A view from the Global Space-based Inter-Calibration System (GSICS

Mitch Goldberg, NOAA
Chair of GSICS Executive Panel

Global Space-based Inter-Calibration System

- What is GSICS?
  - Global Space-based Inter-Calibration System
  - Initiative of CGMS and WMO
  - Effort to produce consistent, well-calibrated data from the international constellation of Earth Observing satellites
- What are the basic strategies of GSICS?
  - Improve on-orbit calibration by developing an integrated inter-calibration system
    - Initially for GEO-LEO Inter-satellite calibration
    - Being extended to LEO-LEO
    - Using external references as necessary
  - Best practices for prelaunch characterisation (with CEOS WGCV)
- This will allow us to:
  - Improve consistency between instruments
  - Reduce bias in Level 1 and 2 products
  - Provide traceability of measurements
  - Retrospectively re-calibrate archive data
  - Better specify future instruments

GSICS Global Space-based Inter-Calibration System

EUMETSAT CNES JMA

NOAA CMA KMA

ISRO NASA WMO

USGS NIST JAXA

ROSHYDROMET IMD ESA

GSICS Principles

- **Systematic** generation of **inter-calibration** products
  - for Level 1 data from **satellite sensors**
  - to **compare**, ***monitor*** and **correct** the calibration of *monitored* instruments to community references
  - by generating calibration corrections
  - with specified uncertainties
  - through well-documented, peer-reviewed procedures
  - based on various techniques to ensure consistent and robust results
- Delivery to users
  - Free and open access
  - Adopting community standards
- To promote
  - Greater understanding of instruments' absolute calibration, by analysing the root causes of biases
  - More accurate and more globally consistent retrieved L2 products
  - Inter-operability for more accurate environmental, climate and weather forecasting products

TRACEABILITY / UNBROKEN CHAINS OF COMPARISONS

GSICS Global Space-based Inter-Calibration System

Core principles for the generation of GSICS inter-calibration products

- Regarding operational on-orbit instrument inter-calibration, GSICS coordinates systematic generation of inter-calibration products for Level 1 data from satellite sensors in accordance with the following principles:
- Calibration of satellite instruments is monitored and assessed by comparing their output with community references, using common methodologies, following international standards and community best practices, and, ultimately, tying these to SI-traceable standards.
- GSICS implements a continuous chain of comparisons, each with stated uncertainties, to ensure metrological traceability.
- Calibration corrections are generated for both Near-Real-Time use and retrospective analyses, with specified uncertainties, through well-documented, peer-reviewed procedures, based on various techniques to ensure consistent and robust results, which are applicable over a broad range of observing conditions.
- These inter-calibration assessments, comparisons and corrections are delivered to users through free and open access, adopting community data standards.

GSICS Global Space-based Inter-Calibration System

What does GSICS say about GRUAN?

- http://www.wmo.int/pages/prog/sat/documents/GSICS_Vision-for-GSICS-in-2020s.pdf
- GSICS should also support collaboration with GRUAN with a view to draw mutual benefits. On one hand, GRUAN could benefit from GSICS in using accurately calibrated satellite measurements as “travelling reference standards” for GRUAN stations; on the other hand, GRUAN in combination with forward radiative transfer models could provide useful references for the calibration of e.g. space-based microwave measurements.
- Furthermore, GRUAN could support the validation of the use of GSICS corrections in Level 2 products through three-way collaboration among GSICS, GRUAN, and downstream communities like SCOPE-CM
- GSICS will need to strike a balance between expanding its scope of activity and fostering partnerships and interaction with communities with adjacent or downstream fields of activity.
- Particular attention should be paid to the cooperation with the community involved in Radiative Transfer Model (RTM) developments, and other thematic application communities

GSICS Global Space-based Inter-Calibration System

GSICS User Community

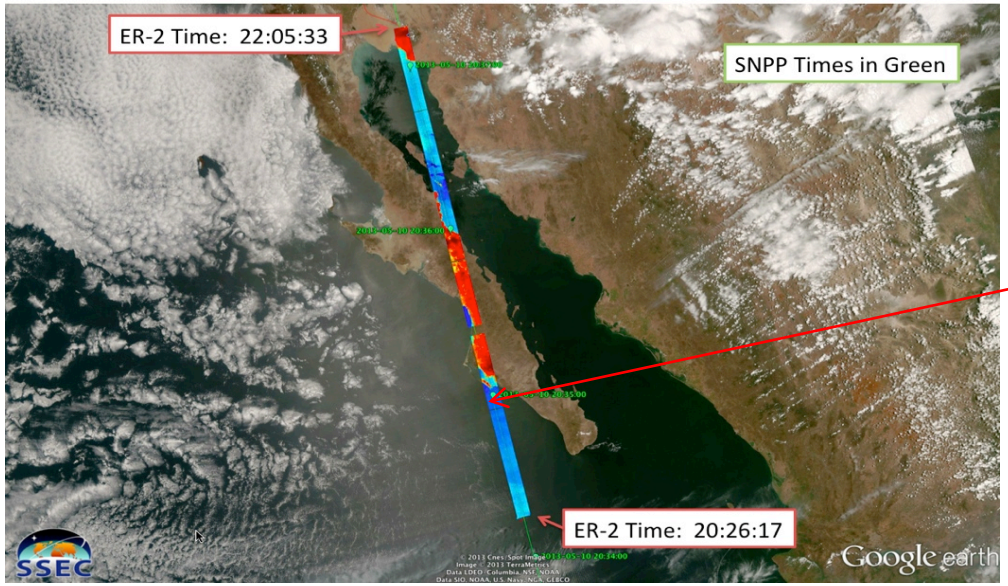
- Satellite Application Community
  - CDR generation for climate monitoring
    "SCOPE-CM" framework, national/international programs
    WCRP/ISCCP - (Planned beta-testing of GEO GSICS Corrections)
  - Reanalysis community for climate modelling (ECMWF reanalysis – 2012/15)
  - Operational NWP: direct radiance assimilation
  - Other users interested in accurate/consistent calibration
- Satellite Operators
  - Prelaunch instrument characterization guidelines
  - Cal/Val Plans
  - Best practices for instrument monitoring and improved calibration
- ➢ Affiliation with partner programmes
  - CEOS WGCV, GPM X-cal, GHRSST, GRUAN, etc...

GSICS Global Space-based Inter-Calibration System

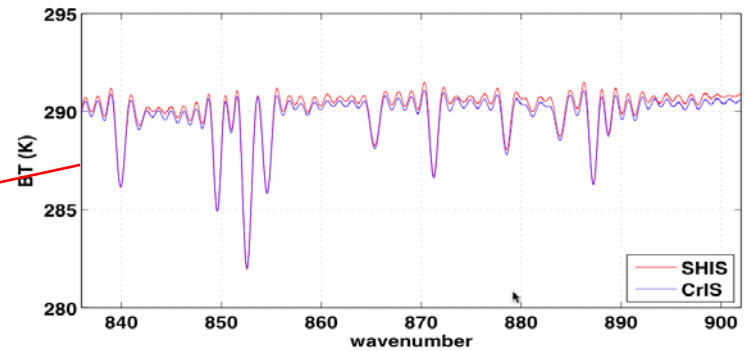
JPSS PGRR Deep-Dive Validation
First S-NPP ER-2 Aircraft Campaign to provide validation for CrIS, ATMS and VIIRS

NIST traceable absolute calibration for CrIS

S-HIS 895-900 cm^{-1} (280 – 320K) over VIIRS Imagery



Zero-th Order S-HIS / CrIS comparison: Window region comparison. Same spectral resolution.



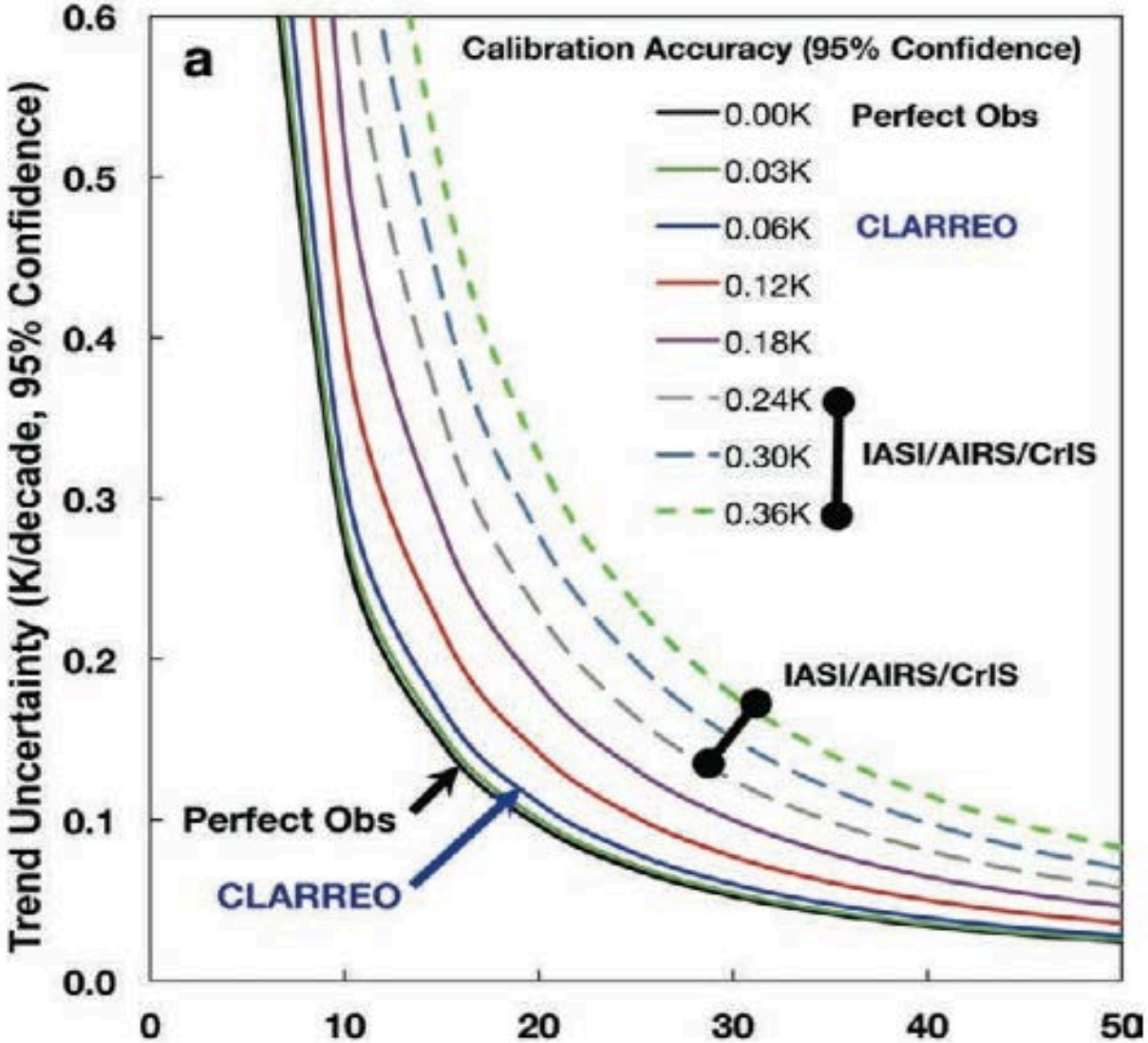
May 10, 2013 – first look

ER-2 with aircraft validation sensors under flies Suomi NPP sensors. In the case of CrIS, the validation sensor in this example is from the Scanning High-resolution Interferometer Sounder (S-HIS) which has been tied to a NIST traceable calibration source. Quick look comparisons show excellent agreement. Significance – NIST traceable validation is critical for uncertainty analysis needed to fully assess data quality of S-NPP and JPSS sensors.

Why do we care about 0.1 C absolute accuracy?

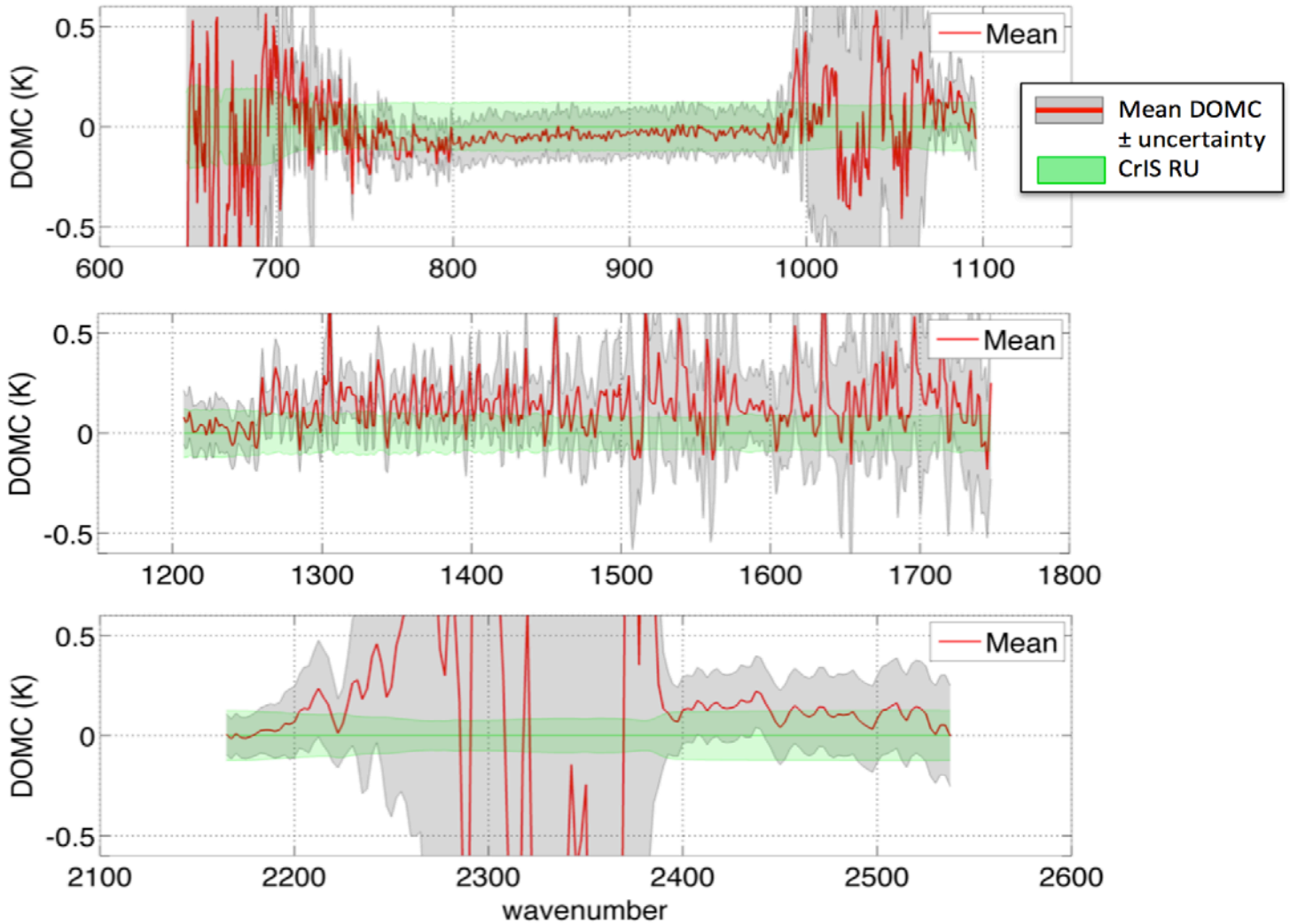
Achieving Climate Change Absolute Accuracy in Orbit
Bruce A. Wielicki , D. F. Young , and M. G. Mlynczak

doi: http://dx.doi.org/10.1175/BAMS-D-12-00149.1



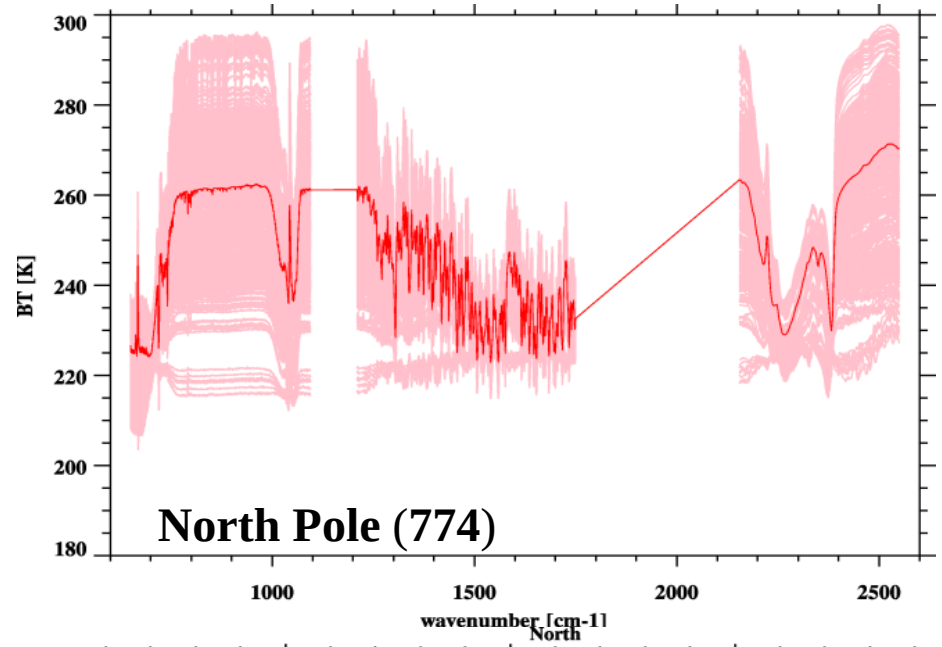
CrIS/S-HIS Underflight Results

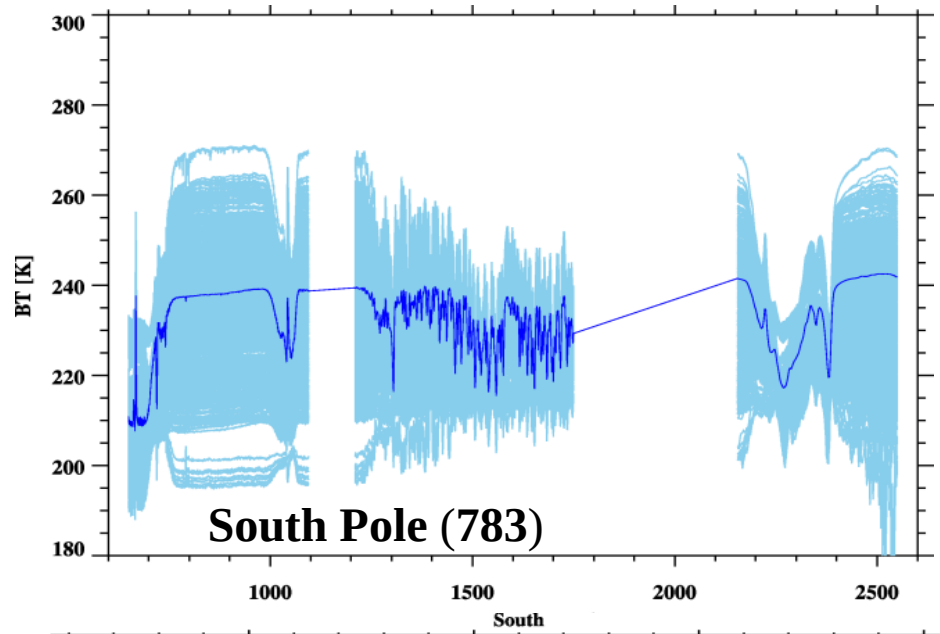
Hamming apodization

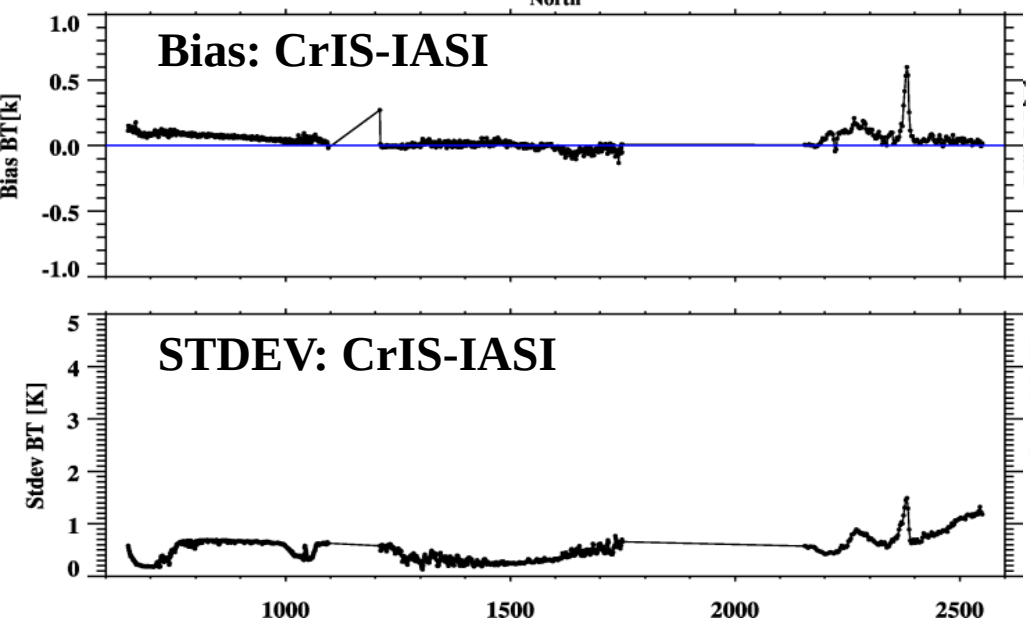


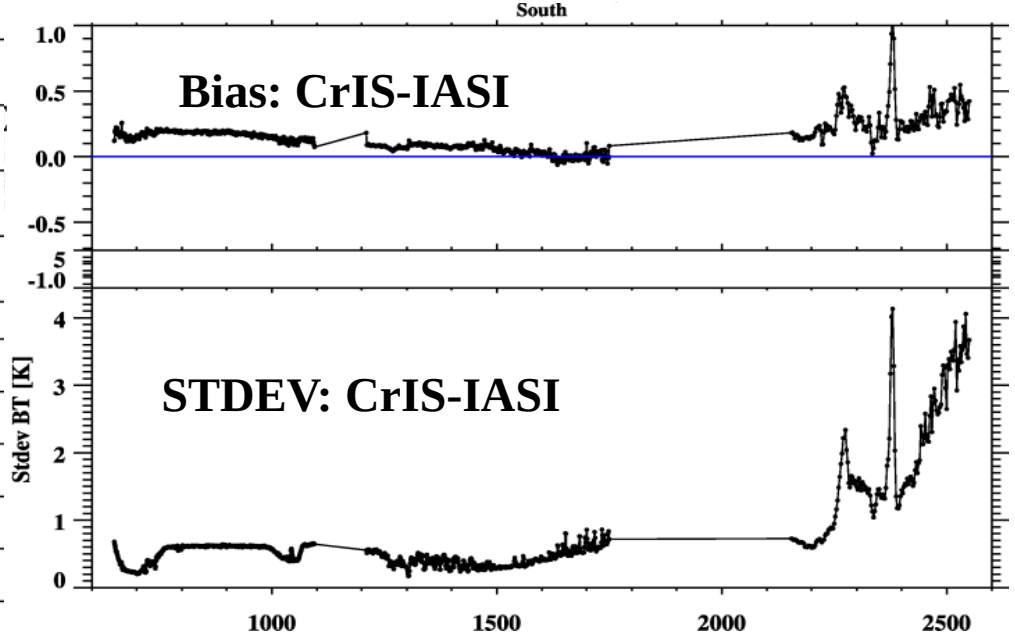
- Aircraft underflights provide periodic end-to-end verification of CrIS RU estimates with 0.1-0.2K uncertainty over most of the spectrum.

SNO Results between CrIS and IASI/Metop-B from 10 months' reprocessed CrIS SDR (2013/02-12)









ATMS Calibration Accuracy Assessment Using GPS RO

- **Time period of data search:**

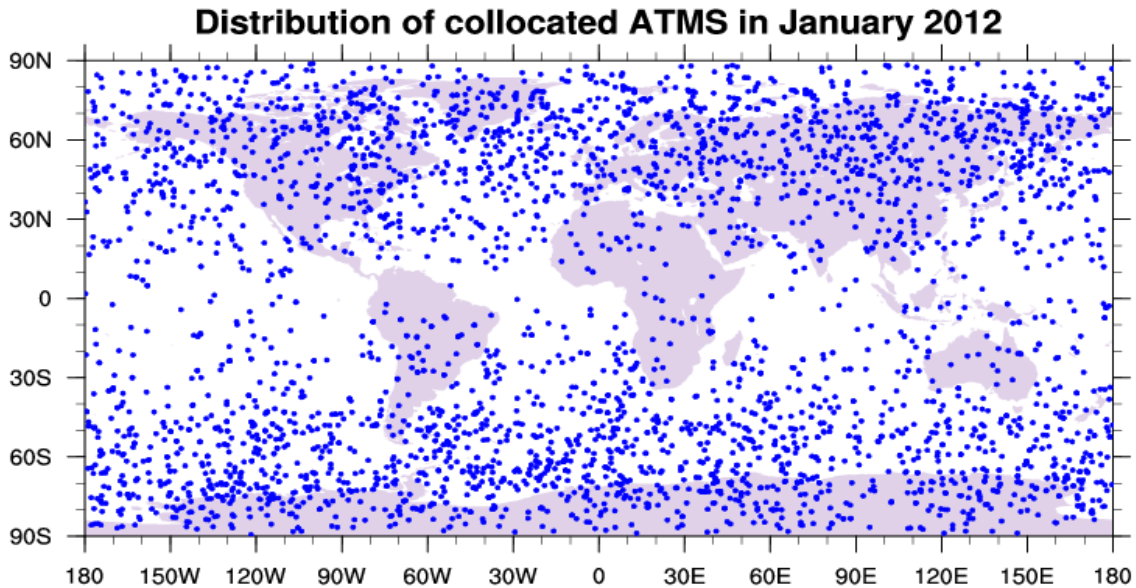
  January, 2012

- **Collocation of ATMS and COSMIC data:**

  Time difference < 0.5 hour

  Spatial distance < 30 km

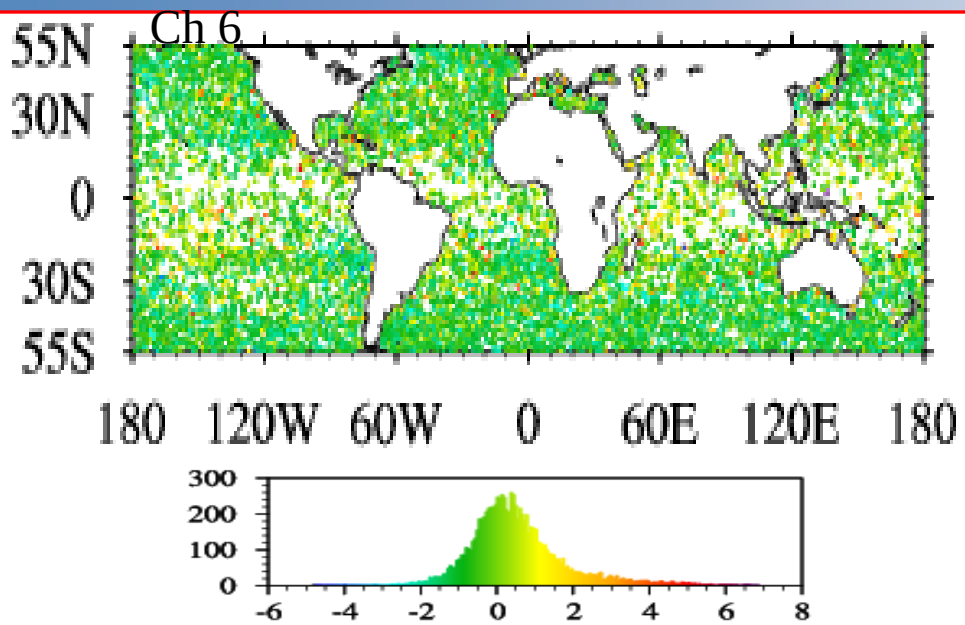
(GPS geolocation at 10km altitude is used for spatial collocation)

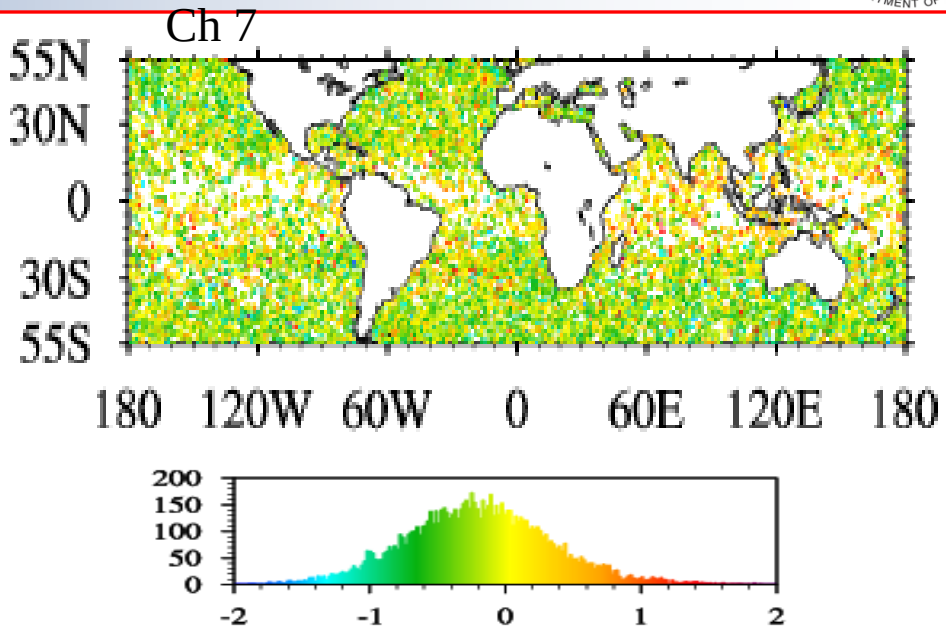


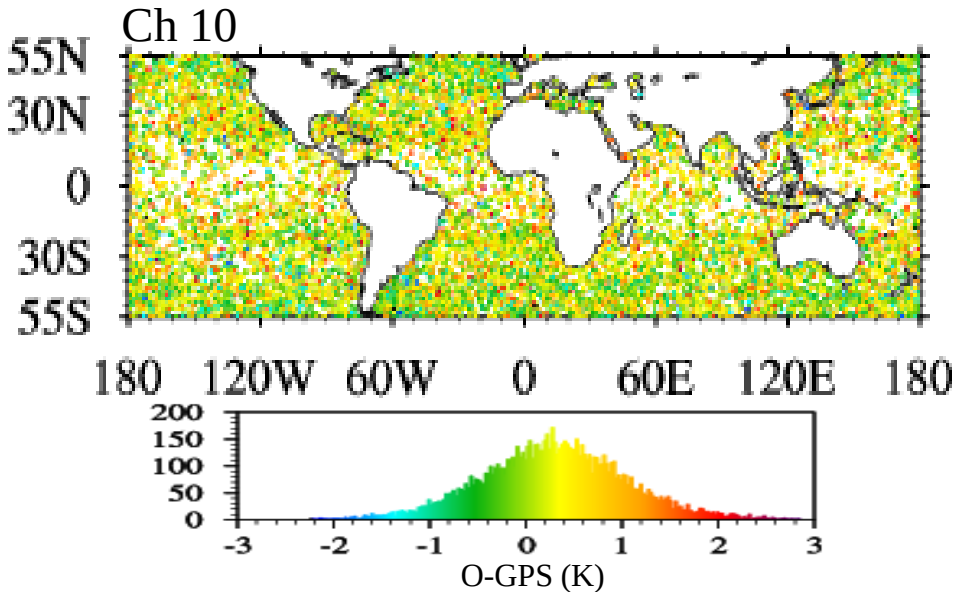
3056 collocated measurements

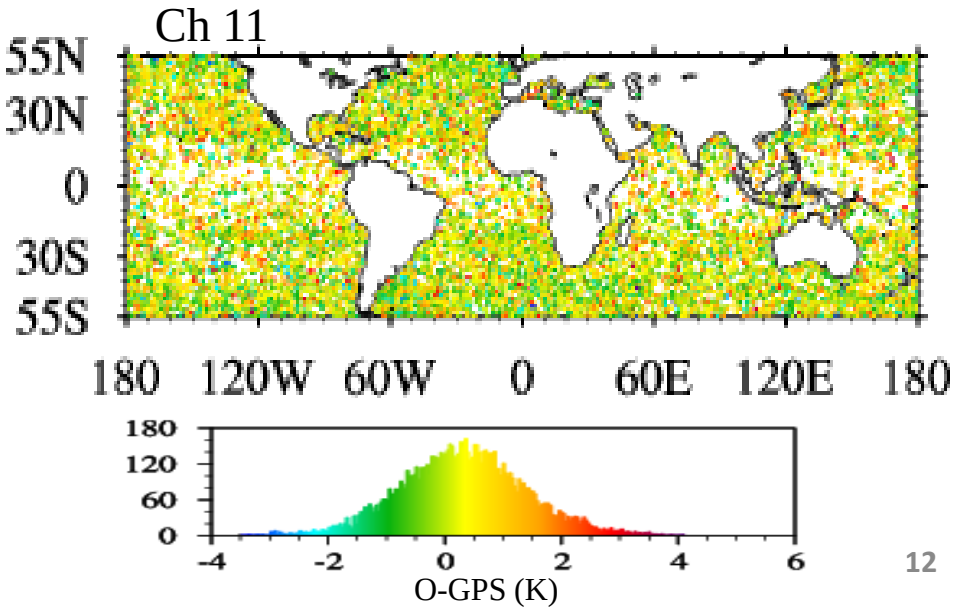
Slide Courtesy of Lin Lin, SAR

ATMS Bias Obs (TDR) - GPS Simulated

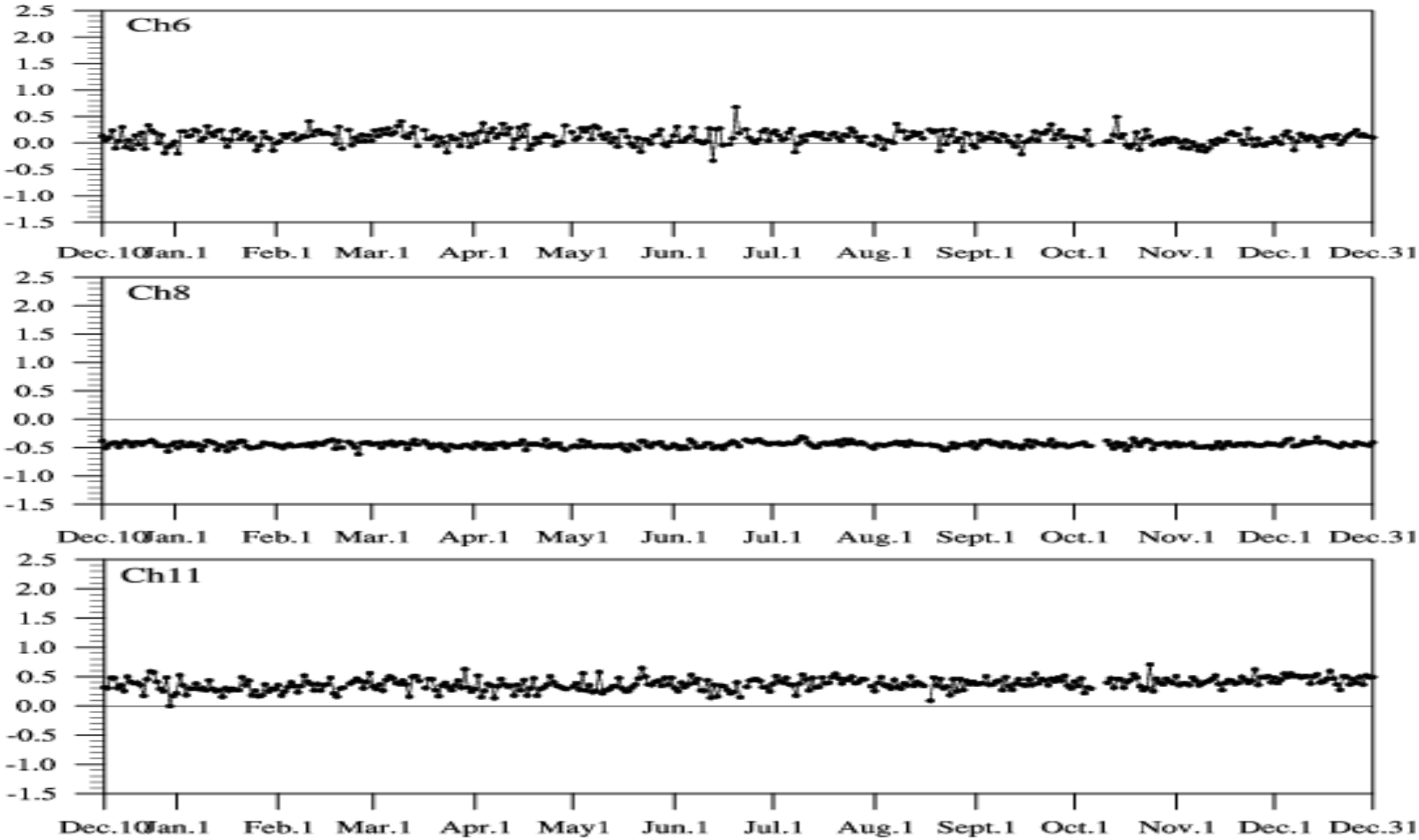








ATMS Bias Obs - Sim (GPS RO)



Slide courtesy of Lin Lin

Use of dedicated sondes for RTA tuning

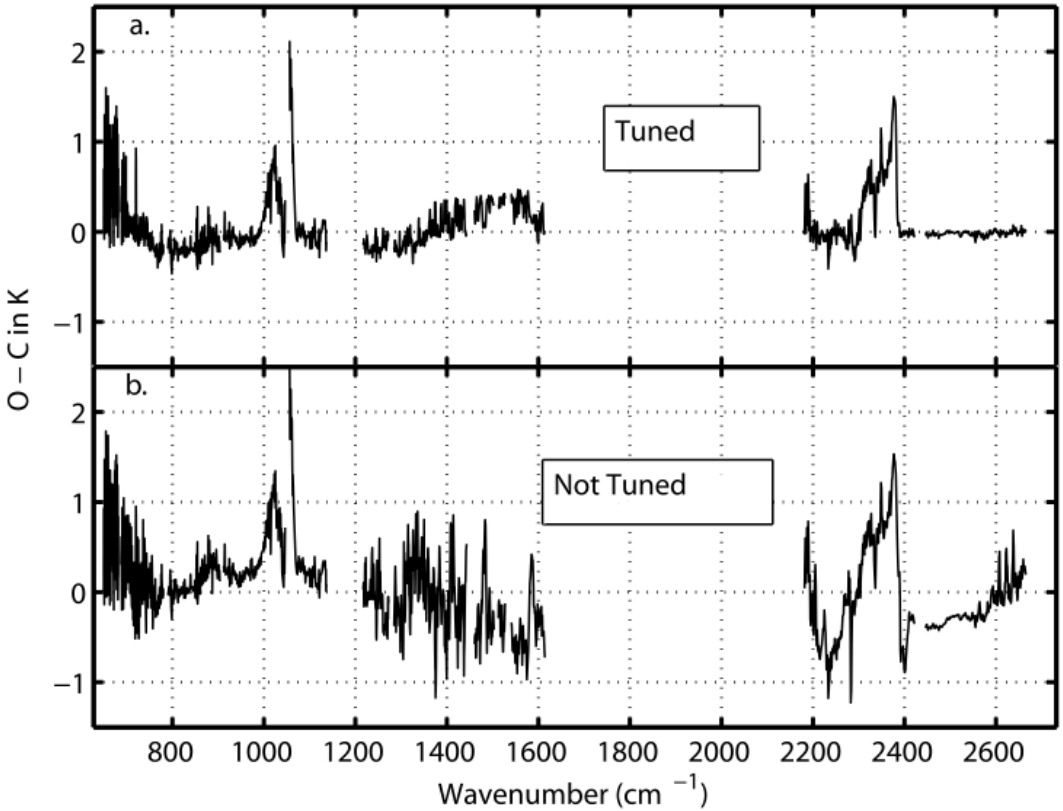


Figure 9. (a) Biases relative to all clear-sky RS-90 sondes, using version 4 RTA, which has been tuned using ARM-TWP Phase 1 observations. (b) Biases relative to all RS-90 sondes but with no empirical adjustments/tuning made. Note that little adjustment is made to channels below 690 cm^{-1} (see text).

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 111, D09S06, doi:10.1029/2005JD006146, 2006

Bias and STD of O-C for all RS90 ocean sonds

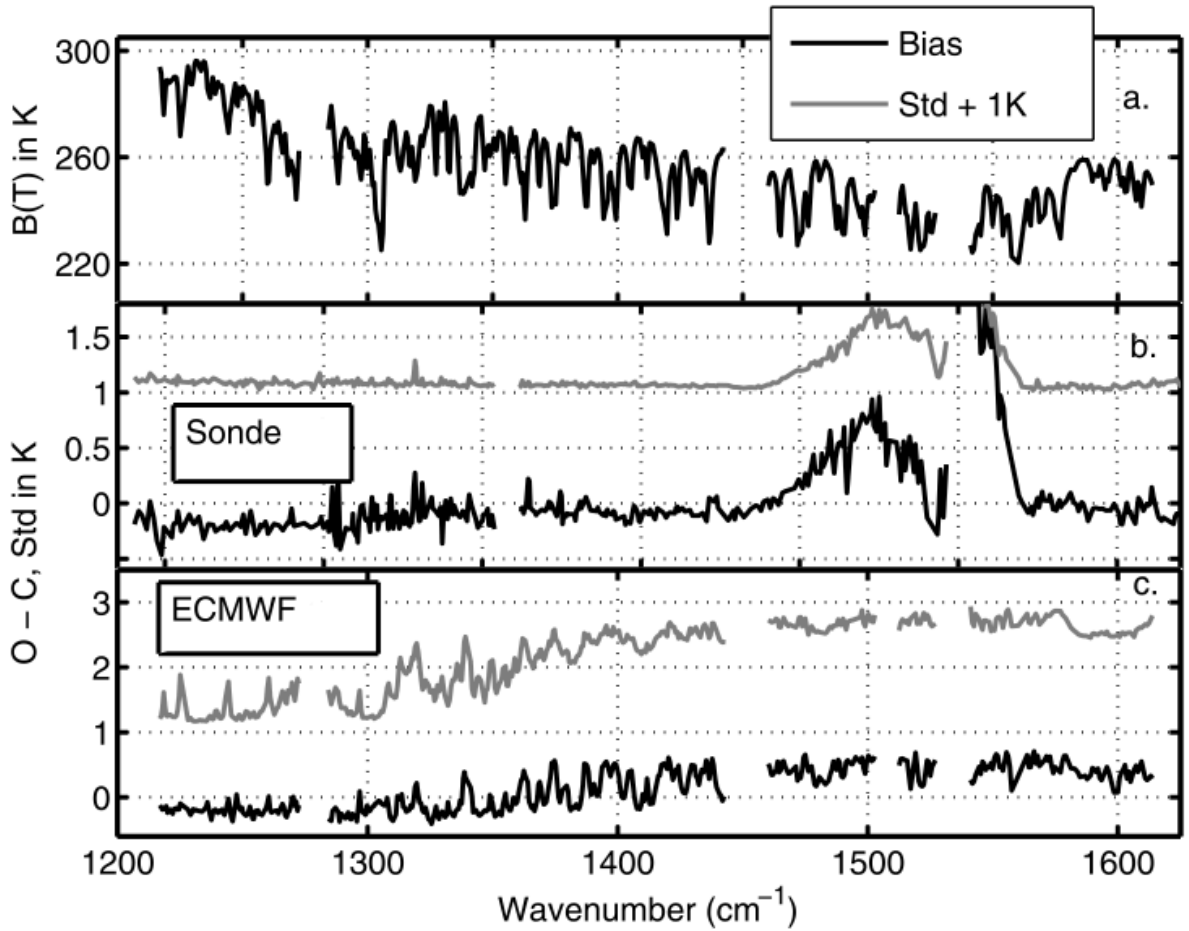


Figure 14. (a–c) Same as Figure 11 for a limited wave number range.

Summary

- GSICS provides well intercalibrated satellite observations with measurement uncertainites
- For satellite users, a limiting factor of “perfect” observations is the radiative transfer algorithm
- GRUAN helps us to provide high quality sondes with measurement uncertainites to improve radiative transfer algorithms
- GRUAN is an excellent source of data to validate level 2 products – derived soundings
- GRUAN can be used to validate reanalyses (ECMWF, JMA, NCEP, GMAO, etc)
- GRUAN should be compared to GPSRO routinely.

- Recommend: GSICS-GRUAN mutual action to leverage resources and brain power.

GSICS
Global Space-based
Inter-Calibration System

Thank You