Hyperspectral applications at NOAA

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Satellite Meteorology and Climatology Division
NOAA/NESDIS/STAR

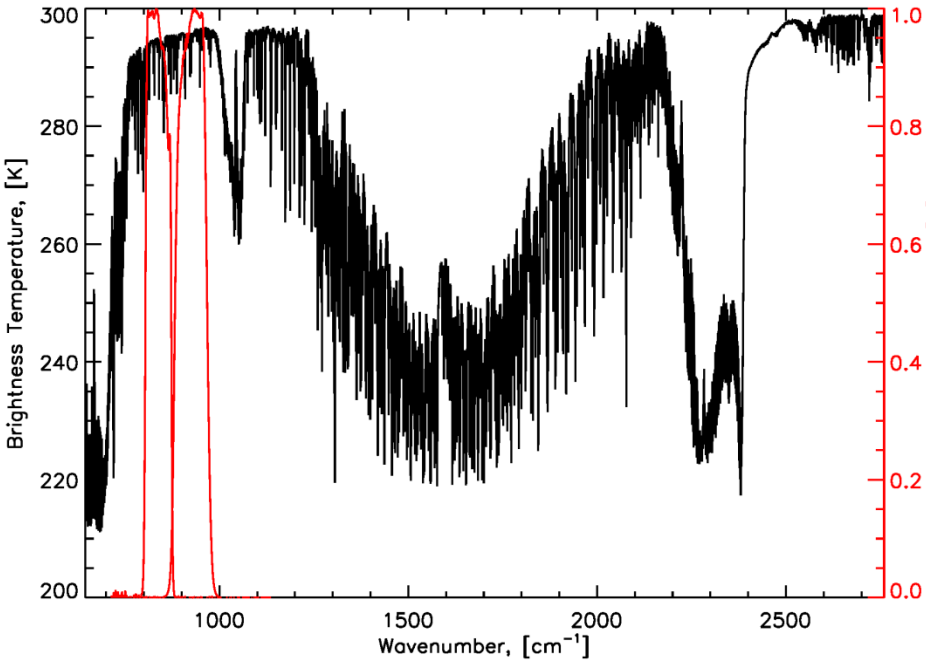
Journey (2O years and counting)

- Science algorithm contributions for AIRS
- Real-time AIRS/AMSU products at NESDIS
- Validation of AIRS/AMSU products
- Algorithm Improvements
- Research (trace gas products, MODIS)
- Science algorithm contributions for IASI
- Real-time IASI/AMSU products at NESDIS
- Validation of IASI/AMSU products
- Algorithm Improvements (trace gases, AVHRR)
- Real-time CriS/ATMS products at NESDIS
- Validation of CrIS/ATMS products
- Algorithm Improvements

Examples (presented during this meeting)

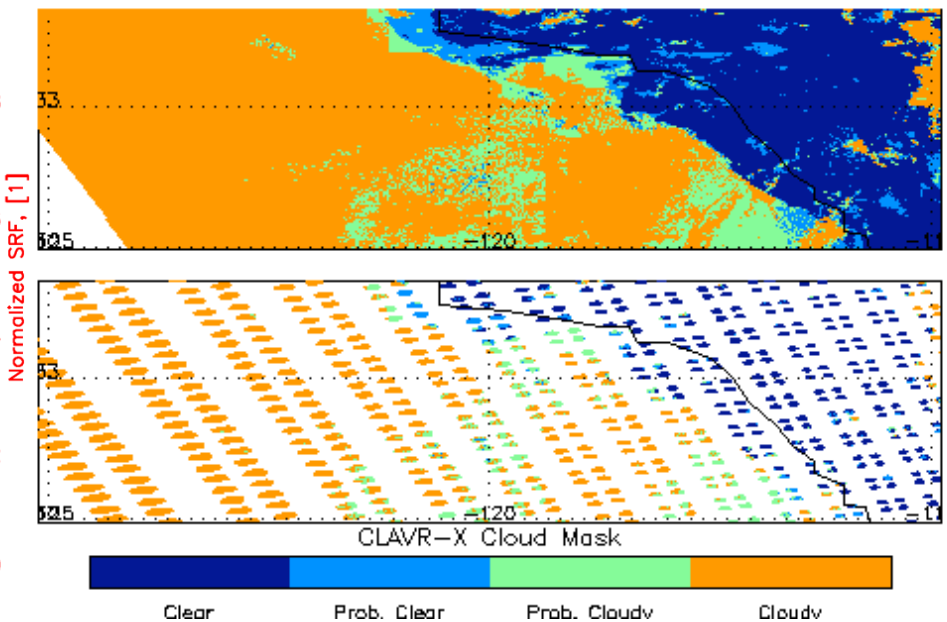
- Eric Maddy - AVHRR and IASI
- Shawn Xiong - Methane
- Fengying Sun - OLR
- Antonia Gambacorta – Climate Data Records from AIRS and IASI
- Murty Divakarla /Xiu Lu - CrIMSS Proxy and Retrieval Evaluations
- Mitch Goldberg/Likun Wang/Xingpin Liu – Radiance Climatology for Validating Reanalyses

Sample IASI spectrum and
AVHRR Spectral Response Functions



Spectral convolution of IASI to
AVHRR resolution

Top: CLAVR-X AVHRR cloud mask (courtesy: A. Heidinger),
Bottom: AVHRR collocated to IASI footprints (H. Sun)



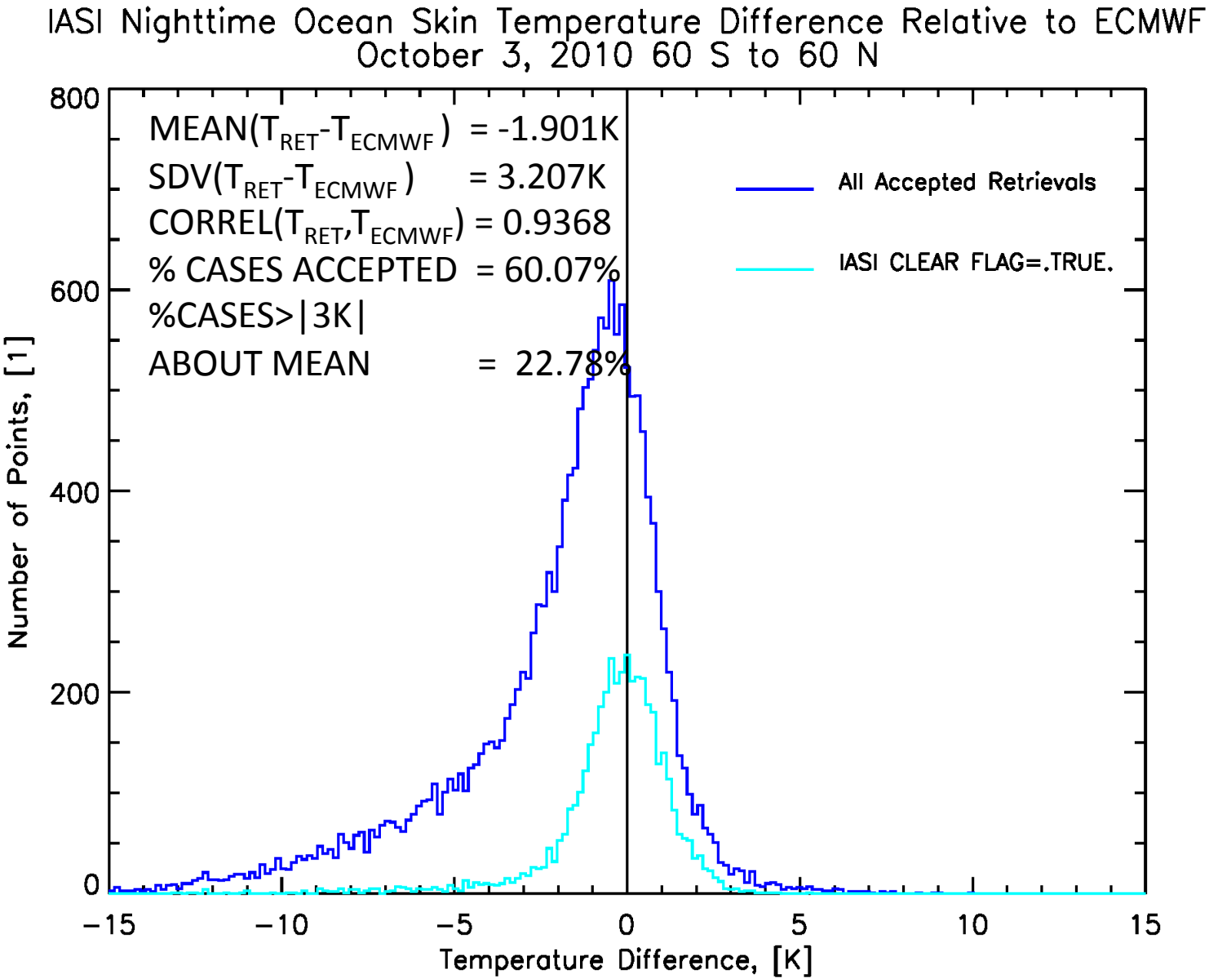
Spatial collocation and convolution of AVHRR to
IASI footprints

We want to exploit the high spatial resolution of the multispectral AVHRR data to improve IASI retrievals:

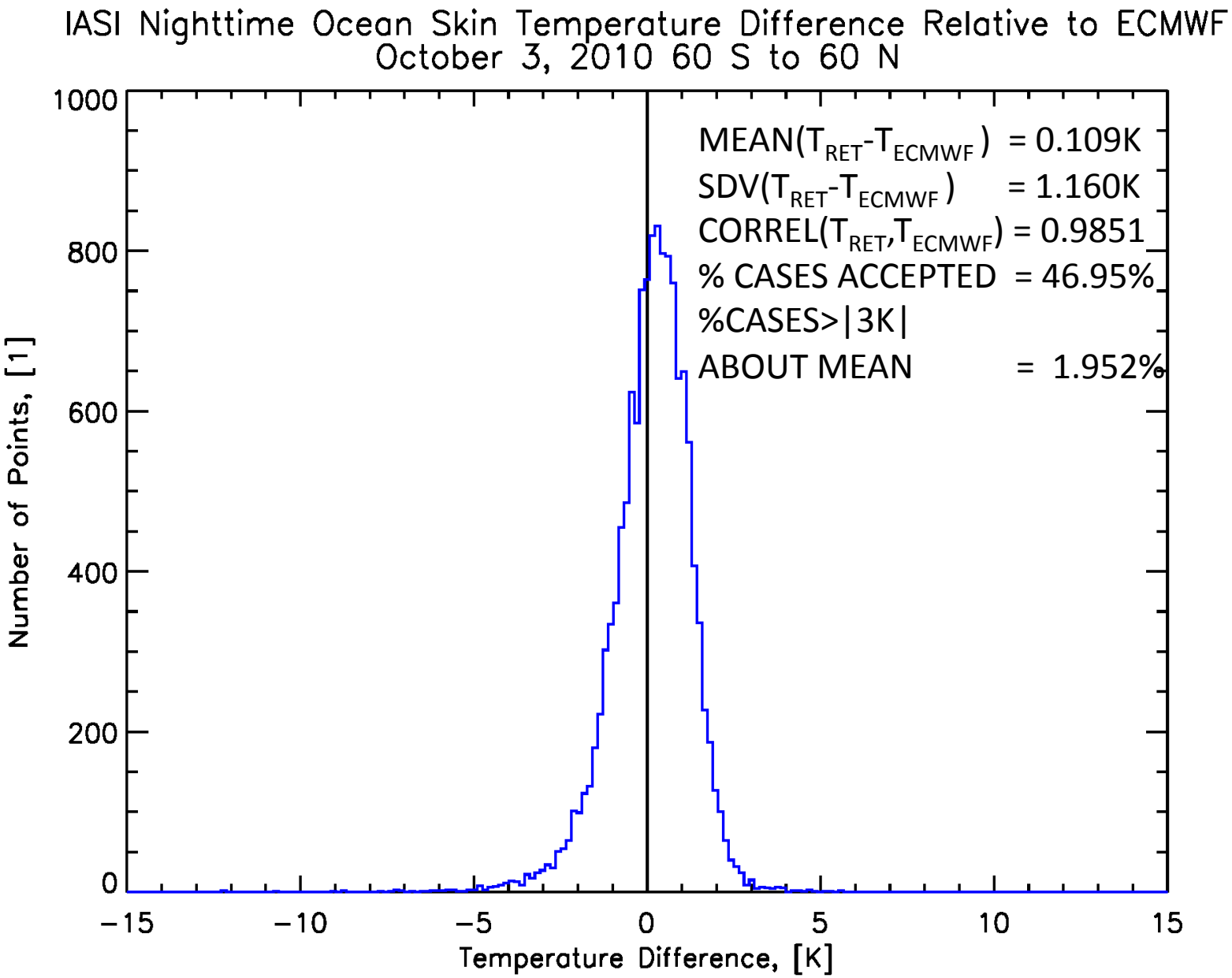
1.QA cloud cleared radiances using spectrally convolved IASI – spatially convolved AVHRR to compare apples to apples.

2.Utilize subpixel (1km AVHRR vs. 12km IASI resolution)/multispectral (visible/NIR) information about clouds from AVHRR to improve/validate cloud-clearing, improve the ‘clear estimate’ required for cloud clearing, and/or other retrievals (cloud retrieval).

IASI Only Cloud Clearing



IASI + AVHRR Cloud Clearing



CH4

(1) Lead the comparison of AIRS CH4 with ground-based Fourier Transform Spectrometers (FTS) measurements of X_{CH4} from over ten sites from the Total Carbon Column Observing Network (TCCON) and the Network for the Detection of Atmospheric Composition Change (NDACC). A paper to use these data to study the recent CH4 trend is under review;

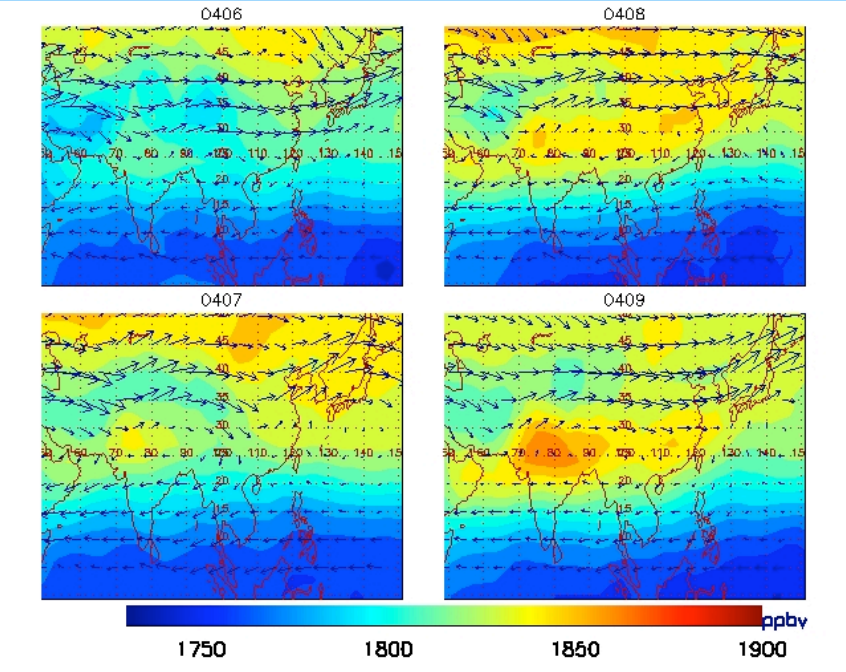
(2) Collaborated with GOSAT team and use NOAA products to validate their new products from thermal infrared sounder;

(3) Close collaboration with modeling groups to compare the AIRS/IASI retrieval with forward modeling and examine the CH4 plume during monsoon season and the source of rice emission in south Asia. A comparison of AIRS retrieval with model simulation points a lower emission of CH4 from rice paddies than estimated before, and this result agrees with most recent bottom-up measurements. The observed CH4 plume agrees well with recent aircraft measurements, and this plume is likely a good a tracer for monitoring monsoon onset and withdrawal.

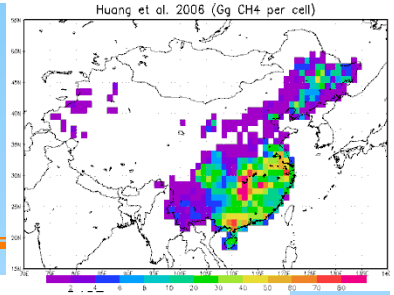
National Environmental Satellite, Data, and Information Service

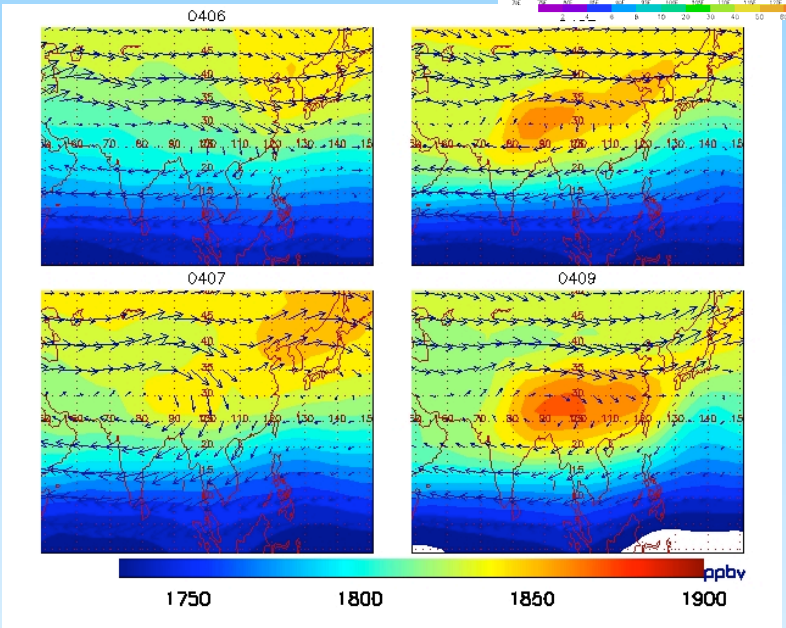
CH4 Plume over South Asia

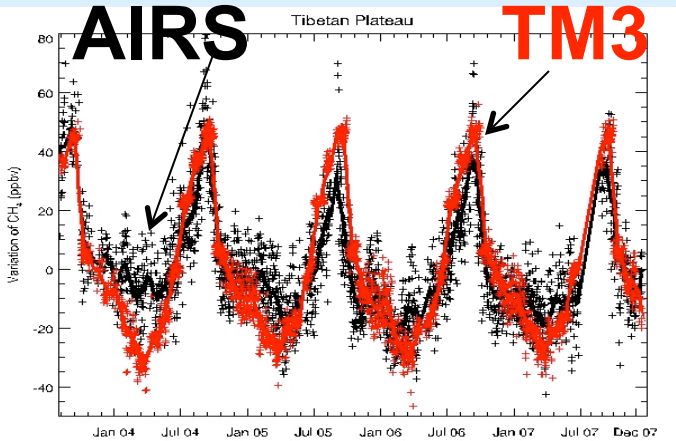
AIRS



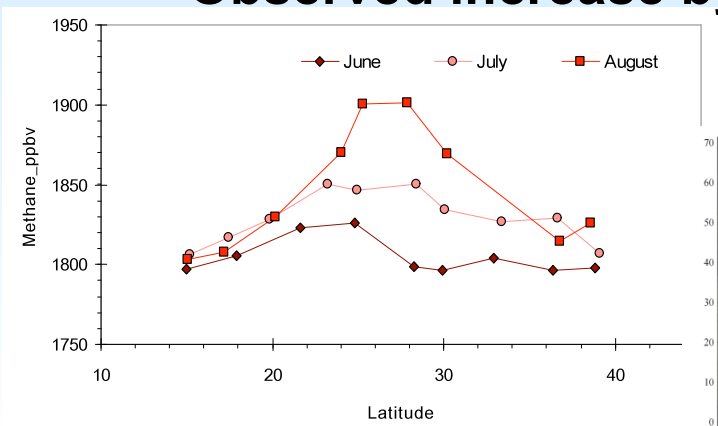
Model

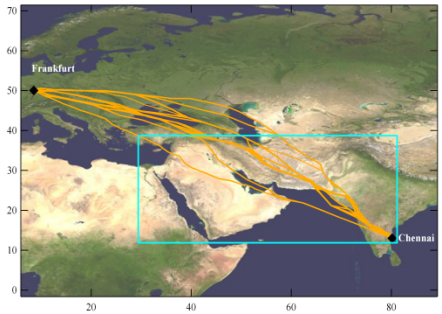






Observed increase by CARIBIC

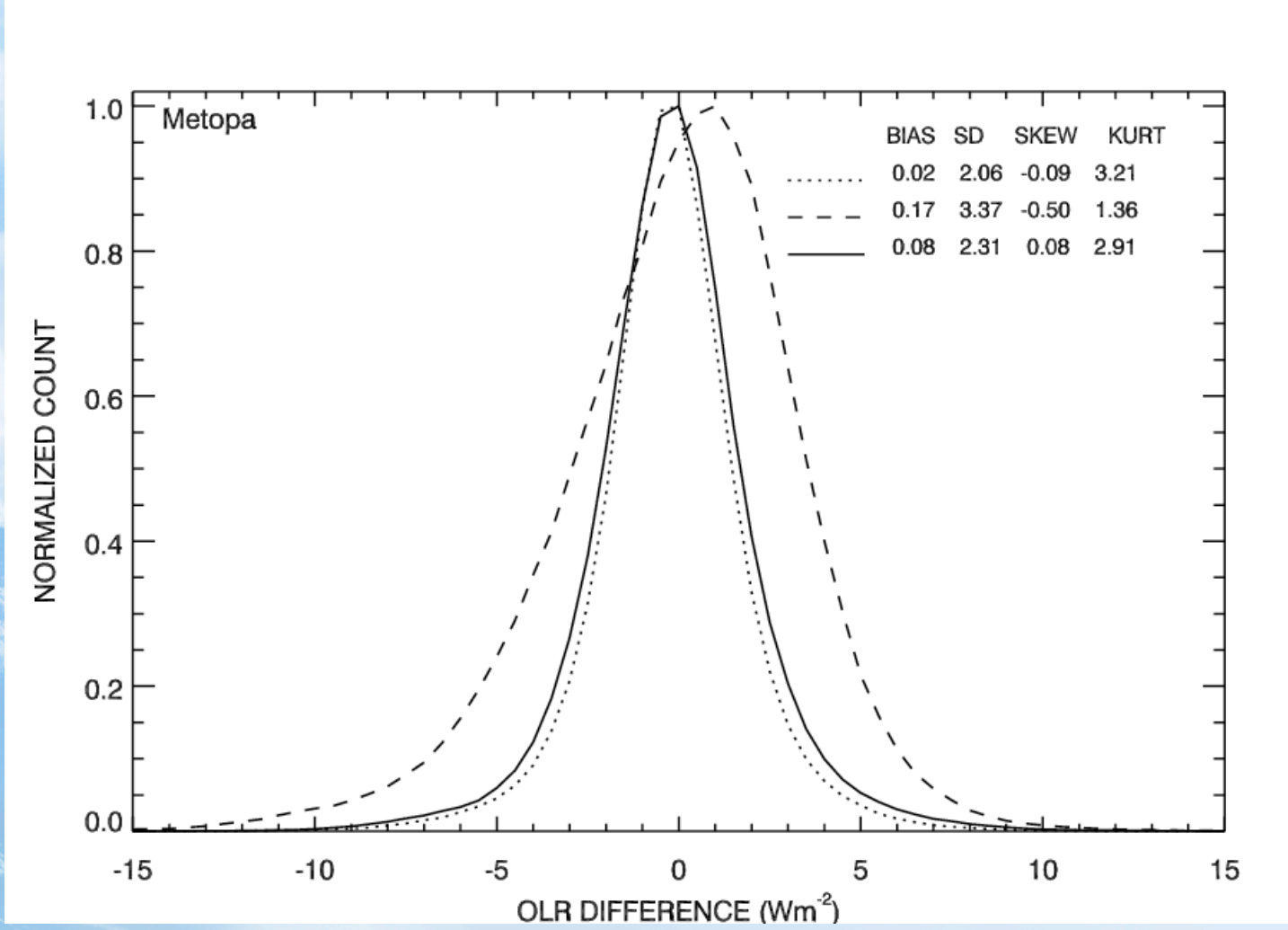




Outgoing Longwave Radiation Derived from AIRS Radiance Observations

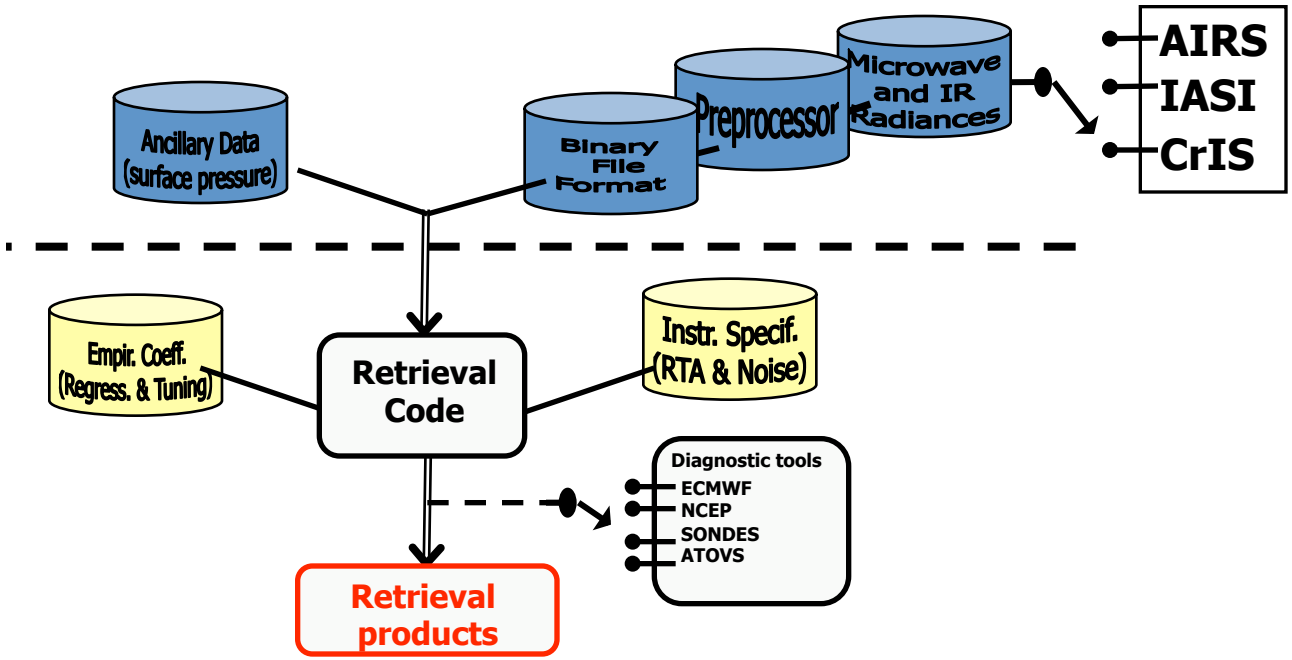
- Produce CERES-like OLR from AIRS. Extend to IASI and other future hyperspectral sounders.
- Method: least-squares regression between CERES OLR and AIRS radiance principal components.
- AIRS OLR is in a good agreement with CERES OLR except for the twilight regions (due to large CERES OLR) and the South Polar regions.
- Simplicity with accuracy. Traceable to CERES, later to CLARREO.

Histogram of OLR Differences



Dotted – (AIRS – CERES) Solid – (HIRS 19CH– CERES) Dashed – (HIRS 4CH– CERES)

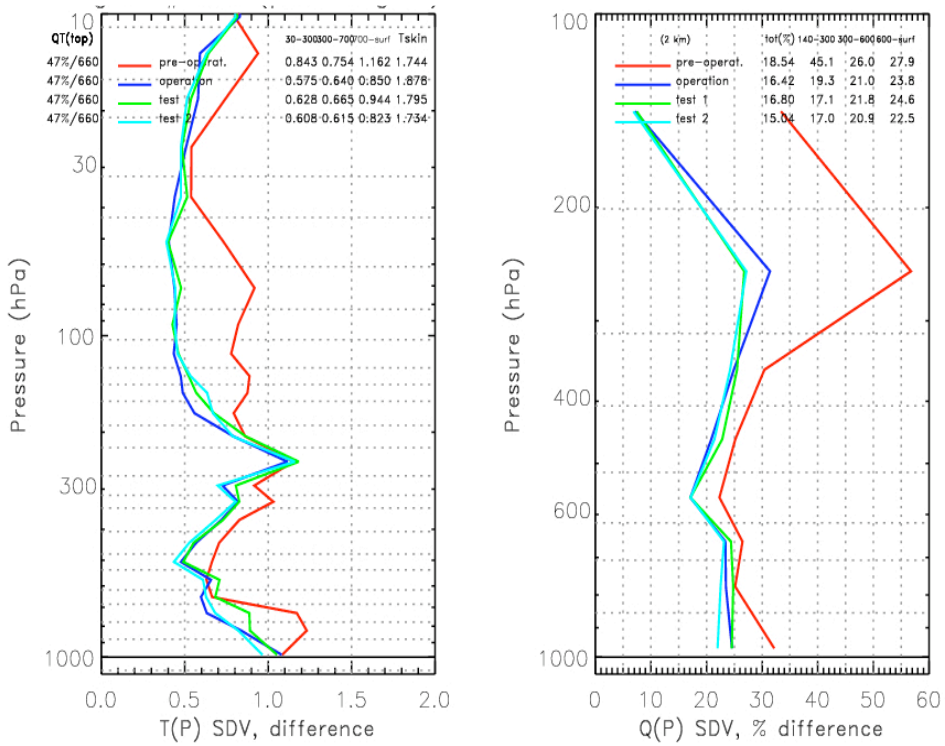
AIRS/IASI/CriS Climate Data Records
The NOAA/NESDIS/STAR processing system:
a modular design compatible with multiple instruments



A long term uniform data record of atmospheric variables (cloud cleared radiances, temperature, water vapor, trace gases) by employing the same retrieval algorithm and the same underlying radiative transfer spectroscopy

History of IASI's Retrieval System

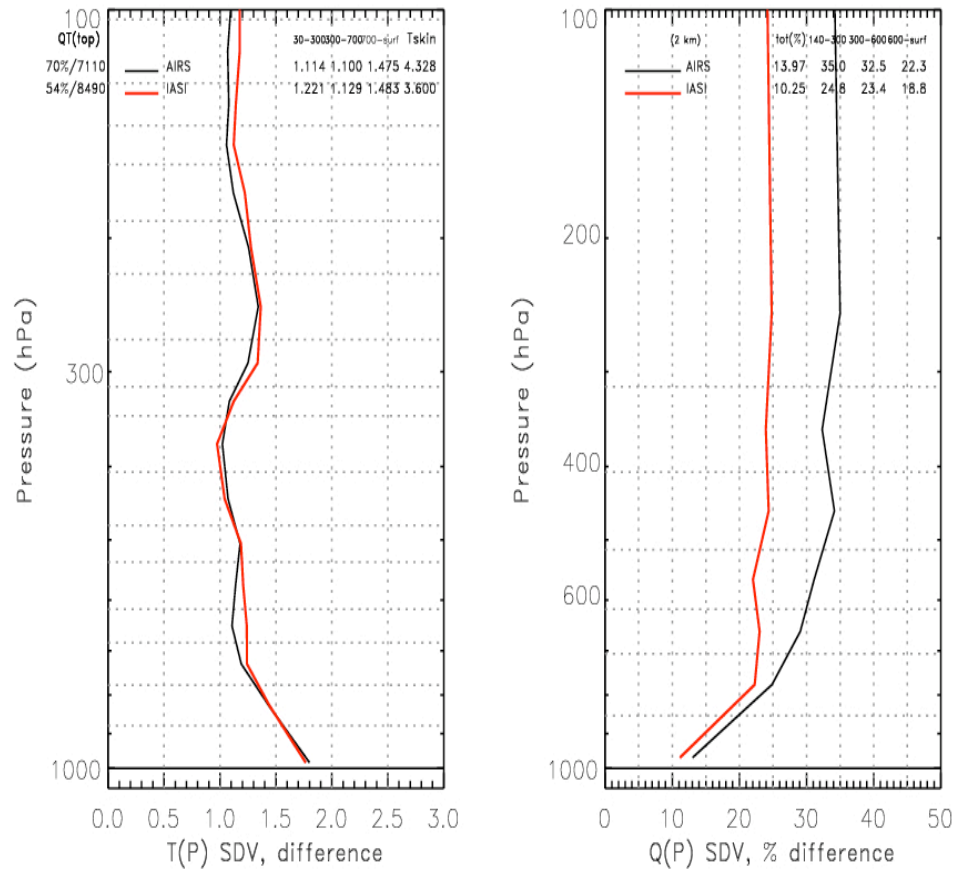
IASI Northern High Latitude Granule wrt GFS



- Pre-operations (2007)
- Operational System (2008)
- Test System I (2009)
- Test System II (2010)

AIRS – IASI comparison

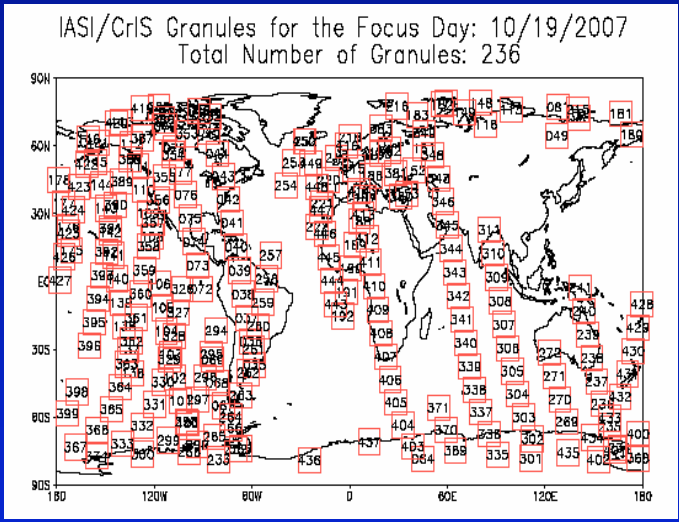
Global statistics wrt ECMWF



- IASI Retrieval System is being built to emulate AIRS system: the exact same executable is being used for both instruments.
- AIRS and IASI have comparable performance; IASI water vapor performs better
- We are following the same strategy for the NOAA Unique CrIS/ATMS Product System

CrIS/ATMS Proxy Data and Results

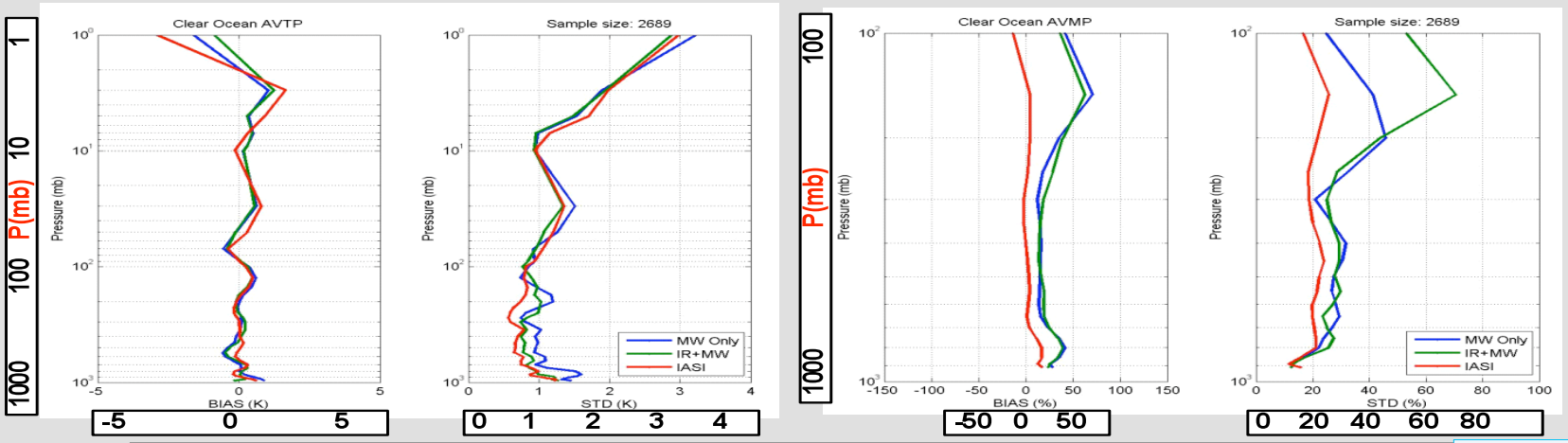
- NOAA-STAR Provided CrIS/ATMS 'Proxy Data Package' to JPSS Cal/Val Team and Other Users
- Results using the CrIS/ATMS proxy SDRs with CrIMSS EDR algorithm indicated the need for empirical bias tuning in the CrIMSS EDR algorithm.
- CrIMSS AVTP and AVMP products generated at NGAS after an implementation of empirical bias corrections showed very good agreement between CrIMSS AVTP/ AVMP products, corresponding IASI EDRs and ECMWF analysis.



Results from NGAS

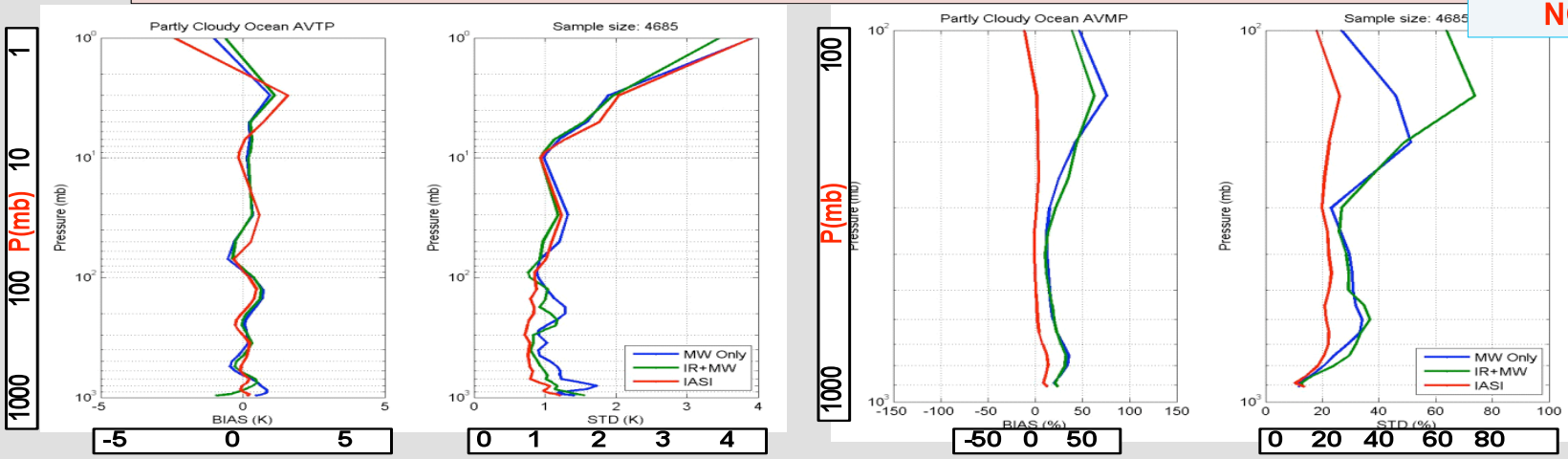
'Clear' (No Cloud-Clearing) Ocean AVTP and AVMP

AVTP Bias | AVTP STDEV | AVMP Bias | AVMP STDEV



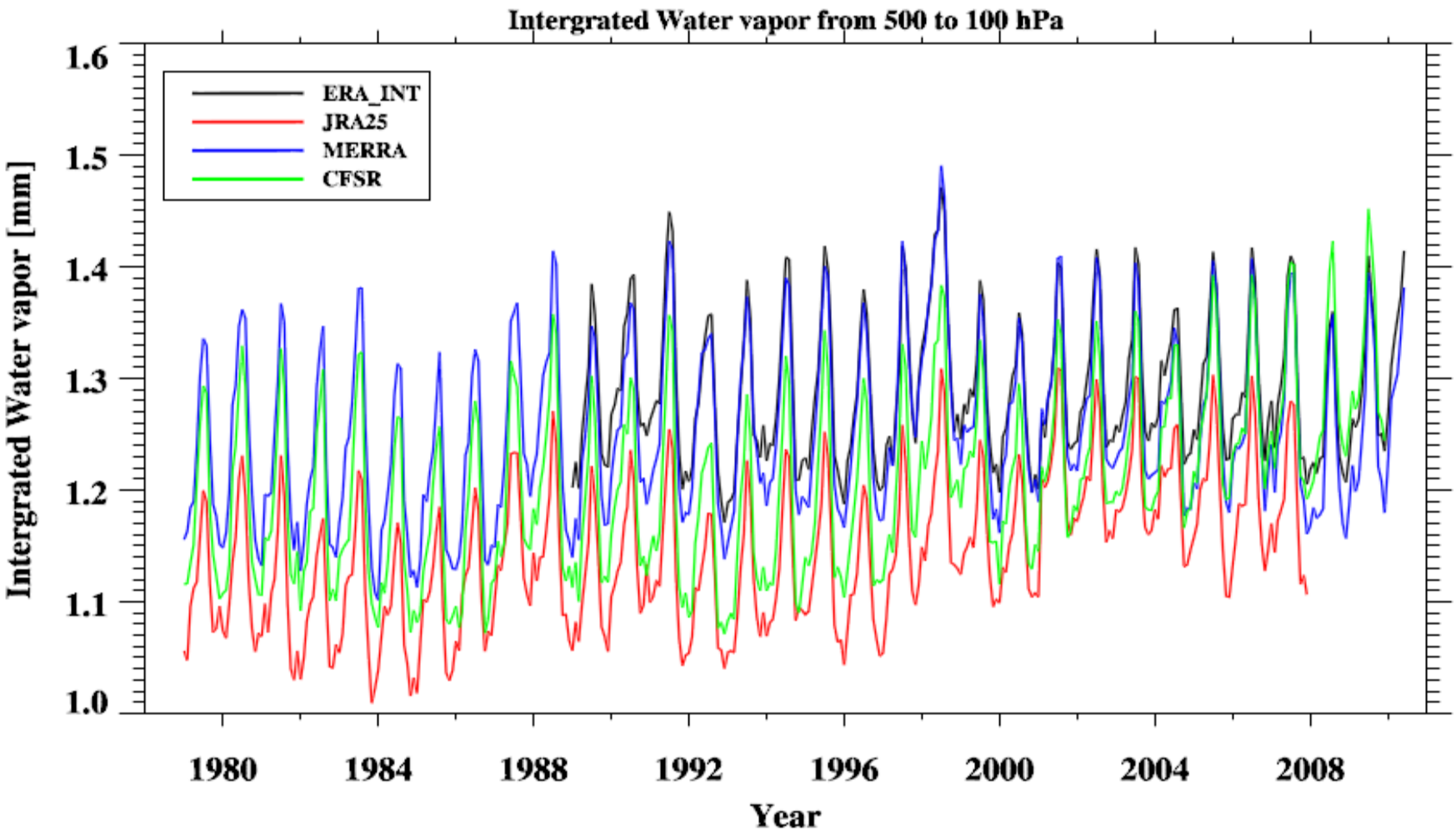
'Partly Coudy' (Cloud-Clearing) Ocean AVTP and AVMP

AVTP Bias | AVTP STDEV | AVMP Bias | AVMP STDEV

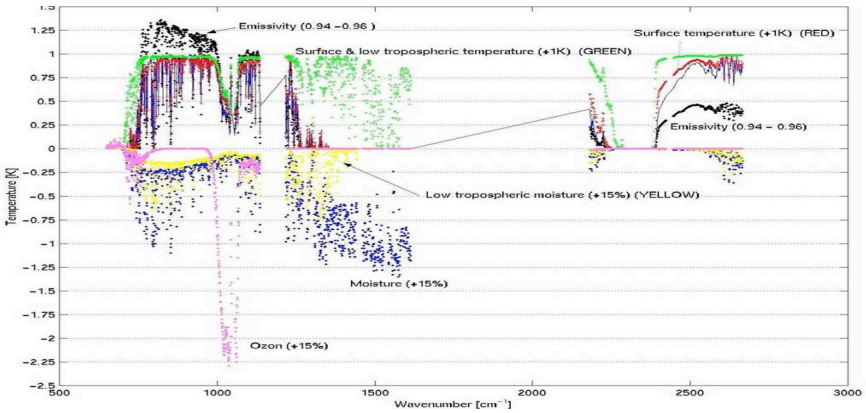


MW (ATMS) Only
CrIS+ATMS
NOAA IASI

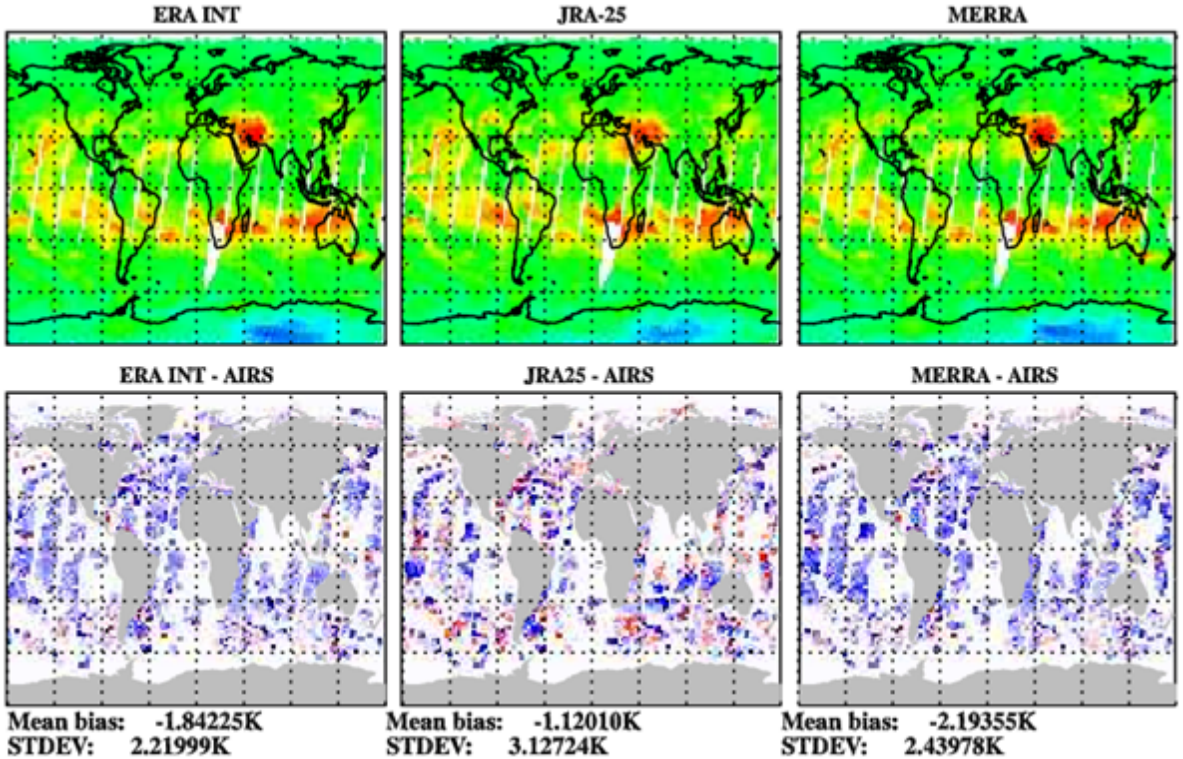
Validating Reanalyses using AIRS



Which one agree more with AIRS?



1518 cm-1 channel



Summary

- NOAA is very engaged in the hyperspectral world
- We have a long history and we look forward to working with the community for many more decades!