Global Space-based Inter-Calibration System (GSICS)

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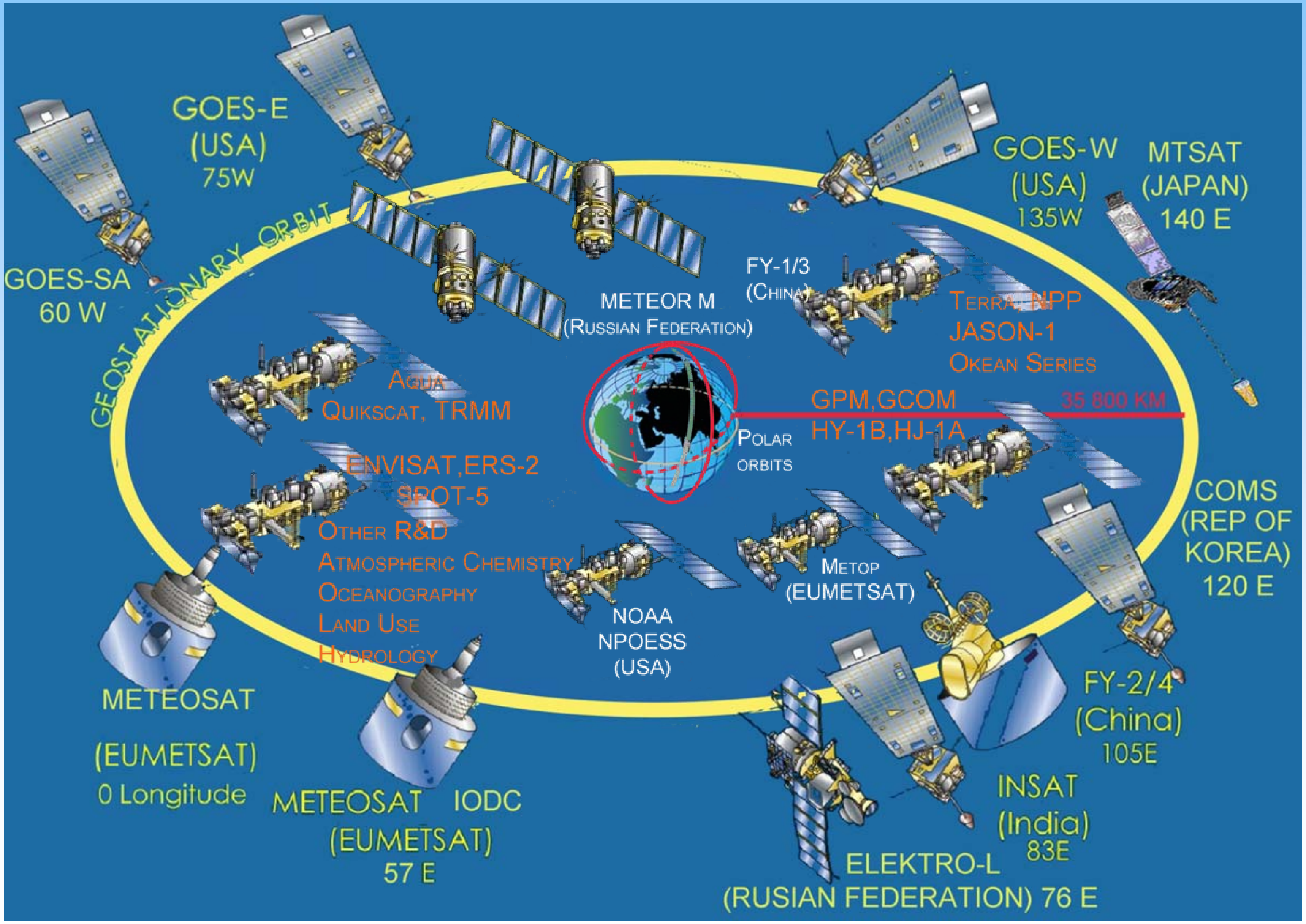
Space-Based component of the Global Observing System (GOS)



What is GSICS?

- Global Space-based Inter-Calibration System (GSICS)
- Goal - Enhance calibration and validation of satellite observations and to intercalibrate critical components global observing system
- Part of WMO Space Programme
  - GSICS Implementation Plan and Program formally endorsed at CGMS 34 (11/06)
- NOAA is the coordination center and chairs the GSICS executive panel

Organizations contributing to GSICS

- NOAA
- NIST
- NASA
- EUMETSAT
- CNES
- CMA
- JMA
- KMA

GSICS current focus is on the intercalibration of operational satellites, and makes use of key research instruments such as AIRS and MODIS to intercalibration the operational instruments

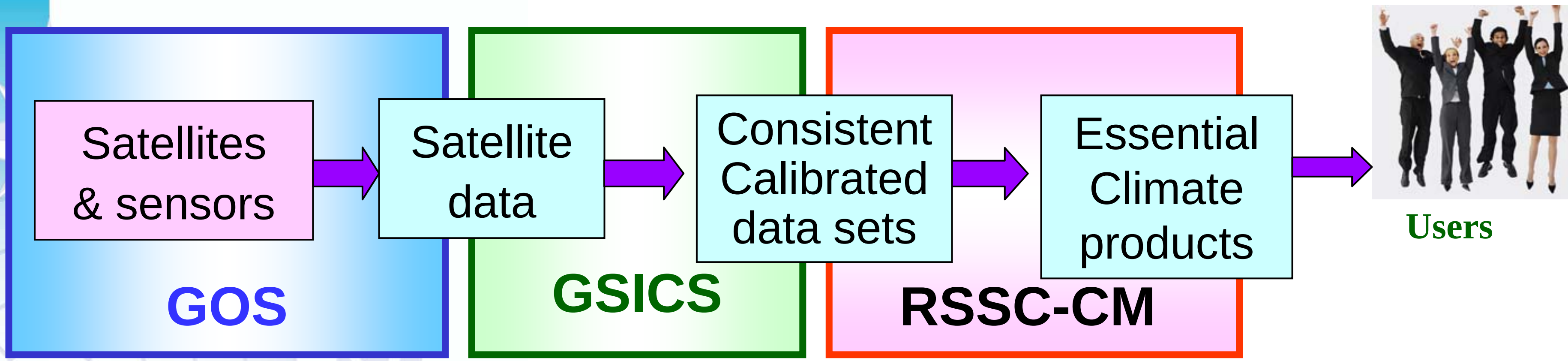
Motivation

- Demanding applications require well calibrated and intercalibrated measurements
  - Climate Data Records
  - Radiance Assimilation in Numerical Weather Prediction
  - Data Fusion
- Growing Global Observing System (GOS)
  - GEOSS

GSICS Objectives

- To improve the use of space-based global observations for weather, climate and environmental applications through operational inter-calibration of satellite sensors.
  - Observations are well calibrated through operational analysis of instrument performance, satellite intercalibration, and validation over reference sites
  - Pre-launch testing is traceable to SI standards
- Provide ability to re-calibrate archived satellite data with consensus GSICS approach, leading to stable fundamental climate data records (FCDR)

RSSC to maximize data usage



- Regional/Specialized Satellite Centres
  - Mobilize effort and expertise in some centres (or distributed virtual centres) to provide quality-controlled products following agreed specifications
  - Initial scope is Climate Monitoring (RSSC-CM) responding to GCOS requirements
  - A number of potential participating agencies
  - Implementation Plan being developed by EUMETSAT for adoption in November 07

GSICS Formulation Team

- Mitch Goldberg – NOAA/NESDIS (Chair)
- Gerald Fraser /Raju Datla– NIST
- Donald Hinsman – WMO (Space Program Director)
- Xu Jianmin (CMA)
- Toshiyuki Kurino (JMA)
- John LeMarshall - JC Sat. Data Assimilation
- Paul Menzel –NOAA/NESDIS
- Tillmann Mohr – WMO
- Hank Revercomb – Univ. of Wisconsin
- Johannes Schmetz – Eumetsat
- Jörg Schulz – DWD, CM SAF
- William Smith – Hampton University
- Steve Ungar – CEOS, Chairman WG Cal/Val

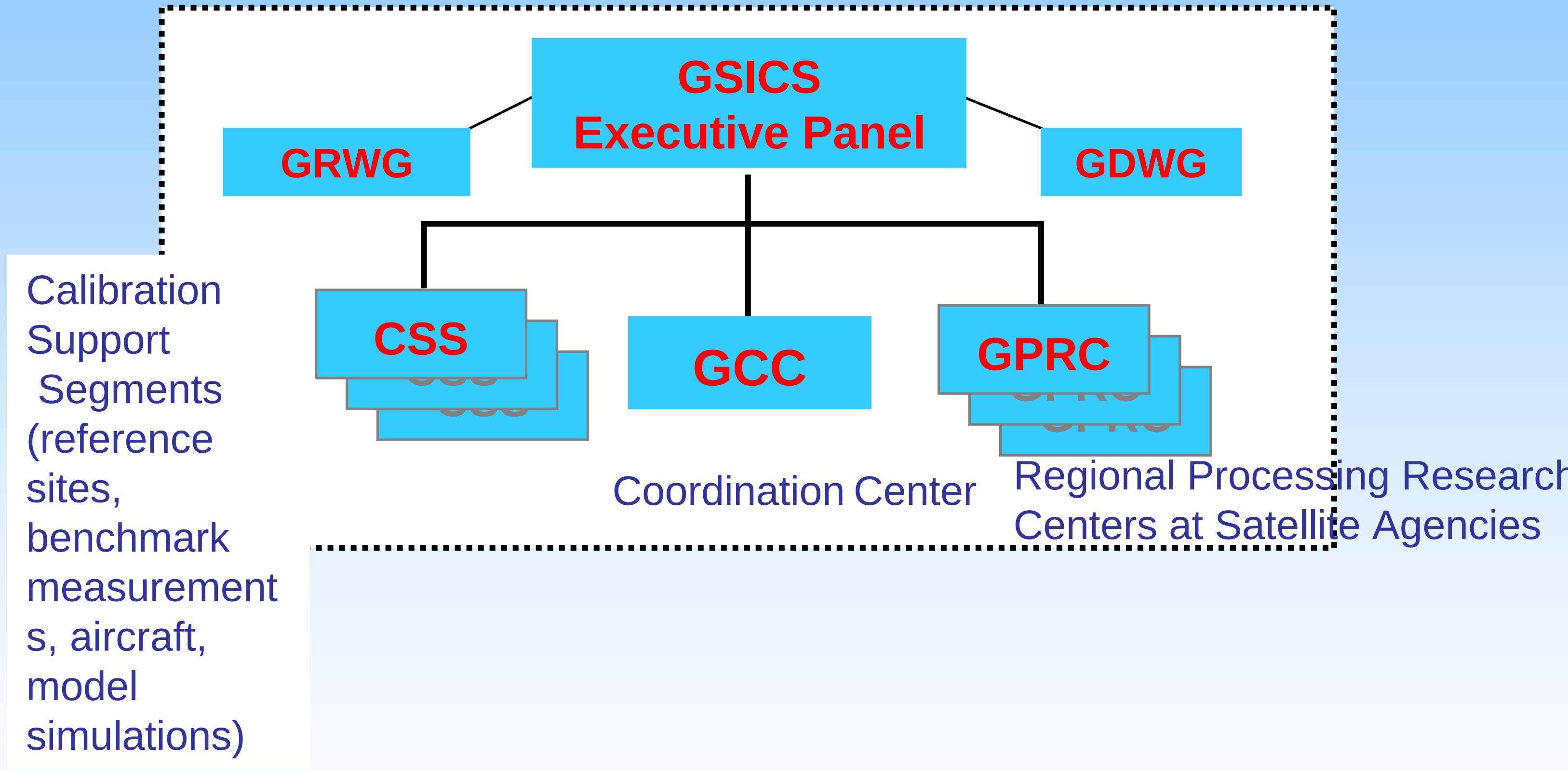
Building Blocks for Satellite Intercalibration

- Collocation
  - Determination and distribution of locations for simultaneous observations by different sensors (space-based and in-situ)
  - Collocation with benchmark measurements
- Data collection
  - Archive, metadata - easily accessible
- Coordinated operational data analyses
  - Processing centers for assembling collocated data
  - Expert teams
- Assessments
  - communication including recommendations
  - Vicarious coefficient updates for “drifting” sensors

Other key building blocks for accurate measurements and intercalibration

- Extensive pre-launch characterization of all instruments traceable to SI standards
- Benchmark instruments in space with appropriate accuracy, spectral coverage and resolution to act as a standard for inter-calibration
- Independent observations (calibration/validation sites – ground based, aircraft)

GSICS Organization



GSICS Components

- GSICS Executive Panel – reps from each satellite agency
  - Priorities, objectives and agreements
- GSICS Coordination Center (GCC) – NESDIS/STAR
  - Transmit intercalibration opportunities to GPRCs
  - Collect data from the GPRCs and provide access
  - Quarterly reports on performance
- GSICS Processing and Research Centers (GPRCs)
  - Satellite agencies
  - Activities:
    - Pre-launch calibration
    - Intersatellite calibration
    - Supporting research

Calibration Support Segments (CSS)

- The GSICS Calibration Support Segments (CSS) will be carried out by participating satellite agencies, national standards laboratories, major NWP centers, and national research laboratories. CSS activities are:

- **Prelaunch Characterisation,** reference instruments, SI traceability
- **Earth-based reference sites,** such as stable desert areas, long-term specially equipped ground sites, and special field campaigns, will be used to monitor satellite instrument performance.
- **Extra-terrestrial calibration sources,** such as the sun, the moon, and the stars, will provide stable calibration targets for on-orbit monitoring of instrument calibration
- **Model simulations** will allow comparisons of radiances computed from NWP analyses of atmospheric conditions with those observed by satellite instruments
- **Benchmark measurements** of the highest accuracy by special satellite and ground-based instruments will help nail down satellite instrument calibrations

Integrated Cal/Val System Architecture

Calibration Opportunity Prediction

Data Acquisition Scheduler

Calibration Opportunity Register (CORE)

Raw Data Acquisition for Calibration Analyses

Stored Raw Data for Calibration Analyses

- SNO/ SCO Rad. Bias and Spectral Analysis
- Calibration Parameter Noise/ Stability Monitoring
- RTM Model Rad. at Calibration Reference Sites
- Inter-sensor Bias and Spectral Analysis
- Earth & Lunar Calibration
- Geolocation Assessment (Coastlines, etc.)

Assessment Reports and Calibration Updates

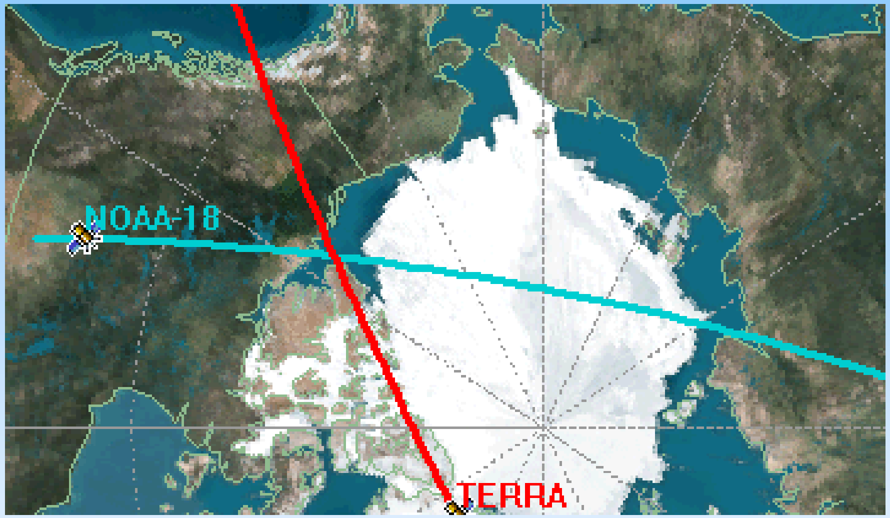
2007 Activities

- Annual Operating Plan
- Two GRWG meetings (chair, Fred Wu)
  - Consensus algorithms for LEO to GEO intercalibration
- GDWG (chair, Volker Gaertner)
  - Data management issues, metadata
- Commissioned GSICS Website and routine LEO to LEO intersatellite calibration, with performance reports at NESDIS
- Intercomparisons of AIRS and IASI

Simultaneous Nadir Overpass (SNO) Method

-a core component in the Integrated Cal/Val System

POES intercalibration



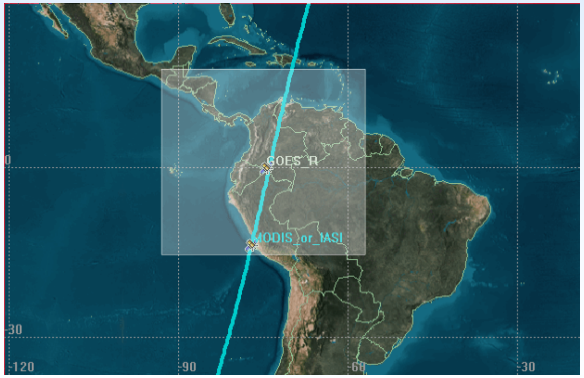
- Useful for remote sensing scientists, climatologists, as well as calibration and instrument scientists

•Support new initiatives (GEOSS and GSICS)

- Significant progress are expected in GOES/POES intercal in the near future

•Has been applied to microwave, vis/nir, and infrared radiometers for on-orbit performance trending and climate calibration support

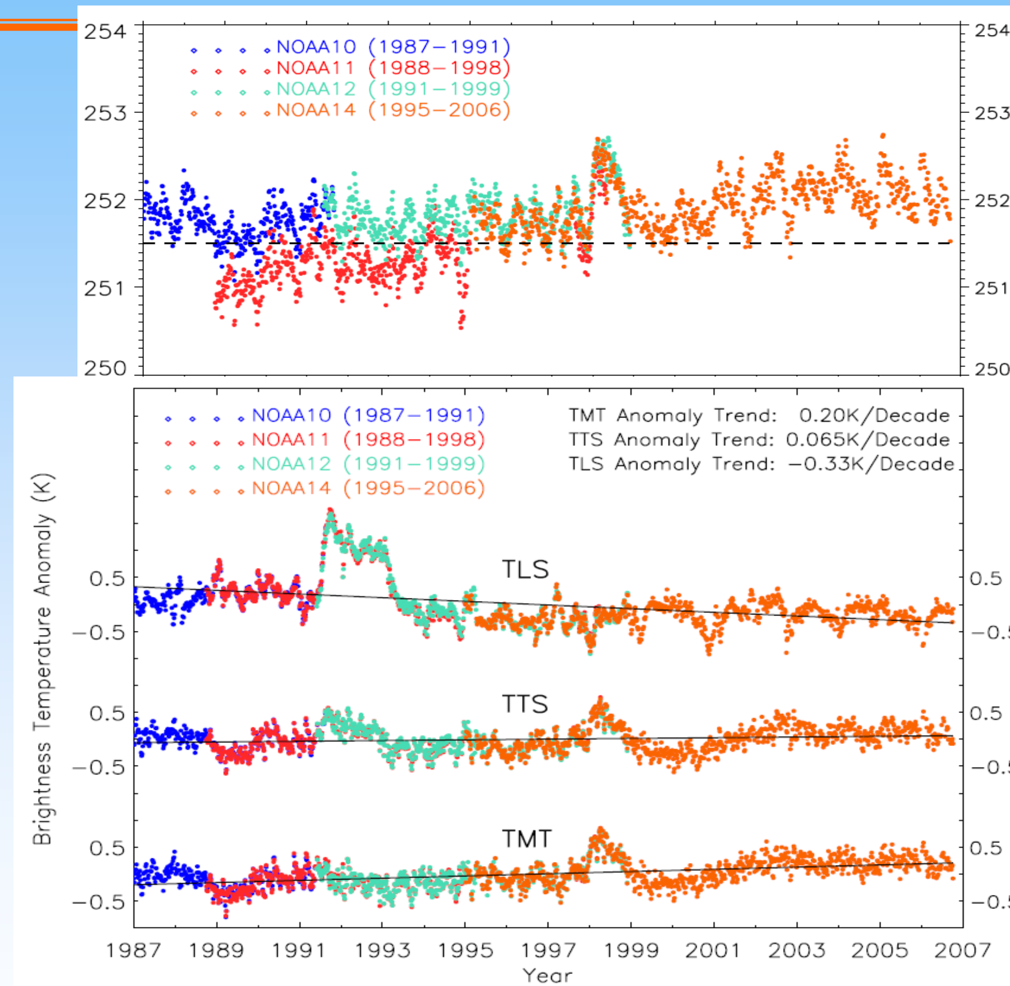
•Capabilities of 0.1 K for sounders and 1% for vis/nir have been demonstrated in pilot studies



GOES vs. POES

Satellite Intercalibration improves MSU time series

- NESDIS/STAR completed a recalibration on the MSU atmospheric channels for NOAA 10 to 14
- The current MSU data are well merged and provide accurate climate trend values.
- The radiance data are well merged for assimilation in reanalysis systems.



Intersatellite bias removal among the NOAA MSU instruments are crucial for climate trend detection.

Top: Ocean-averaged MSU channel 2 time series for NOAA 10, 11, 12, and 14 for 1987-2007 before the SNO calibration; Bottom: Anomaly time series for MSU channels 2, 3, and 4 after the SNO recalibration. The abbreviations Middle Troposphere, Temperature Tropopause and Stratosphere TMT, TTS, and TLS refer respectively to Temperature, and Temperature Lower Stratosphere.

Courtesy of C. Zou

Global Space-Based Inter-Calibration System

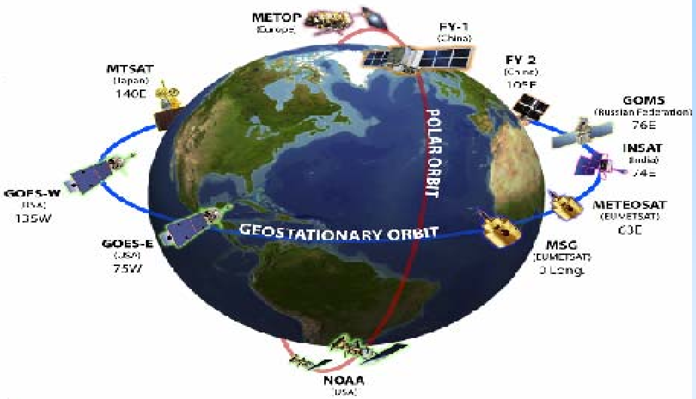
Mission:

Assure high-quality, inter-calibrated measurements from the international constellation of operational satellites to support the GEOSS goal of increasing the accuracy and interoperability of environmental products and applications for societal benefit.

Goals:

The primary goal of GSICS is to improve the use of space-based global observations for weather, climate and environmental applications through operational inter-calibration of the space component of the WMO World Weather Watch (WWW) Global Observing System (GOS) and Global Earth Observing System of Systems (GEOSS). The basic GSICS strategies to achieve this goal are:

- To establish a GSICS Virtual Library to efficiently share information, software and data relevant to calibration;
- To build collaborations ensuring that each satellite instrument meets specifications by making pre-launch tests traceable to SI standards;
- To improve on-orbit calibration of satellite instrument observations by means of an integrated cal/val system, including instrument performance monitoring, inter-satellite/inter-sensor calibration, lunar and stellar calibration, vicarious calibration and validation with reference sites;
- To establish a distributed research component and a plan for research to operations transition;
- To build collaborations to retrospectively re-calibrate archive satellite data using the operational inter-calibration system in order to make satellite data archives worthy for NWP forecasts and climate studies.



Satellite Inter-Calibration

LEO - LEO

- Microwave Sounder
- Microwave Imager
- Infrared Sounder
- VIS/IR Imager
- Method and Result Documentation

GEO -LEO

- Infrared Sounder
- VIS/IR Imager
- Method and Result Documentation

Microwave Sounder

● :Active ● : Inactive

	NOAA 9	NOAA 10	NOAA 11	NOAA 12	NOAA 14	NOAA 15	NOAA 16	NOAA 17	NOAA 18	Metop-A	Aqua
NOAA 9		Inactive	Inactive	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOAA 10			Inactive	Inactive	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NOAA 11				Inactive	Inactive	N/A	N/A	N/A	N/A	N/A	N/A
NOAA 12					Inactive	Inactive	Inactive	N/A	N/A	N/A	N/A
NOAA 14						Inactive	Inactive	Inactive	Inactive	Inactive	Inactive
NOAA 15							Active	Active	Active	Active	Inactive
NOAA 16								Active	Active	Active	Inactive
NOAA 17									Inactive	Inactive	Inactive
NOAA 18										Active	Active
Metop-A											Active
Aqua											

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Intersatellite Instrument Characteristics

POES NOAA18 AMSU-A and Metop-A AMSU-A

AMSUA

Tb Bias vs. Date

AMSU (57.252 GHz)

Show Plot

Tb Bias vs. Tb

AMSU (57.252 GHz)

Show Plot

Individual Inter-cal Event Distribution Statistics Table

AMSU (57.252 GHz)

Show Table

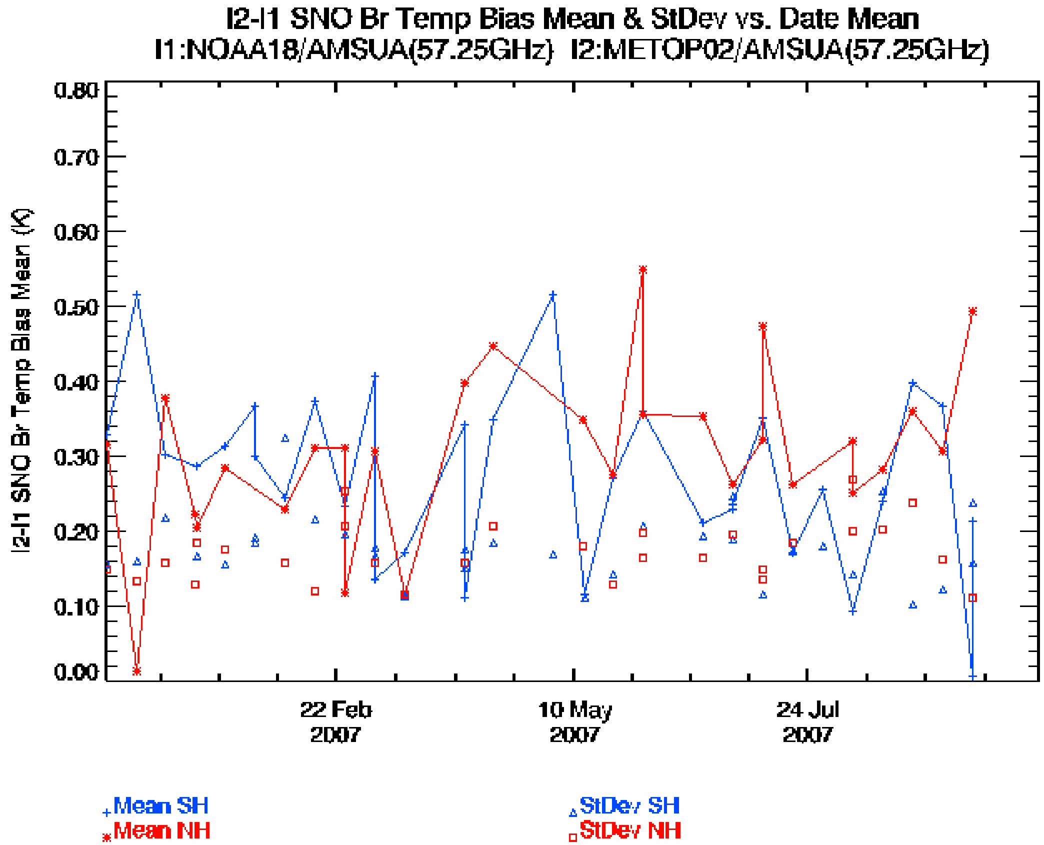
Individual Inter-cal Event Covariance Statistics Table

AMSU (57.252 GHz)

Show Table

Ensemble Statistics Table

Show Table



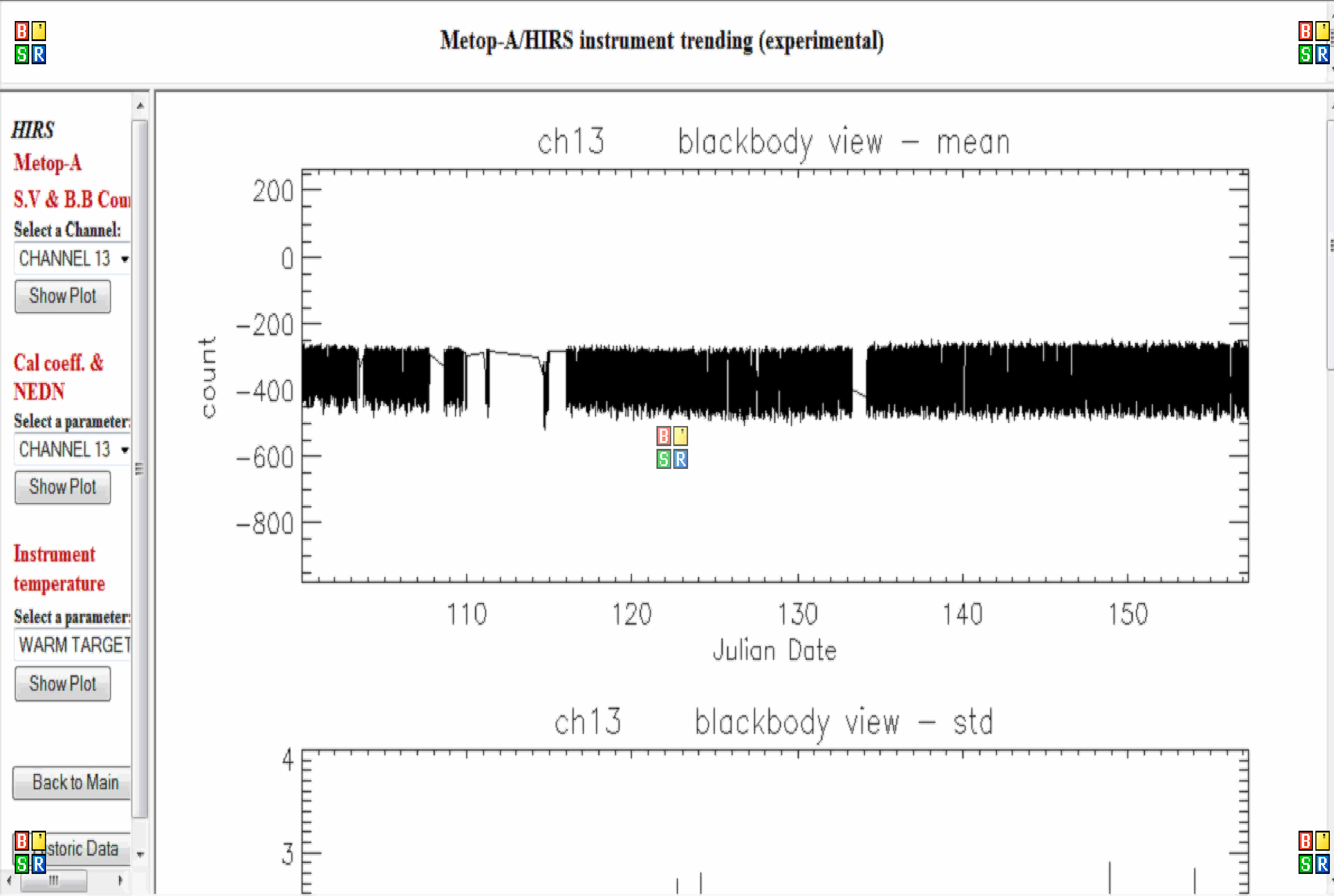
LEO-LEO SNO Ensemble Statistics

Satellite 1: NOAA18 Satellite 2: METOP02

Instrument 1: AMSUA Instrument 2: AMSUA

Ch_I1	Ch_I2	Parameter	Hemis	#SNOs	Average	StandDev	GaussDist	Sig_Avg	Trend_Param(t)	Sig_Trend	Slope_Param(BrT/Refl)	Sig_Slope	Avg_I1(BrT/Refl)	Avg_I2(BrT/Refl)	Avg_delTime	Avg_delLoc
00001	00001	BrTempBias	South	31	0.504	0.941	Yes	no@99%	-2.930	no@99%	-1.6185E-02	no@99%	202.244	202.748	15.3	19.69
00002	00002	BrTempBias	South	31	0.473	0.966	No	no@99%	-2.190	no@99%	-1.8961E-02	yes@99%	201.121	201.595	15.3	19.69
00003	00003	BrTempBias	South	32	-0.200	0.536	Yes	no@99%	-5.857	yes@99%	5.1997E-03	no@99%	218.958	218.759	15.3	19.69
00004	00004	BrTempBias	South	32	-0.226	0.201	Yes	yes@99%	-2.822	yes@99%	6.3014E-03	yes@99%	230.785	230.559	15.3	19.69
00005	00005	BrTempBias	South	32	-0.230	0.165	No	yes@99%	-1.698	yes@99%	9.3951E-03	yes@99%	230.518	230.288	15.3	19.69
00006	00006	BrTempBias	South	32	0.078	0.094	No	yes@99%	-1.668	yes@99%	7.4439E-03	yes@99%	223.174	223.251	15.3	19.69
00007	00007	BrTempBias	South	32	0.291	0.084	No	yes@99%	-0.649	no@99%	1.8069E-03	no@99%	216.976	217.267	15.3	19.69
00008	00008	BrTempBias	South	32	0.187	0.094	Yes	yes@99%	0.907	yes@99%	-2.0781E-03	no@99%	213.513	213.700	15.3	19.69
00009	00009	BrTempBias	South	32	0.273	0.116	No	yes@99%	-1.634	yes@99%	1.6123E-03	no@99%	210.095	210.369	15.3	19.69
00010	00010	BrTempBias	South	32	0.369	0.138	No	yes@99%	-0.530	no@99%	4.9849E-04	no@99%	210.686	211.054	15.3	19.69
00011	00011	BrTempBias	South	32	0.366	0.147	Yes	yes@99%	-1.314	yes@99%	5.1872E-04	no@99%	213.685	214.051	15.3	19.69
00012	00012	BrTempBias	South	32	0.230	0.145	No	yes@99%	-1.222	no@99%	4.8267E-04	no@99%	221.238	221.469	15.3	19.69
00013	00013	BrTempBias	South	32	0.130	0.222	Yes	no@99%	-2.263	yes@99%	-8.9412E-04	no@99%	233.044	233.174	15.3	19.69
00014	00014	BrTempBias	South	32	0.023	0.380	No	no@99%	1.305	no@99%	-3.1174E-03	no@99%	246.620	246.643	15.3	19.69
00015	00015	BrTempBias	South	32	0.089	1.104	Yes	no@99%	-9.018	no@99%	-2.0378E-03	no@99%	203.449	203.537	15.3	19.69
00001	00001	BrTempBias	North	29	0.278	1.493	No	no@99%	12.175	no@99%	-6.1263E-03	no@99%	214.128	214.406	16.0	19.67
00002	00002	BrTempBias	North	29	0.244	1.593	No	no@99%	13.848	no@99%	-8.5765E-03	no@99%	213.032	213.276	16.0	19.67
00003	00003	BrTempBias	North	29	-0.350	0.503	No	yes@99%	-6.933	no@99%	-1.4771E-02	yes@99%	234.872	234.521	16.0	19.67
00004	00004	BrTempBias	North	29	-0.099	0.136	Yes	yes@99%	-2.446	no@99%	-3.2917E-03	no@99%	245.023	244.924	16.0	19.67
00005	00005	BrTempBias	North	29	-0.124	0.108	Yes	yes@99%	-1.005	no@99%	-3.1786E-03	no@99%	241.009	240.886	16.0	19.67
00006	00006	BrTempBias	North	29	0.103	0.077	No	yes@99%	-0.262	no@99%	8.5038E-04	no@99%	230.615	230.719	16.0	19.67
00007	00007	BrTempBias	North	29	0.336	0.072	No	yes@99%	0.565	no@99%	1.1509E-03	no@99%	224.128	224.464	16.0	19.67
00008	00008	BrTempBias	North	29	0.207	0.086	Yes	yes@99%	0.205	no@99%	3.3178E-04	no@99%	221.386	221.593	16.0	19.67
00009	00009	BrTempBias	North	29	0.304	0.113	No	yes@99%	1.940	no@99%	6.5323E-04	no@99%	219.825	220.129	16.0	19.67
00010	00010	BrTempBias	North	29	0.346	0.114	Yes	yes@99%	1.512	no@99%	1.3000E-03	no@99%	221.043	221.389	16.0	19.67
00011	00011	BrTempBias	North	29	0.403	0.148	Yes	yes@99%	1.642	no@99%	-1.7633E-04	no@99%	224.738	225.141	16.0	19.67
00012	00012	BrTempBias	North	29	0.247	0.239	Yes	yes@99%	0.201	no@99%	-2.4013E-03	no@99%	232.296	232.543	16.0	19.67
00013	00013	BrTempBias	North	29	0.195	0.284	No	yes@99%	-3.925	no@99%	-1.2264E-02	yes@99%	243.009	243.204	16.0	19.67
00014	00014	BrTempBias	North	29	0.102	0.541	No	no@99%	-5.361	no@99%	-2.5504E-02	yes@99%	253.781	253.884	16.0	19.67
00015	00015	BrTempBias	North	29	0.123	1.217	No	no@99%	-22.803	no@99%	-2.2769E-02	no@99%	222.534	222.657	16.0	19.67

32 SNOs, BIAS 0.27 K, STDV 0.116 …….. Avg Time Dif 15.3 secs, Avg Dist 19.7 km


Metop-A/HIRS instrument trending (experimental)
HIRS
Metop-A
S.V & B.B Cou
Select a Channel:
CHANNEL 13
Show Plot
Cal coeff. & NEDN
Select a parameter:
CHANNEL 13
Show Plot
Instrument temperature
Select a parameter:
WARM TARGET
Show Plot
Back to Main
storic Data
ch13 blackbody view – mean
count
200
0
−200
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−600
−800
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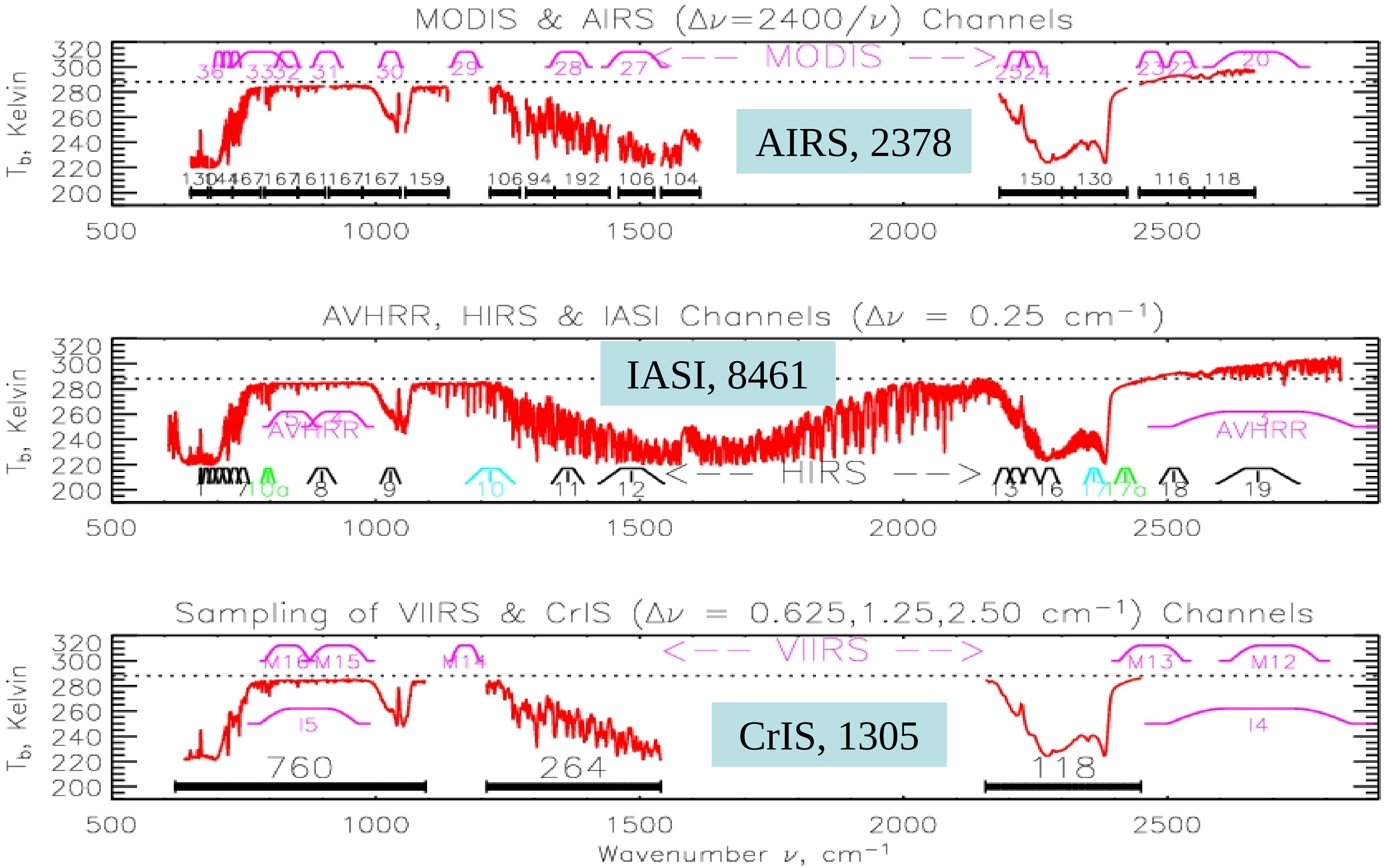
3

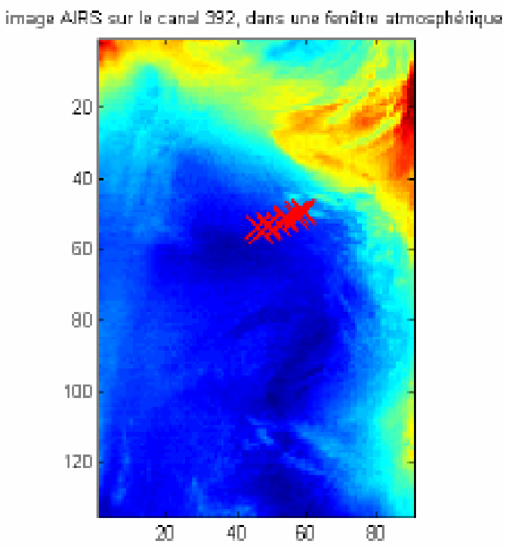
Routine Intercalibration of AIRS and IASI

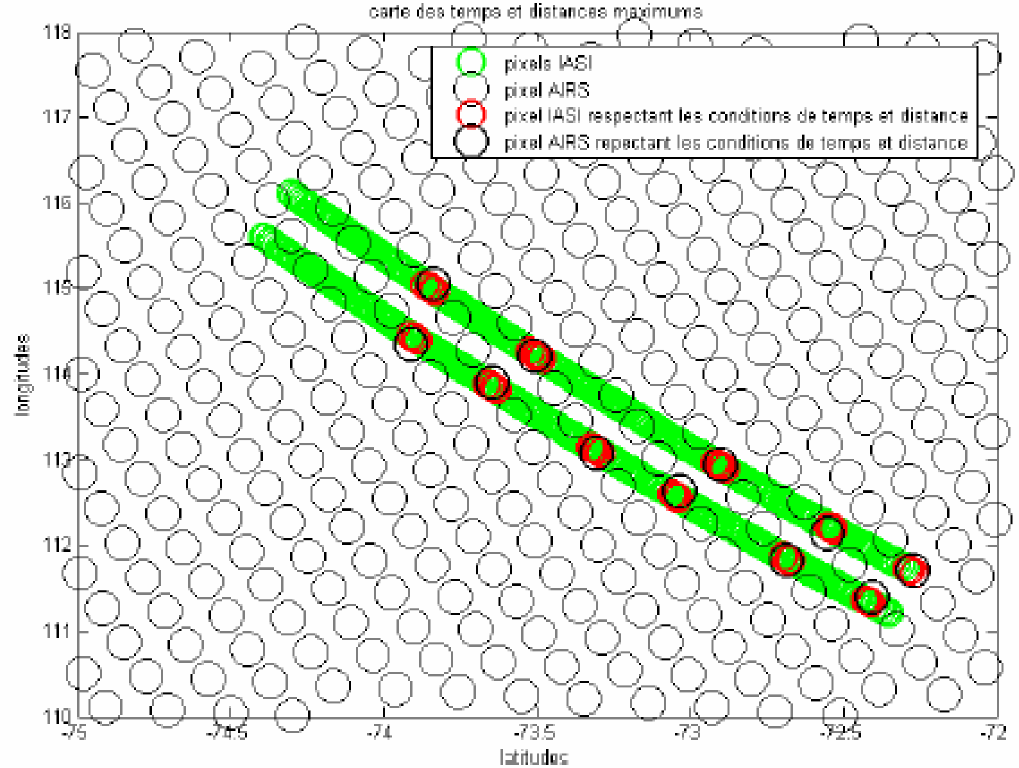


Situation 16th of April

(Blumstein)

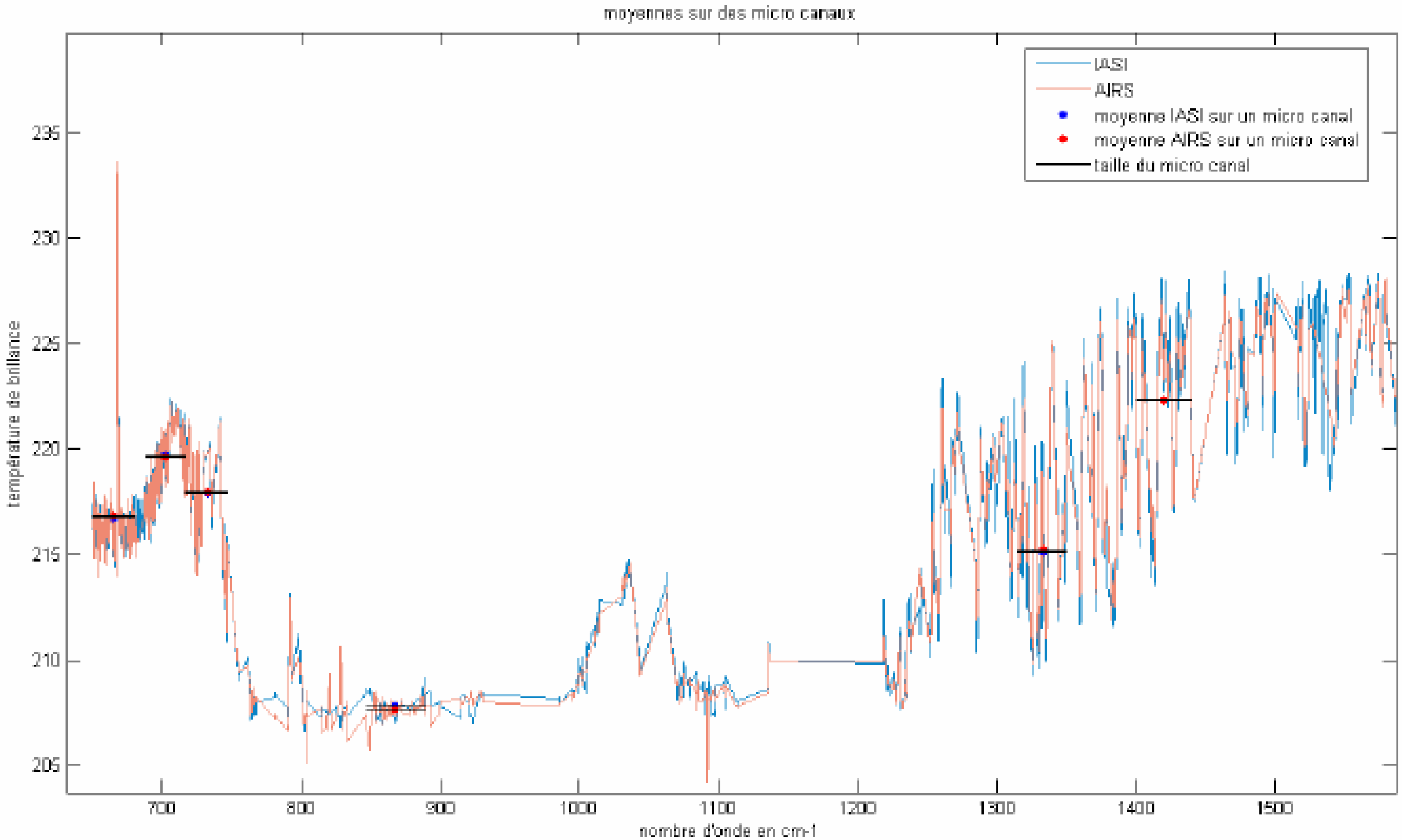
- IASI in External Cal.
  - Close to nadir
- Many comparison opportunities
  - 49 used
- Good uniformity
  - Cold scene





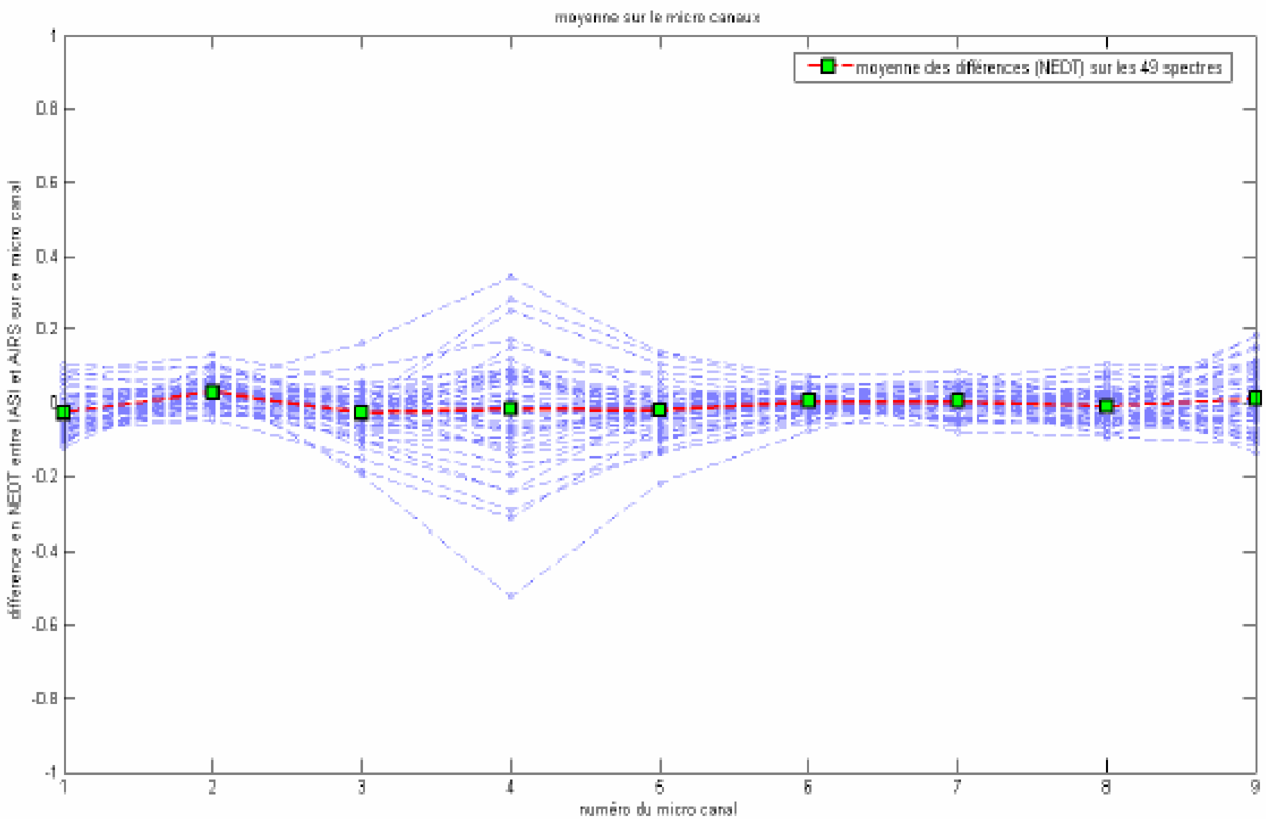
Radiometric calibration — IASI versus AIRS

Pseudo-channels



Summary results (case 16th of April 2007)

- IASI External Calibration Mode. Very uniform situation
- 9 pseudo-channels / 49 soundings / 210 K in atmospheric window
- Differences scaled to 280 K reference temperature

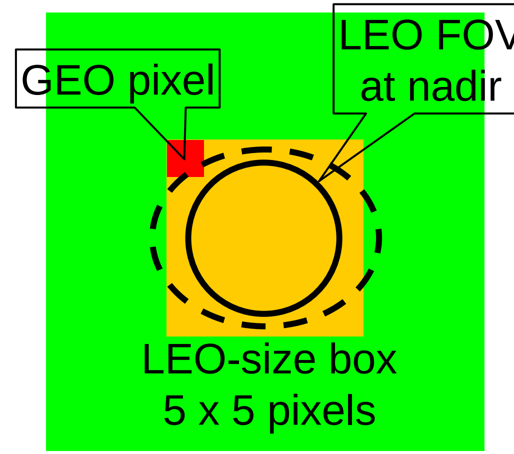


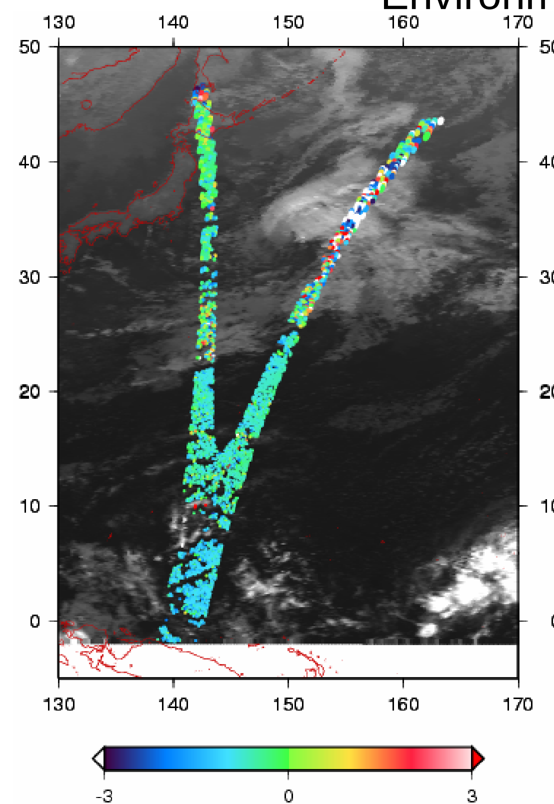
2008 Activities

- Commission intercalibration of MTSAT, MSG, GOES and FY2 Infrared Imagers with IASI and AIRS.
  - Routine intercomparisons between MSG (SEVIRI) and AIRS/IASI at EUMETSAT
  - Routine intercomparisons between GOES and AIRS/IASI at NESDIS
  - Routine intercomparisons between MTSAT and AIRS/IASI at JMA
  - Routine intercomparisons between FY2 and AIRS/IASI at CMA

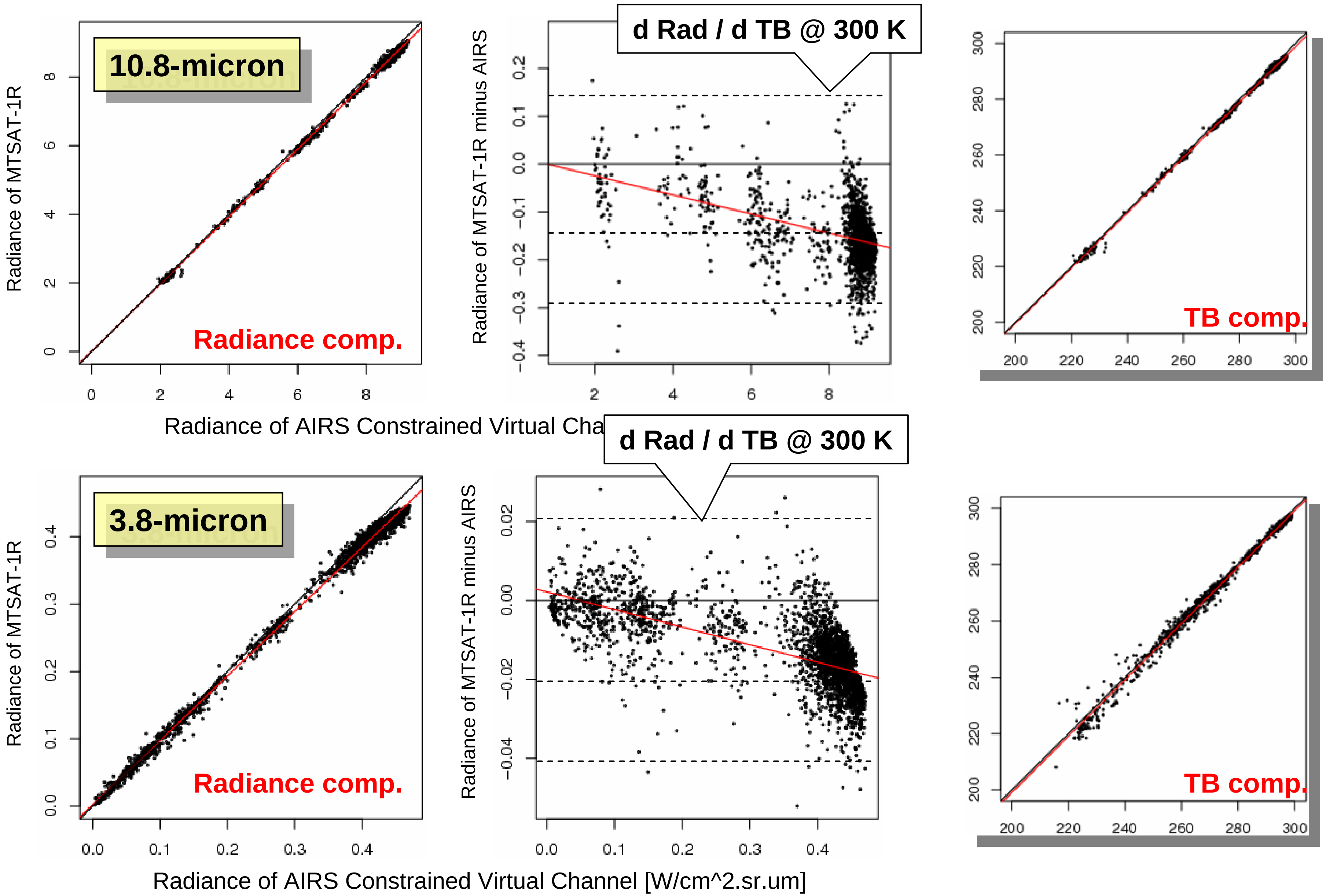
Intercalibration Algorithm Ver 0.0

- Key match-up conditions between GEO and LEO
  - Difference of observing times < 1800 (sec)
  - Difference of 1/cos(sat. zenith angles) < 0.05
  - Environment uniformity check
    - To choose only spatially uniform area to alleviate navigation error, MTF, observing time difference, optical path difference, etc.
    - Environment domain = 11x11 IR pixel box (MTSAT-1R vs. AIRS)
    - env_stdv_tb < (TBD)
  - Representation check of LEO-size GEO pixels in the environment
    - z-test
    - LEO FOV = 5x5 IR pixel box (MTSAT-1R vs. AIRS)
    - abs(fov_mean_tb – env_mean_tb) < Gaussian x env_stdv_tb / 5



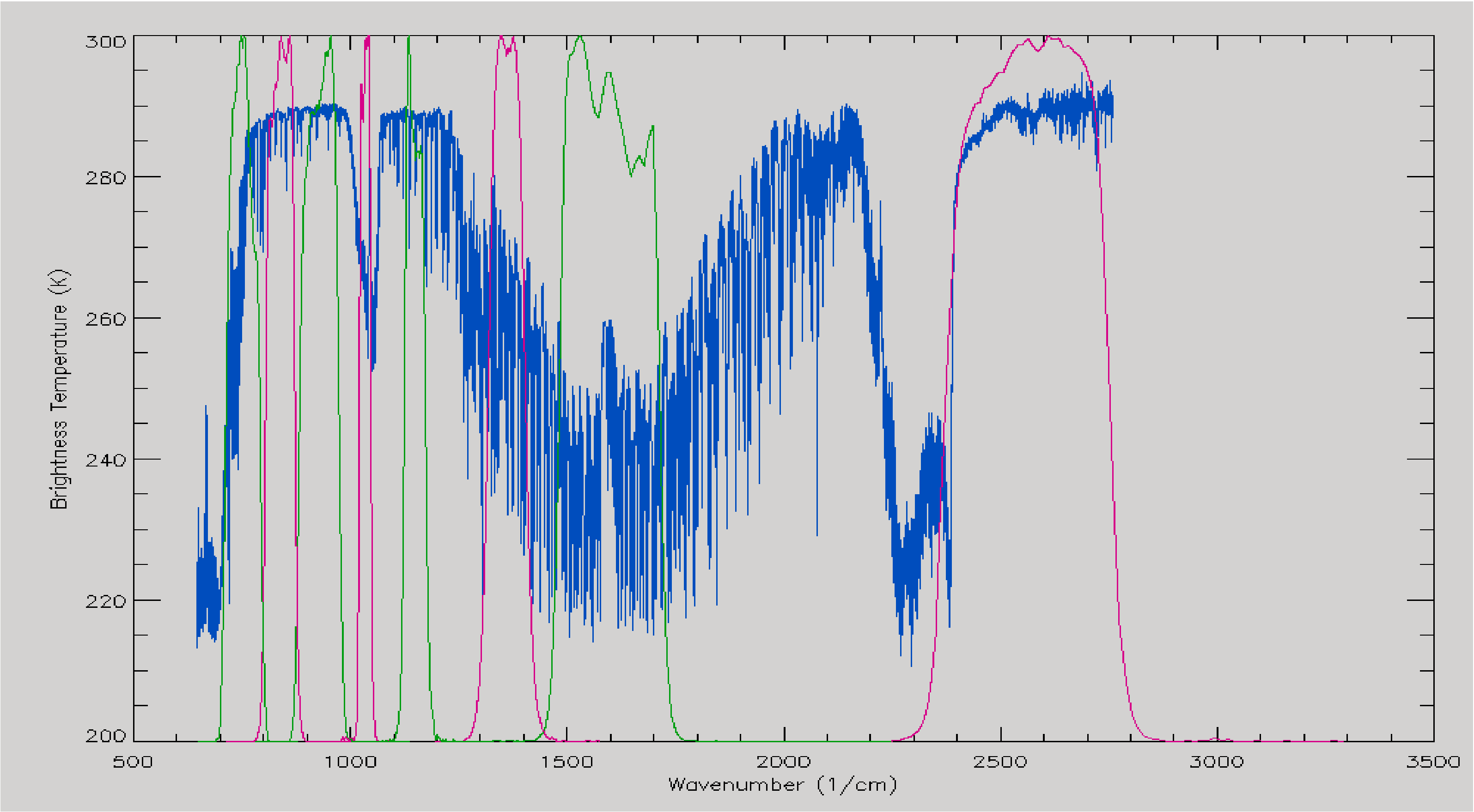


TB Comparison and Radiance Comparison

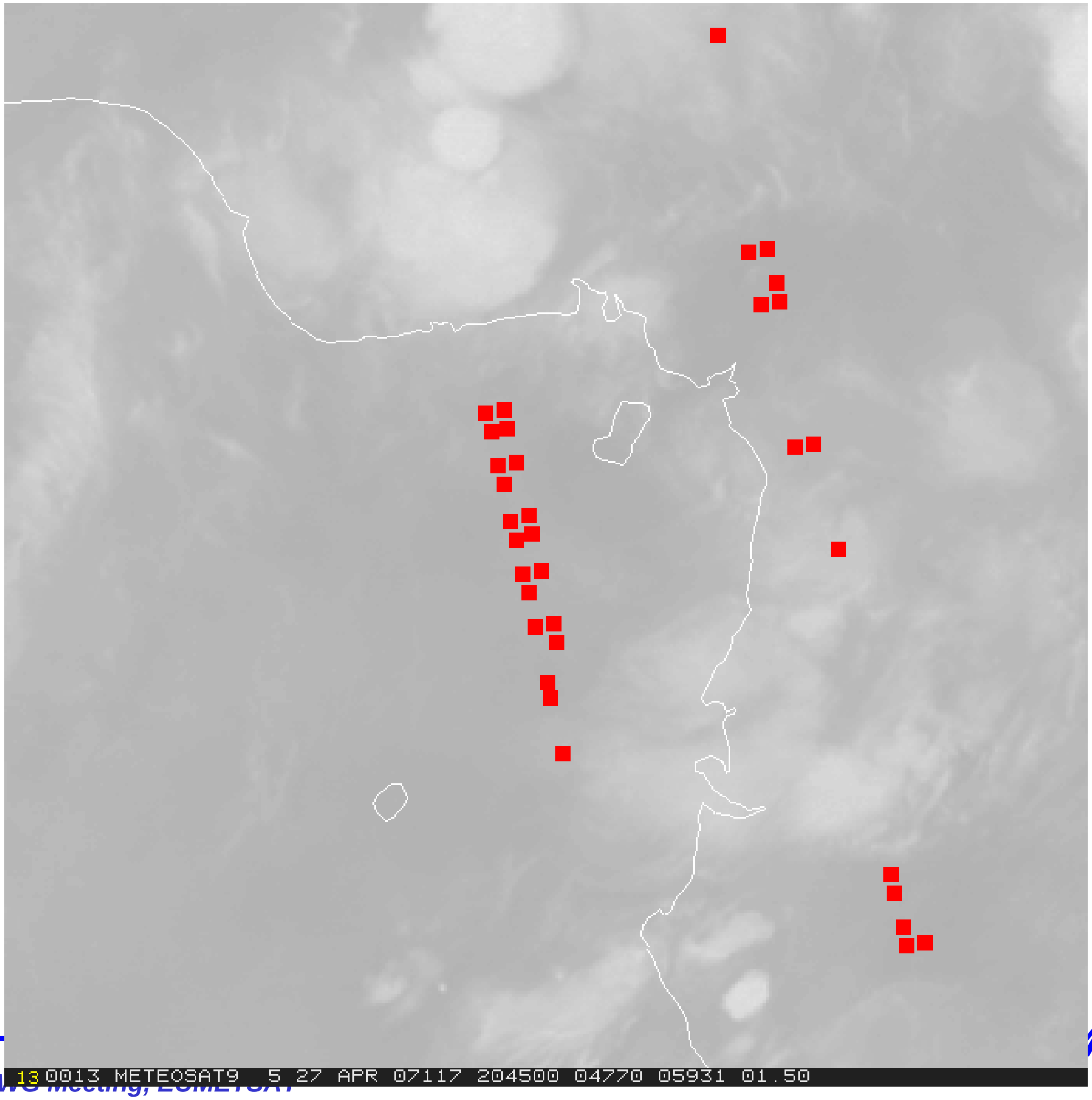


IASI Spectrum – MSG Filter

(Koenig)



"Homogeneous" Targets (WV6.2)



Meteosat-8

and

Meteosat-9

Results for 27 April 2007

Channel	ΔT IASI – Meteosat-8*	ΔT IASI – Meteosat-9 *
IR3.9	-0.17	-0.20
WV6.2	-0.24	-0.40
WV7.3	-0.51	-0.14
IR8.7	0.15	0.15
IR9.7	0.17	0.20
IR10.8	0.16	0.07
IR12.0	0.19	0.08
IR13.4	0.44	1.7

*Uncertainty 0.1 – 0.2 K

EUMETSAT

Post- launch technical approach for improving satellite instrument characterisation

Satellite-to-Satellite

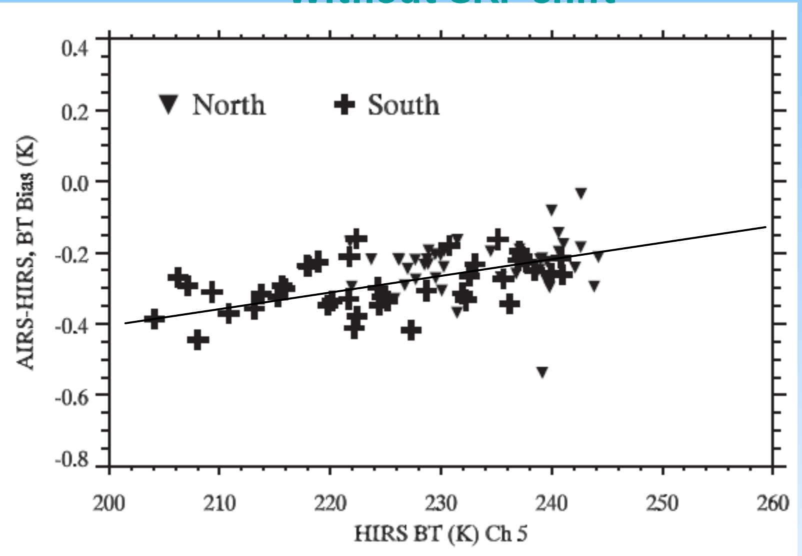
Satellite-to-Aircraft

Satellite-to-Model

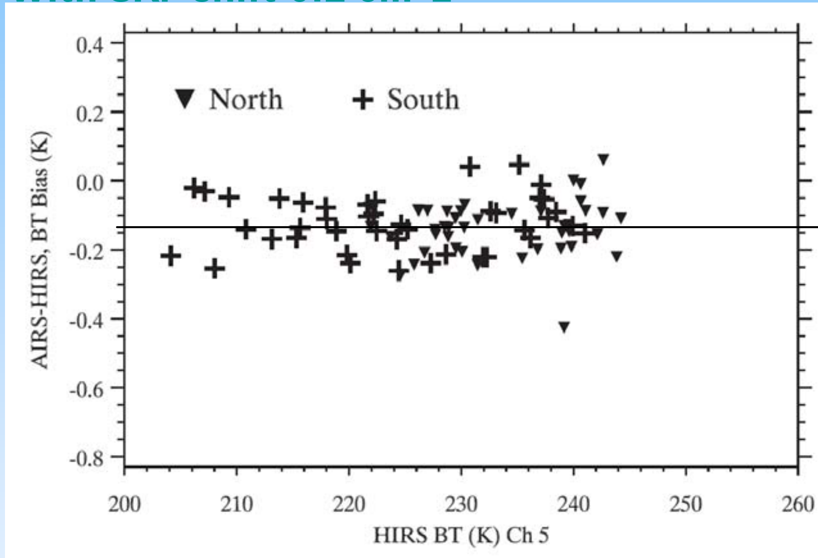
Satellite-to-Reference Sites (including Lunar and Star calibration)

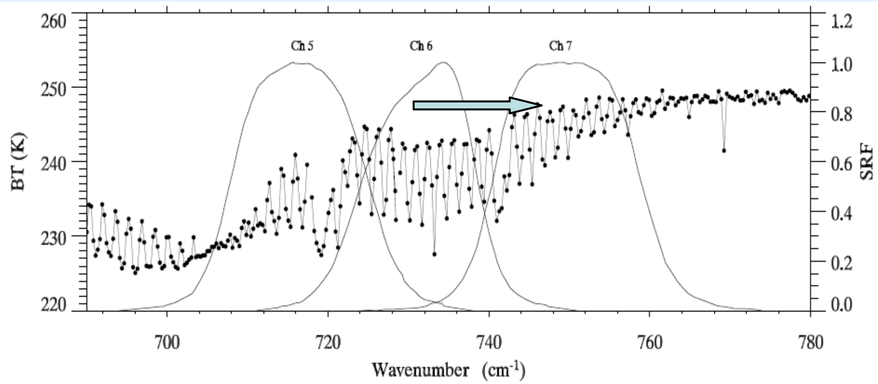
SRF Shift for HIRS Channel 6

Without SRF shift



With SRF shift 0.2 cm-1



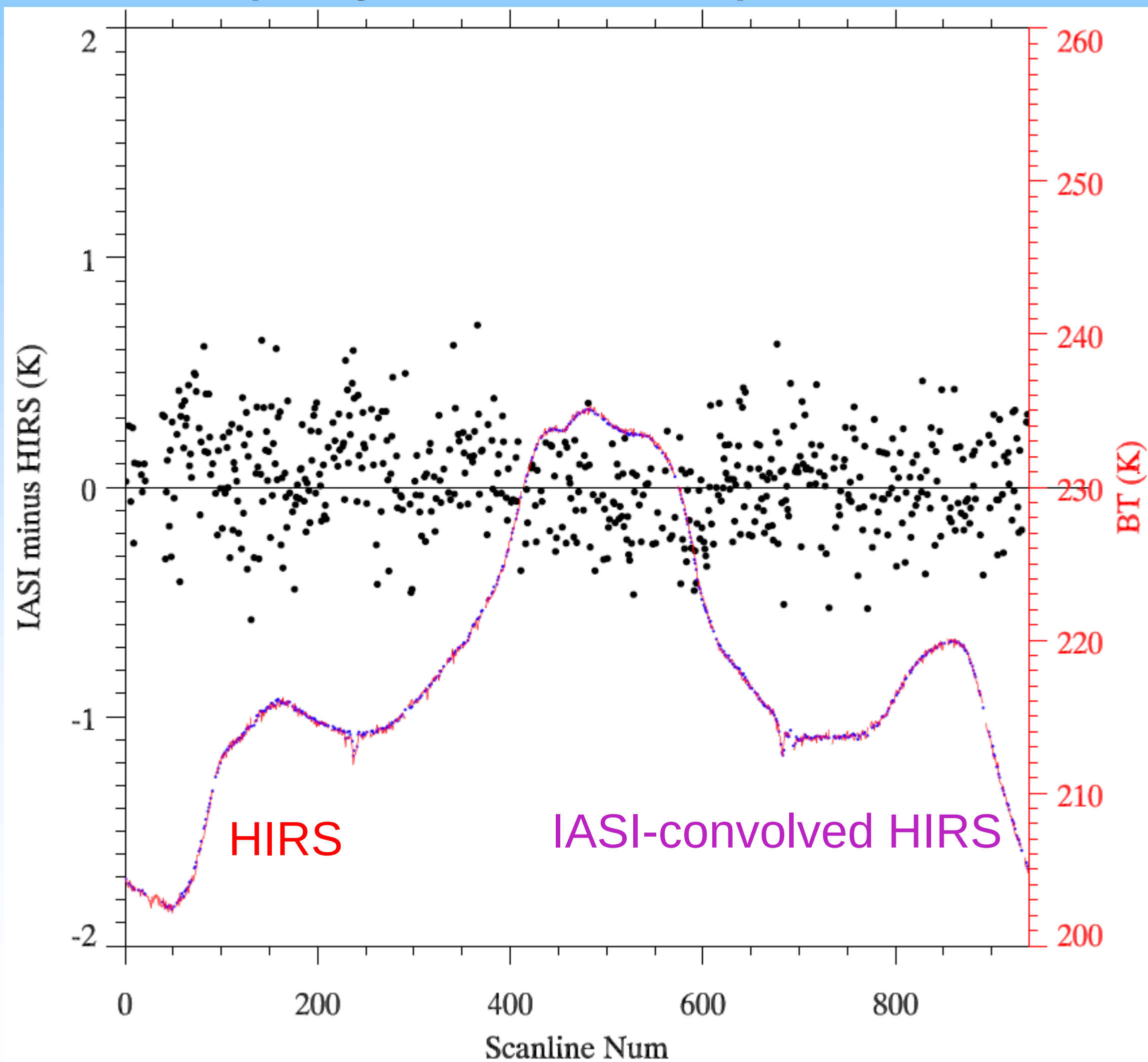


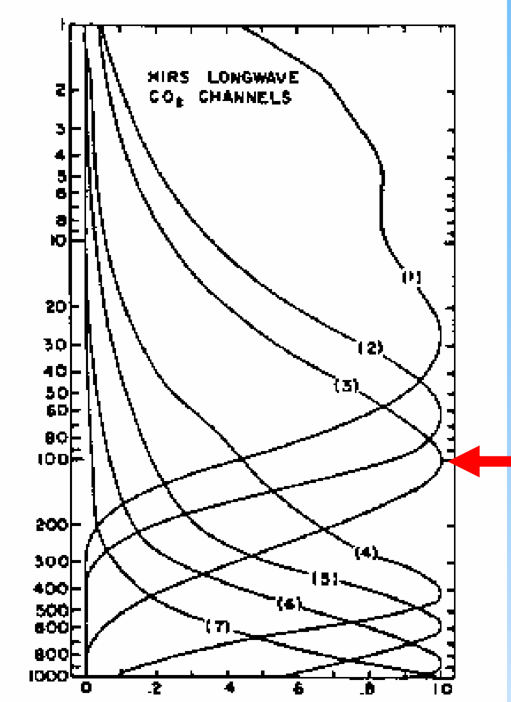
Since the HIRS sounding channels are located at the slope region of the atmospheric spectra, a small shift of the SRF can cause biases in observed radiances.

Details can be referred to Wang et al. (manuscript for JTECH, 2006)

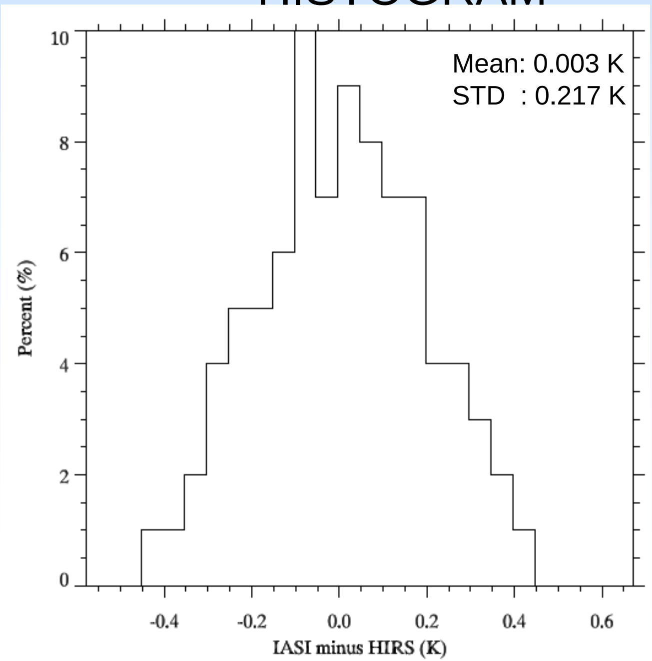
Channel 3 at nadir view

(Wang and Cao, NESDIS)



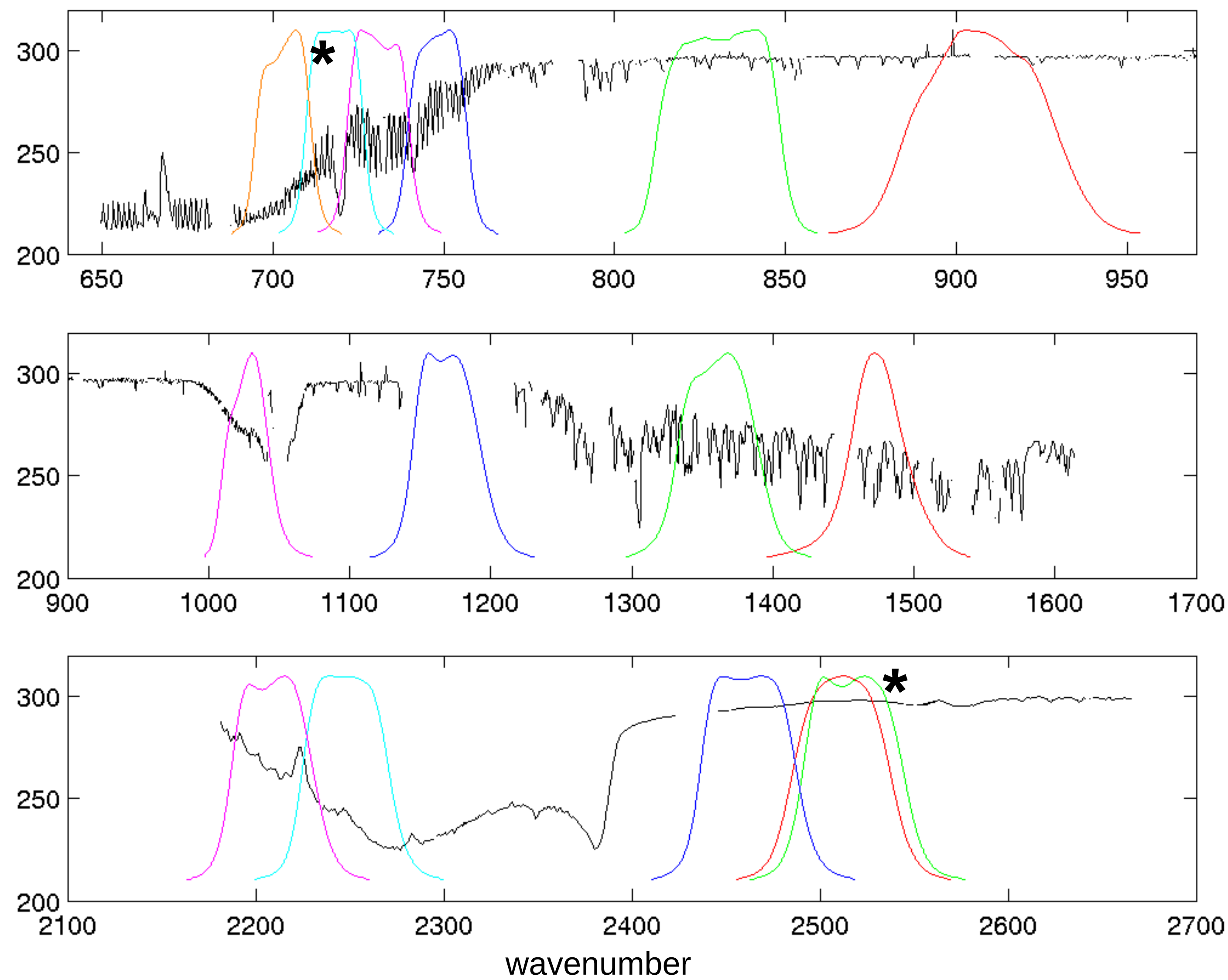


HISTOGRAM



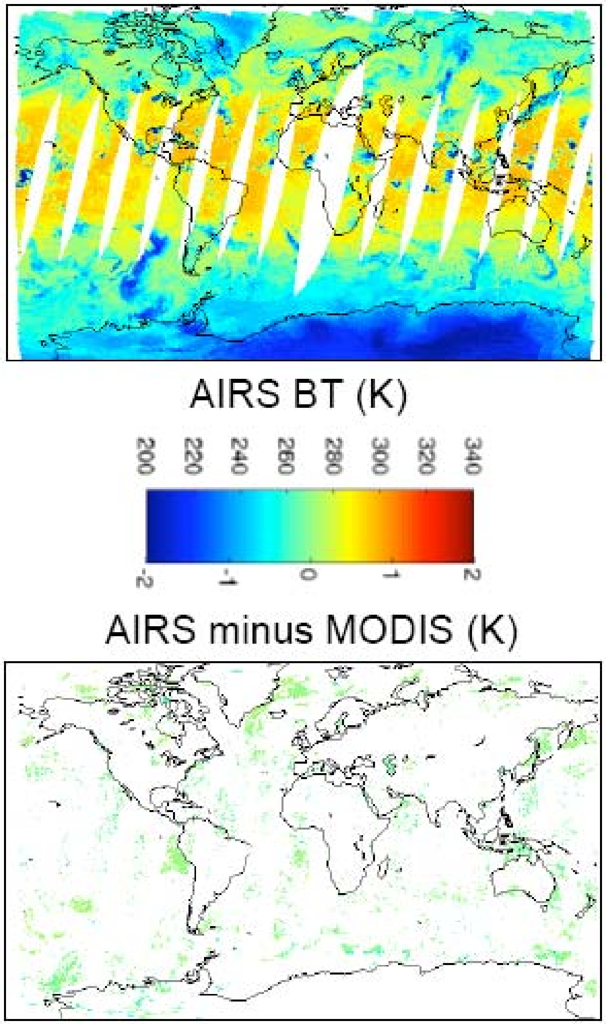
National Environmental Satellite, Data, and Information Service

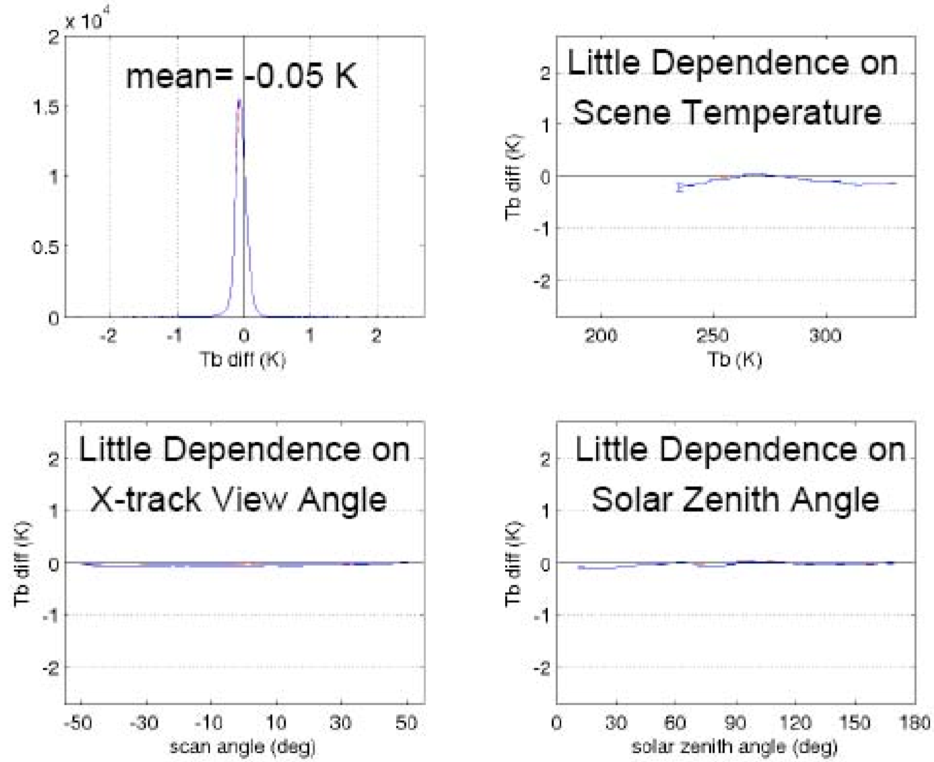
AIRS spectrum and Aqua MODIS Band Spectral Response Functions (Tobin)



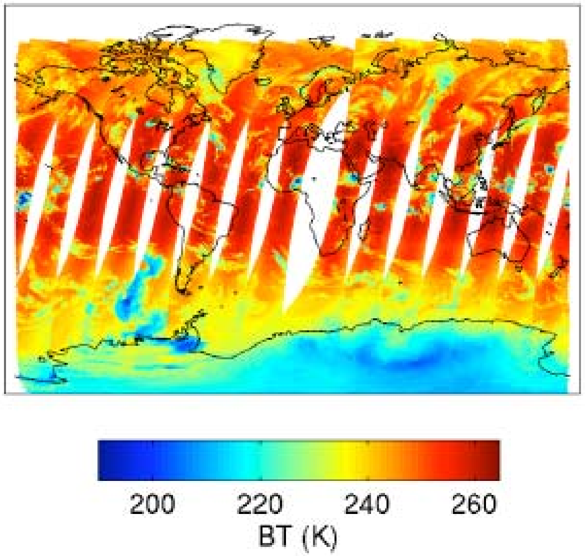
MODIS Band / wavelength(μm)	
36	/ 14.2
35	/ 13.9
34	/ 13.7
33	/ 13.4
32	/ 12.0
31	/ 11.0
30	/ 11.0
29	/ 9.7
28	/ 7.3
27	/ 6.8
25	/ 4.5
24	/ 4.4
23	/ 4.1
22	/ 4.0
21	/ 4.0

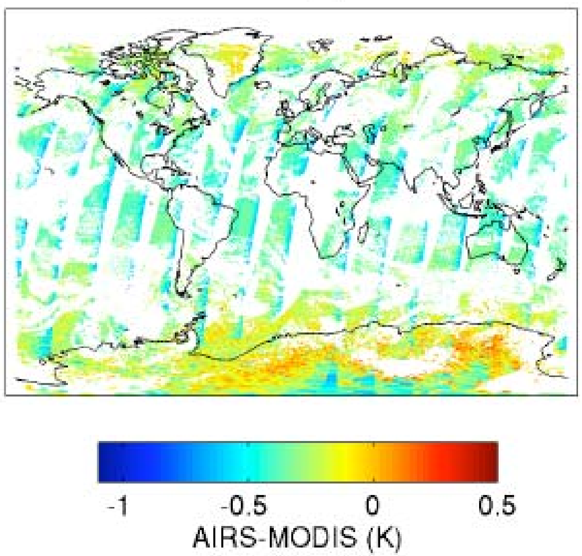
Example comparisons for band 22 (4.0 μm) on 6 Sept 2002.

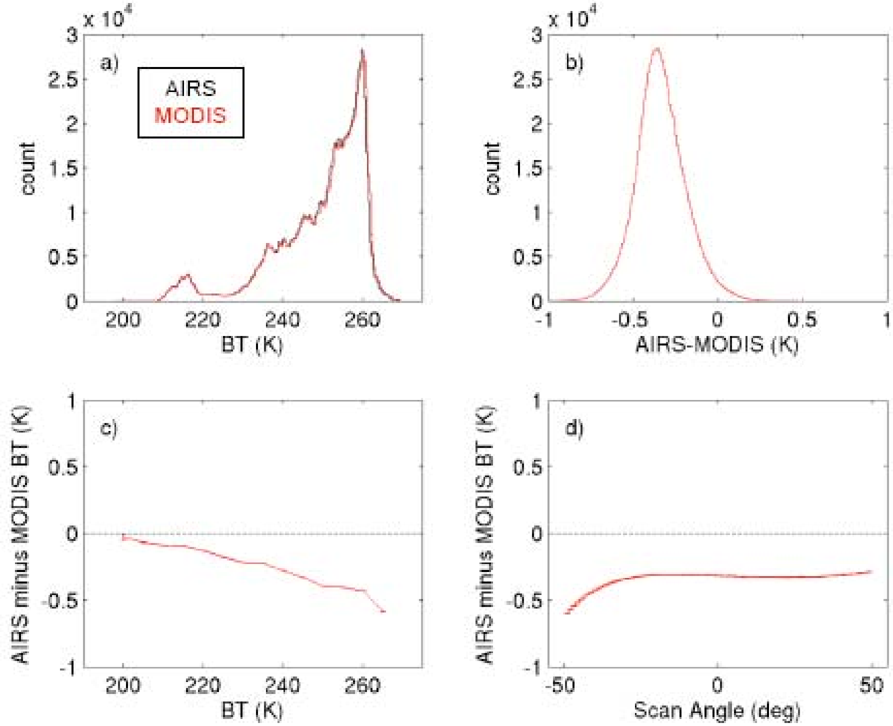




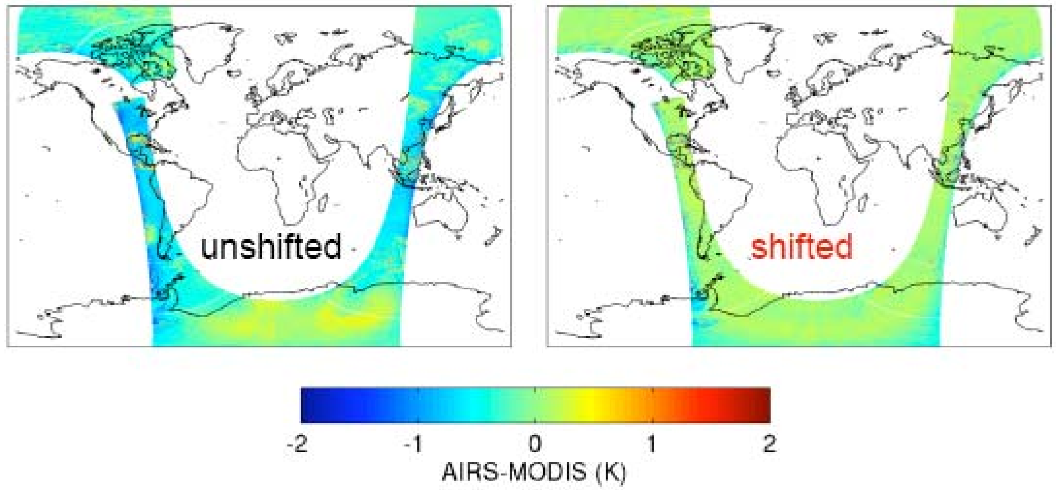
Example comparisons for band 34 (13.7 μm) on 6 Sept 2002.



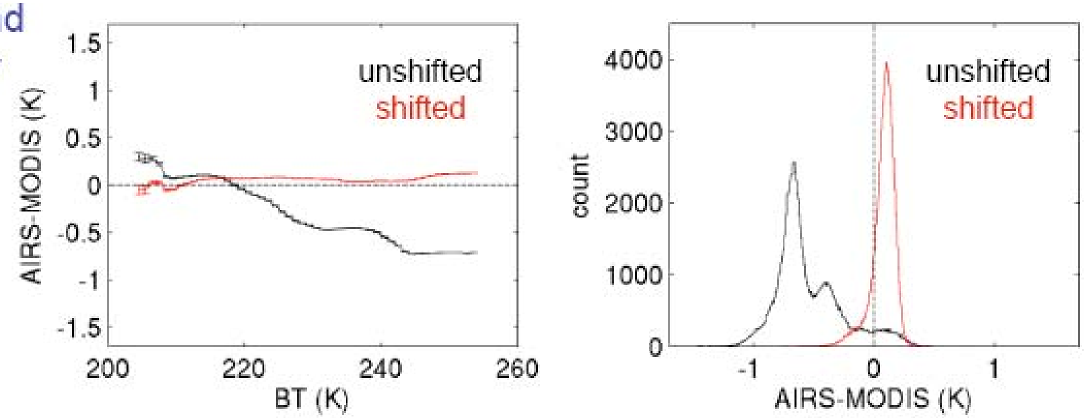




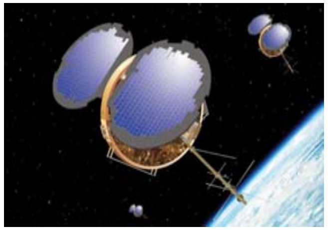
Band 35 (13.9 μm) brightness temperature differences for one orbit of data on 6 Sept 2002 using (1) the nominal MODIS SRF and (2) the MODIS SRF shifted by +0.8 cm^{-1}.



MODIS SRF out-of-band response also currently being investigated.

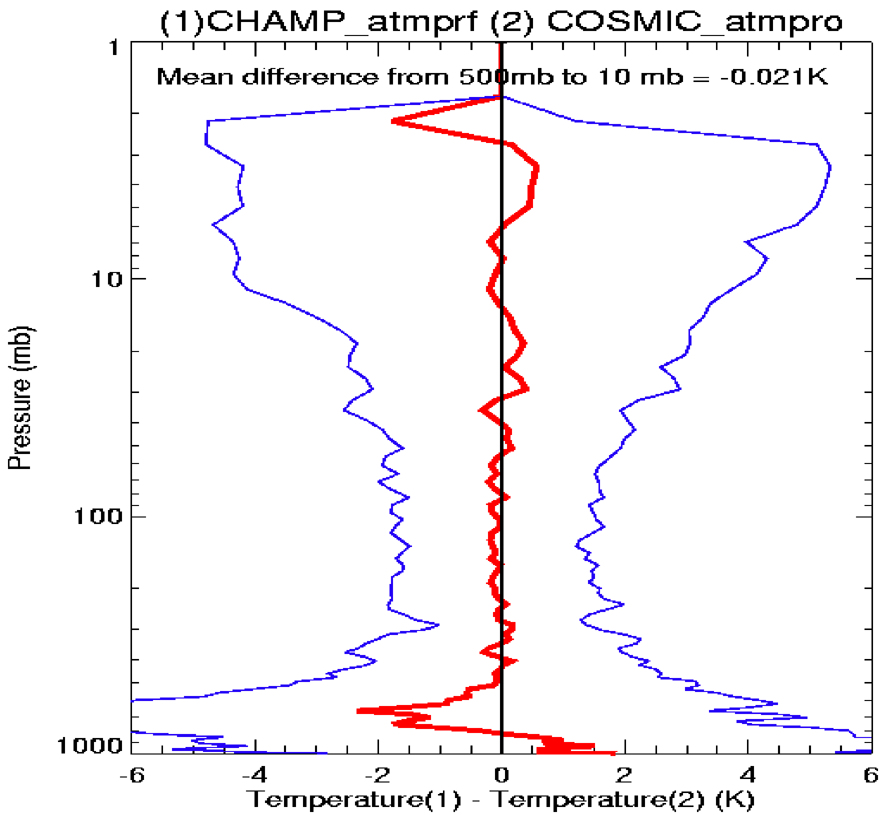


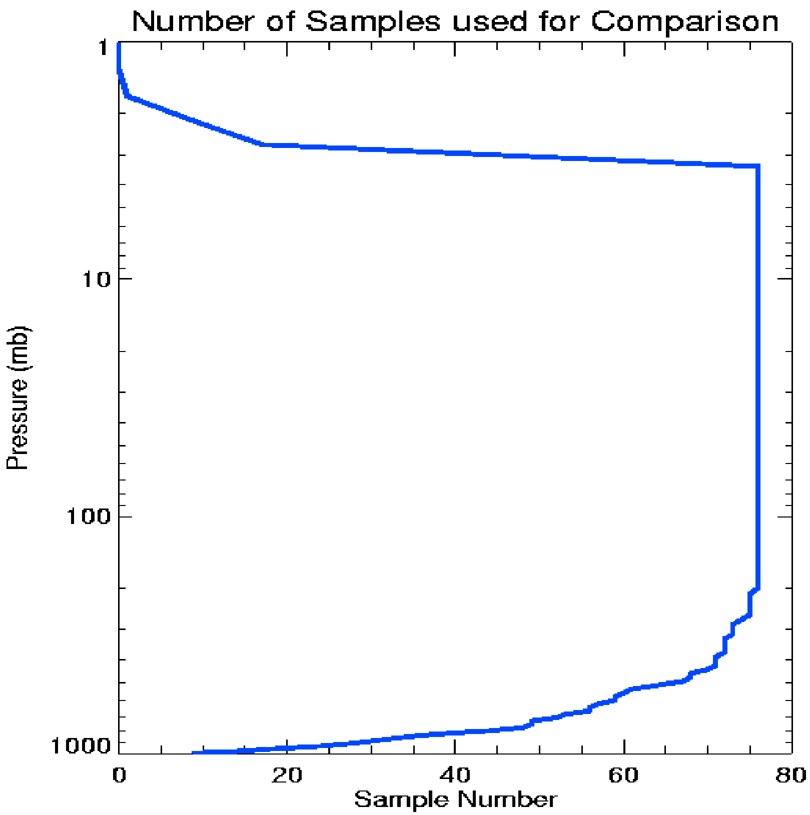
NWP can benefit with improved characterization of spectral response instead of relying on statistical bias corrections!!!



Difficulty II: to find measurements with long term stability

Mean bias CHAMP-COSMIC temp from 500mb to 5 mb =-0.021K

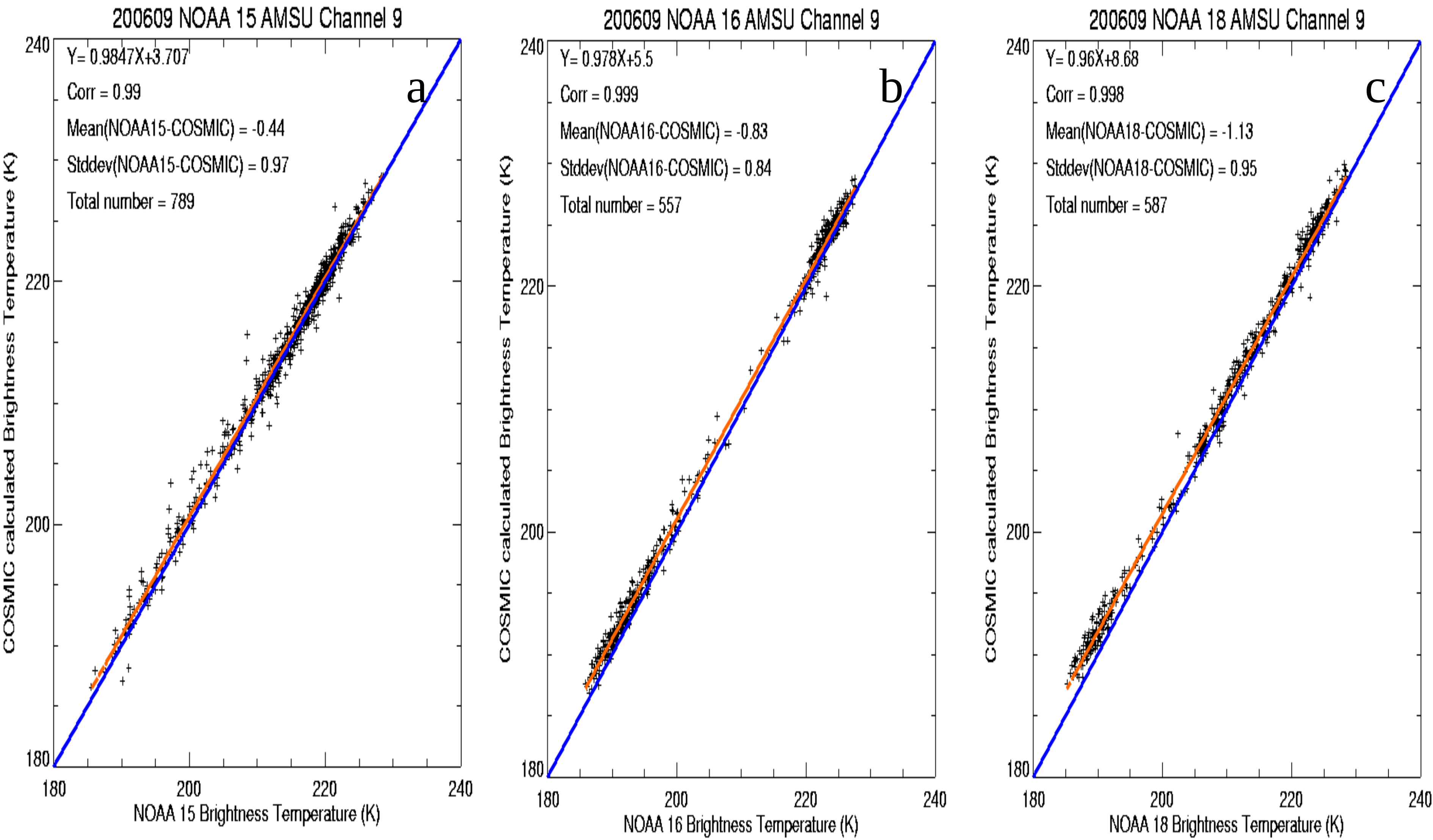




COSMIC (launched in 2006) vs. CHAMP (launched in 2000) atm tmp

Shu-peng Ben Ho, UCAR/COSMIC

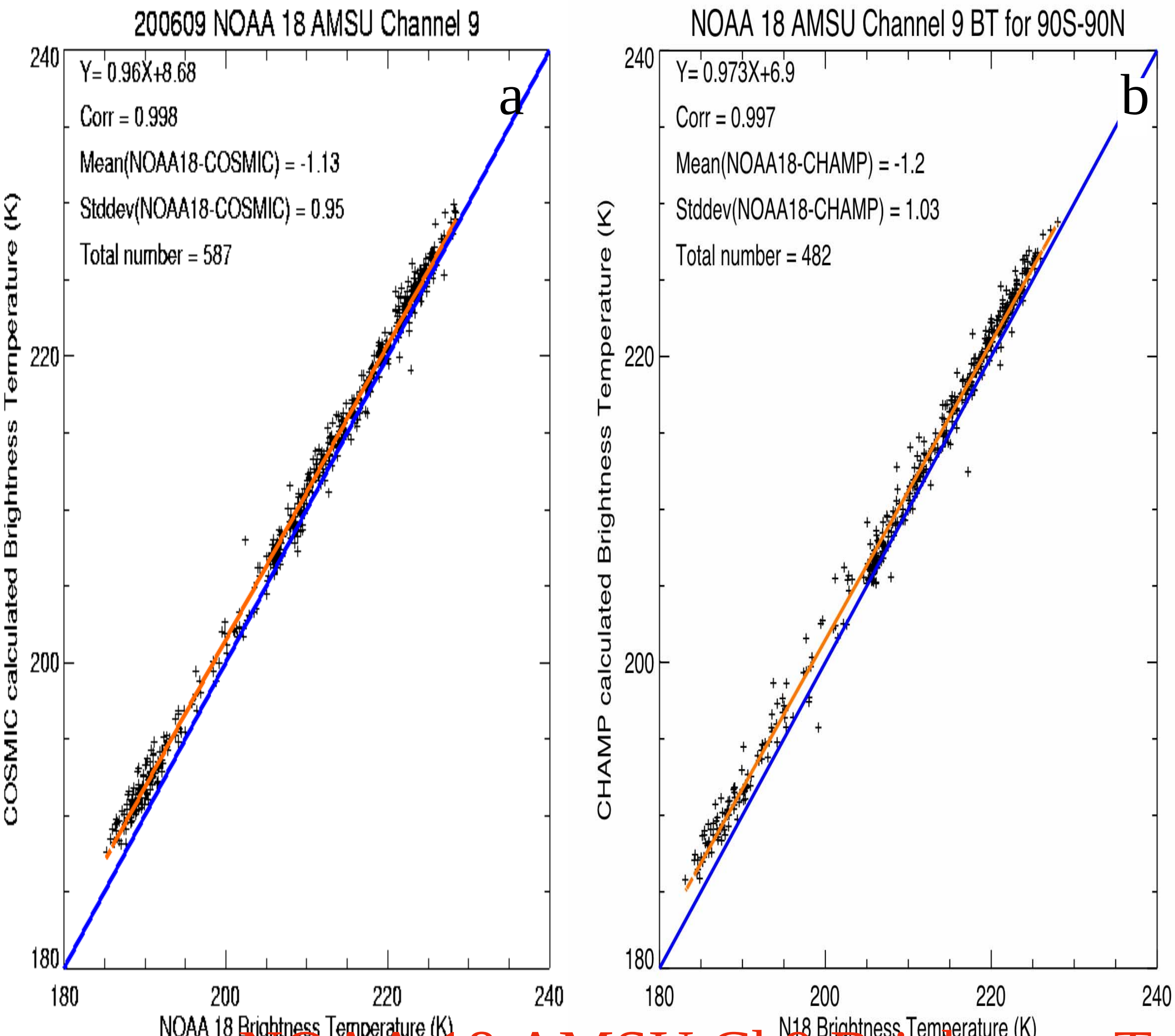
Can we use GPS RO data to calibrate other instruments ?



N15, N16 and N18 AMSU calibration against COSMIC

(Ho et al., TAO, 2007)

The precision of using GPS RO data to inter-calibrate other satellite is about 0.07 K

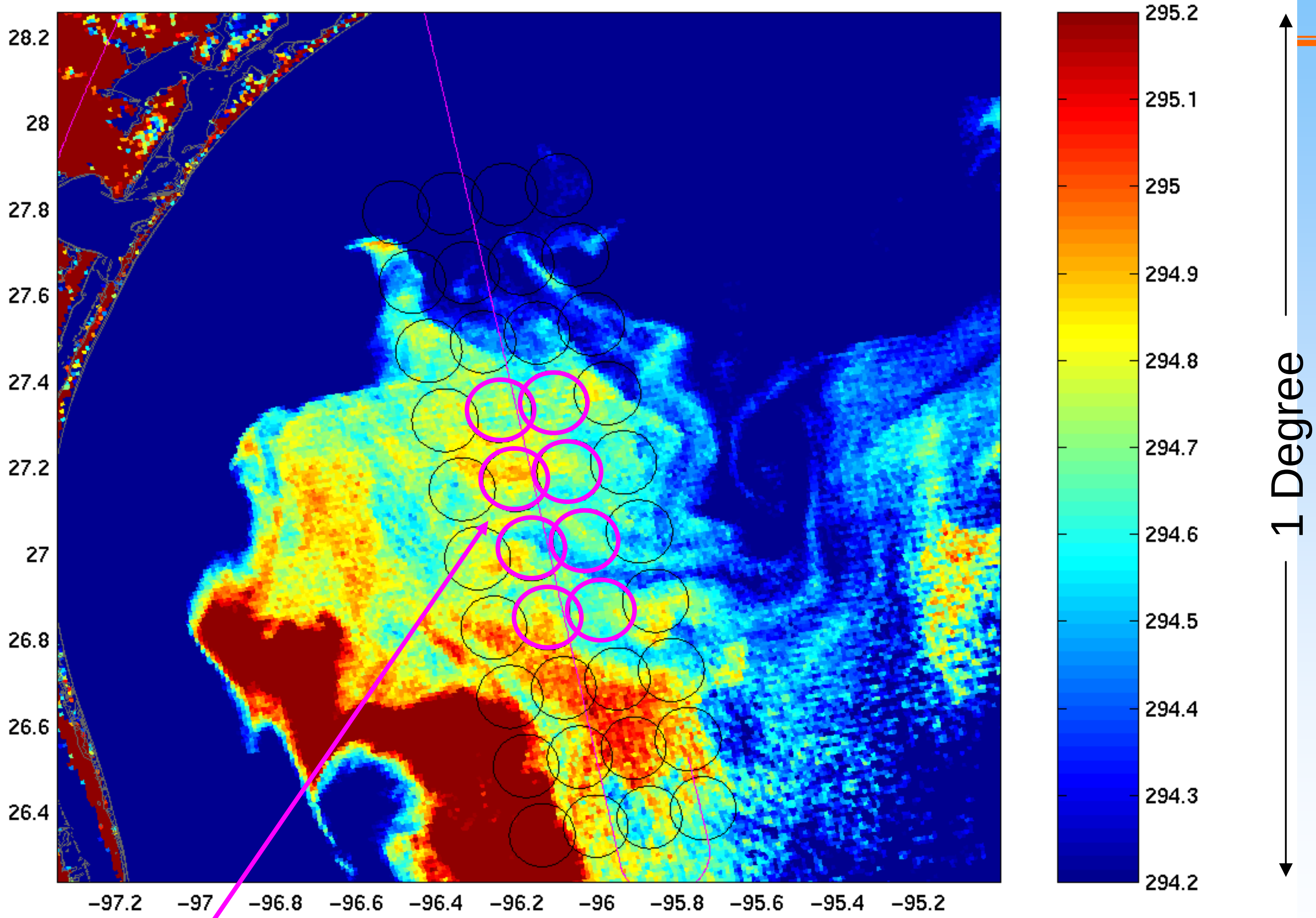


NOAA 18 AMSU Ch9 Brightness Temperature

(Ho et al., TAO, 2007)

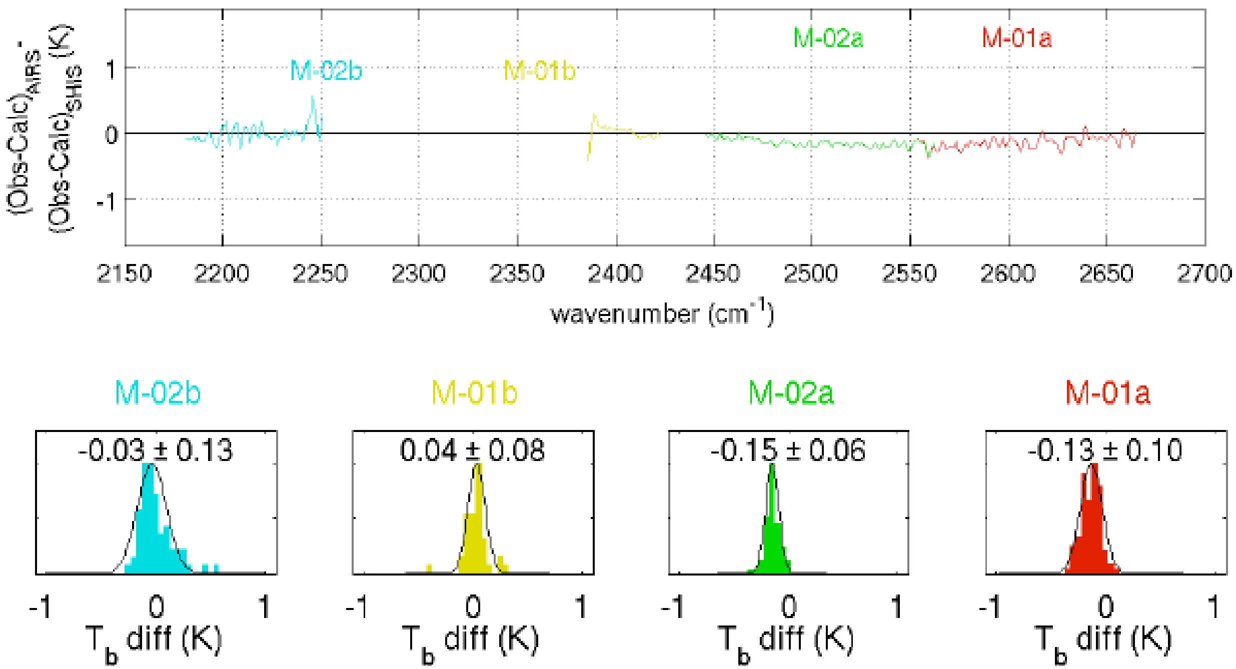
Satellite to Aircraft

Use of aircraft interferometers to validate AIRS



8 AIRS FOVs and SHIS Data w/in them (448 fovs) used in the following comparisons

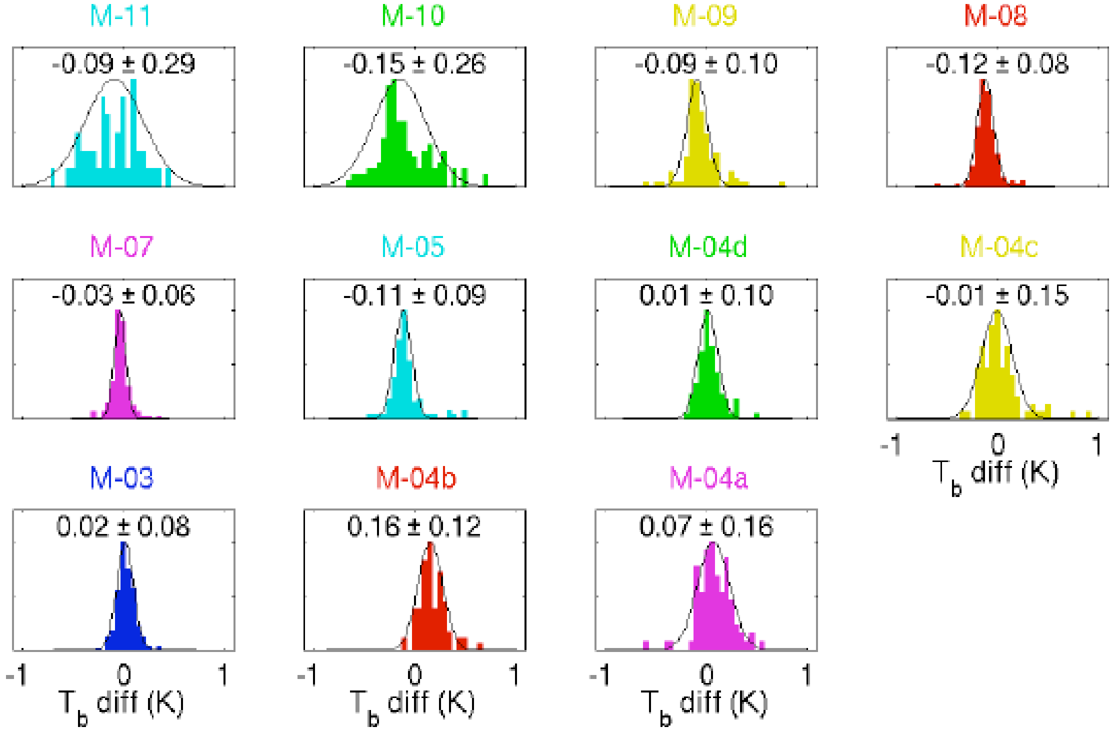
Night-time case summary: Shortwave



<u>1st Direct SW Radiance Validation</u>

Excellent agreement for night-time comparison from Adriex/Italy campaign

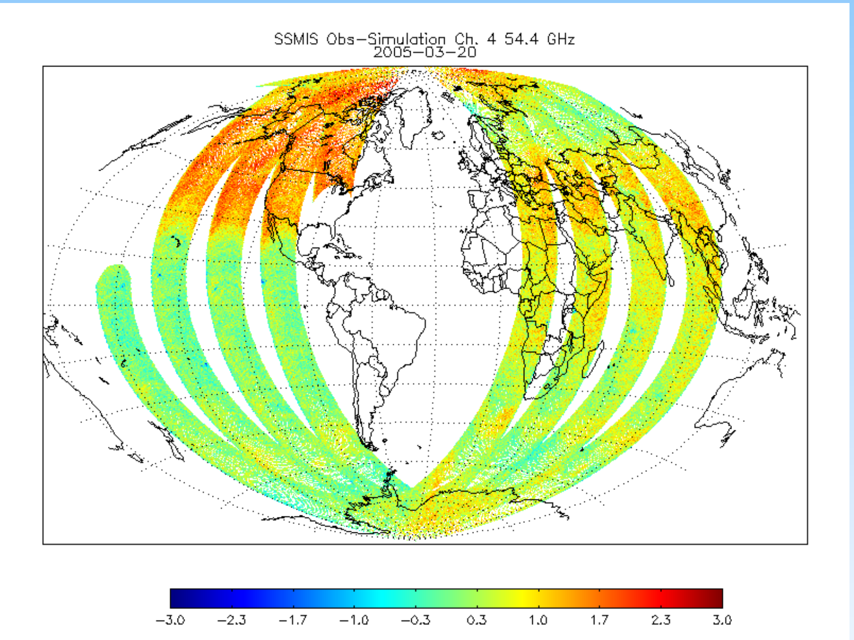
Gulf of Mexico Validation case: 2002.11.21

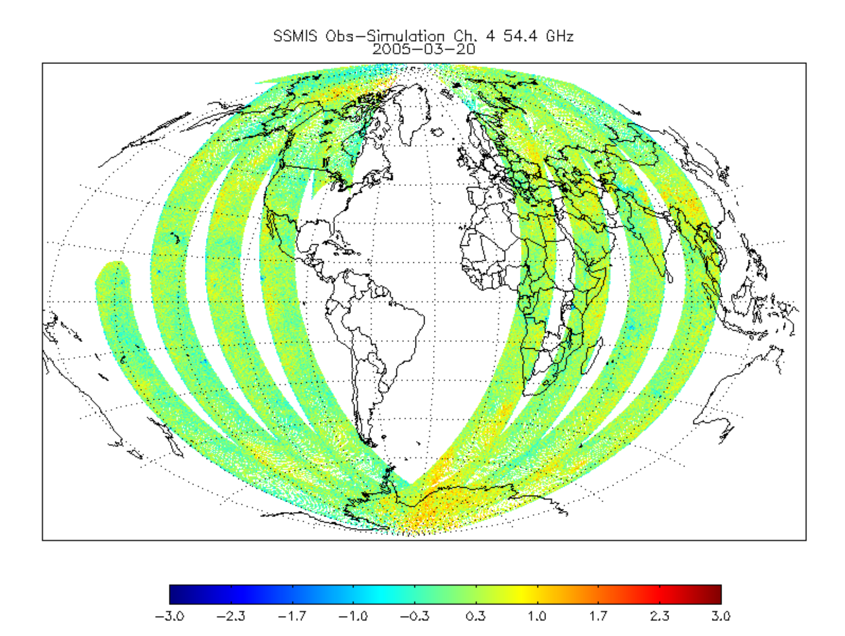


Satellite to Model

Understanding Global Biases and Developing Calibration Algorithms for Bias Correction

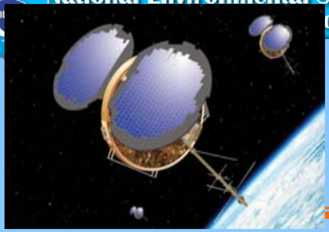
SSMIS (54.4 GHz)



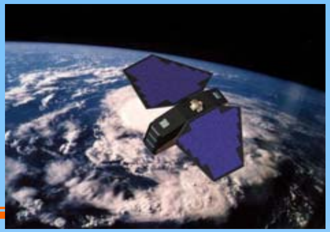


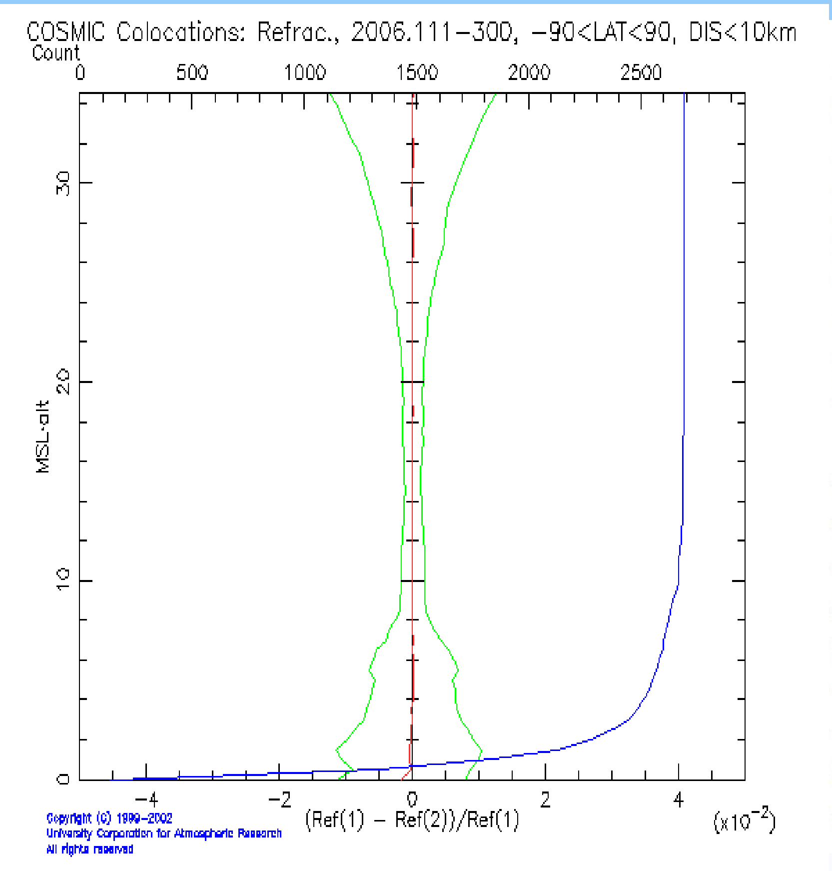
- **SSMIS is the first conical microwave sounding instrument, precursor of NPOESS CMIS.**
- **Shown are the differences between observed and simulated measurements. Biases are caused by 1) antenna emission, 2) direct solar heating to warm load and 3) stray light contamination to its calibration targets.**

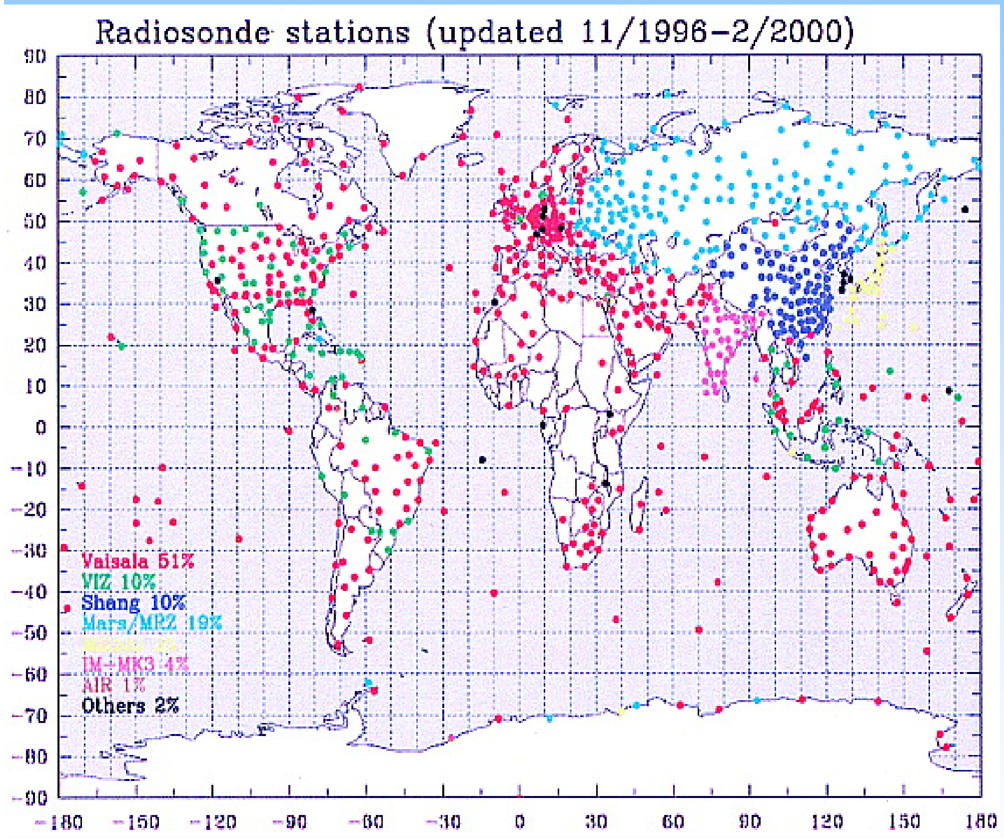
Satellite to Ground



Global Radiosondes







$$N = 77.6\frac{P}{T} + 3.73\times10^{5}\frac{P_W}{T^2}$$

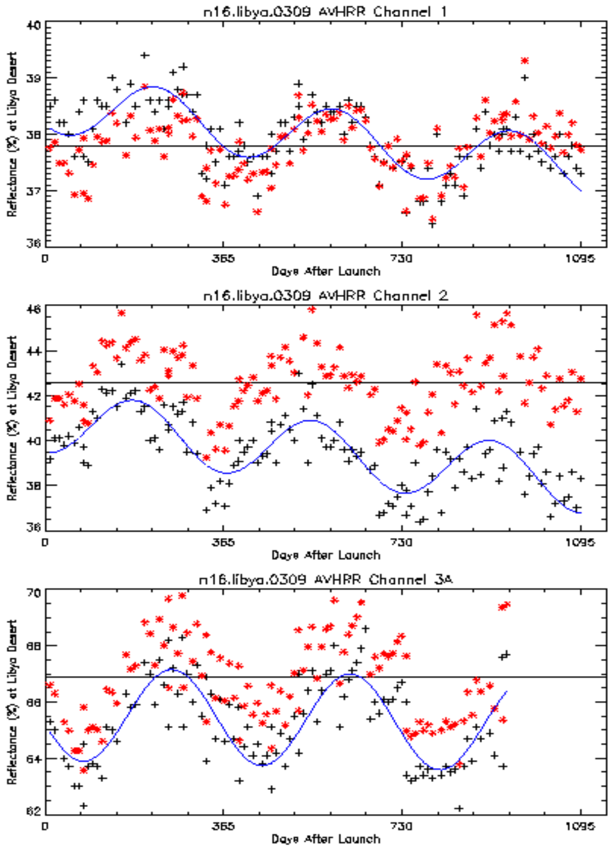
(Kuo et al., GRL, 2005)

Mean Absolute Fractional Differences and Standard Deviation (S.D.) of Refractivity Between CHAMP RO Soundings and the Soundings From Five Different Types of Radiosonde System

Regions	Sonde Type	# of Matches	Dev Nradio/S.D.	Dev Necmwf/S.D.
India	IM-MK3	87	0.82/3.2	0.15/1.
Russia	Mars	1003	0.3/1.3	0.09/0.9
Japan	MEISEI	107	0.26/1.7	0.14/1.1
China	Shanghai	402	0.19/1.4	0.15/1.0
Australia	Vaisala	366	0.18/1.3	0.13/0.9

AVHRR VIS/NIR Vicarious Calibration using the Libyan Desert Target

–NOAA 16 AVHRR Albedo

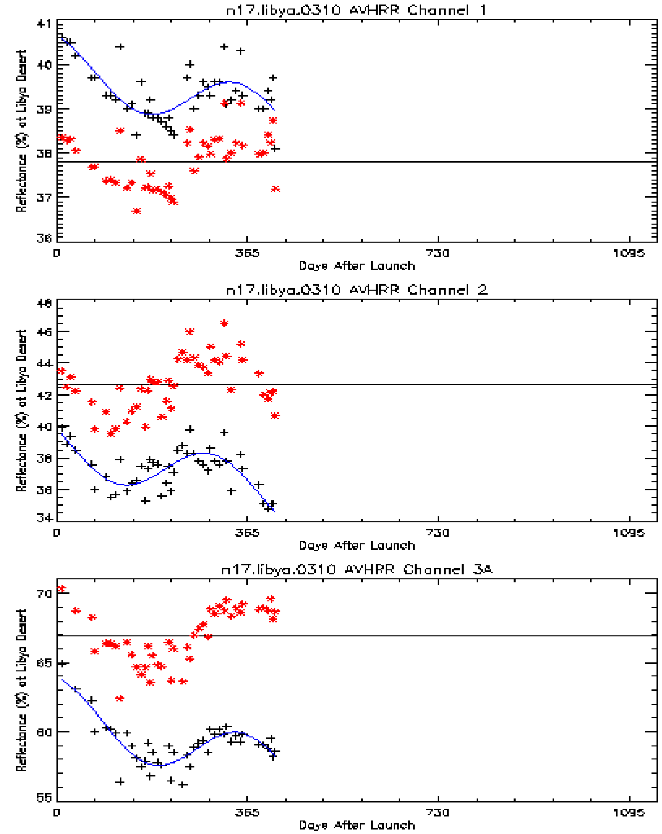


CH1

CH2

CH3

–NOAA 17 AVHRR Albedo



Courtesy of X. Wu

Simultaneous Nadir Overpass(SNO) Observation System - Mozilla

http://www.orbit.nesdis.noaa.gov/smcd/spb/calibration/sno/sno.html

Intersatellite Biases from Simultaneous Nadir Overpass (SNO) Observations (updated monthly)

POES NOAA-16 vs. NOAA-17

HIRS

Select a HIRS Channel:

CHANNEL 1

Show Plot

AMSU-A

Select an AMSU Channel:

CHANNEL 1

Show Plot

AVHRR GAC

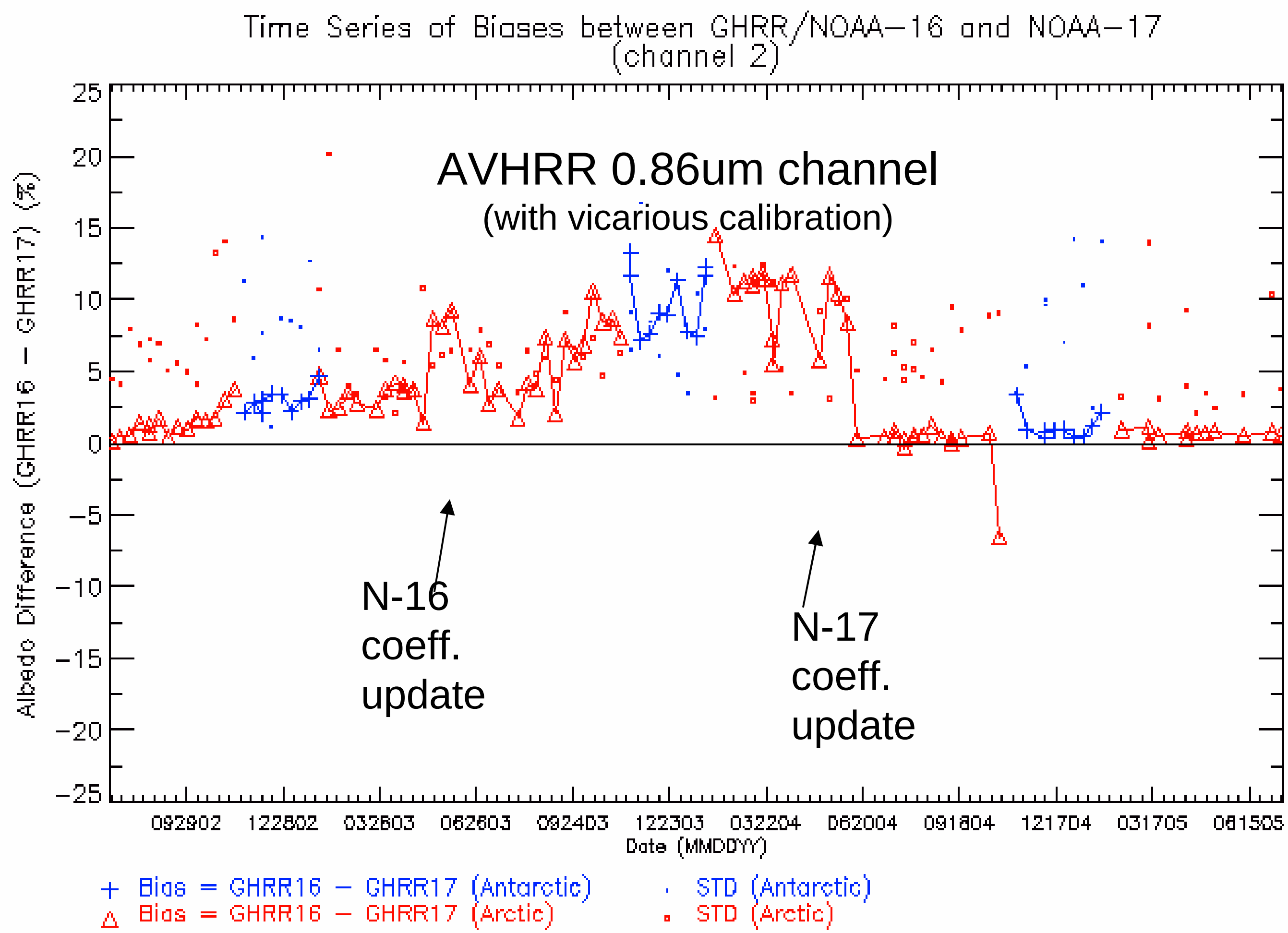
Select an AVHRR Channel:

(CH3 data not reliable due to CH3A/3B switching)

CHANNEL 2

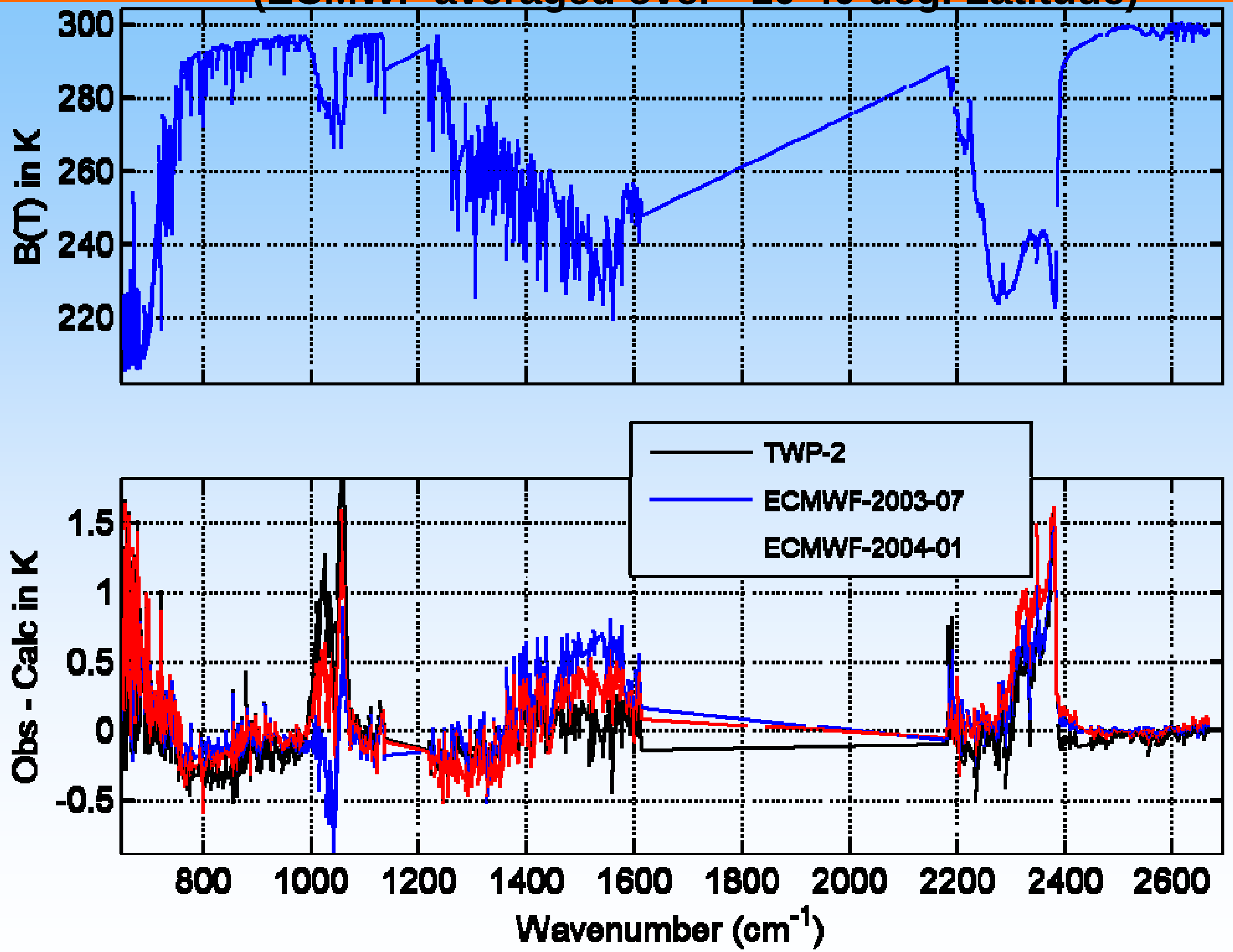
Show Plot

Back to Main Page



Use of DOE ARM TWP reference sites to improve radiative transer

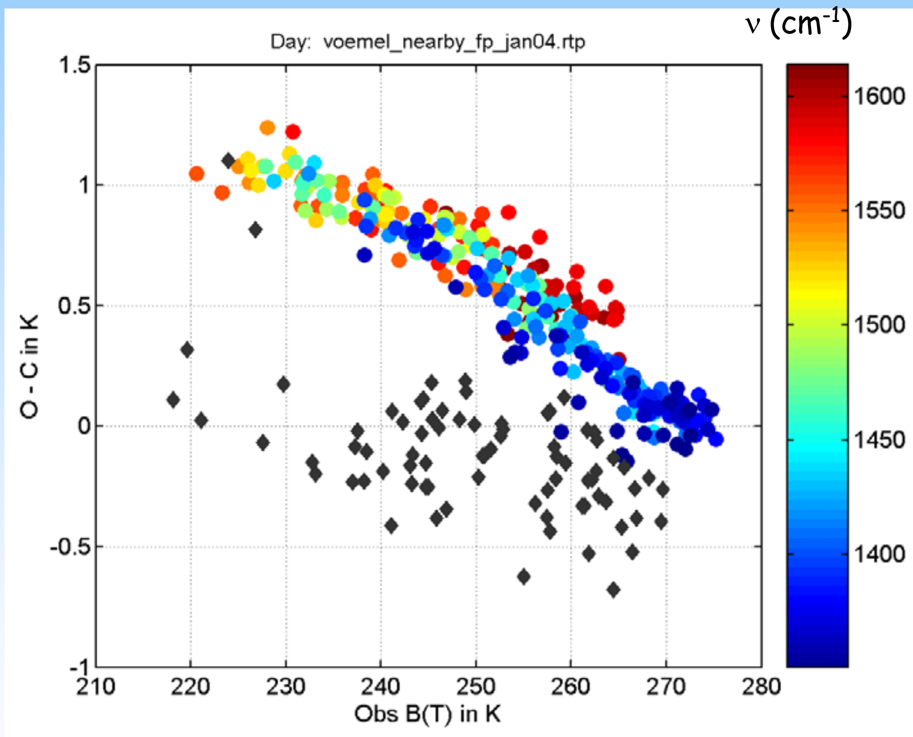
(ECMWF averaged over ~10-40 deg. Latitude)

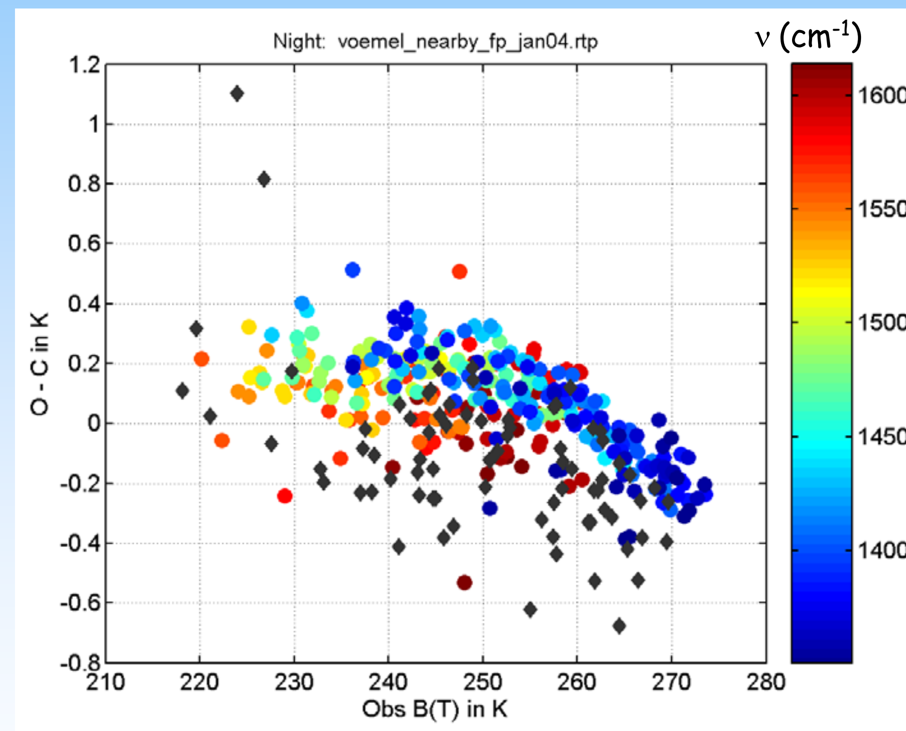


Frost-Point Observations Show Significant Deviations

Frost-Point Observations by H. Voelmer: NOAA Boulder

Represents far fewer observations than RS-90's and inconsistencies day vs night.





Diamonds are CO_2 Biases for channels with similar peaking weighting functions.

GSICS Outcome

- Coordinated international intersatellite calibration program
- Exchange of critical datasets for cal/val
- Best practices/requirements for monitoring observing system performance (with CEOS WGCV)
- Best practices/requirements for prelaunch characterisation (with CEOS WGCV)
- Establish requirements for cal/val (with CEOS WGCV)
- Advocate for benchmark systems
- Quarterly reports of observing system performance and recommended solutions
- Improved sensor characterisation
- High quality radiances for NWP & Climate