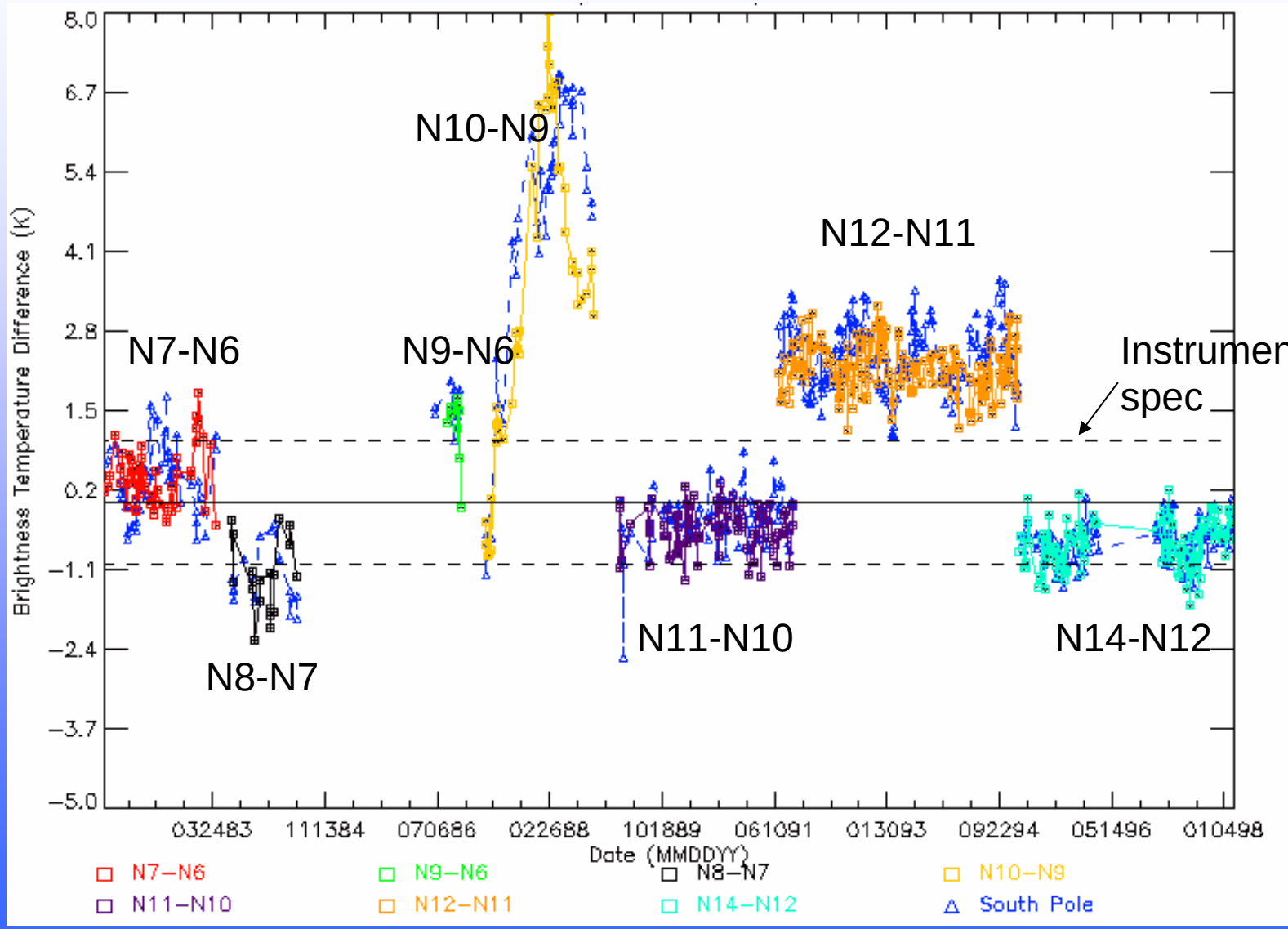
Outline

- Progress in recalibration to support climate change detection studies
- GOES-R cal/val working group
- Expanding cal/val capabilities through the development of an integrated cal/val system
- Product validation update

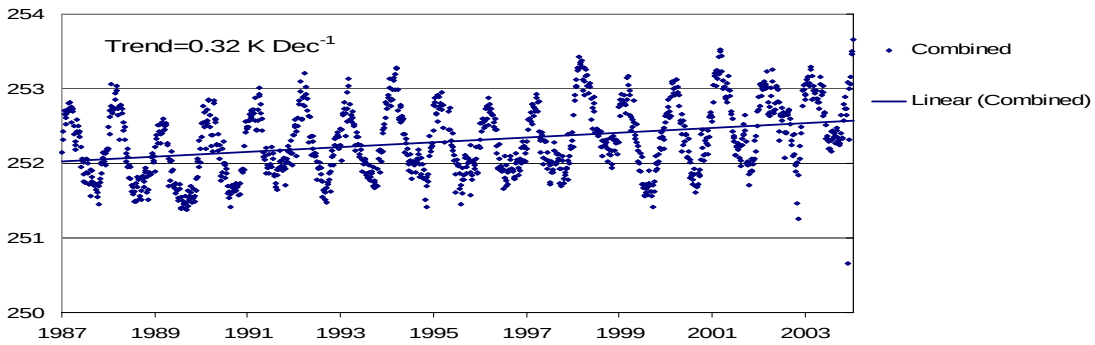
Recalibration to Support Climate Studies

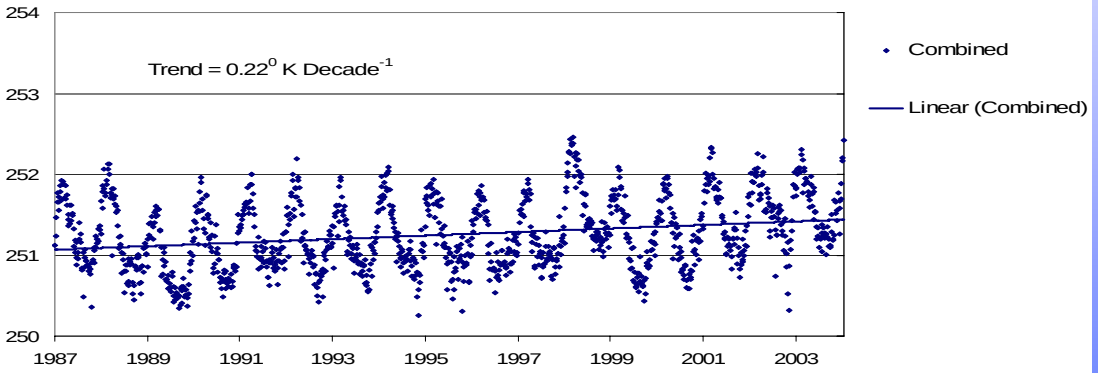
- Improve the calibration accuracy of level 1b radiance data for better FCDR.
- Completed intersatellite bias quantification for MSU, AVHRR, and HIRS from 1980 to 2003 using the SNO (Simultaneous Nadir Overpass) method.
- Scientists begin to use the SNO calibrated data sets to construct time series (e.g., MSU Ch2 mid-troposphere temperature trend reanalysis). Evaluate the impact of recalibration on products (e.g., aerosols).
- Recalibration also reveals discrepancies in calibration traceability (e.g., MODIS vs. AVHRR VIS/NIR channels)

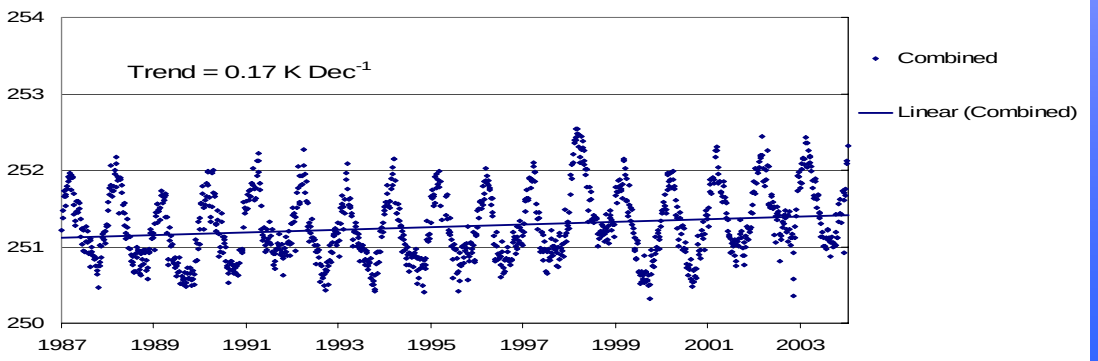
SNO Time Series for MSU CH3



Impact of Calibration on Climate Change Detection
MSU Ch 2 Mid-troposphere Temperature







Trends for linear calibration algorithm

0.32 K Decade^{-1}

Trends for NESDIS operational calibration algorithm

0.22 K Decade^{-1}

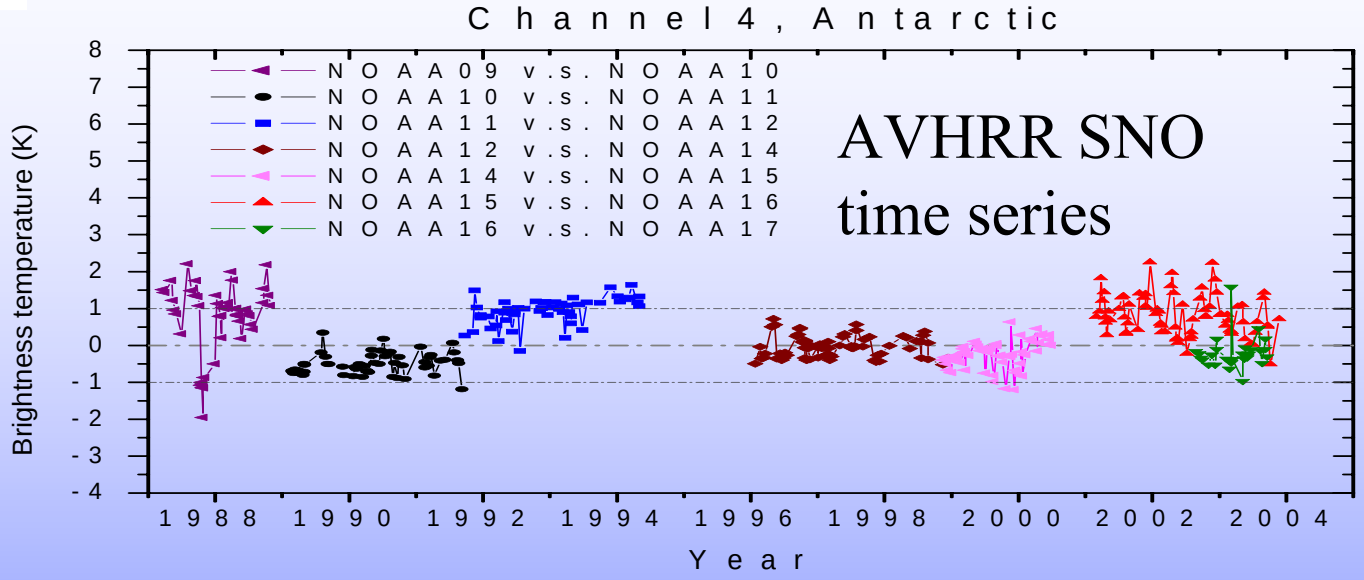
(Vinnikov and Grody, 2003)

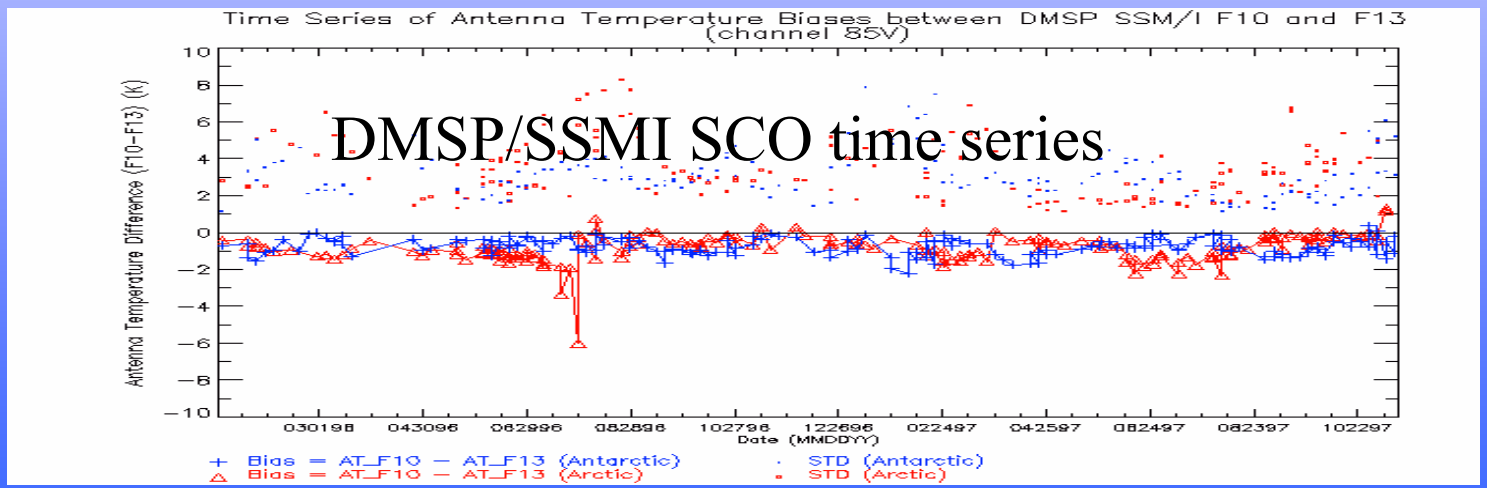
Trends for nonlinear calibration algorithm using SNO cross calibration

0.17 K Decade^{-1}

Zou, et al, submitted to JGR

Quantify Intersatellite Biases using SNO/SCO

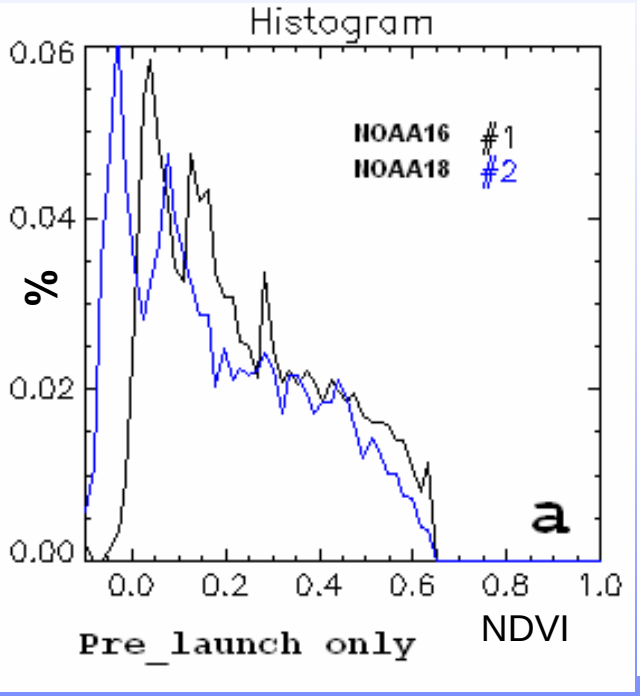


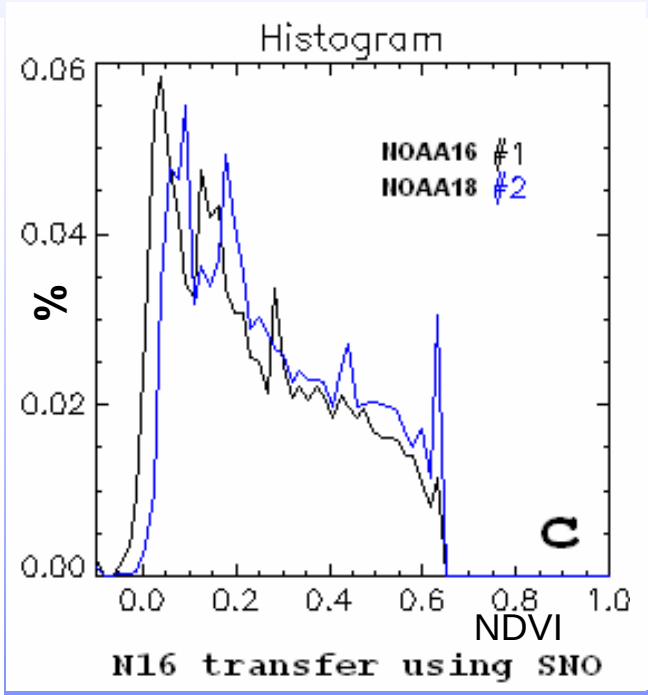


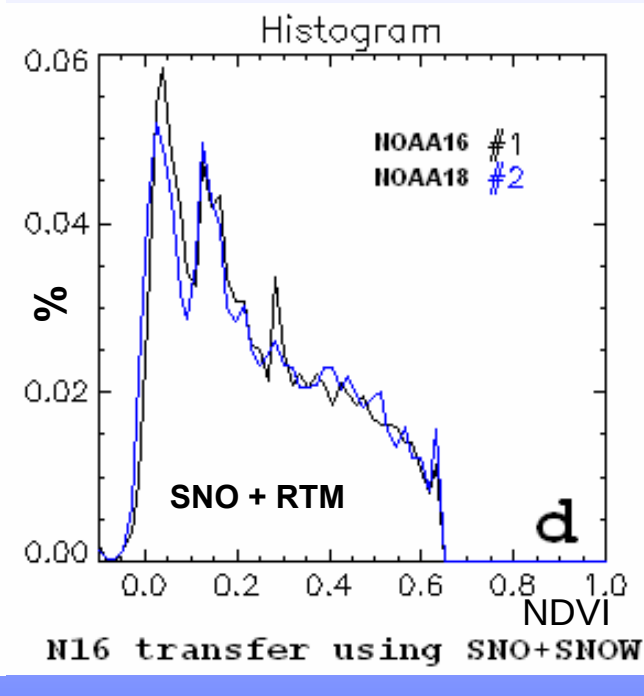
Weng, et al 2005

The Impact of SNO Calibration on NDVI

intercalibration between N16/N18 AVHRR





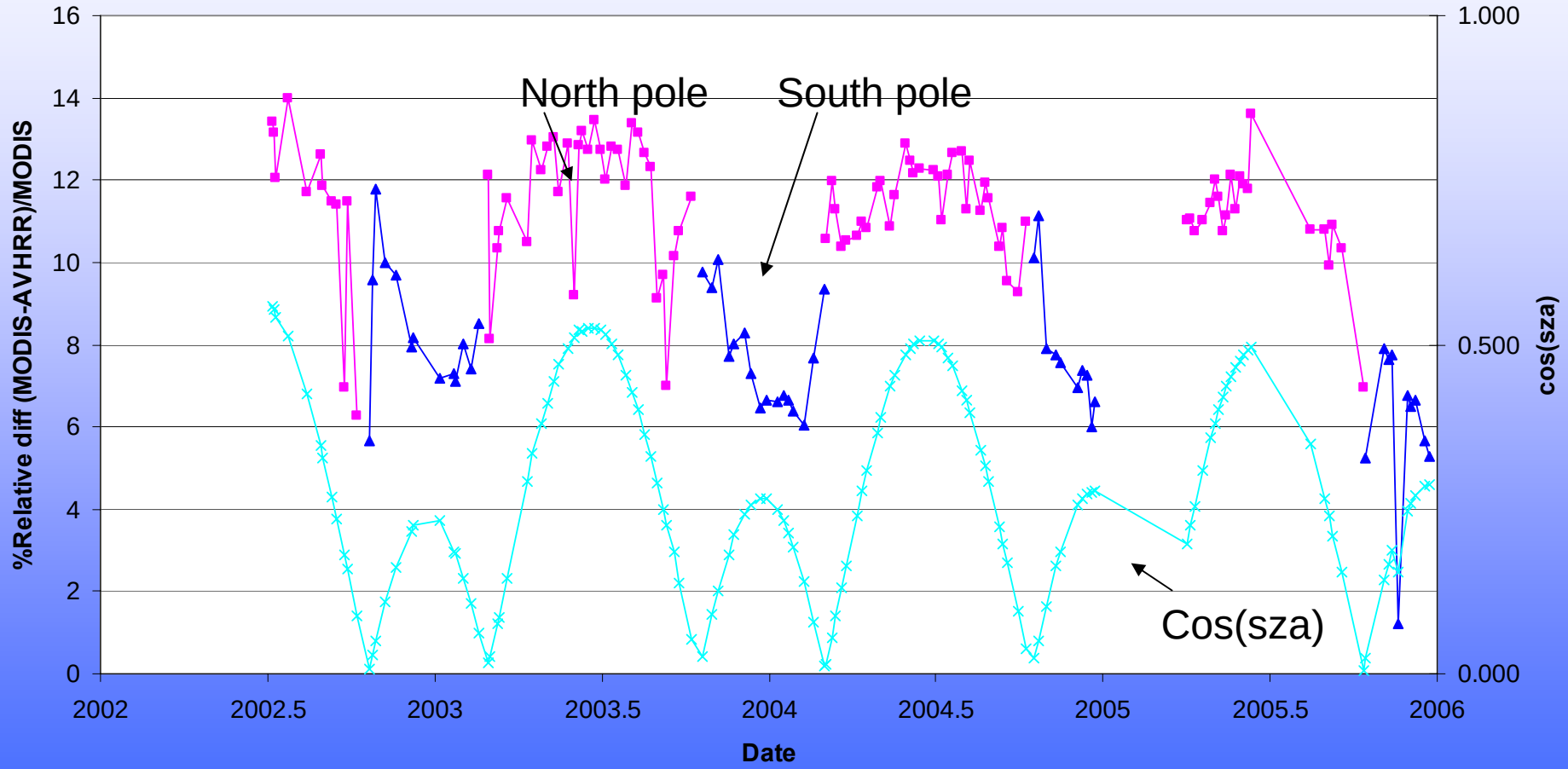


N18/N16 one-day global NDVI histogram comparison (9/27/2005)

Courtesy of Gou & Kogan

Discrepancies bet. MODIS and AVHRR calibration

SNO time series for channel 1 (0.68um) (N16 vs. Aqua)



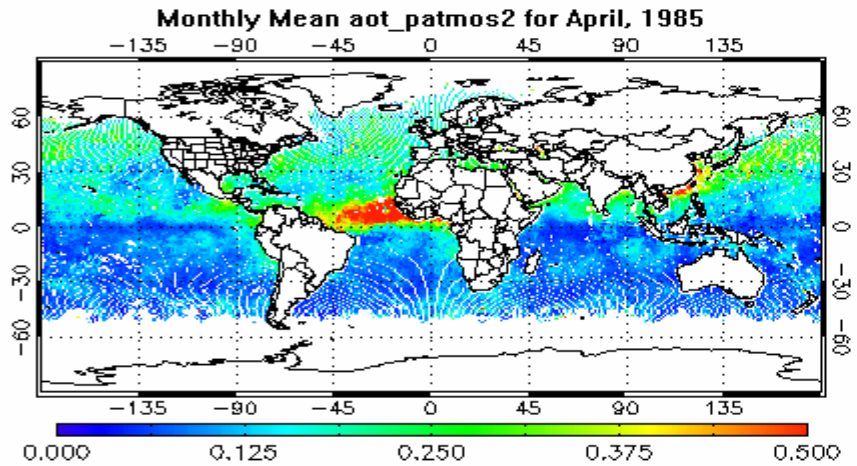
Different on-orbit calibration traceability causes discrepancies between MODIS and AVHRR, which cannot be explained by SRF differences based on radiative transfer calculations. Similar discrepancy also observed at the Libyan and Taklimakan desert sites.

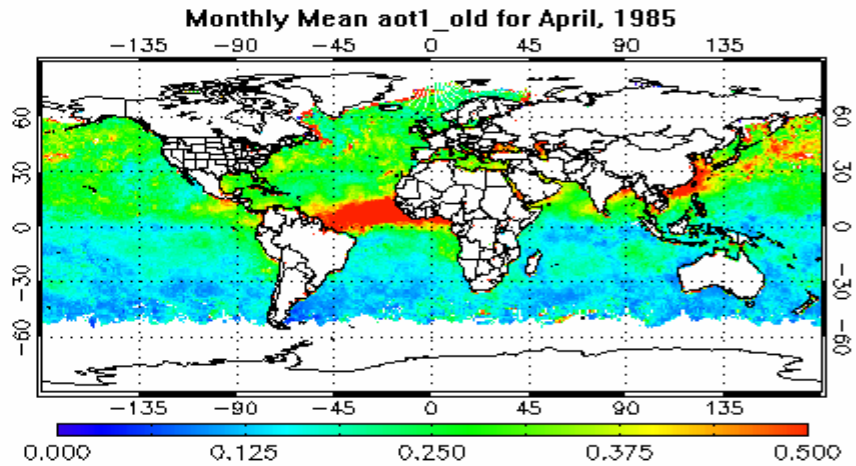
AVHRR Aerosol AOD Difference Due to Calibration

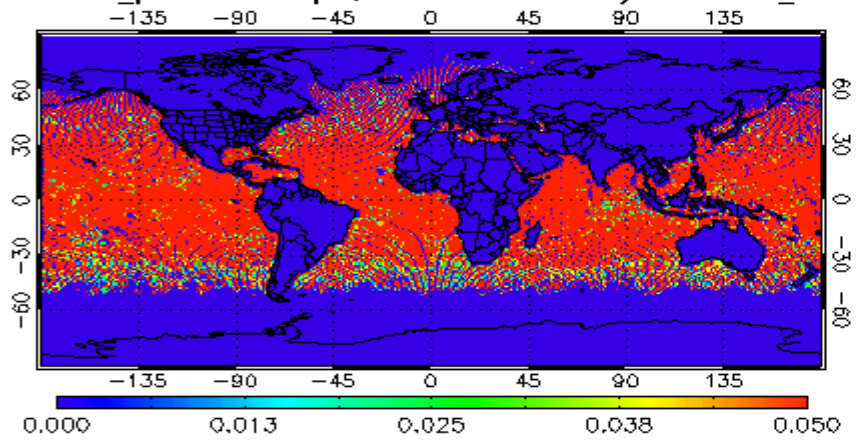
AVHRR Old Calibration (OC)

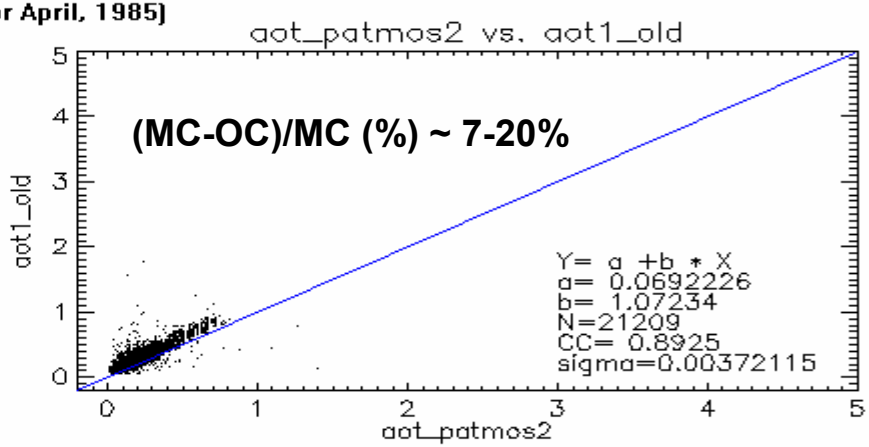
AVHRR MODIS-type Calibration (MC)

Compare two AOT fields









Courtesy of Tom Zhao

Challenges and Opportunities

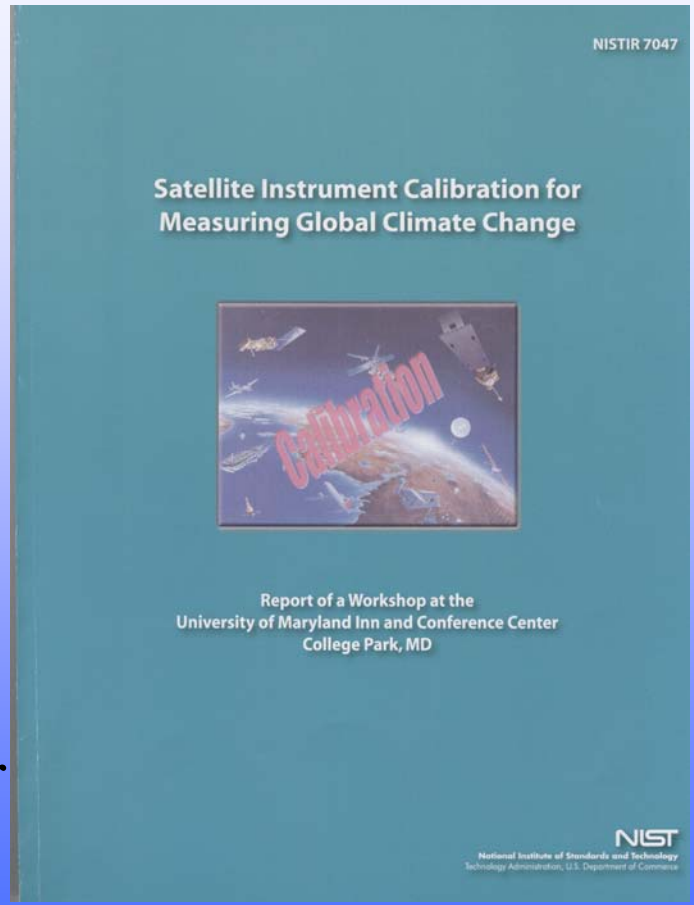
With requirements as stringent as ~0.1 K/decade, climate change detection is challenging the state of calibration science and technology. SNO allows us to quantify biases but not to find the root cause

- Understanding the root cause of intersatellite biases is critical for proper bias correction and better future instrumentation
- Climate quality instrumentation: longterm stability and degradation in the piece parts of the calibration system
    - Radiometric: PRT, blackbody paint, nonlinearity postlaunch and longterm change, prelaunch nonlinearity measurement accuracy, orbital dependency of blackbody performance.
    - Spectral:
        - Spectral response functions (SRF): long term SRF shift, SRF cloning
        - Possible frequency drift in microwave.
- On-orbit calibration traceability (especially in the VIS/NIR)
    - Improved knowledge of the SNO sites and desert sites
    - Using VIS/NIR hyperspectral data for site characterization
        - Hyperion: what's the calibration accuracy?
        - AVIRIS: data availability?
        - Other hyperspectral data in the VIS/NIR?

Other Climate Related Activities

- Achieving Satellite Instrument Calibration for Climate Change (ASIC3) **Workshop**, National Conference Center near Leesburg, VA, May 16-18, 2006 (as a follow-up on the 2002 workshop in College Park)

- Western Pacific Geophysics Meeting in Beijing, session on Satellite Instrument Calibration: The Challenges of Global Climate Change and Numerical Weather Prediction, in collaboration with CMA



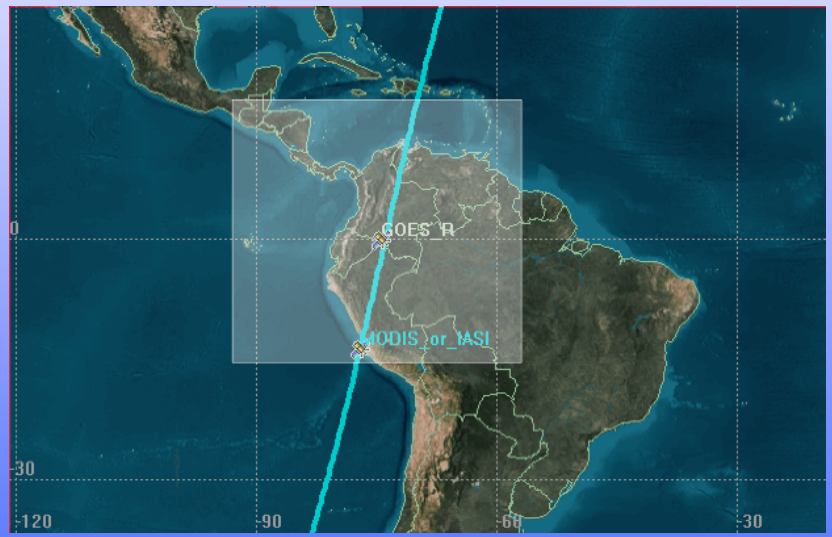
GOES-R Cal/Val Working Group

- NOAA will take the lead, with members from NASA, Vendors, NIST, MIT/LL, other labs and universities.
- Include pre&postlaunch calibration, longterm monitoring of instrument performance, and validation of products
- Leverage the integrated cal/val system developed for the POES/NPOESS
- A comprehensive cal/val plan will be developed next year.

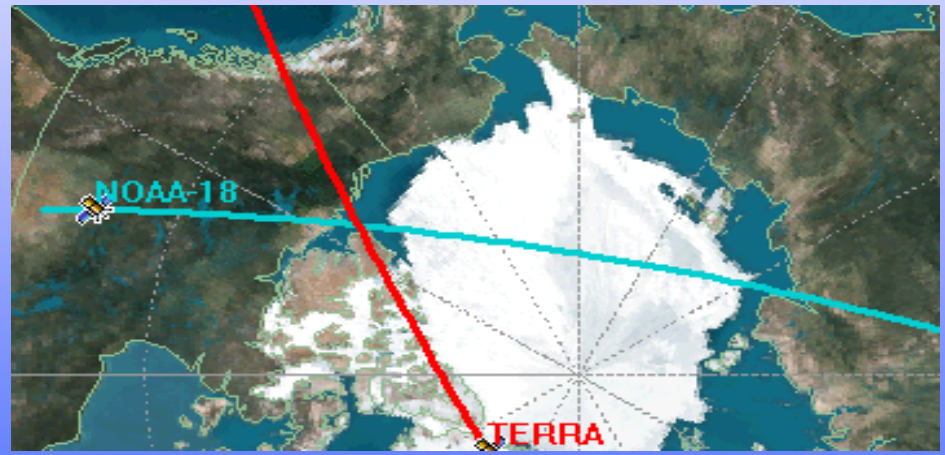
SNO (Simultaneous Nadir Overpass) Methodology

-a core component in the Integrated Cal/Val System

Intercalibrate GOES/GOES-R with POES/NPOESS

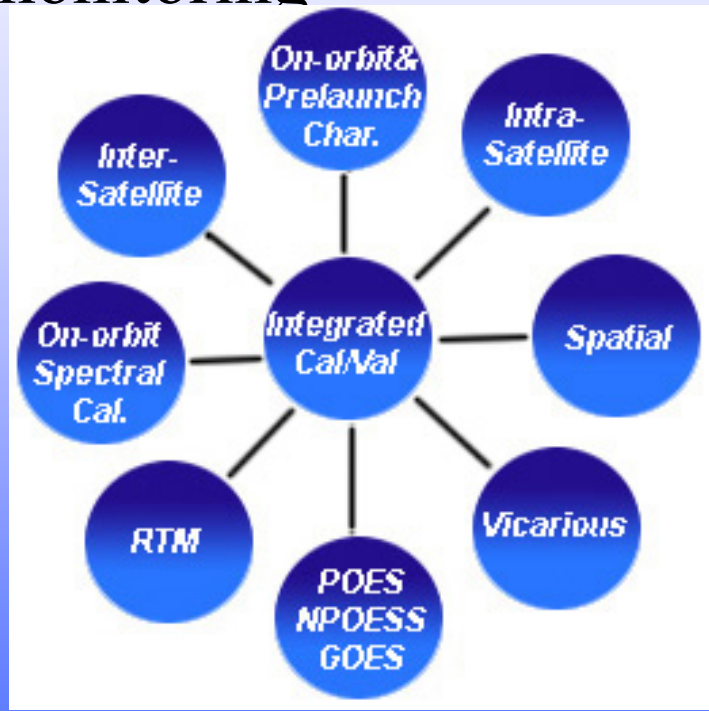


POES intercalibration



Capability Expansion through the Development of an Integrated Cal/Val System

- Prelaunch calibration
- On-orbit instrument performance monitoring
- Inter-satellite calibration
- Intra-satellite calibration
- Cal/val at ARM and desert sites with RTM
- Spectral and Spatial calibration
- Cross-platform calibration



Web Interface to the Integrated Cal/Val System

Integrated Satellite Instrument Calibration/Validation System - Microsoft Internet Explorer

File Edit

Back

Address http://www.orbit.nesdis.noaa.gov/smcd/spb/calibration/icvs/newweb/index.html

Go Links

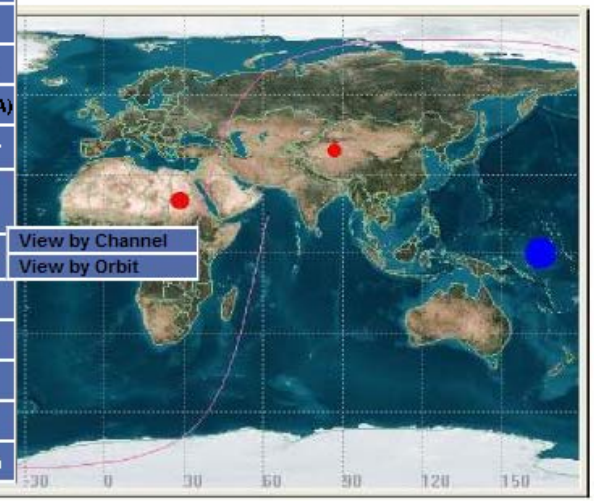
NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

STAR – Center for Satellite Applications and Research
formerly ORA – Office of Research Applications

STAR > SMCD > SPB > Integrated Satellite Instrument Calibration/Validation System

Integrated Satellite Instrument Calibration/Validation System

- Introduction
- Microwave Sounders >>
  - NOAA18/HIRS/4 >>
  - NOAA17/HIRS/3 >>
  - NOAA16/HIRS/3 >>
  - METOP-A/HIRS/4 >>
  - METOP-A/MASI >>
  - NPP/CrIS >>
  - NPOESS/CrIS >>
  - GOES-10/Sounder
  - GOES-11/Sounder
  - GOES-12/Sounder
  - GOES-R/HES
  - Retrospective Cal.
- Microwave Imagers >>
- Infrared Sounders >>
  - SNO Biases (N18 vs. N16)
  - SNO Biases (N18 vs. N17)
  - SNO Biases (N18 vs. Aqua)
  - SNO Biases(N18 vs. Metop-A)
  - SNO Predictions >>
  - Instrument Performance Monitoring
  - View Current Rad. Data >>
    - View by Channel
    - View by Orbit
  - RTM at ARM Sites
  - RTM at NWP Gridpoints
  - Spectral Calibration
  - Spatial Calibration
  - Prelaunch Characterization
- Infrared Imagers >>
- Visible & Near Infrared Instruments >>
- Ultraviolet Instruments >>
- Projects >>
- Publications >>
- FAQ and Tools >>



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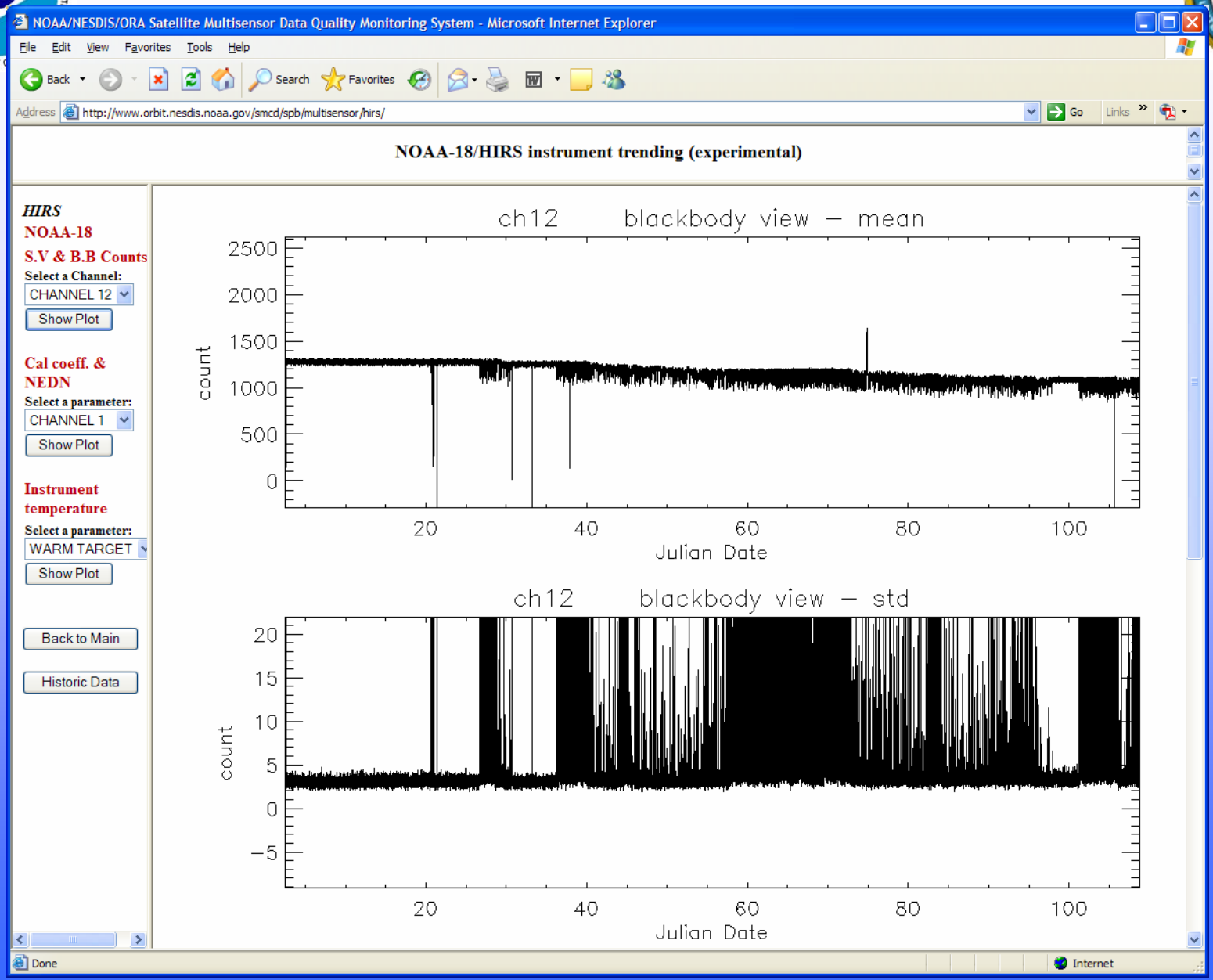
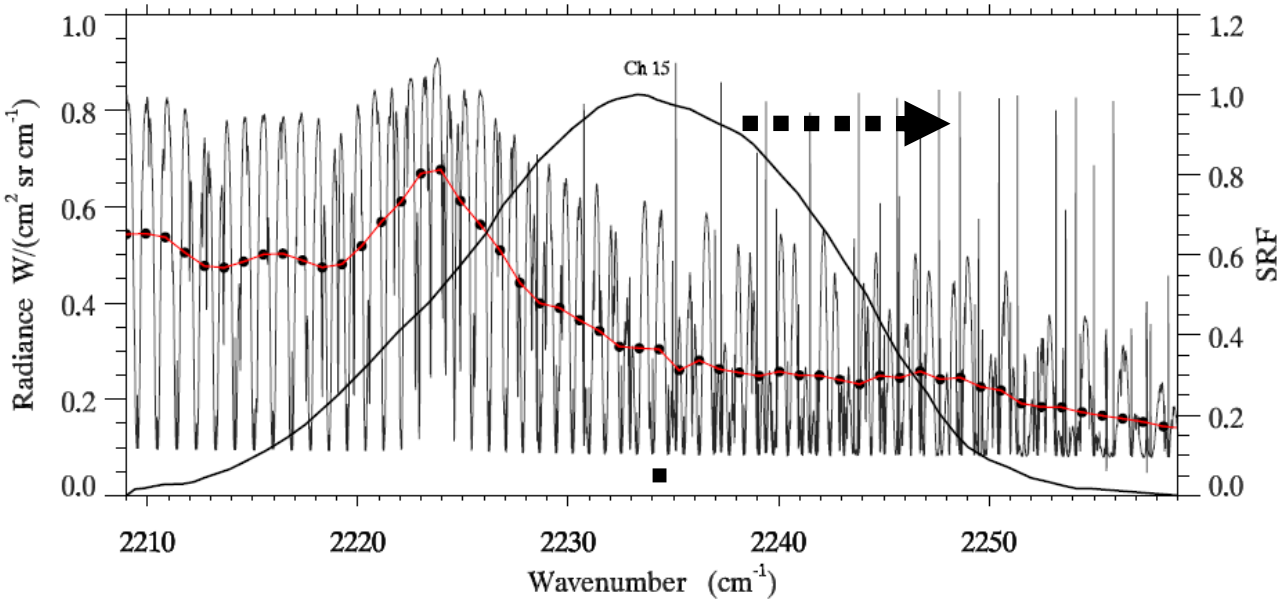
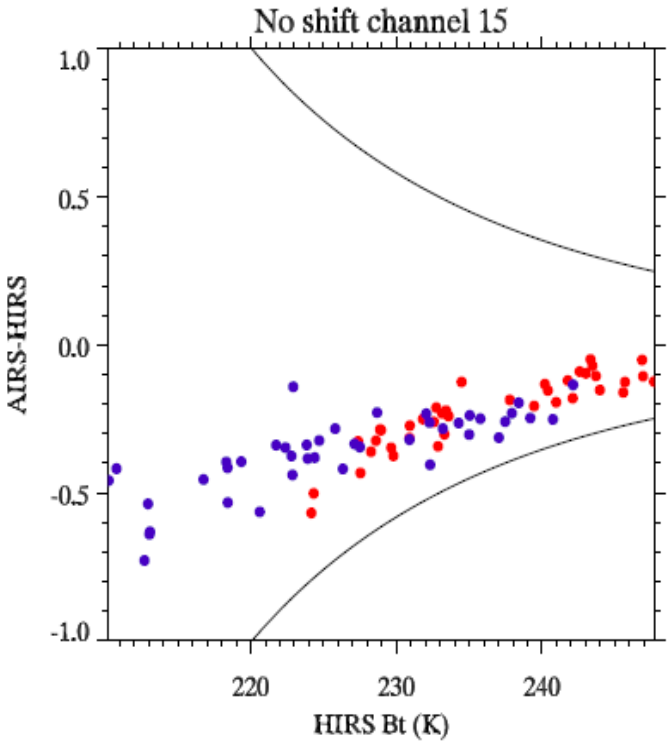
Internet

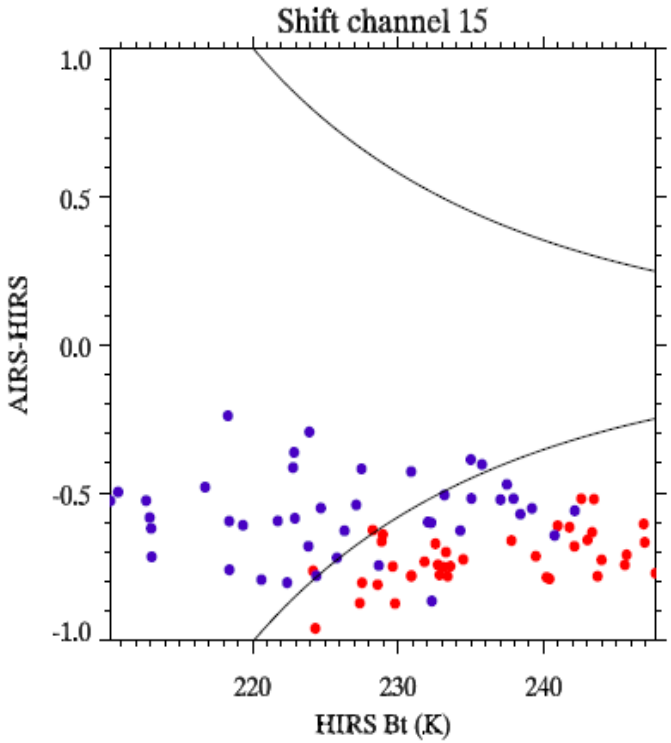
Near Real-Time Instrument Performance Monitoring



On-orbit spectral calibration using hyperspectral sounders



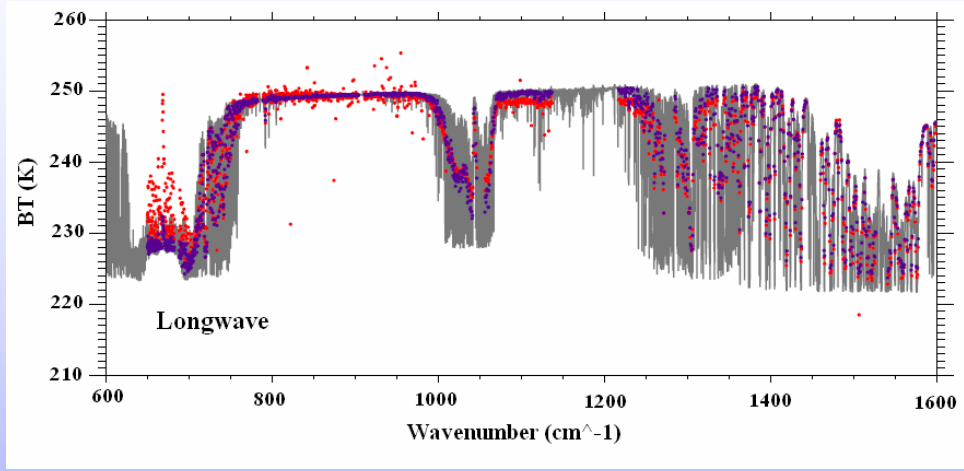


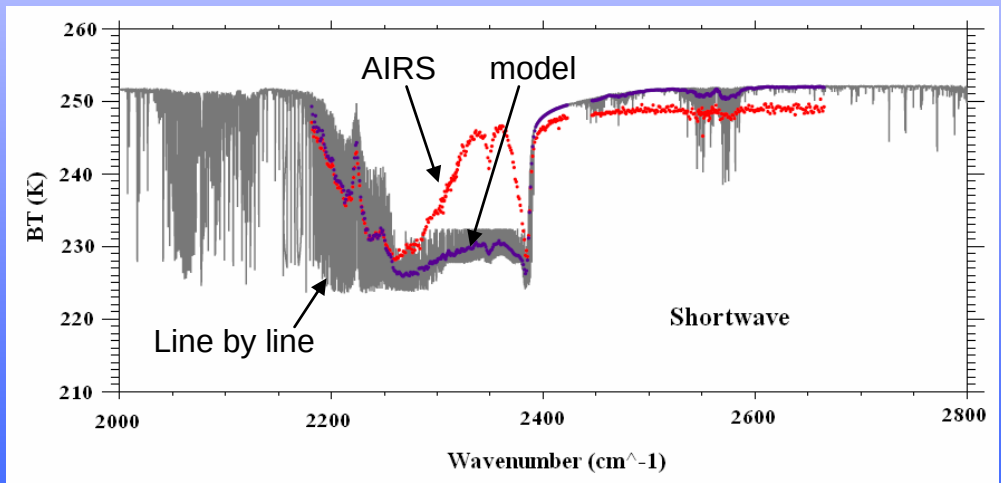


SRF 1 wavenumber Shift changes BT dependence but not bias

Radiance Validation at ARM Sites

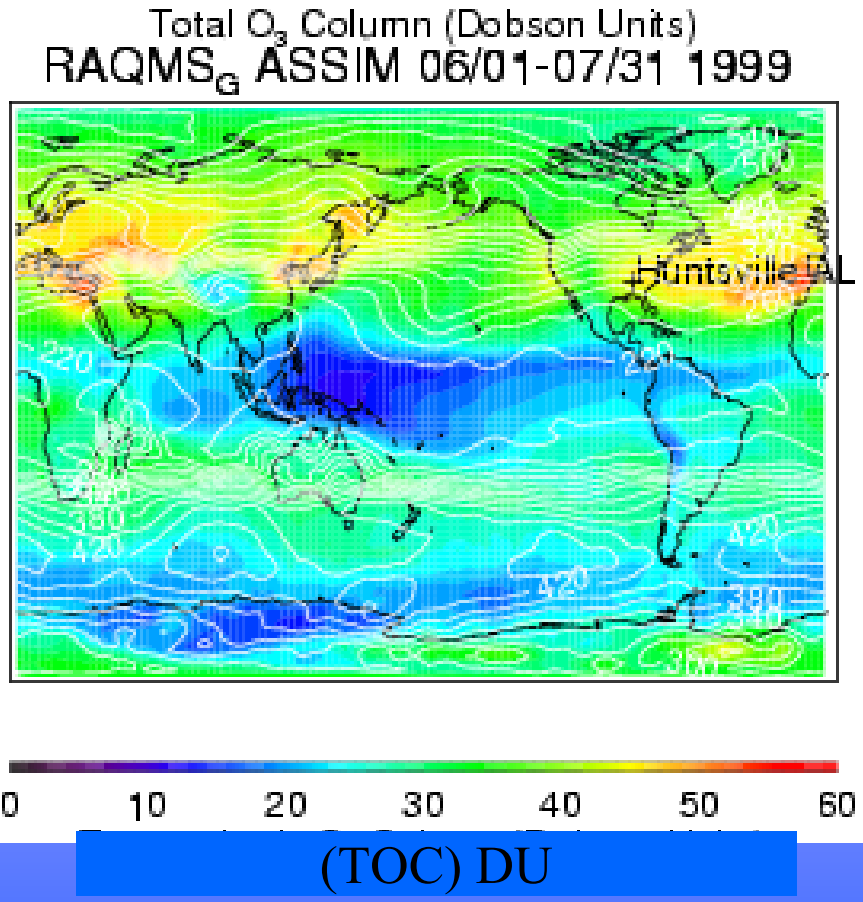
- Longterm time series to be established at all ARM sites
- Example overpass show good agreement between RTM and AIRS, with exceptions:
  - Shortwave Non-LTE channels
  - Longwave CO2
  - Surface emissivity for window channels
- RTM Model deficiency issues need to be addressed with JCSDA

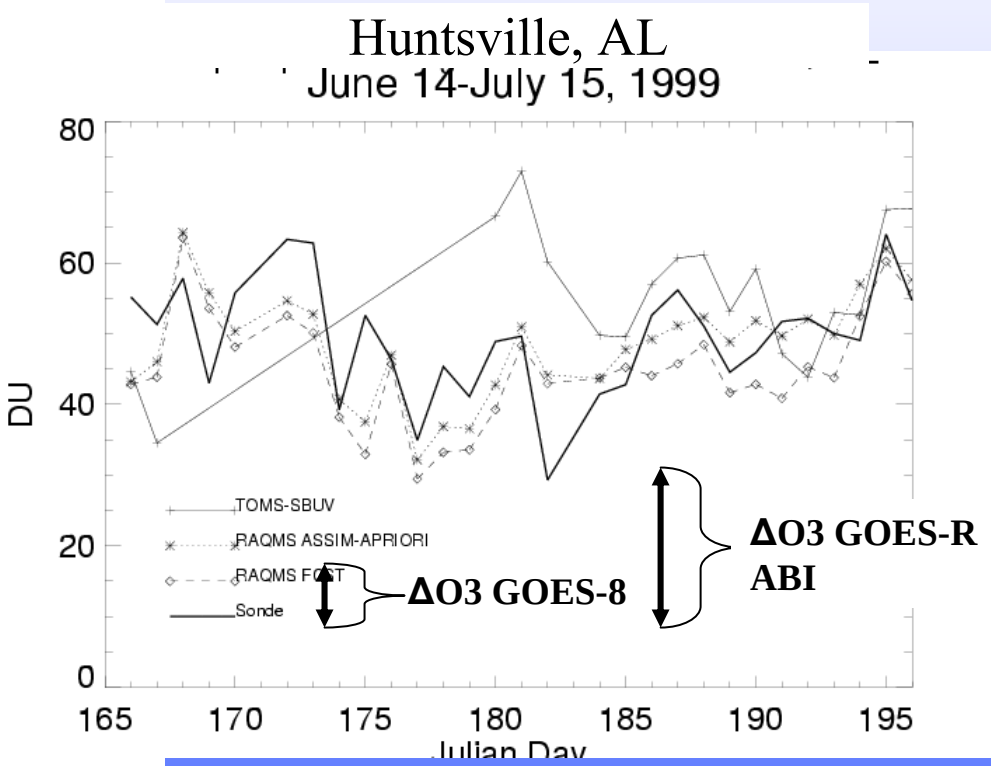




Product Validation GOES Example: Total Ozone

Tropospheric Ozone Column

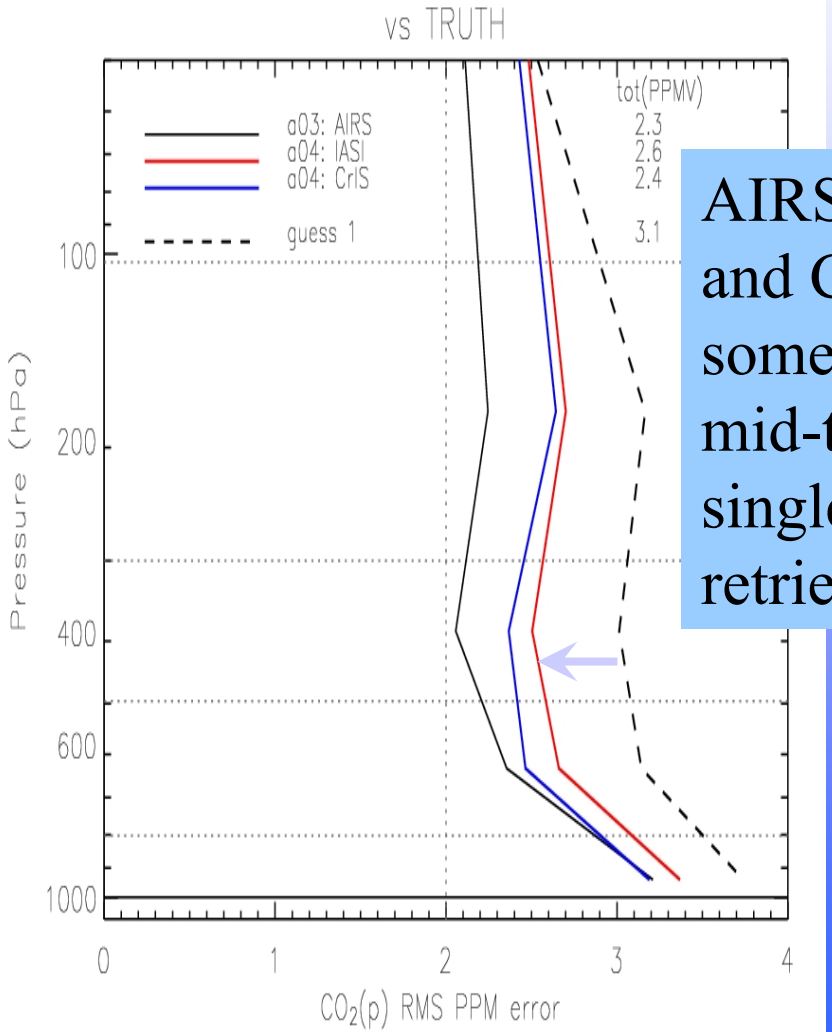




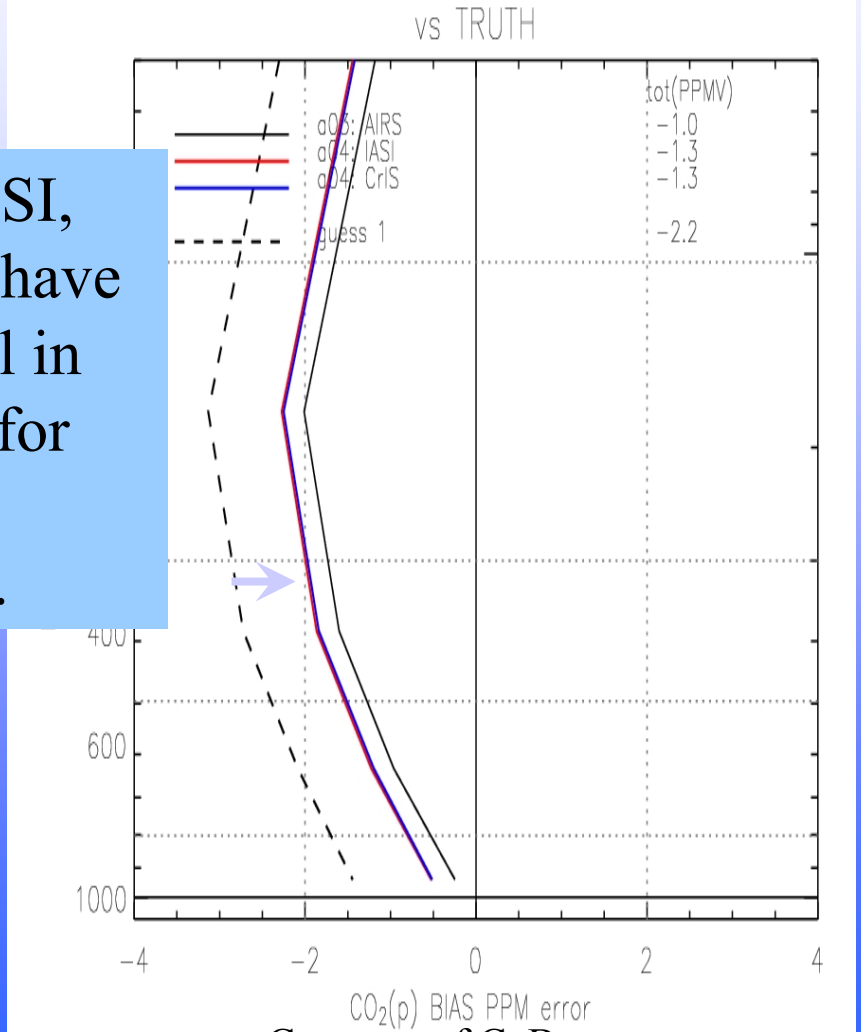
Courtesy of S. Kondragunta

Product Validation POES Example: 15 μm CO_2 Retrieval

RMS



BIAS



AIRS, IASI, and CrIS have some skill in mid-trop for single retrievals.

Courtesy of C. Barnet

Summary

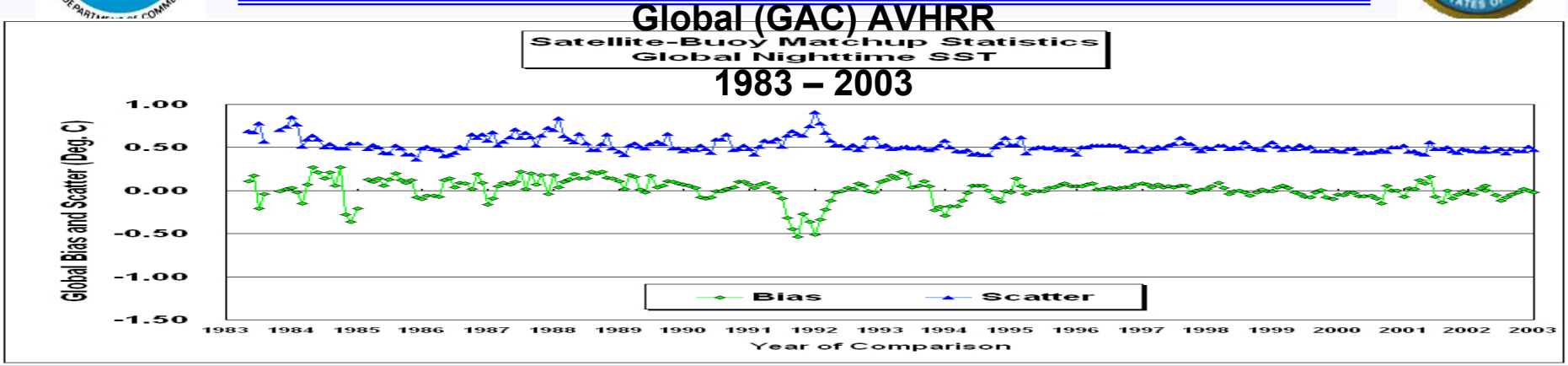
- Recalibration of MSU, AVHRR, HIRS, and SSMI begins to show the usefulness of the SNO/SCO time series for climate change detection studies
- Experience as well as lessons learned in recalibration help us in assessing the GCOS implementation plan and related tasks
- GOES-R Cal/Val Working Group is being formed
- Expanding cal/val capabilities with an integrated system to support current and future operational instruments

- Backup

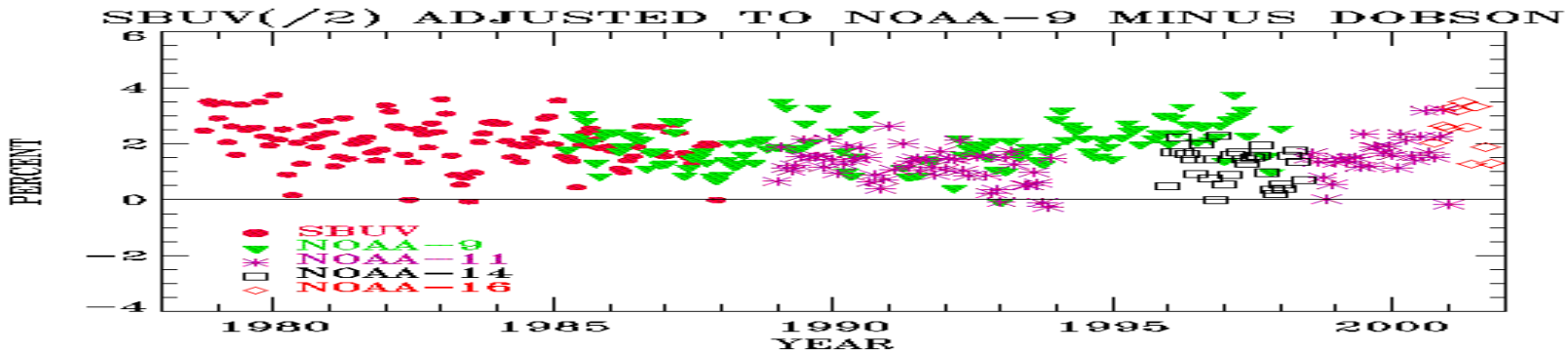
NOAA/NESDIS Cal/Val Overview

- **Operational Support to Current/Near-Future Operational Systems**
  - AVHRR, HIRS, AMSU, SBUV, GOES Imager/Sounder, and MetOP instruments
  - Oversee pre-launch sensor calibration; Develop & maintain on-orbit calibration approach, algorithms, & databases
  - Perform post-launch checkout, monitoring, and trouble-shooting
- **Transition to NPOESS and GOES-R**
  - Assist IPO in government oversight
  - Independent verification/validation of Sensor Data Records (SDRs) and Environment Data Records (EDRs)
  - Technical liaison between the data users and data producers on cal/val
  - Risk reduction studies
  - Very different role in NPOESS and GOES-R
- **Apply Experience to Design of Future systems**
  - Define future measurement requirements & support development of future systems
- **Calibration for Fundamental Climate Data Records**
- **Serve Community of Data Providers and Users**
  - **NOAA, Other US Government Agencies, Academia and Industry, International partners**

Example Product Validation



- Periodic global GAC AVHRR SST **validation** has been conducted **continuously since 1983.** SST retrieval precision has gradually improved to within 0.5 K rms of buoy matchups



Miller et al., JGR Atmospheres, 2004