Assessment of CrIS Radiometric Accuracy using Community Radiative Transfer Model (CRTM) and Double Difference Approach

Yong Chen[1,3], Yong Han[2], and Fuzhong Weng[2]

1 Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, Colorado, USA.
2 Center for Satellite Applications and Research, NESDIS, NOAA, College Park, Maryland, USA.
3 Joint Center for Satellite Data Assimilation, College Park, Maryland, USA.

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- CrIS cloud detection algorithm using Community Radiative Transfer Model (CRTM)
- IASI spectral resample to CrIS spectral
- CrIS FOV-2-FOV variability and sweep direction bias among FORs
- Forward model simulation bias and double difference between CrIS and IASI
- Summary

Inter-Comparison of CrIS with IASI

- Object: Independently assess radiometric consistency between CrIS and IASI

- Method:
  - Simulations with Community Radiative Transfer Model (CRTM) using NWP forecast fields
  - Indirect comparison: Double difference

- Dataset
  - IDPS CrIS SDRs and IASI level 1C dataset
  - May 15 golden day

IR Cloud Detection Algorithm using CRTM

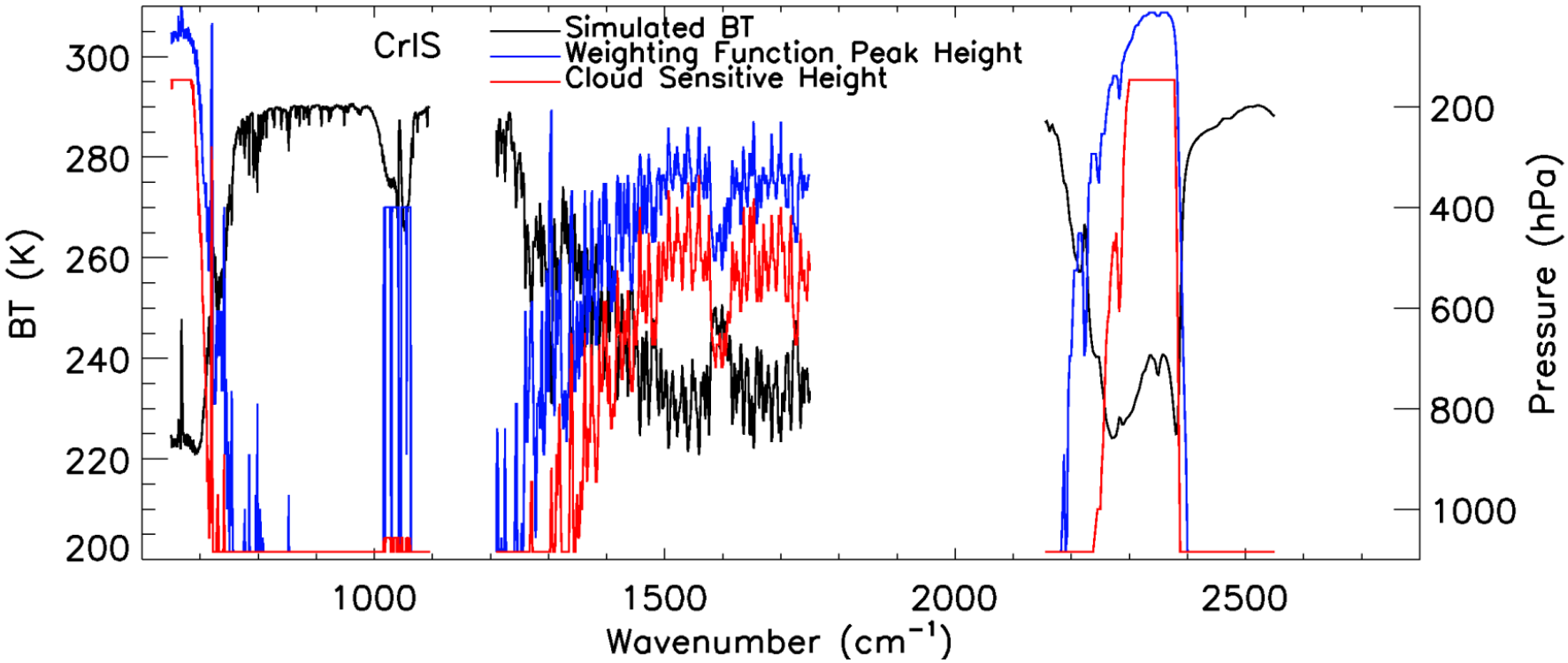
- The channels are first ordered according to their cloud sensitivity: the highest channels first and the channels closest to the surface last (McNally and Watts, 2003)

- The overcast variable contains overcast radiances assuming the presence of a black cloud at each of CRTM levels. The height for a particular channel is assigned by finding the level where the difference between the overcast and clear radiances is less than 1%.

$$\frac{\left|R_{clear} - R_{cloudy}\right|}{R_{clear}} < 0.01$$

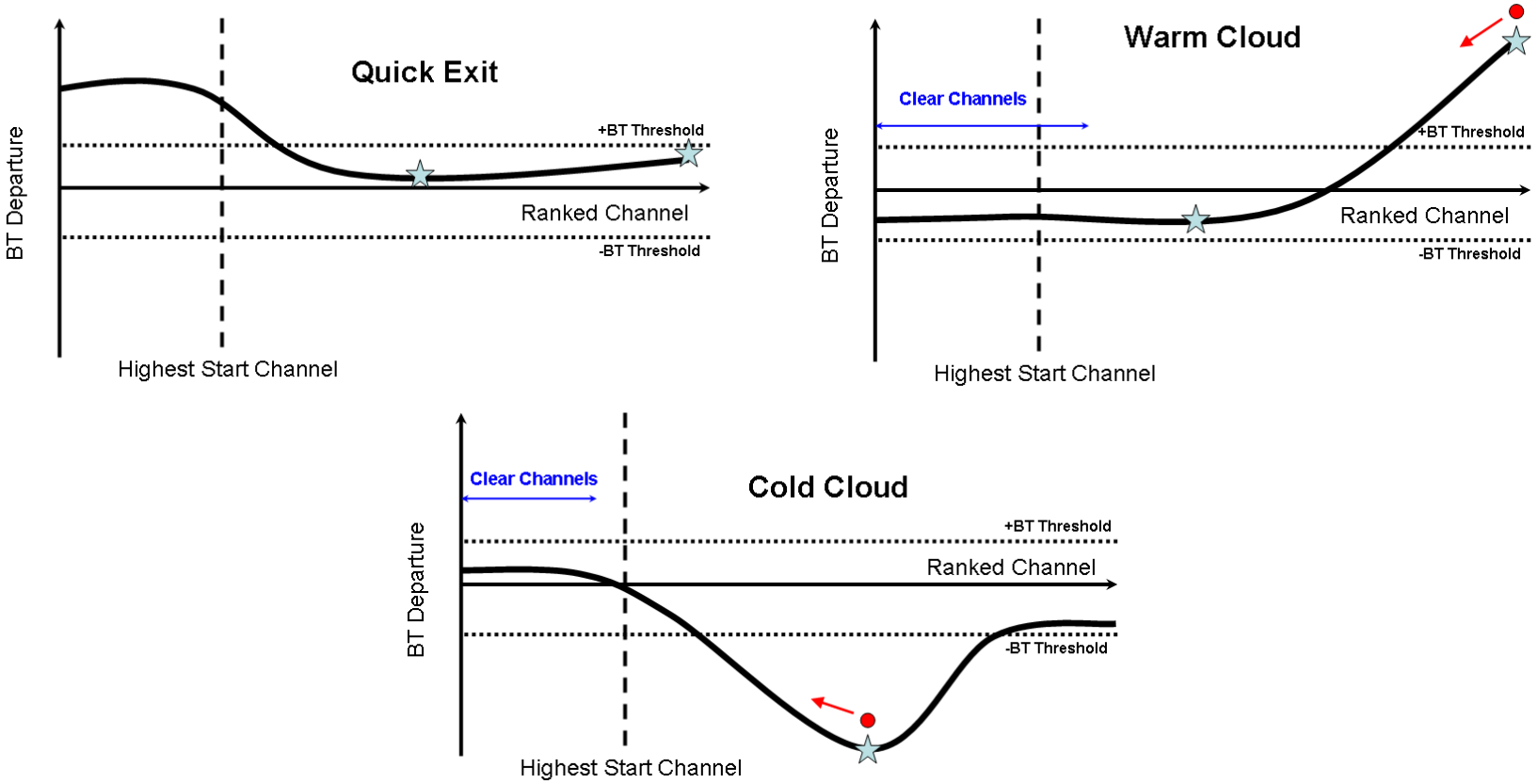
- The resulting ranked brightness temperature departures are smoothed with a moving-average filter in order to reduce the effect of instrument noise

CrIS Channel Cloud Sensitivity Height and Weighting Function Peak Height



Three Scheme Cases for Cloud Detection

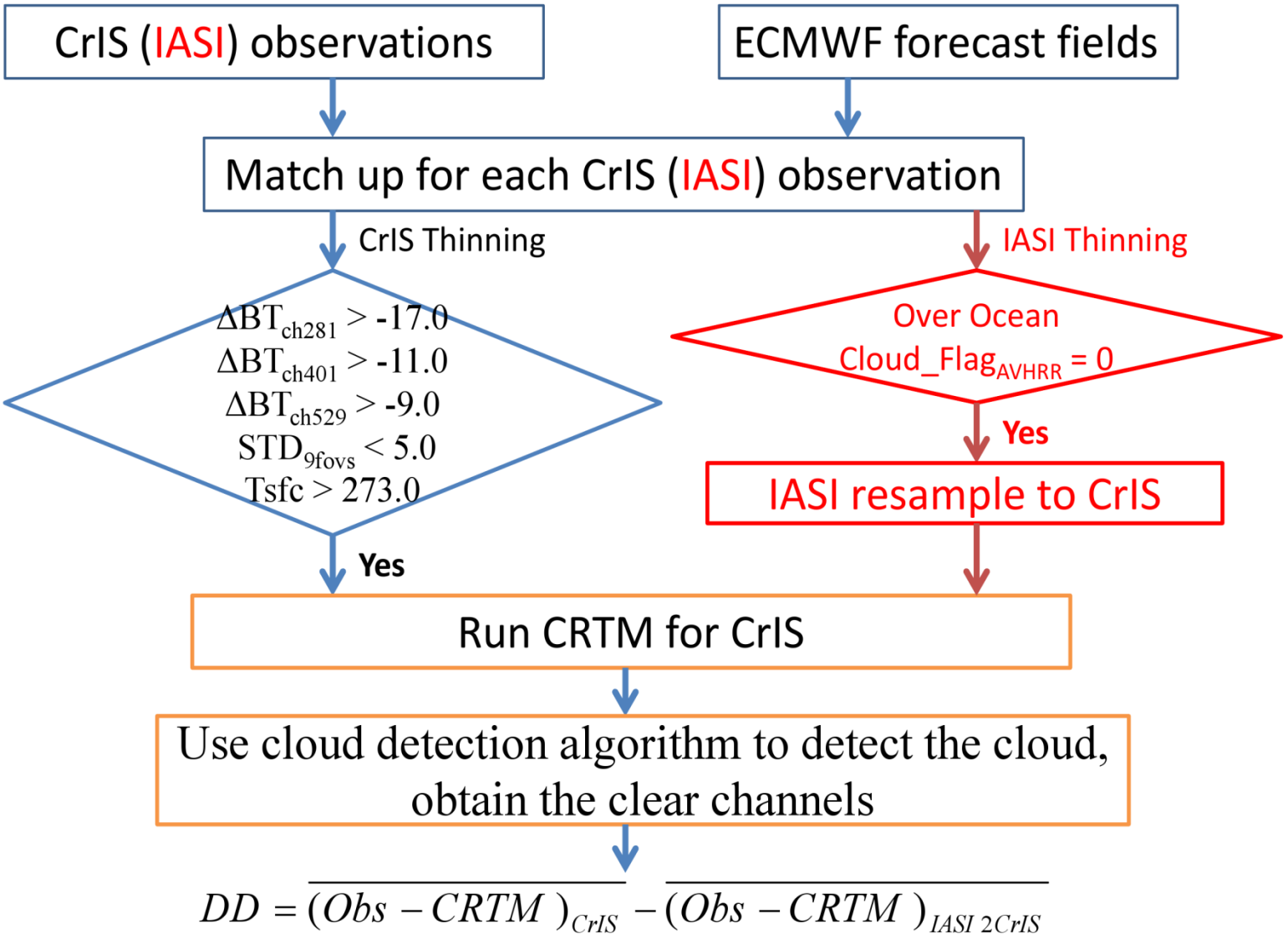
The "warm start" accounts for cases with a warm cloud over a cold surface.



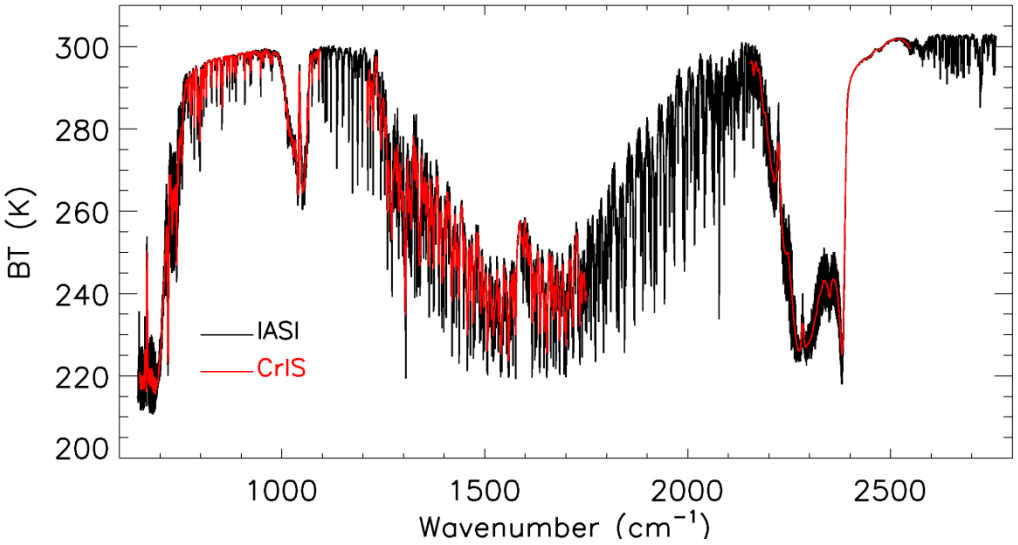
The "cold start" accounts for cases with a cold cloud over a warm surface and occurs when the criteria for the other two scenarios are not met

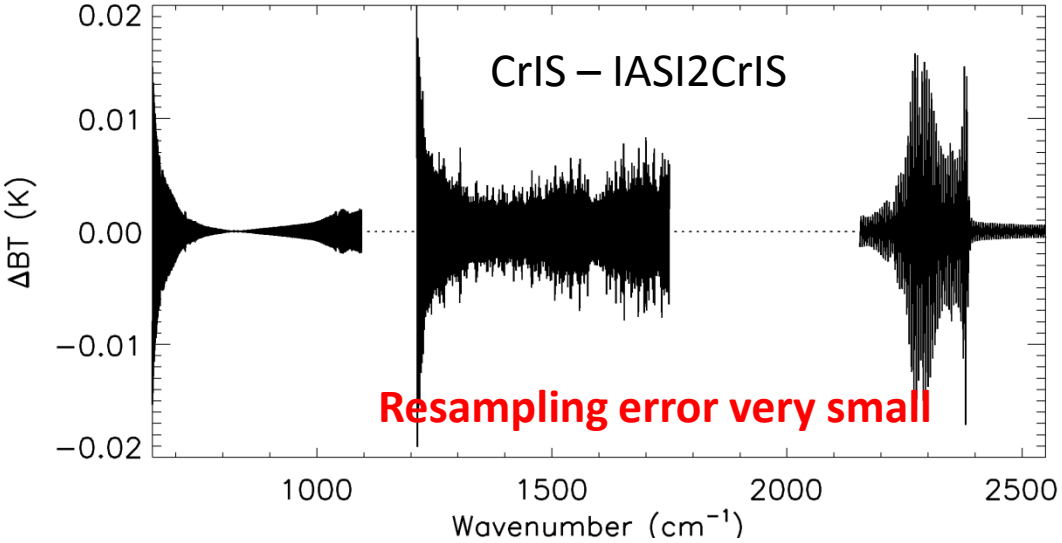
(McNally and Watts, 2003)

Clear Channel Simulation and Double Difference



Resample IASI to CrIS





IASI Observed Spectra

FFT

Fourier transform of the spectra to the interferogram space

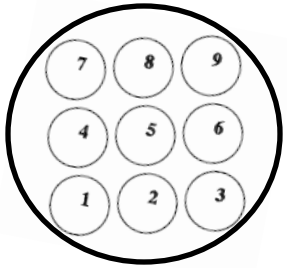
Apodization Function

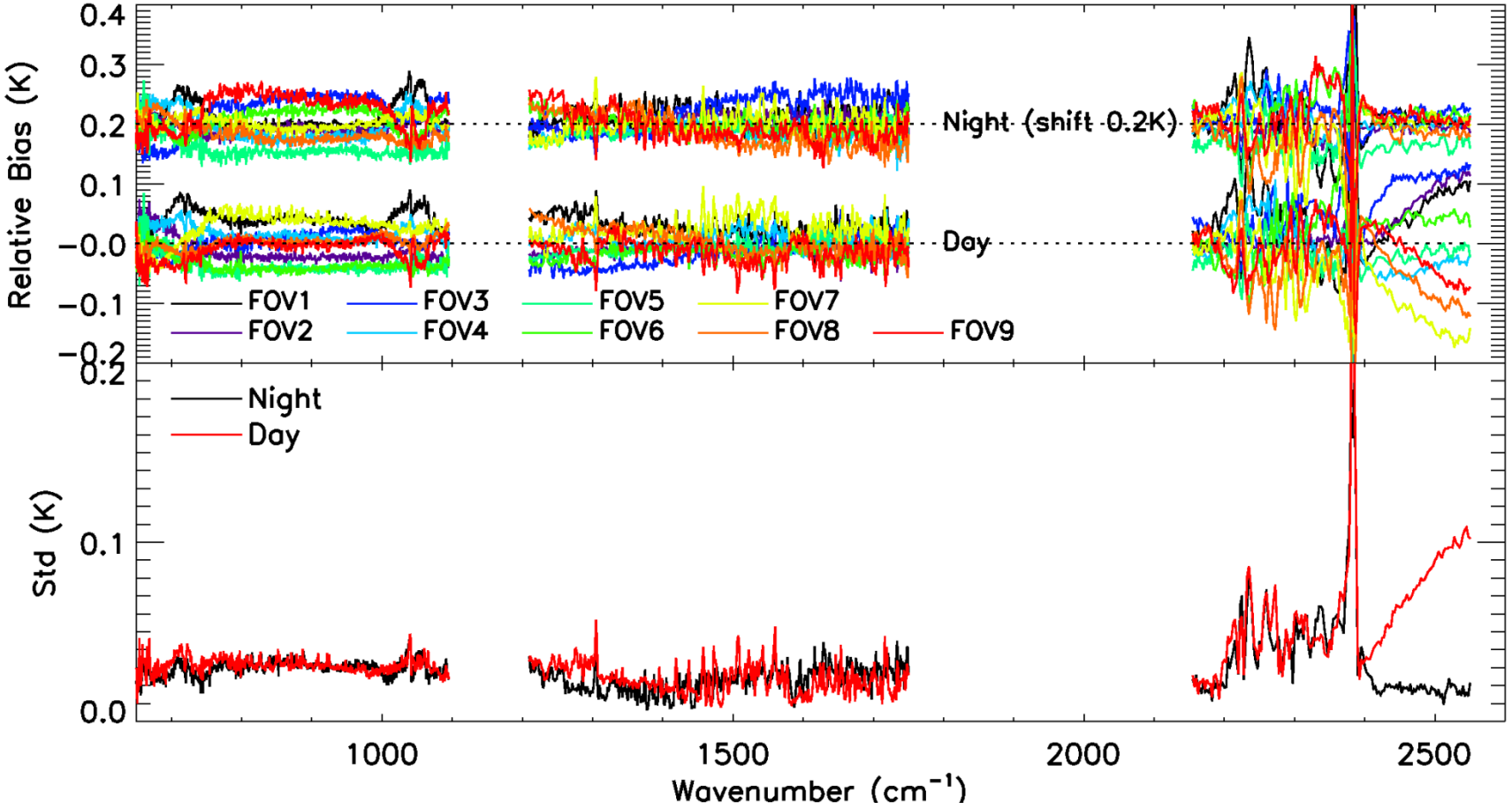
1) De-Apodization with IASI SRF
2) Truncation to CrIS OPD
3) Apodization with CrIS SRF

FFT^{-1}

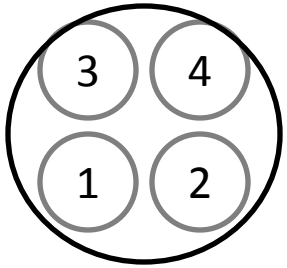
Inverse Fourier transform of the products to spectra space, resampling the spectra on CrIS wavenumber basis.

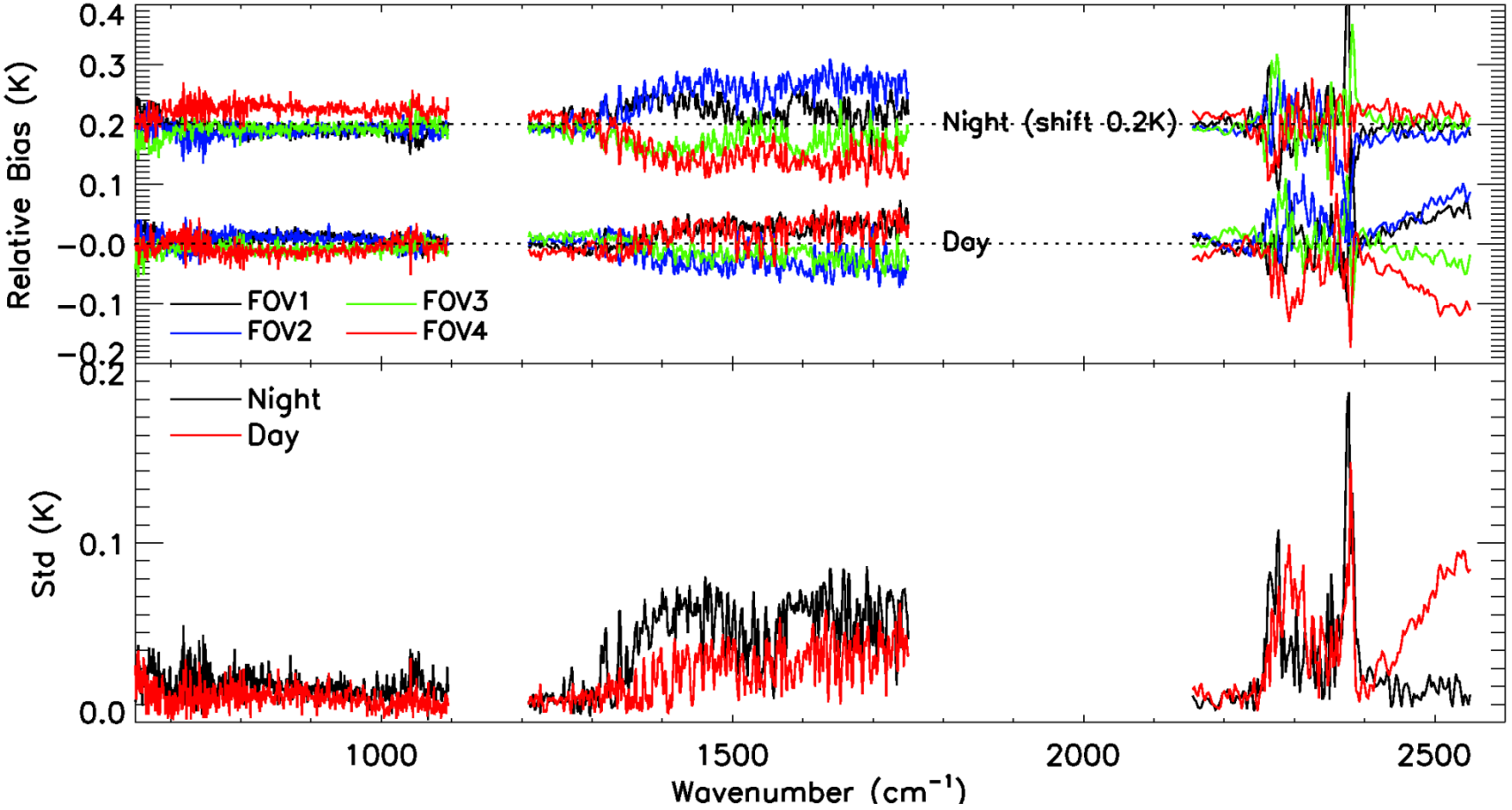
CrIS 9 FOVs Nadir Observation Variability (FOR 14 and 15) for Clear Sky over Ocean





IASI 4 FOVs Nadir Observation Variability (FOR 14 and 15) for Clear Sky over Ocean





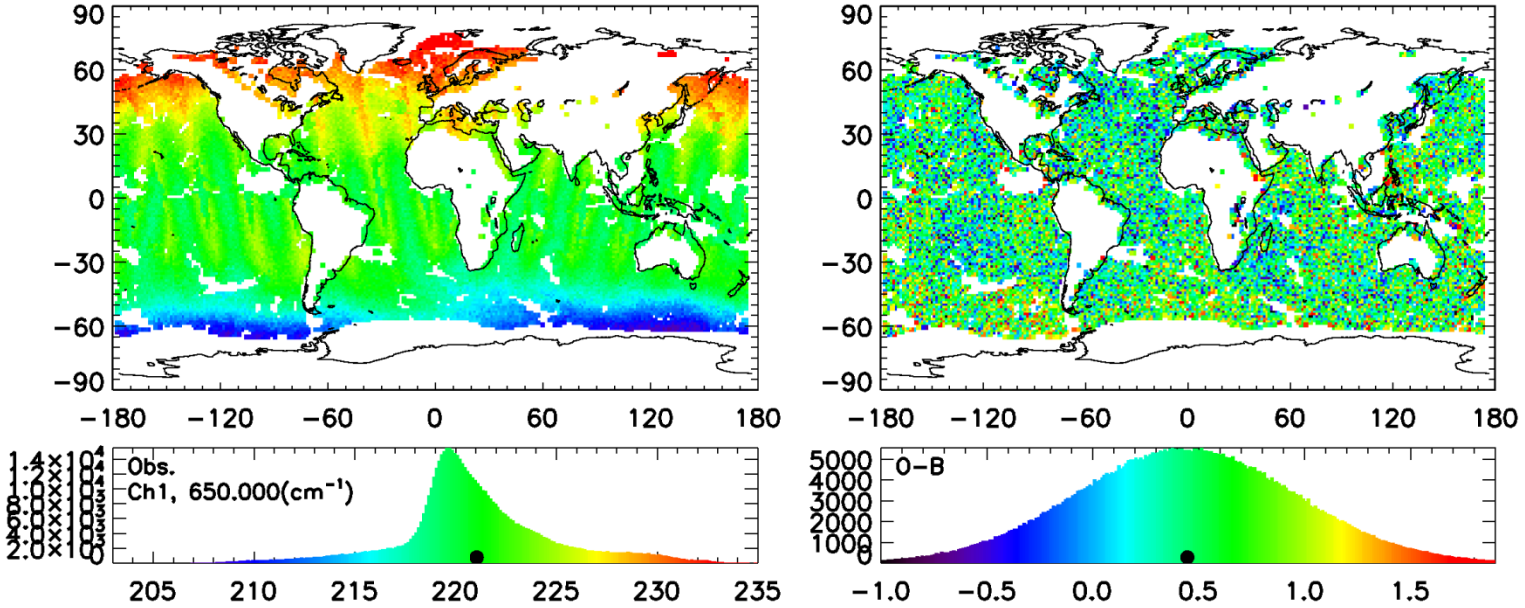
Observation BT and O-B Global Distribution

05/15/12

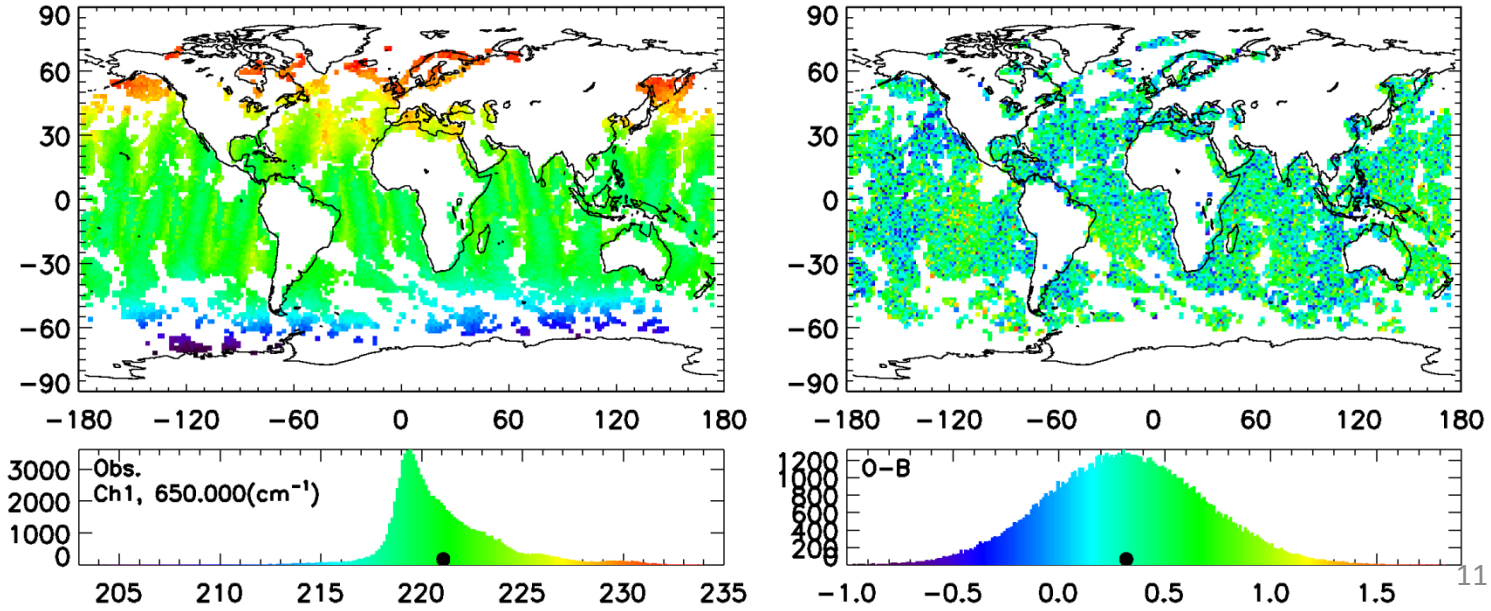
Ch 1

CO_2 channel

CrIS



IASI2CrIS



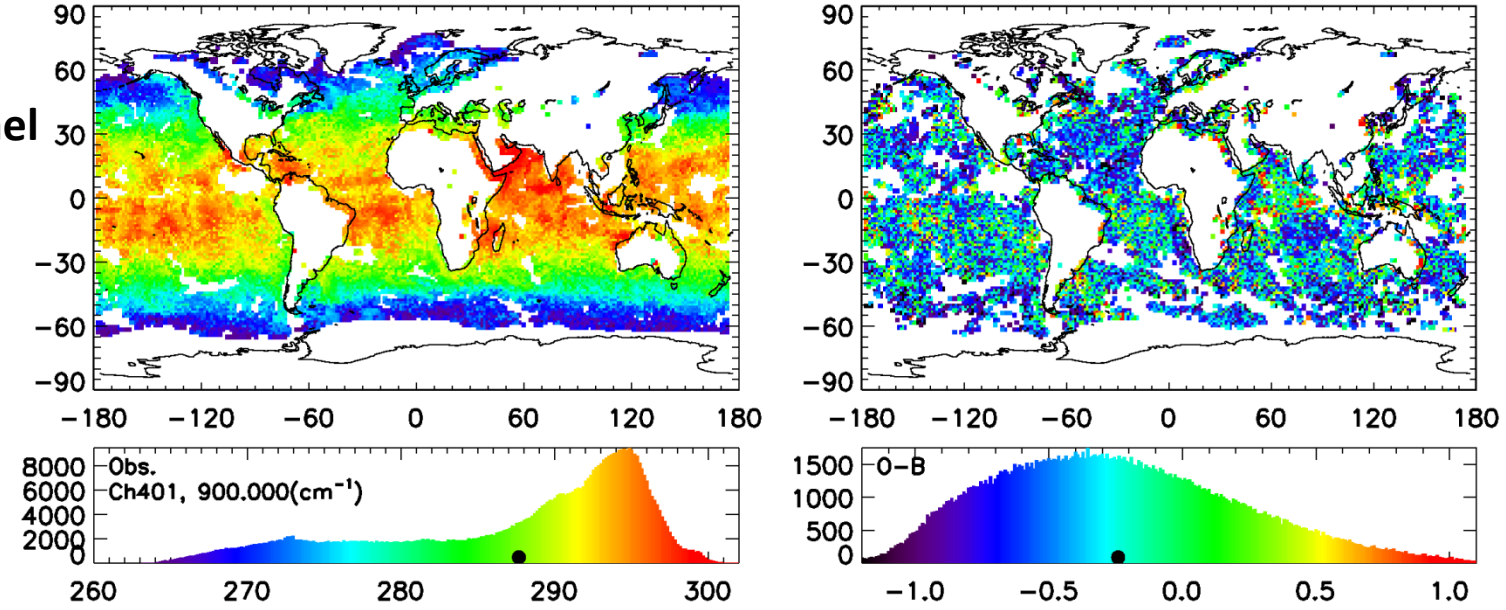
Observation BT and O-B Global Distribution

05/15/12

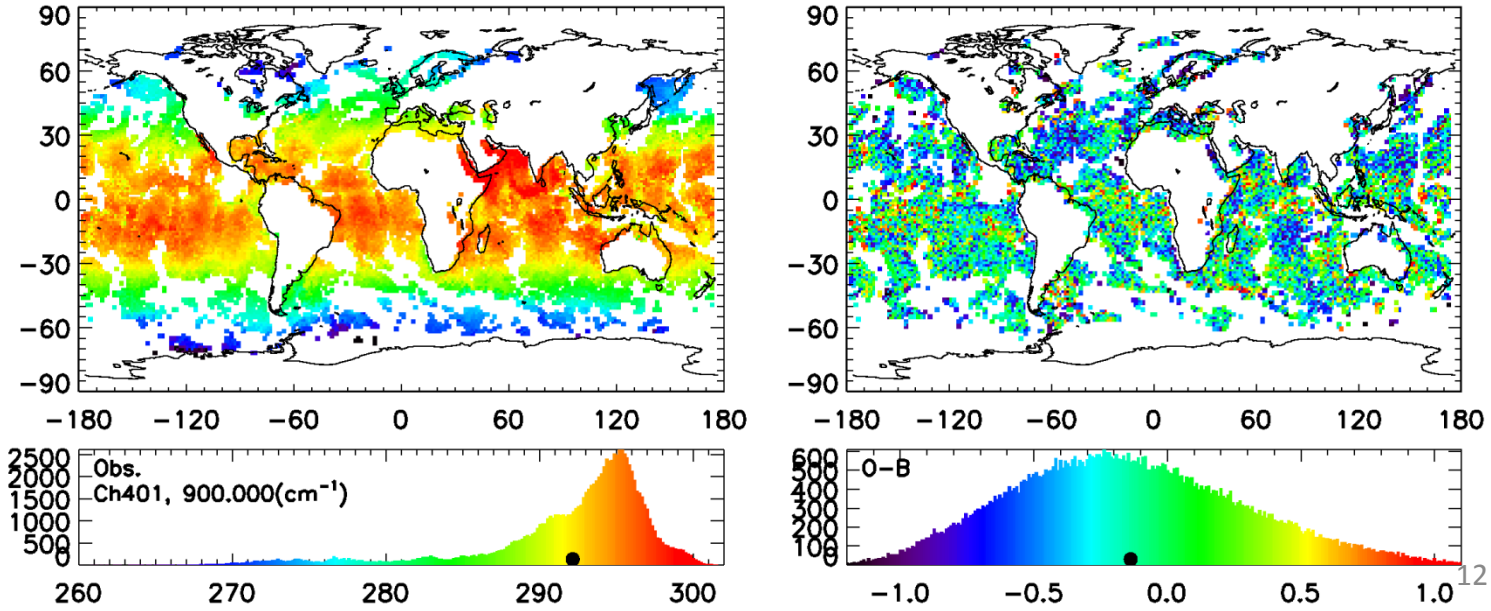
Ch 401

Surface Channel

CrIS



IASI2CrIS



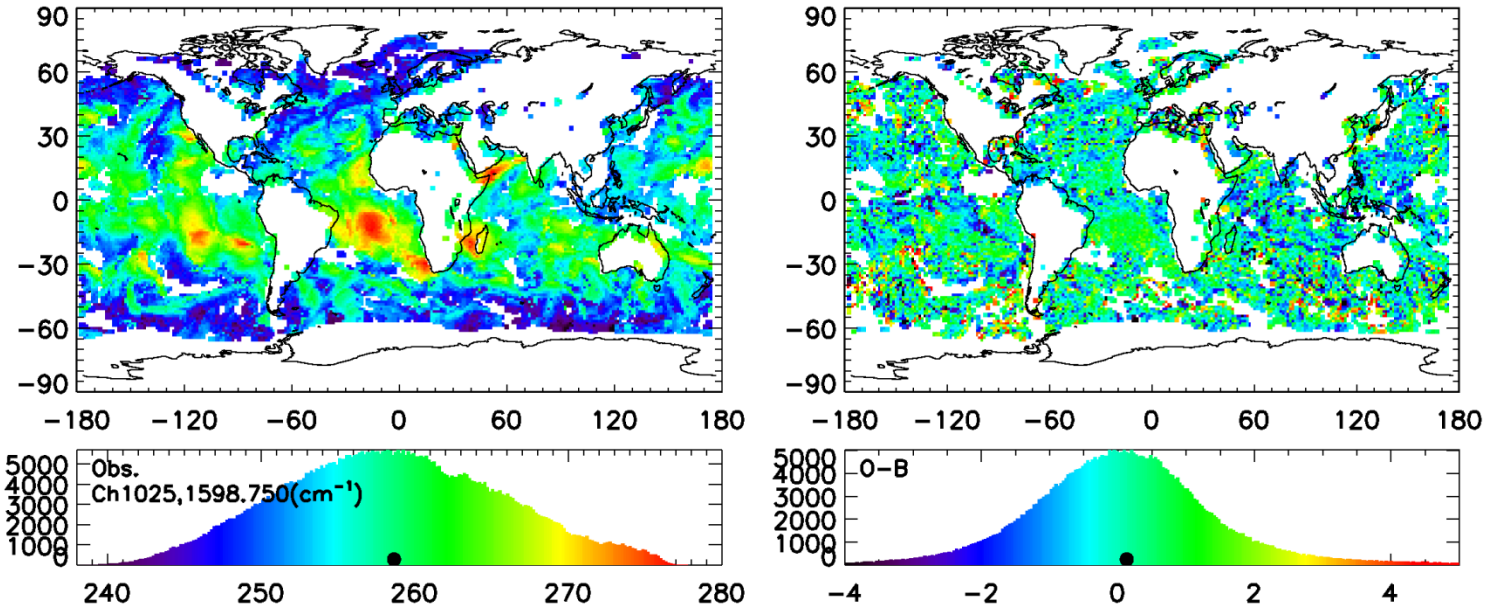
Observation BT and O-B Global Distribution

05/15/12

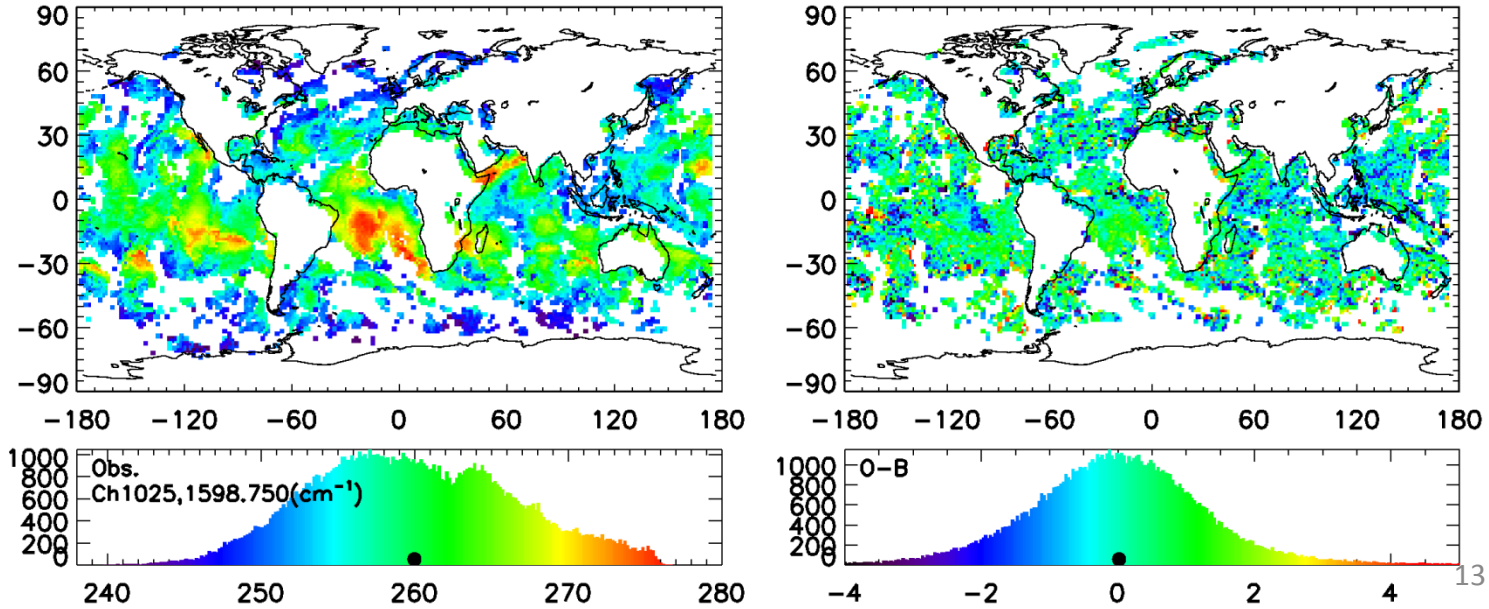
Ch 1025

Water Vapor Channel

CrIS



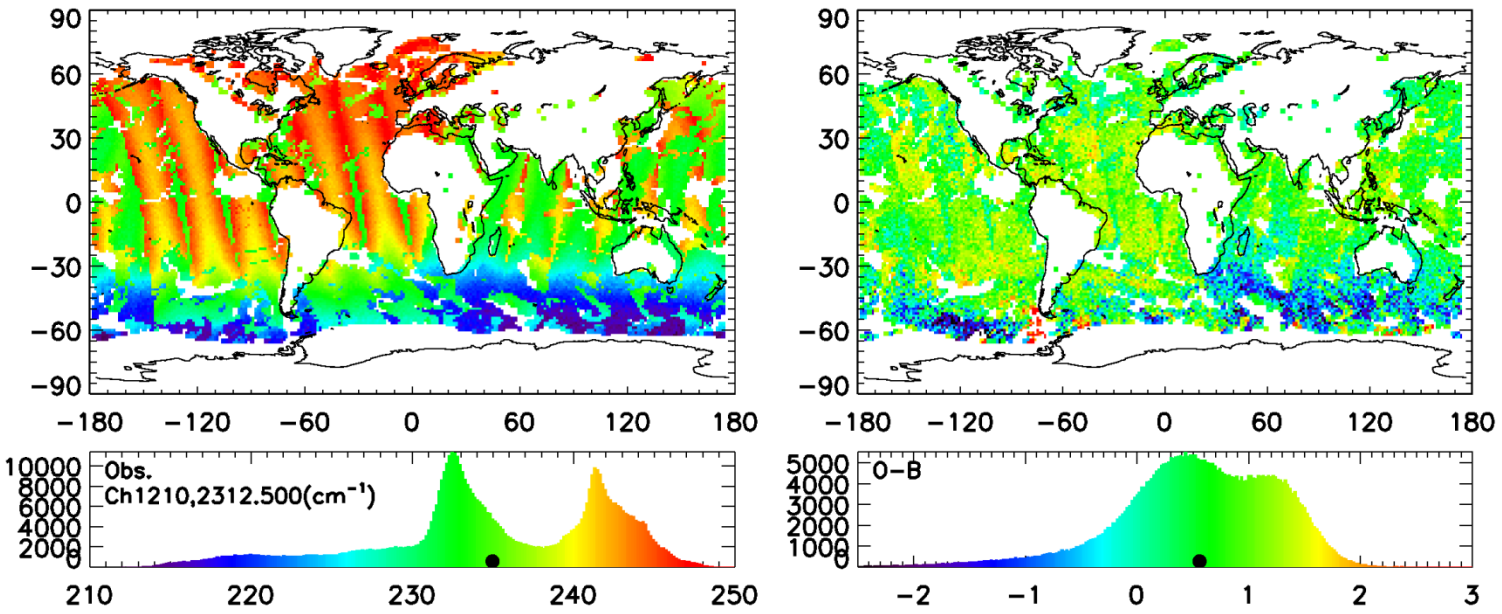
IASI2CrIS



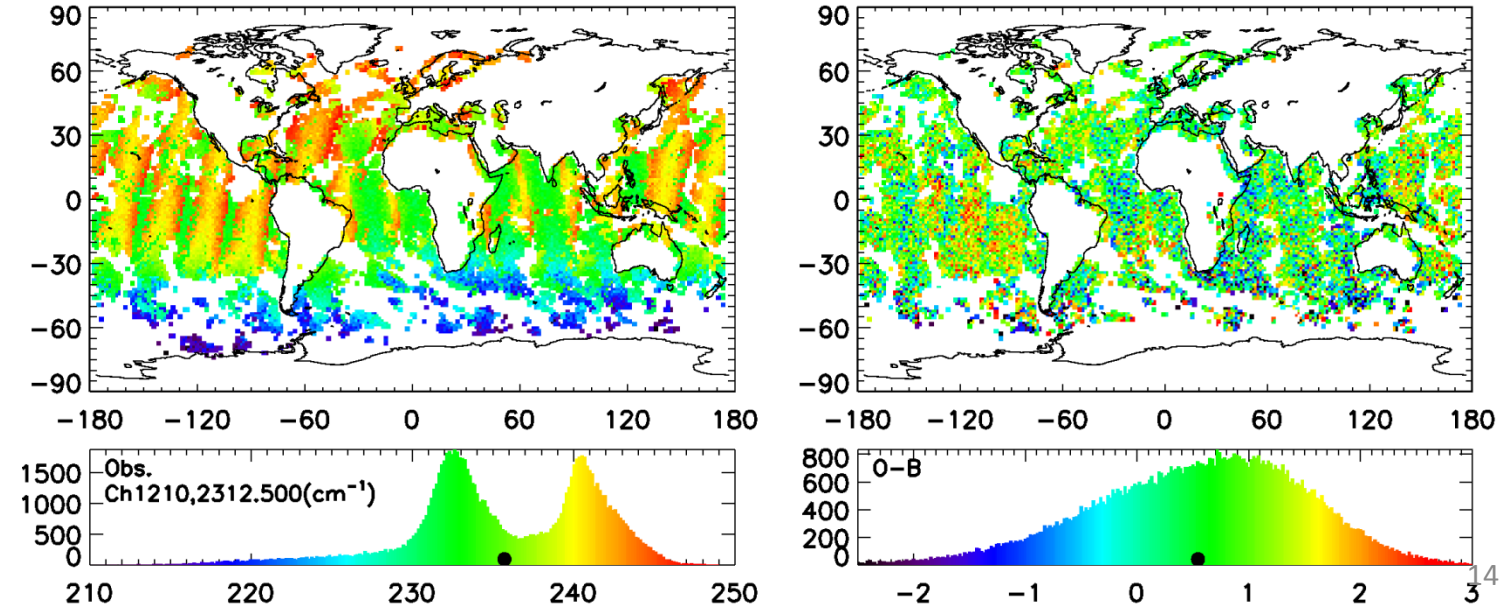
Observation BT and O-B Global Distribution

05/15/12
Ch 1210
CO2 NLTE
Channel

CrIS



IASI2CrIS



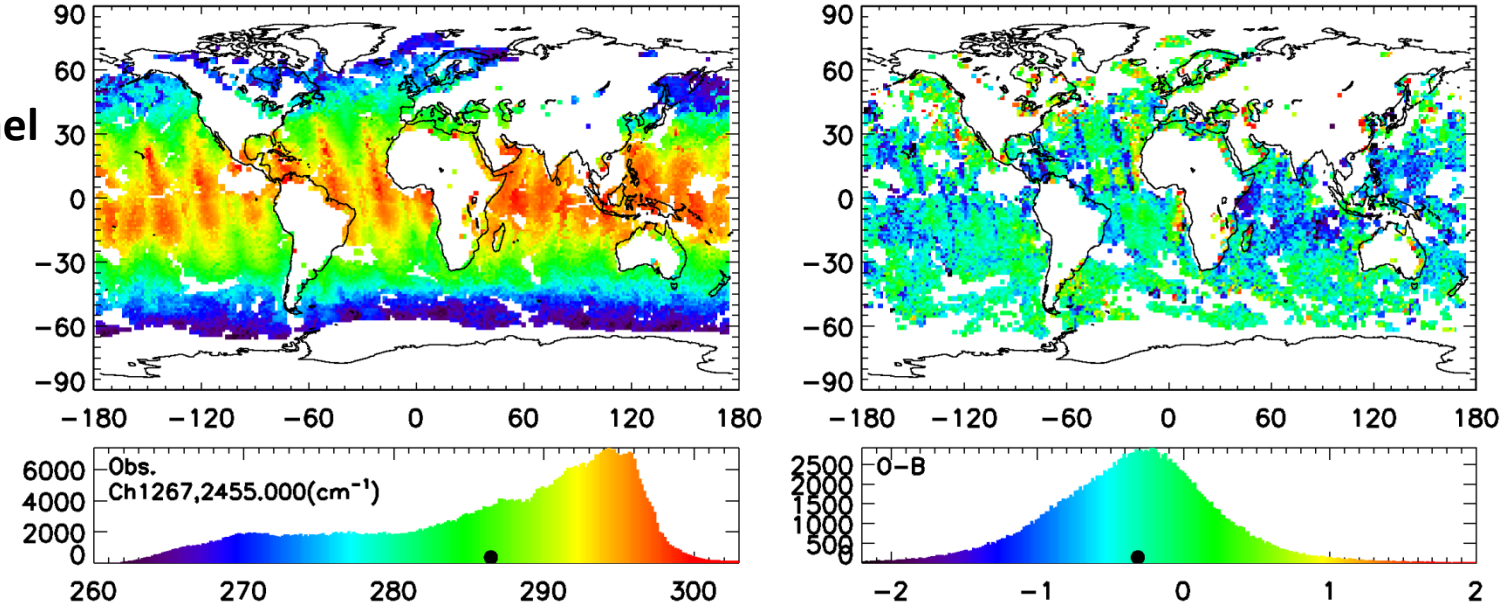
Observation BT and O-B Global Distribution

05/15/12

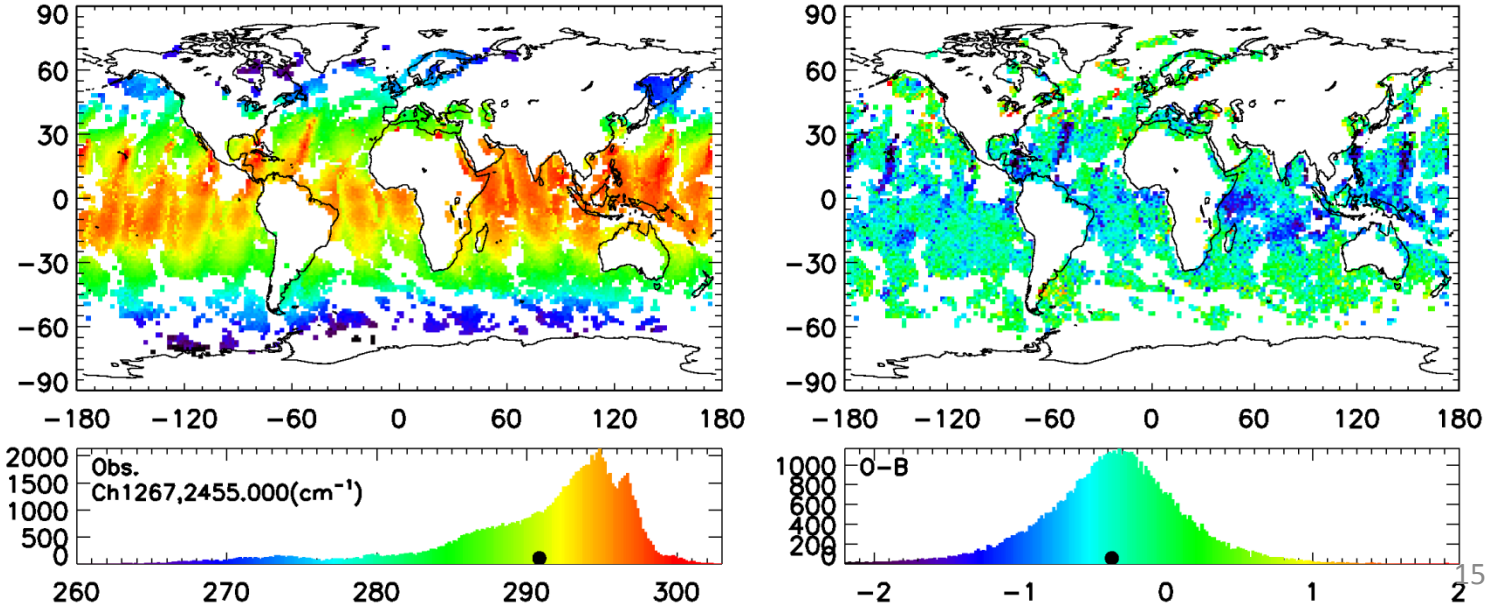
Ch 1267

Surface Channel

CrIS



IASI2CrIS



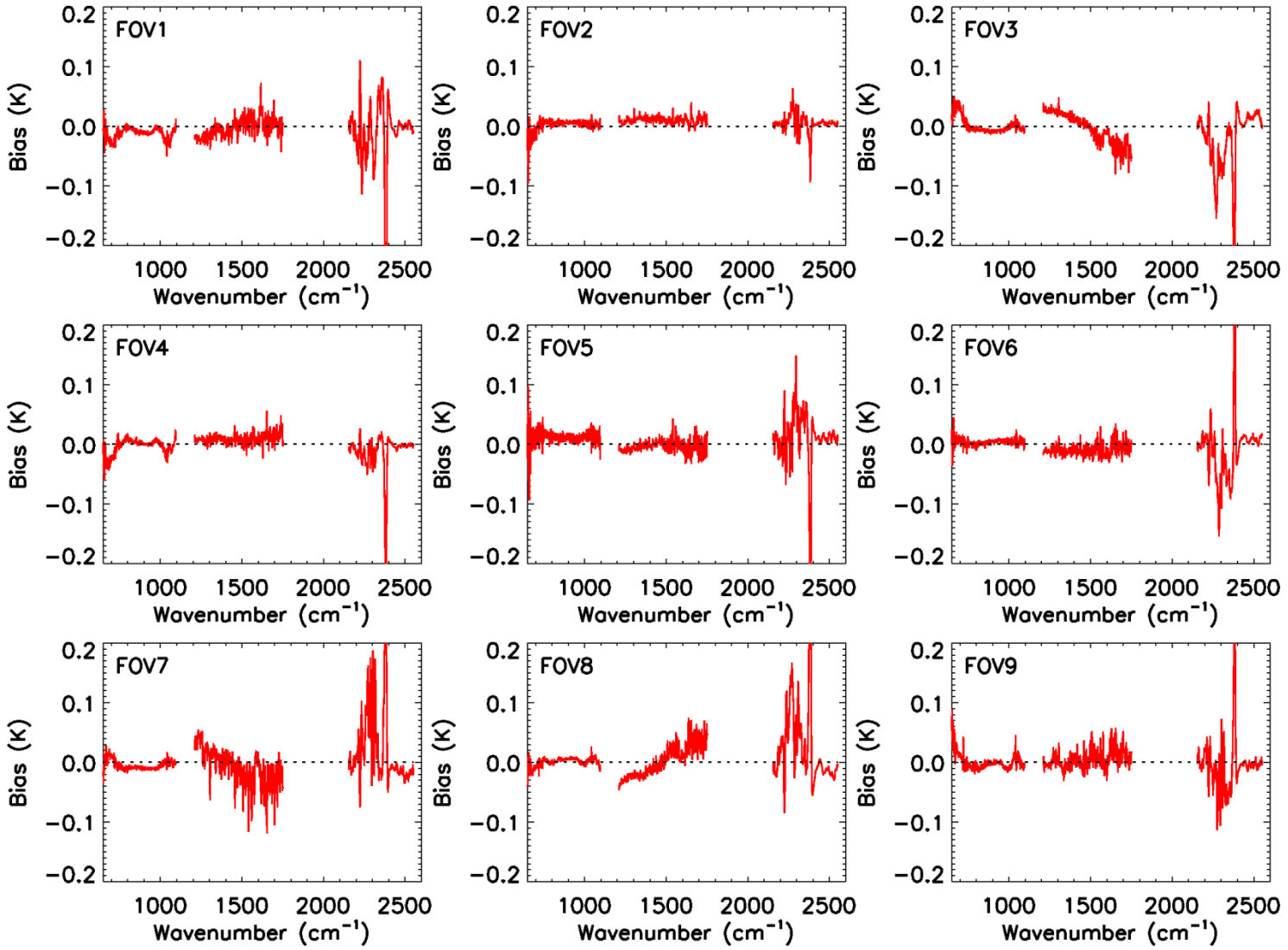
FOV-2-FOV Variability

(remove the mean bias between observations and CRTM simulations)

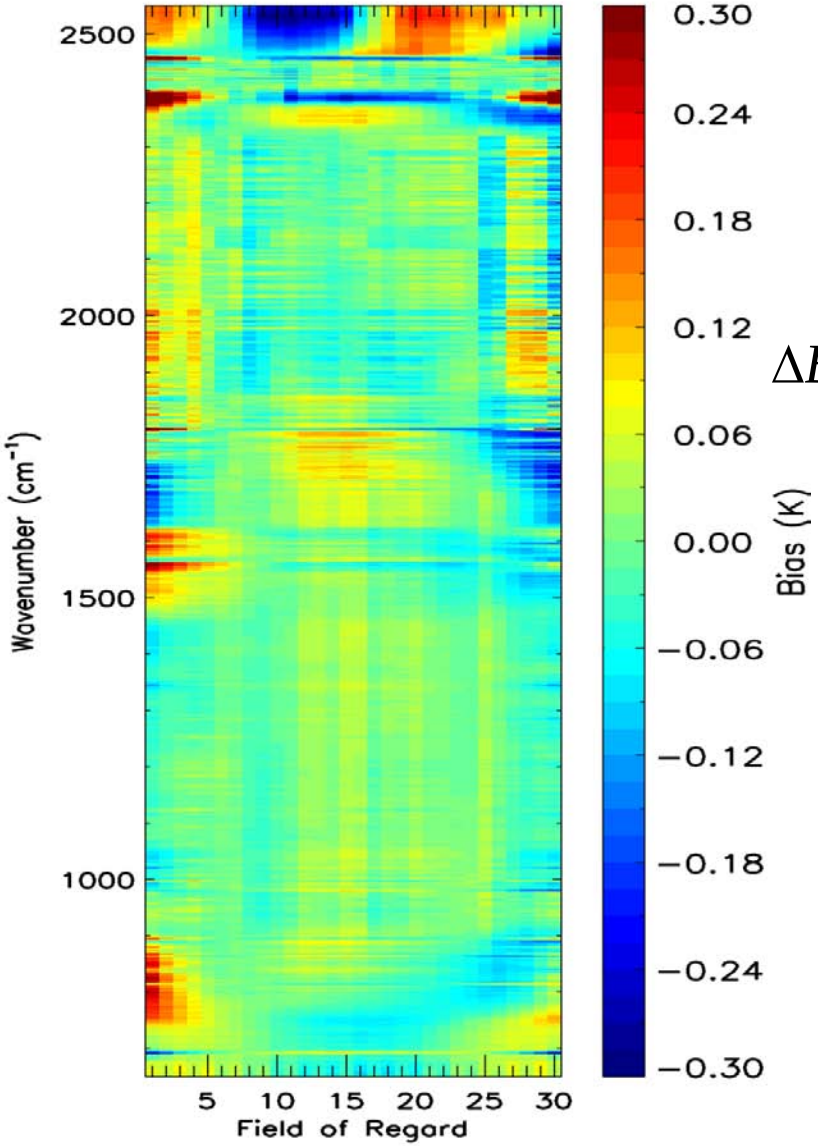
$$BIAS_{FOV_i} = \overline{(Obs - CRTM)_{FOV_i}} - \overline{(Obs - CRTM)_{all}}$$

total clear sky observation points ~300,000

Average all the FORs for each FOV



Sweeping Direction Bias: CrIS Observations Compared with CRTM Calculations



$$\Delta BT_{FOR_i} = \overline{(Obs - CRTM)_{FOR_i}} - \overline{(Obs - CRTM)_{all}}$$

Total clear sky observation points ~300,000 within ±60 degree latitude over ocean

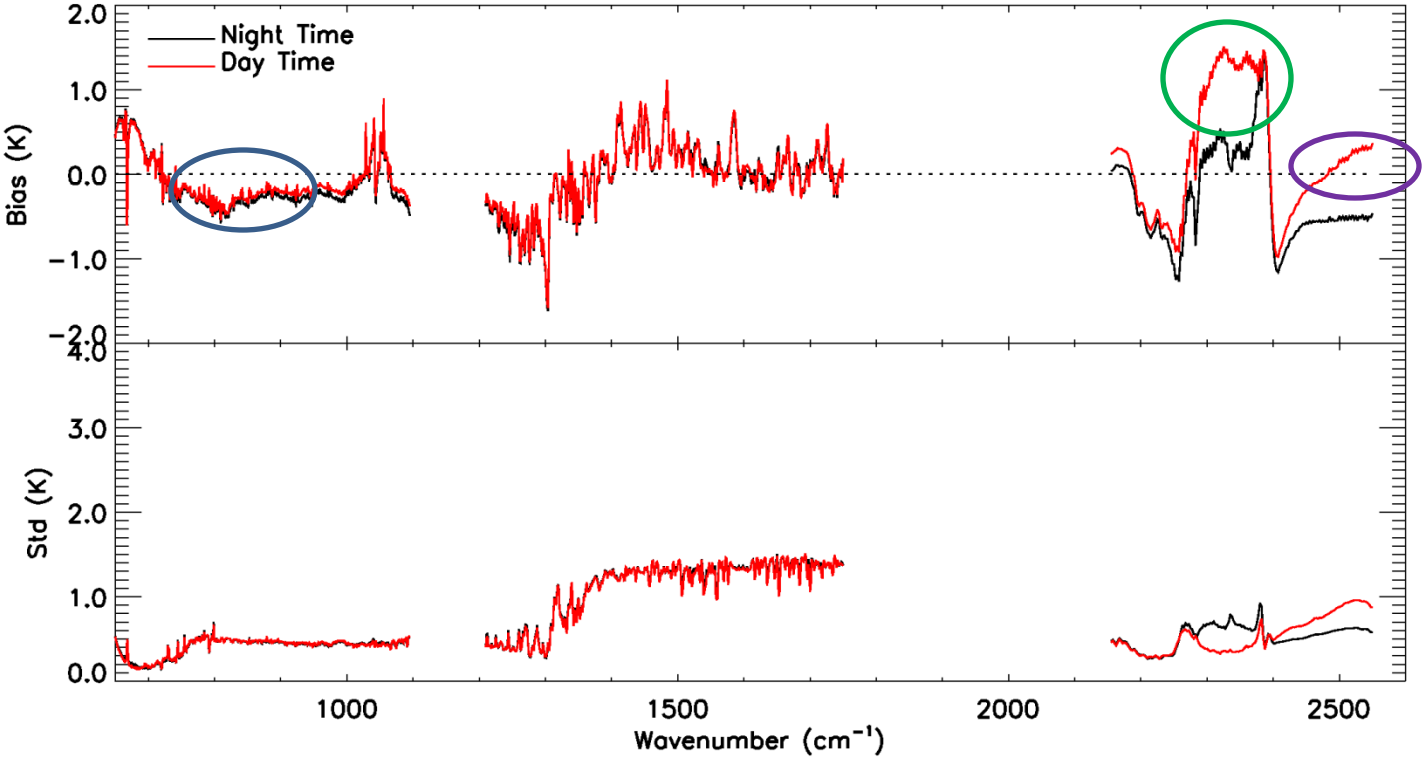
Bias and STD of CrIS O-S for Clear Sky over Ocean

About 10% data are clear sky (~300,000 each day).

Window region negative bias may partial contribute from the cloud contamination.

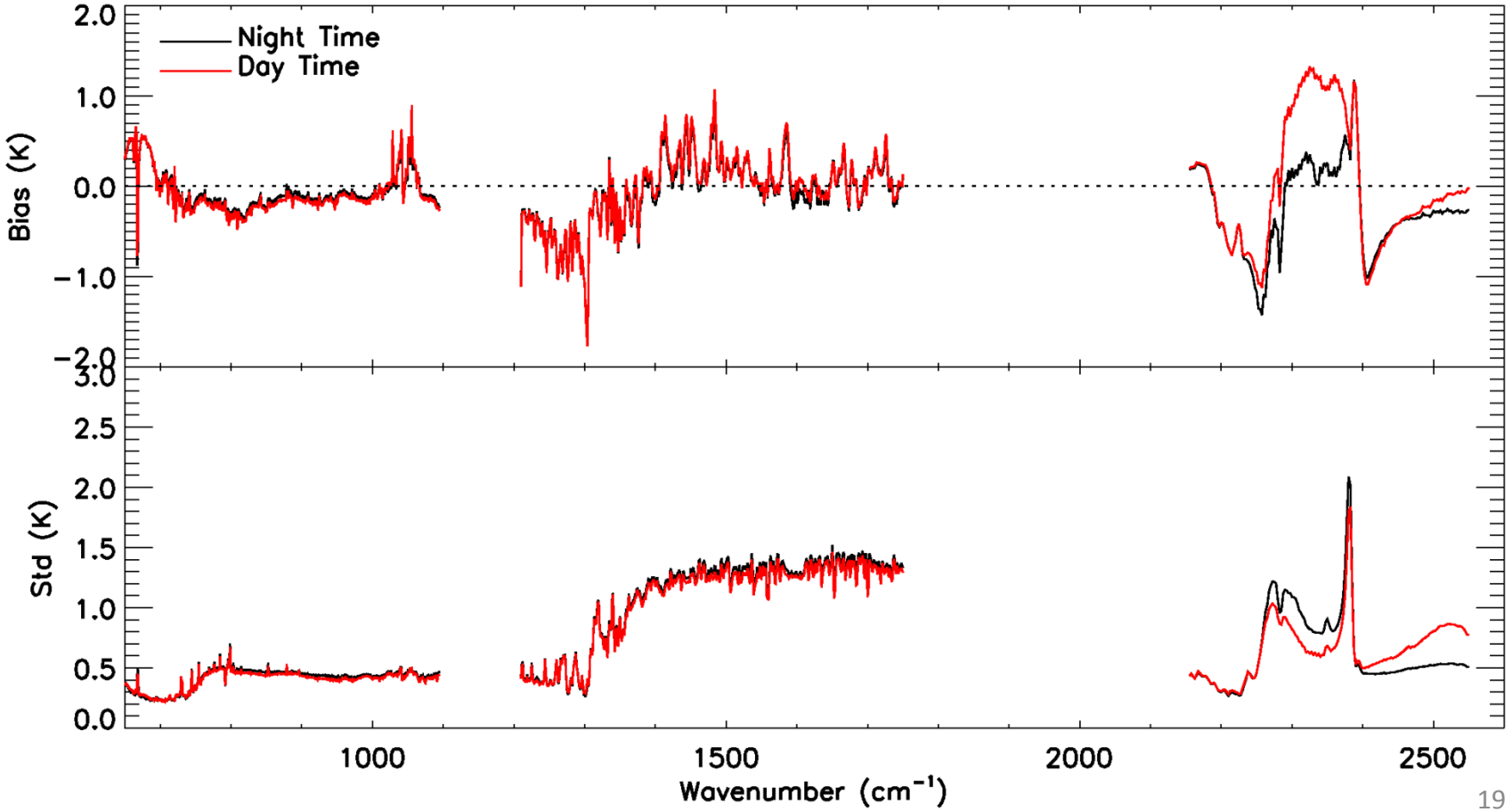
NLTE effect over SWIR channels

Ocean BRDF effect



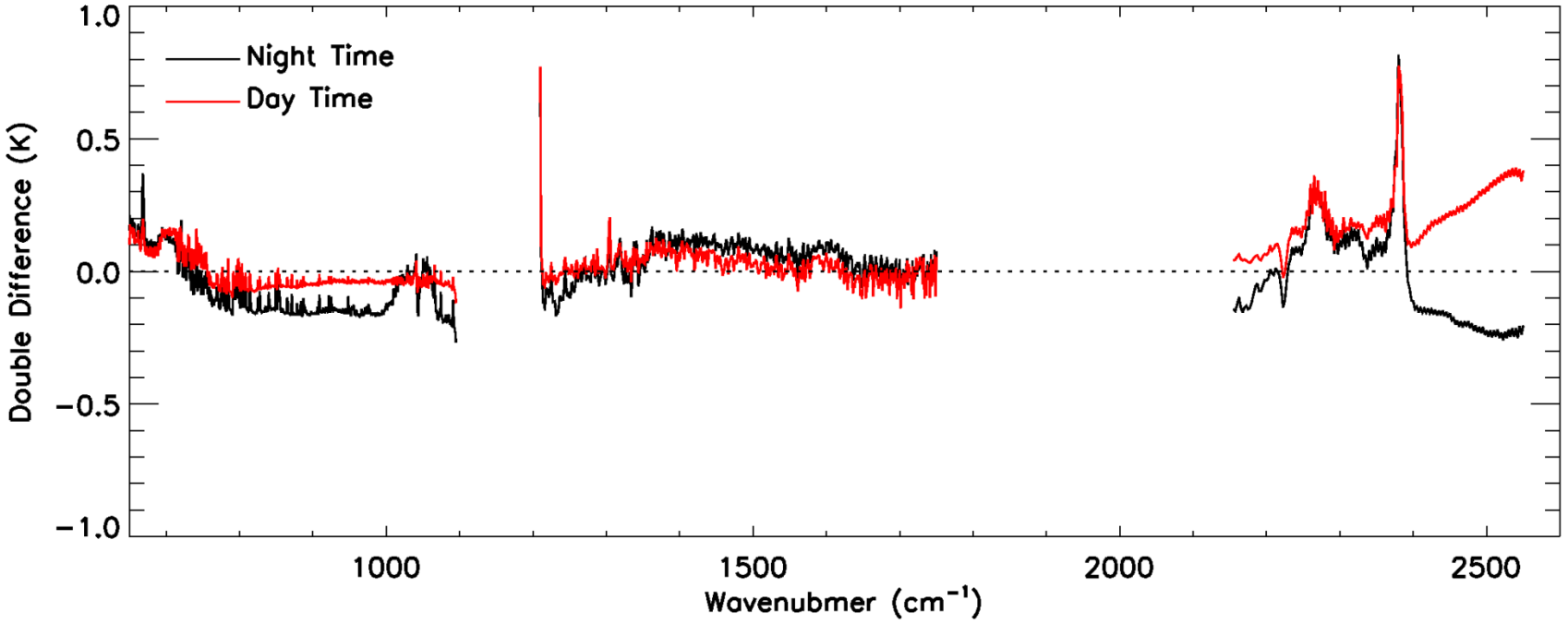
Bias and STD of IASI2CrIS O-S for Clear Sky over Ocean

Clear sky data points (~100,000)



Double Difference between CrIS and IASI2CrIS

$$DD = \overline{(Obs - CRTM)_{CrIS}} - \overline{(Obs - CRTM)_{IASI\,2\,CrIS}}$$



Summary

- The CrIS Sensor Data Record (SDR) data sets were assessed by using CRTM and ECMWF forecast data for clear sky and over ocean and compared with IASI data.

- The SDR data sets were evaluated to estimate the FOV-2-FOV variability and sweep direction bias. Results show that FOV-2-FOV variability is small; The sweep direction bias among FORs is also small.

- Results from the double difference with IASI show that the differences are within ± 0.2 K for most of channels. CrIS SDR are on the right path to meet the high quality standard for the usage by NWP and the scientific community.