# Early CrIS checkout results and Intercalibration


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University of Wisconsin - Madison
Space Science and Engineering Center (SSEC)


CLARRREO SDT Meeting
10 April 2012 (via telecon)

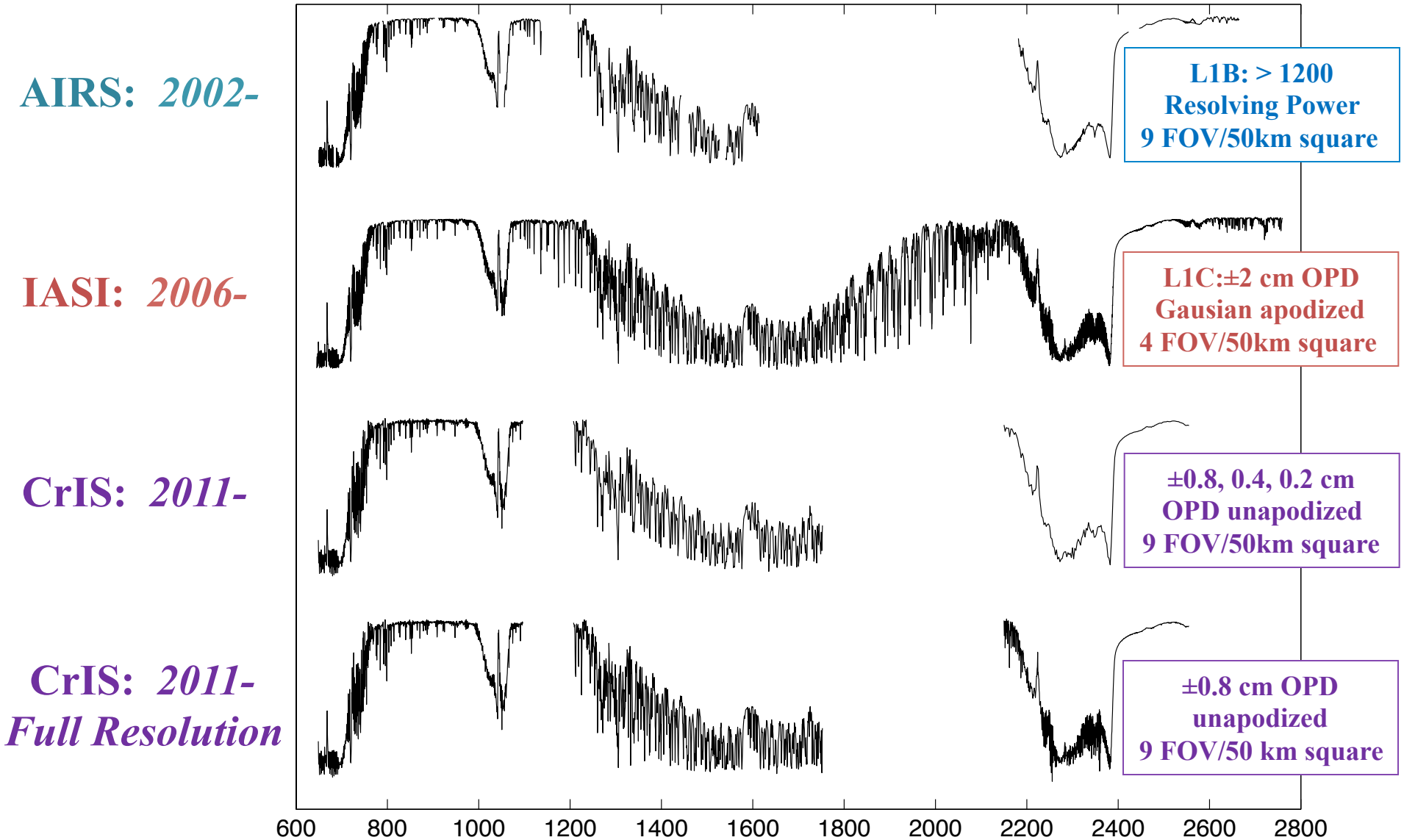
**AIRS**
Atmospheric InfraRed Sounder
Grating spectrometer
166 kg, 256 W
13.5 km FOV at nadir, contiguous
Launched on NASA Aqua in 2002

**IASI**
Infrared Atmospheric Sounding Interferometer
Michelson interferometer
236 kg, 210 W
2x2 12 km FOVs at nadir, non-contiguous
Launched on Metop-A in 2006

***Full scale model at 2010 IASI meeting***

**CrIS**
Cross-track Infrared Sounder
Michelson interferometer
146 kg, 110 W
3x3 14 km FOVs at nadir, contiguous
Launched on Suomi NPP, 28 Oct 2011

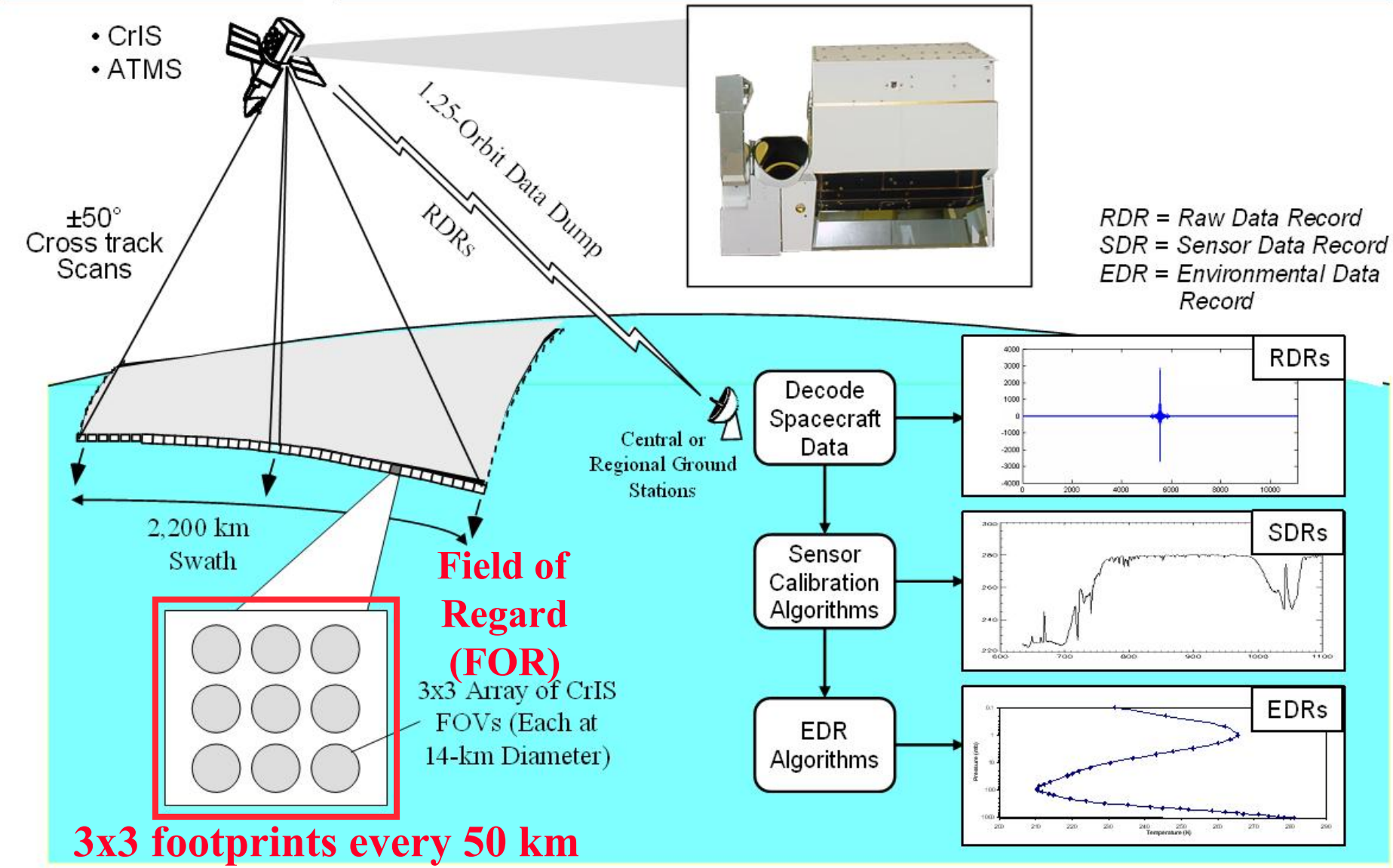
# Spectral Coverage and Resolution Comparison




*from LBLRTM for US Standard Atmosphere*

# Mission Overview

# CrIS Mission: Construct Vertical Profiles of Temperature, Moisture, and Pressure (EDRs)

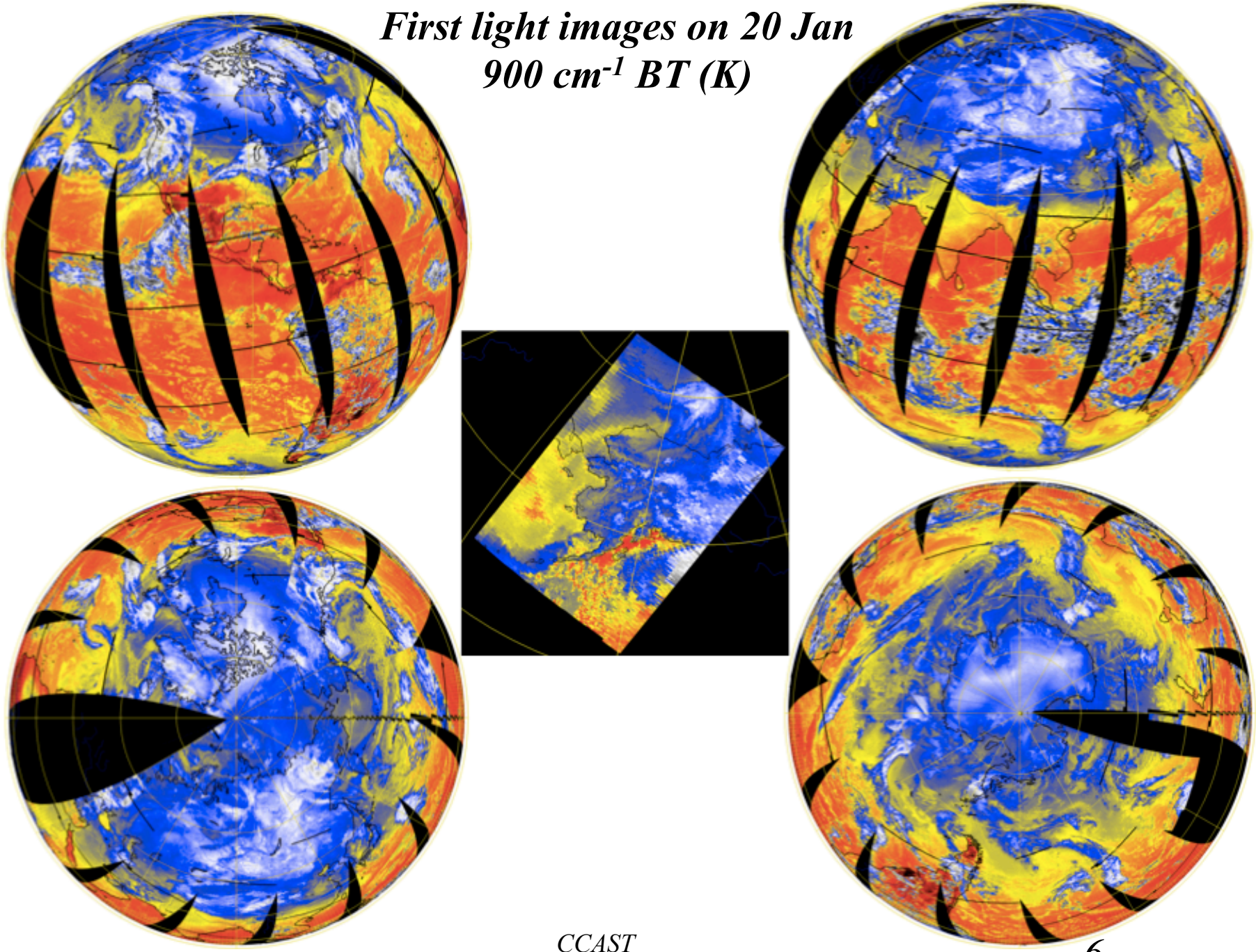



*RDR = Raw Data Record*
*SDR = Sensor Data Record*
*EDR = Environmental Data Record*

# Schedule

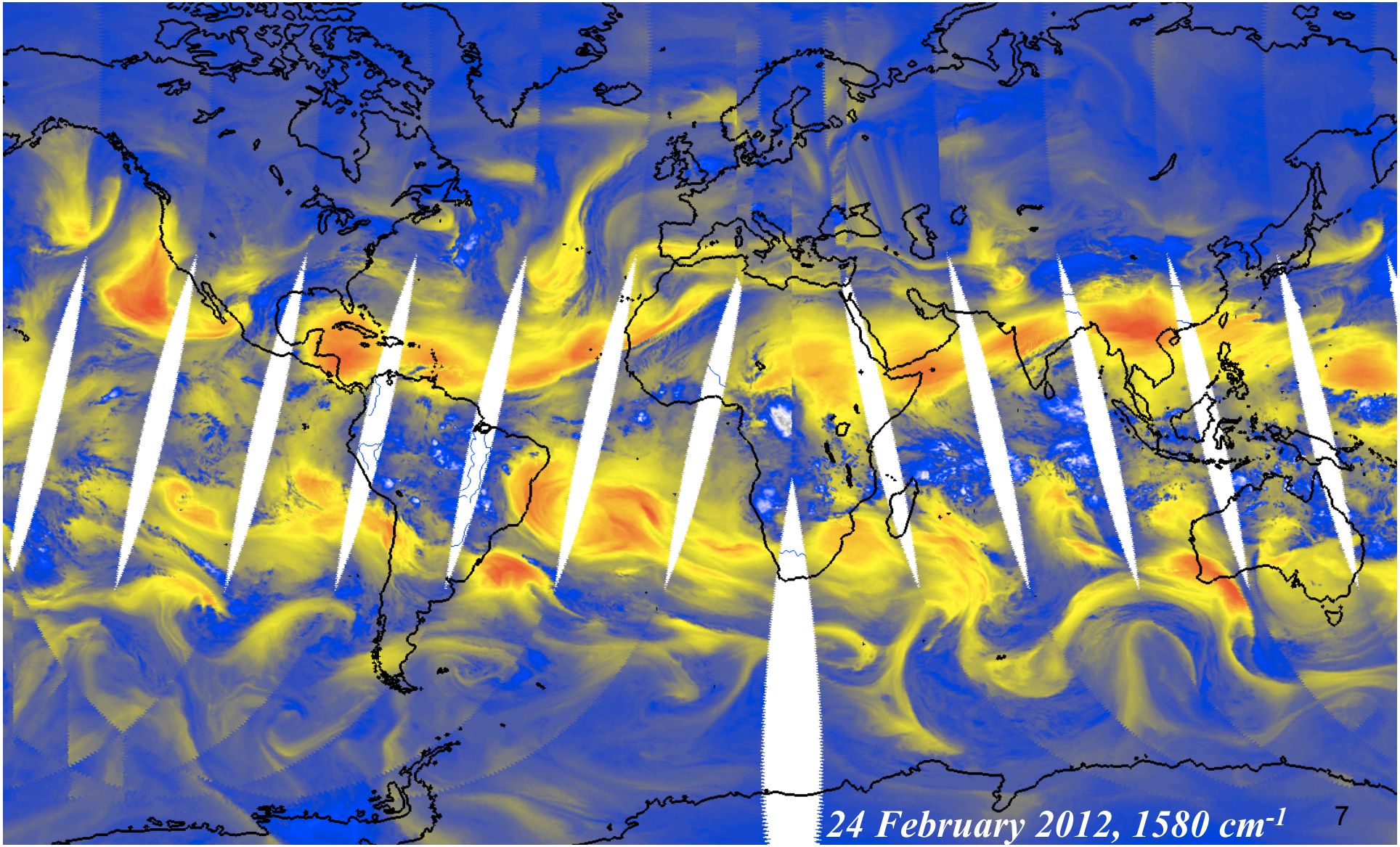
- NPP launched on October 28
- CrIS activated on Jan 20
- CCAST processing and products on Jan 20
- ADL/CSPP processing in place on Feb 21
- IDPS processing in place on April 2
- Product review meeting held April 4
- v33 calibration coefficients to be uploaded April 11
- New FIR filter to be uploaded April 16
- Product declared “beta” status and beginning of Extended Cal/Val phase, the week of April 23.

# *First light images on 20 Jan*
# *900 cm$^{-1}$ BT (K)*

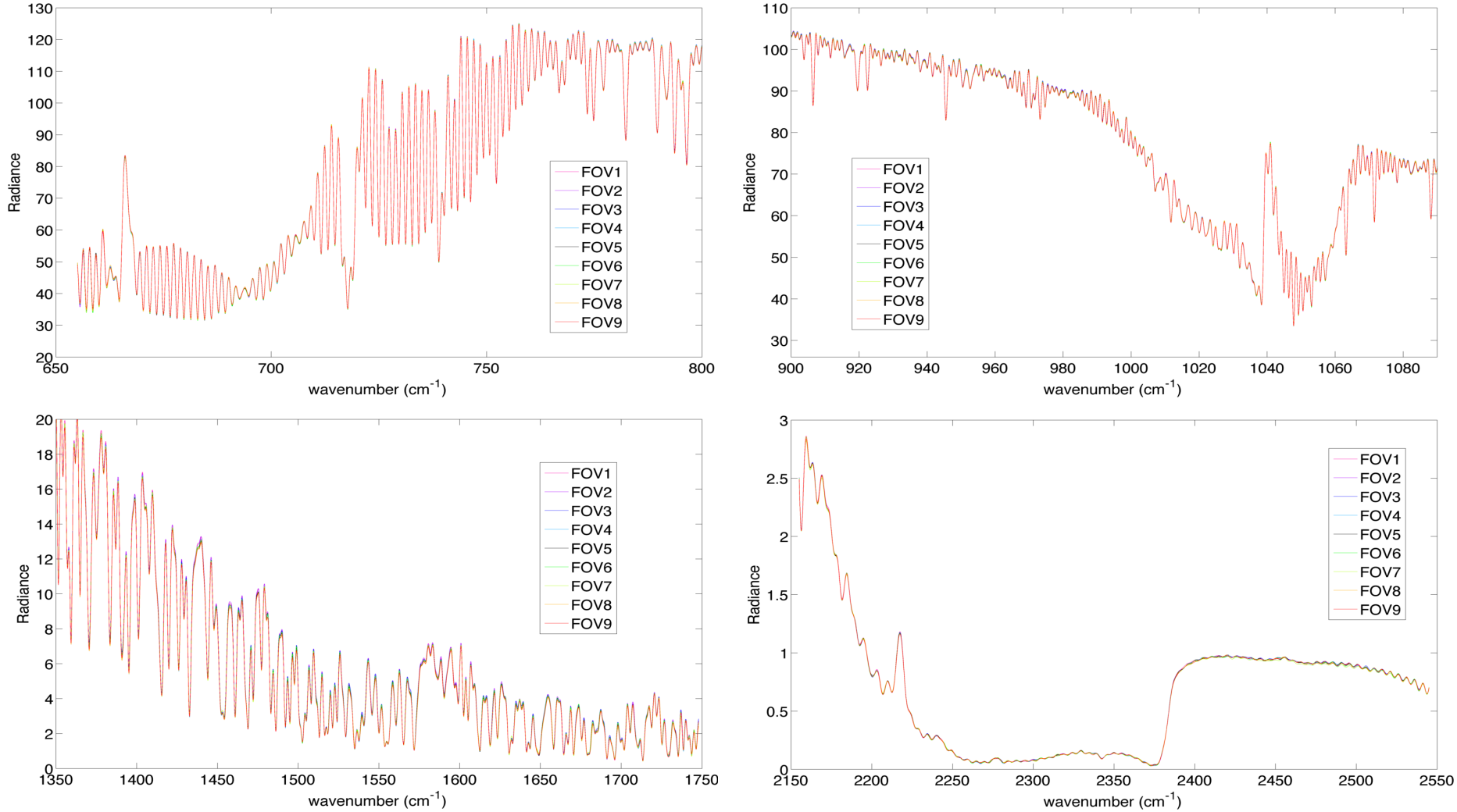


# Water Vapor Map from CrIS

*Especially important given lack of WV channels on VIIRS*



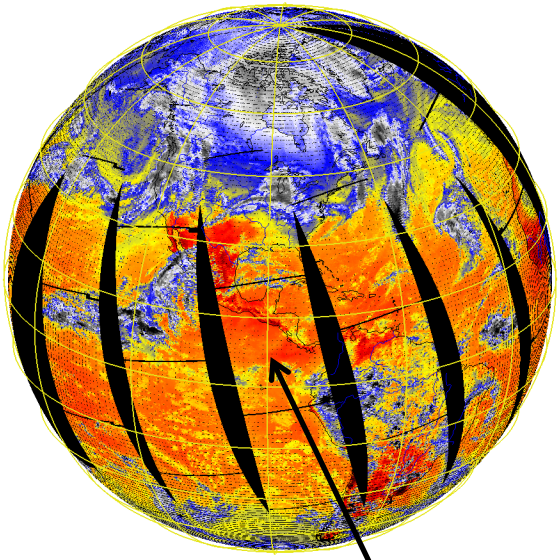
# *Sample spectra for a uniform 3x3 FOR on 20 Jan*

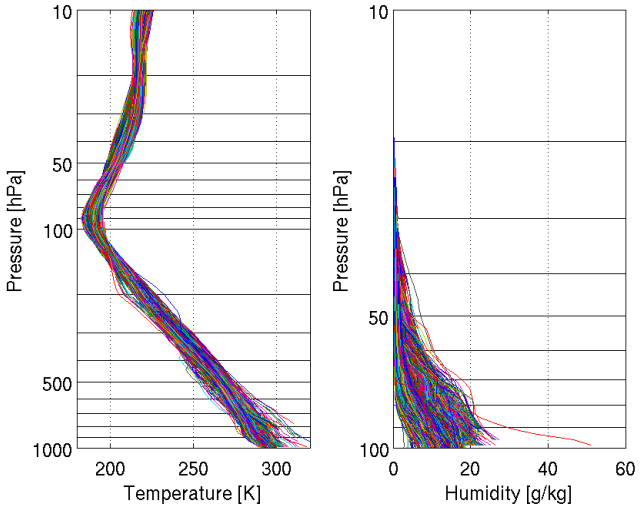


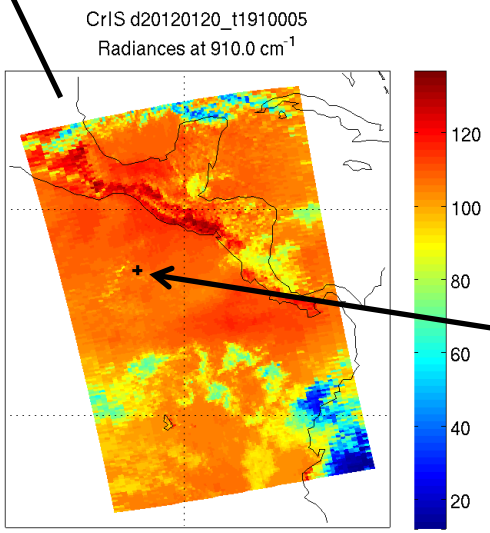
# *T/q Soundings for 20 Jan 2012, t1910005*

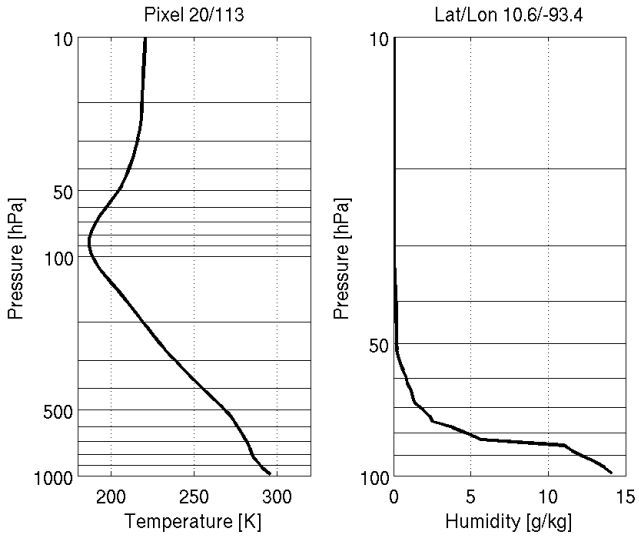
*Dual Regression retrievals*

*c/o Elisabeth Weisz and Bill Smith, 24 Jan*



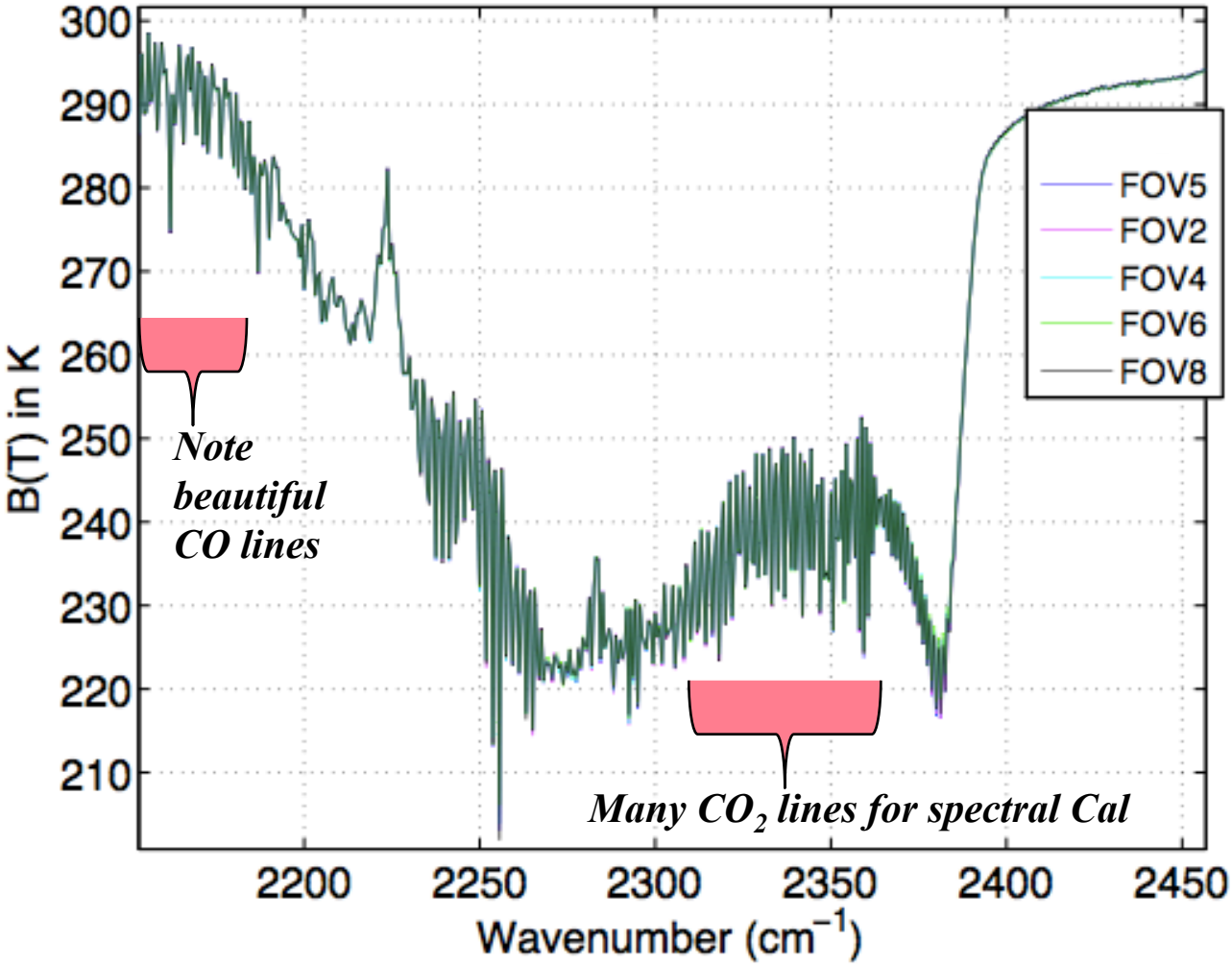


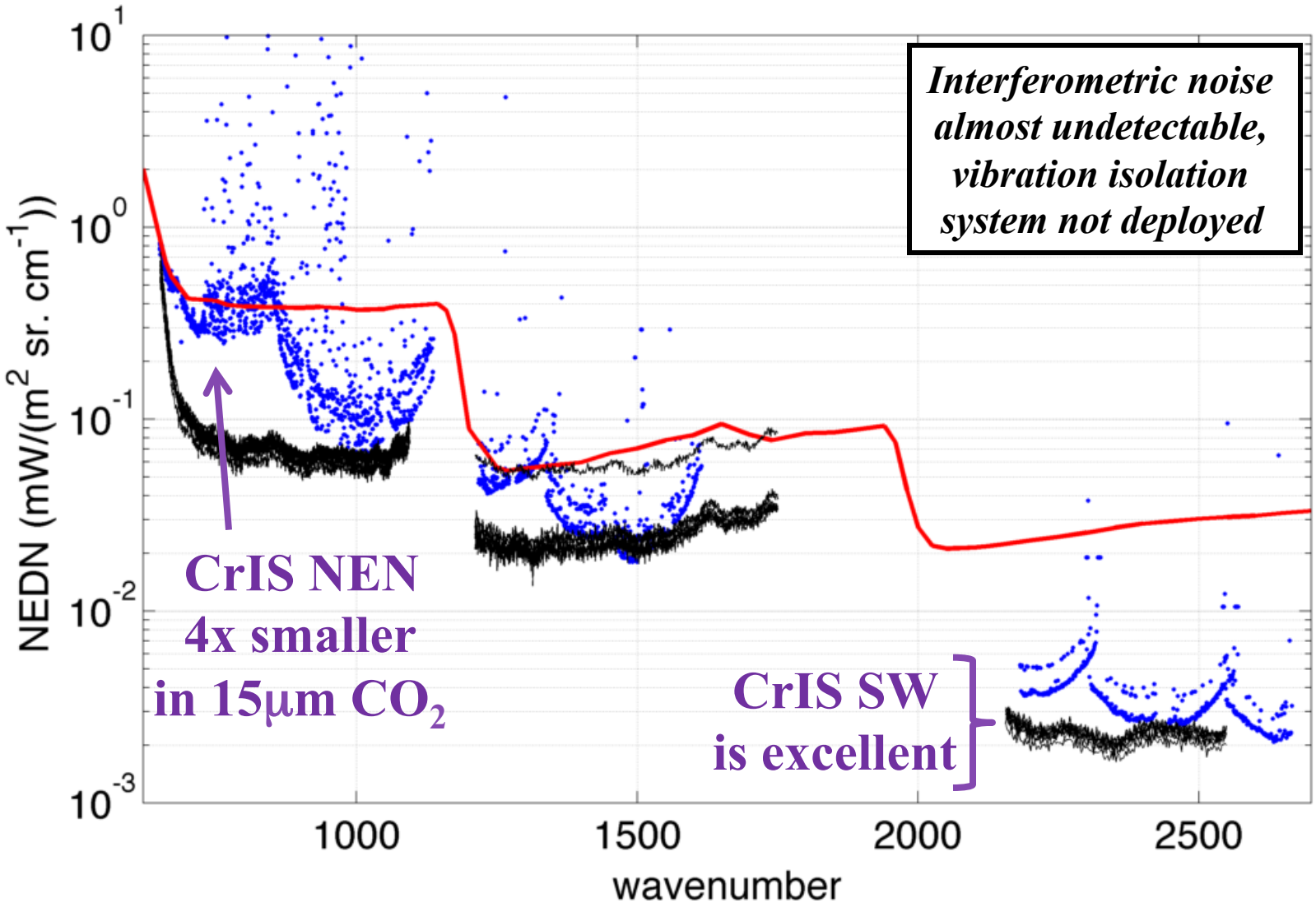
# Full Resolution SW band from CrIS

*We need to lobby for running this resolution routinely*

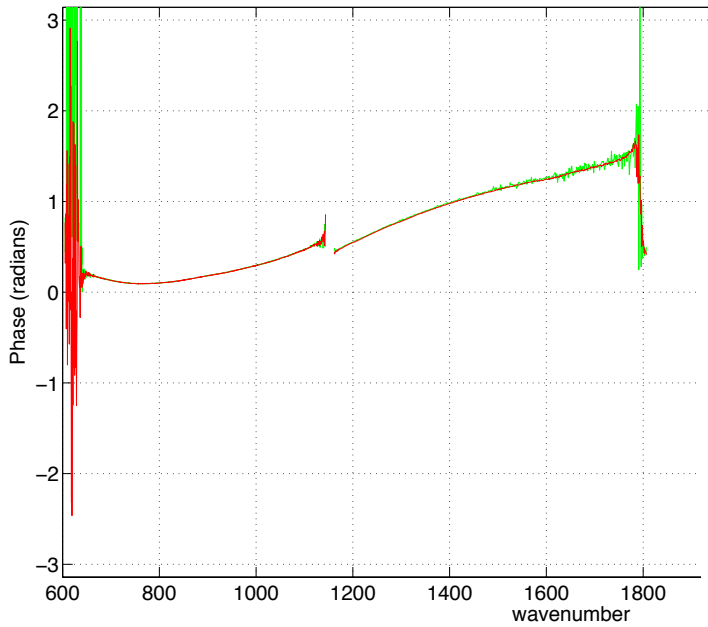


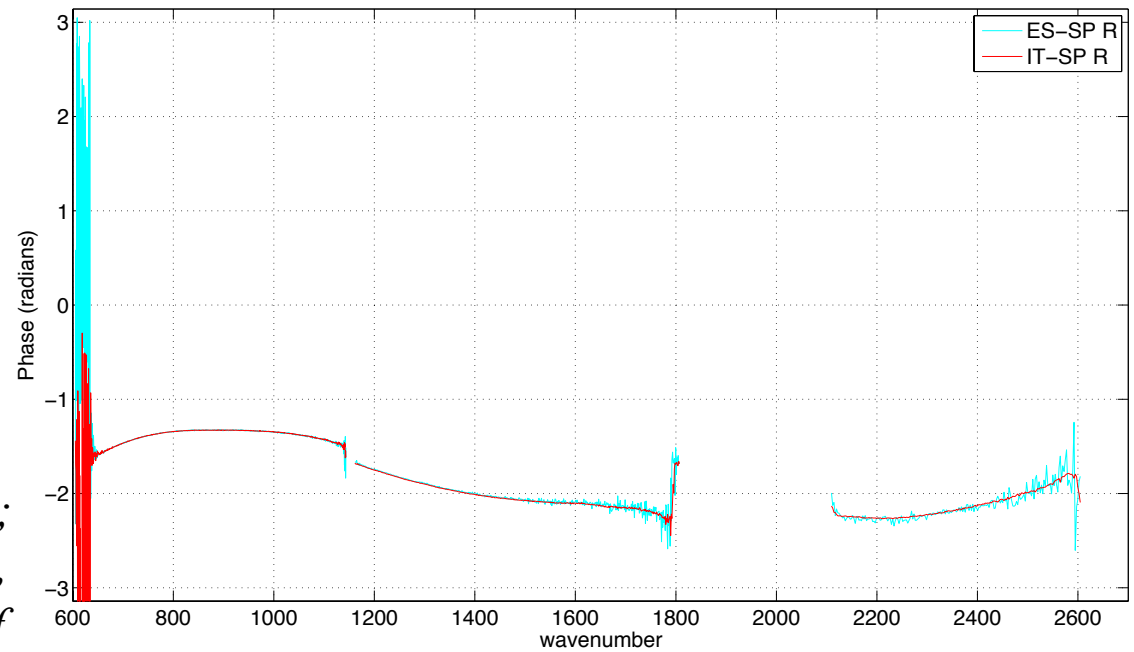

***Calibrated with UW/UMBC CCAST—thanks to Larrabee Strow***

# Noise Comparison:
## CrIS, AIRS L1B, IASI L1C



# *Example Difference Phases: angle($C_{ES}$-$C_{SP}$) and angle($C_{IT}$-$C_{SP}$)*



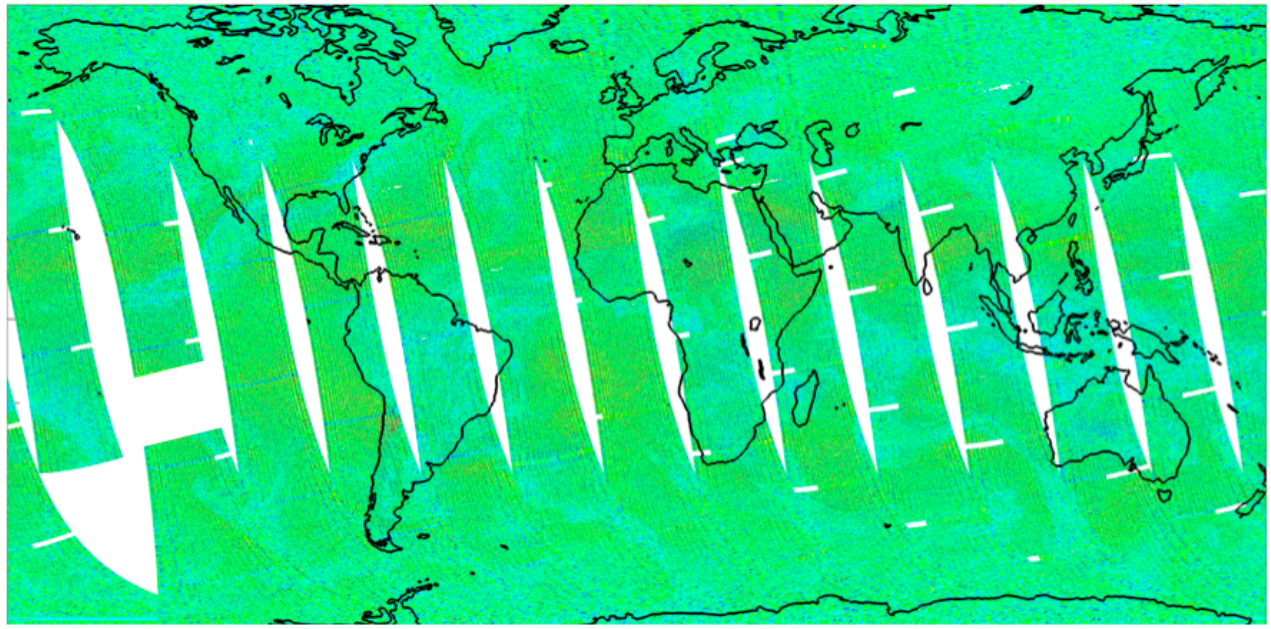



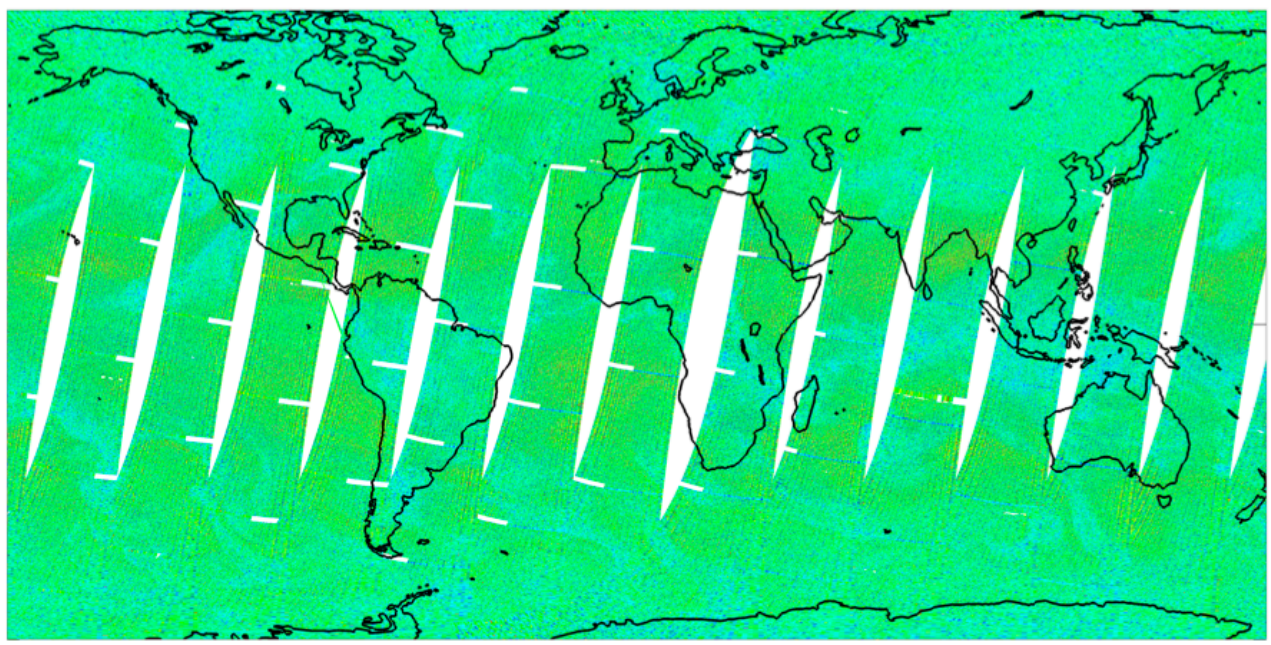

*Instrument fringe counting is robust; Difference Phases are well behaved, resulting in small imaginary parts of the calibrated spectra.*

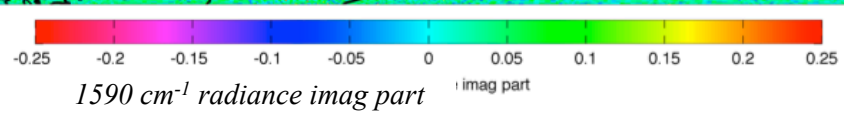
*CCAST*
*21-Jan-2012*

*Small imaginary parts are a key quality control of radiances*

*No Fringe Count errors detected to date.*

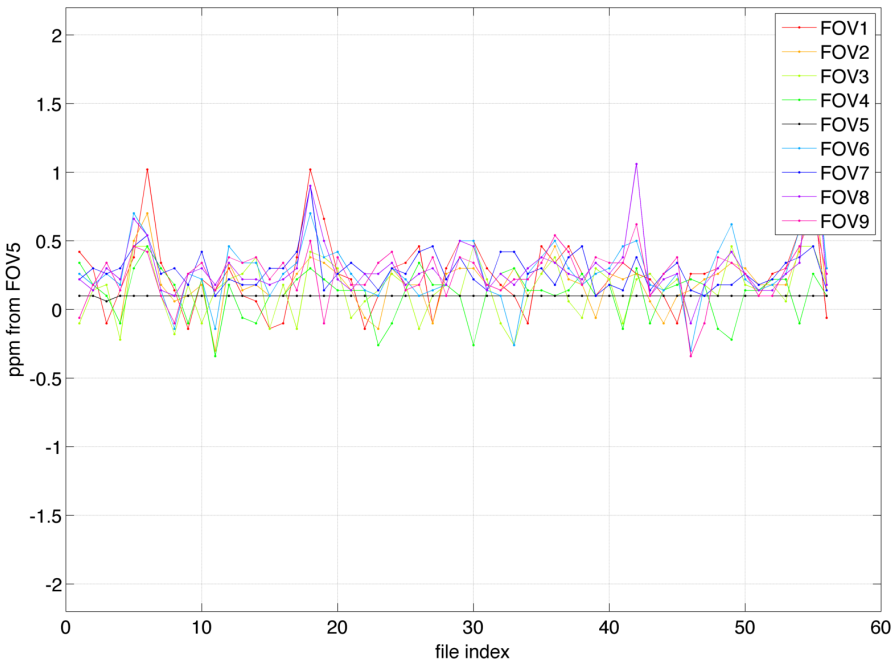




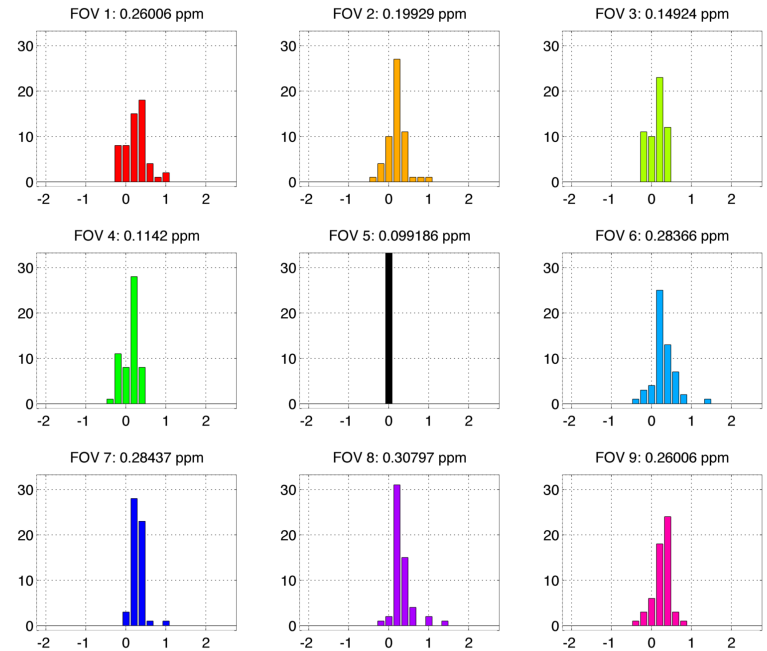



*1590 cm$^{-1}$ radiance imag part*

# 27 March 2012 (following 24/25 event)
# Longwave Spectral shifts (ppm) from FOV5, wrt v33 ILS parameters:



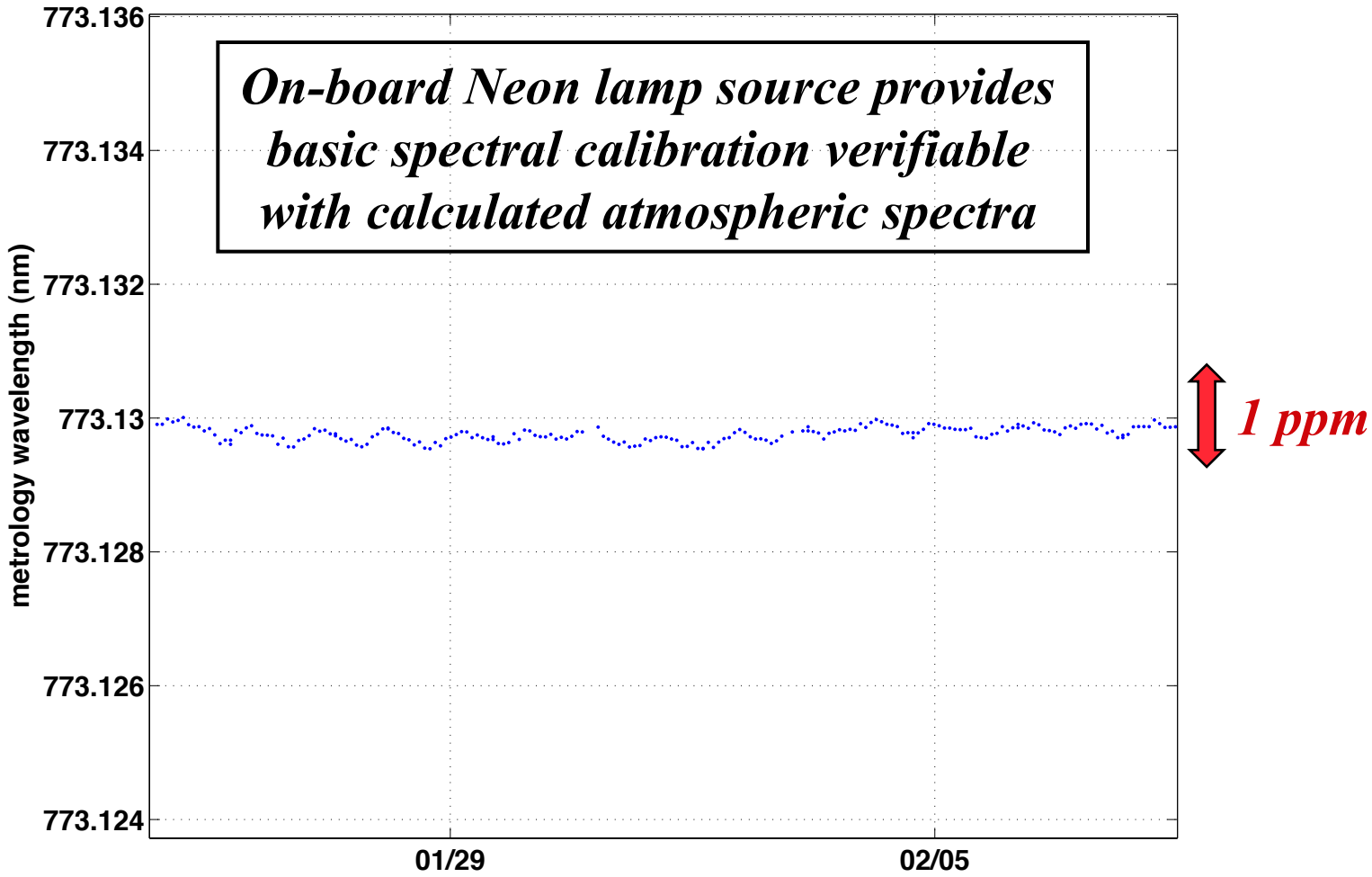

*00 UTC*




*08:15 UTC*

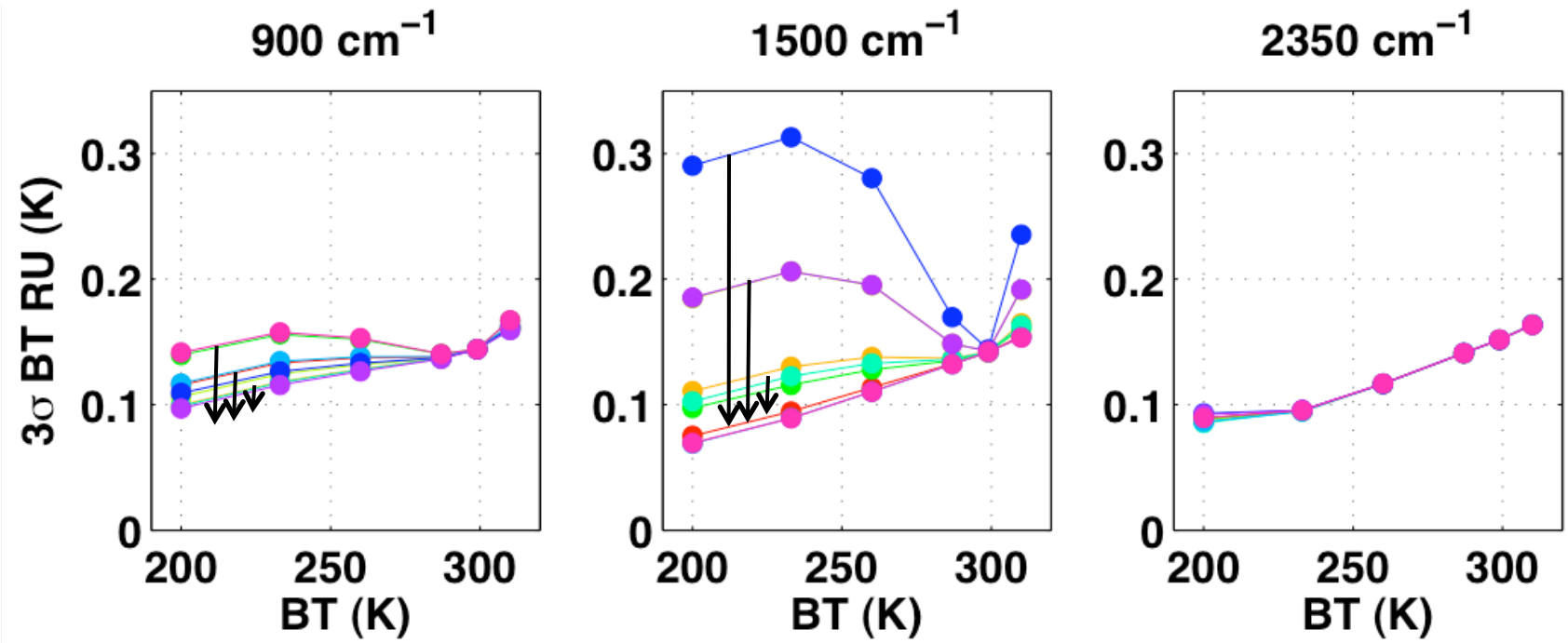
# Neon Spectral Calibration Stability

## Better than 1 ppm!



# Expected Radiometric Uncertainty

**Shown versus scene temperature for all FOVs for ~mid-band spectral channels**




*FOV to FOV spread in LW and especially MW is due to non-linearity*

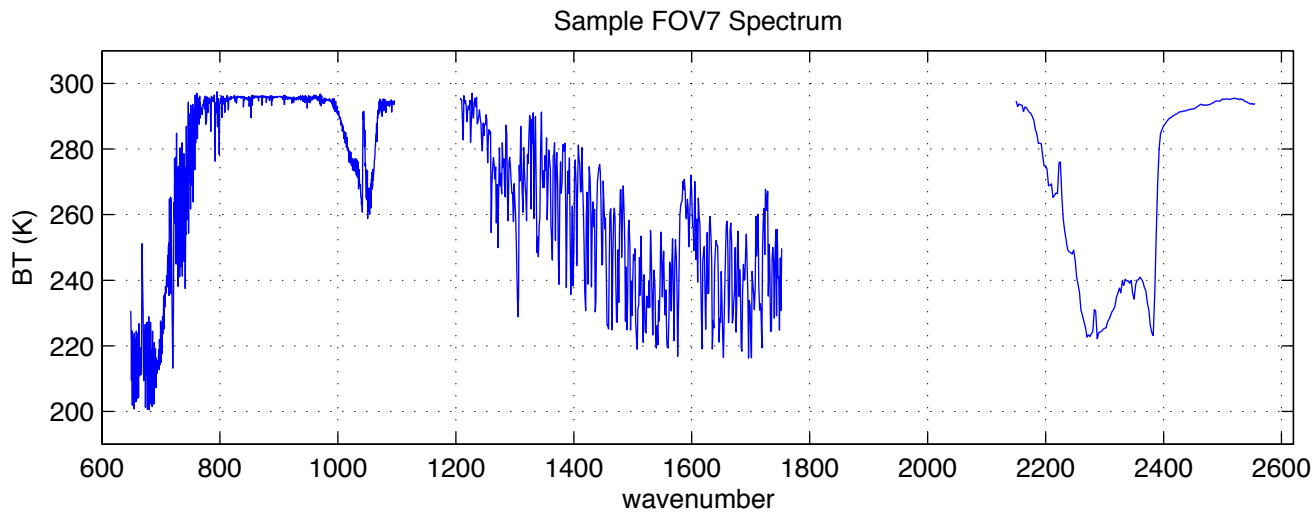
***Final inflight uncertainty far better than spec!***

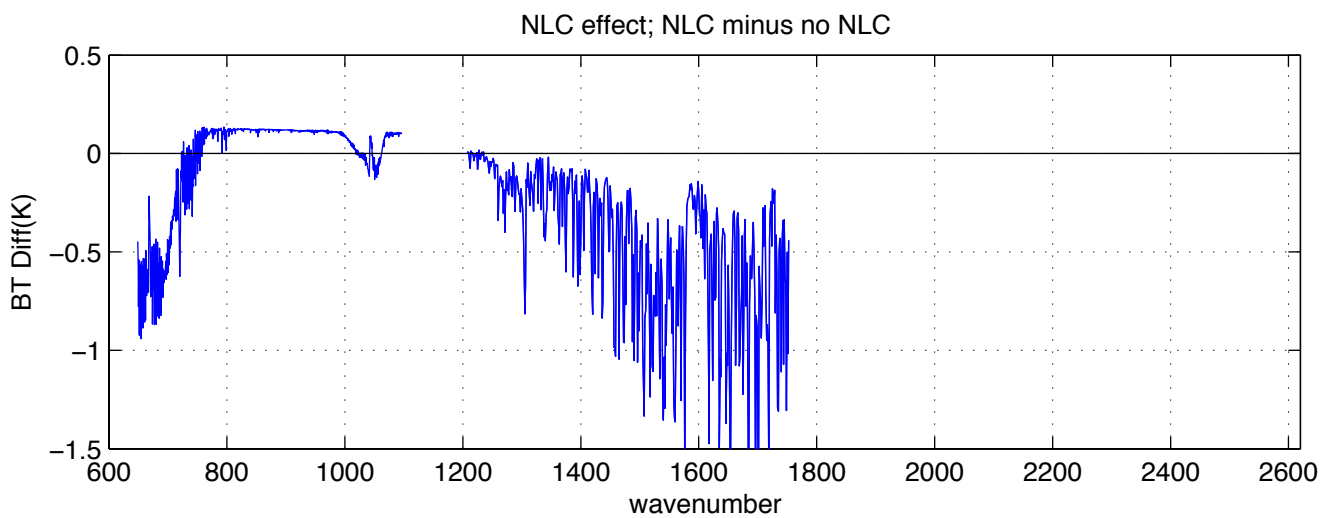
*(< 0.2K 3-sigma, after inflight non-linearity refinement)*

# Non-linearity Correction

- **Out-of-Band Harmonics**
  - Shape fits squared non-linearity
  - Low wavenumber signal fit to $a_2$, coefficient of squared term
- **Relative FOV to FOV adjustments with Earth data**
  - Samples weighted by uniformity
  - As reference, MW uses its one very linear detector (FOV9)
  - As reference, LW uses $a_2$ for FOV5 from Out-of-Band Harmonic analysis

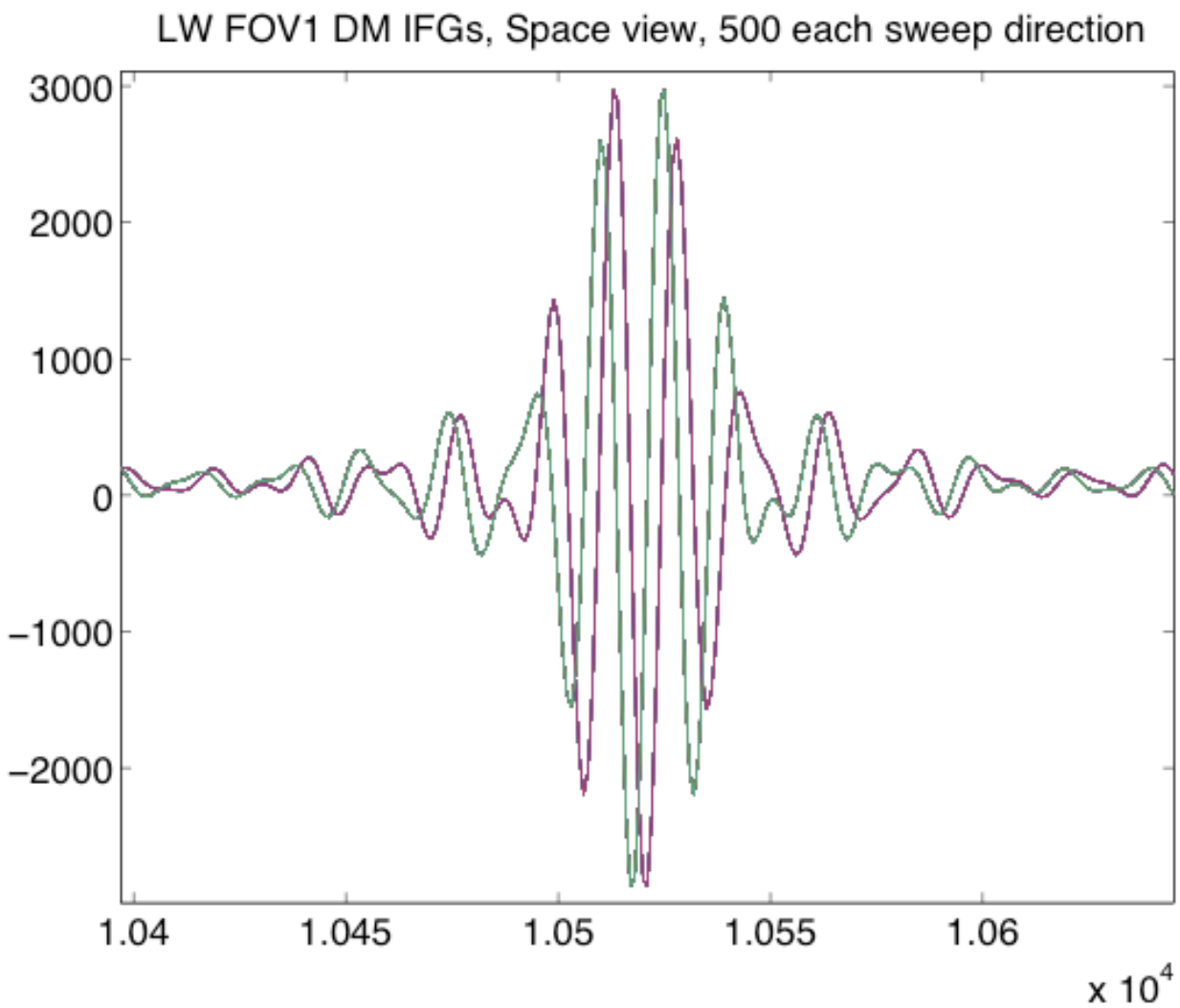
# Example Non-linearity
## (~Largest)



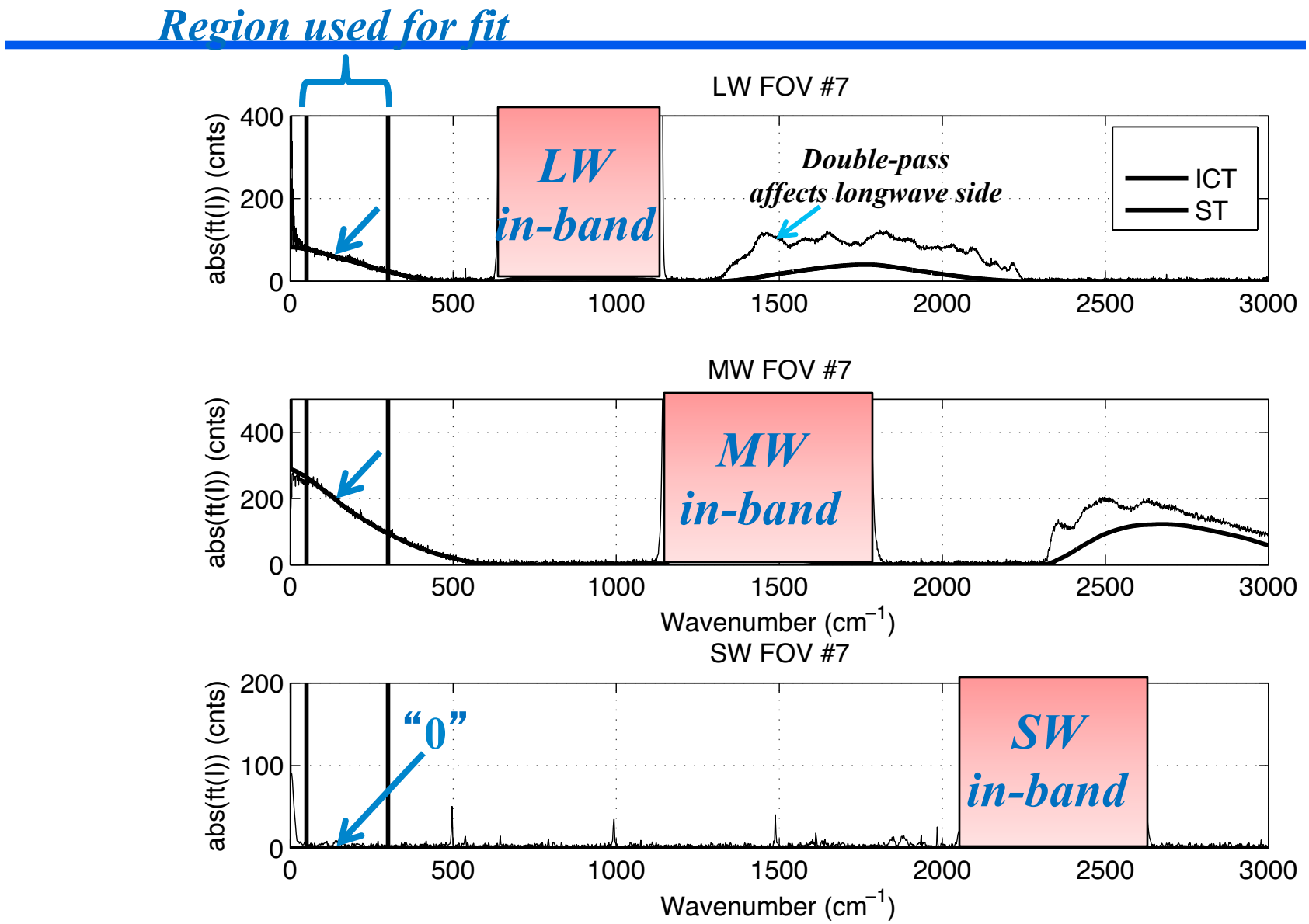



# Example Interferograms

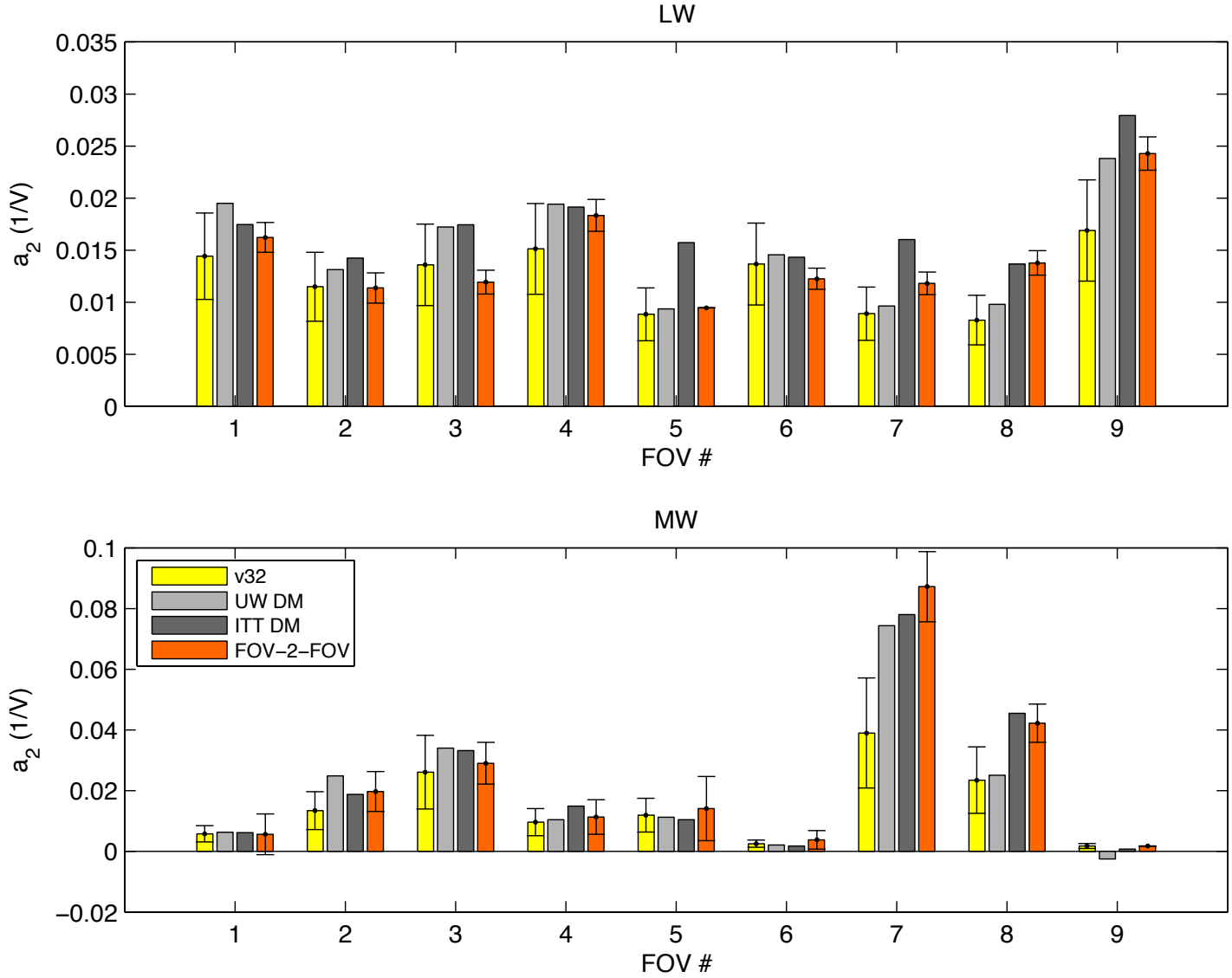
## Over-sampled to preserve Non-linearity Harmonics



# Fit for squared non-linearity coefficient $a_2$



# Non-Linearity Correction Coefficient, $a_2$




v32 based on TVAC3; "02" based on Earth view FOV-to-FOV analysis; Gray from Out-of-Band analyses

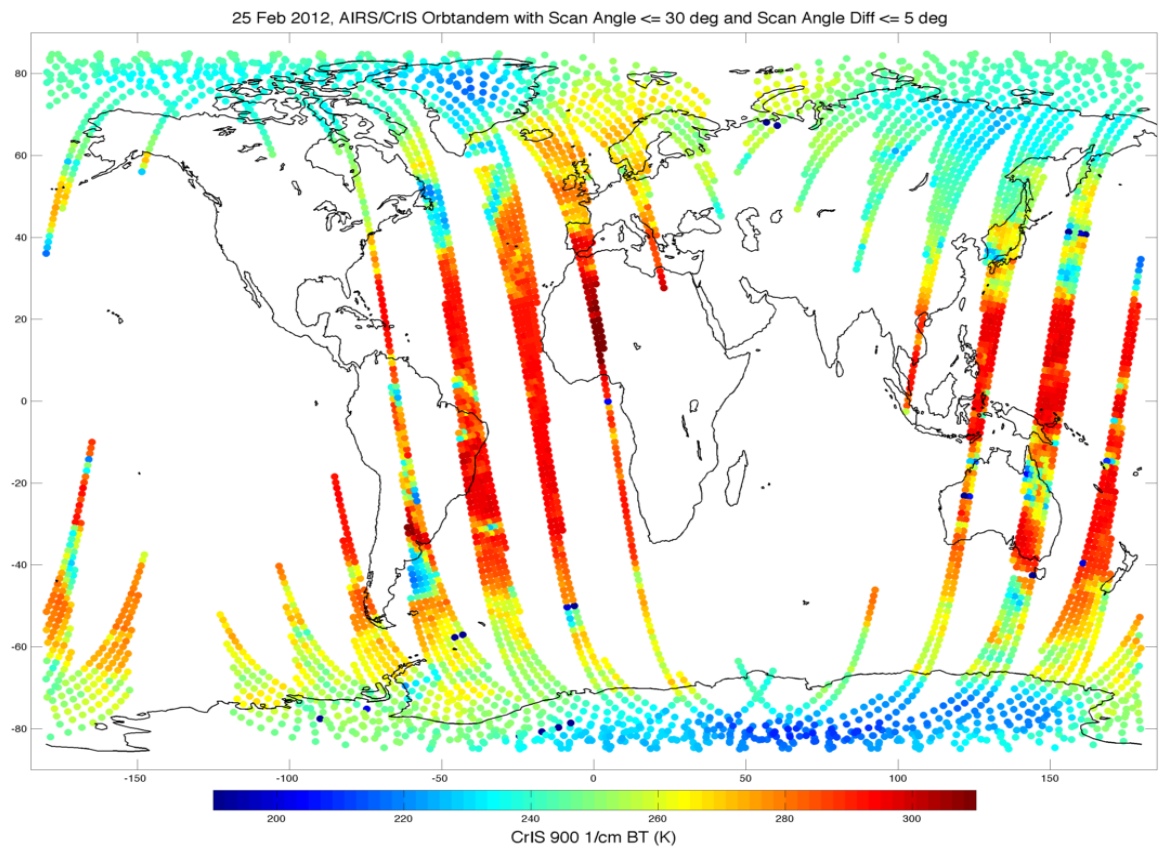
***Corrected Raw Complex Spectrum = Raw Complex Spectrum × (1+ 2 $a_2$ V)***

*where V is DC level voltage at 1st stage of preamplifier*

# *Preliminary Comparisons with AIRS*

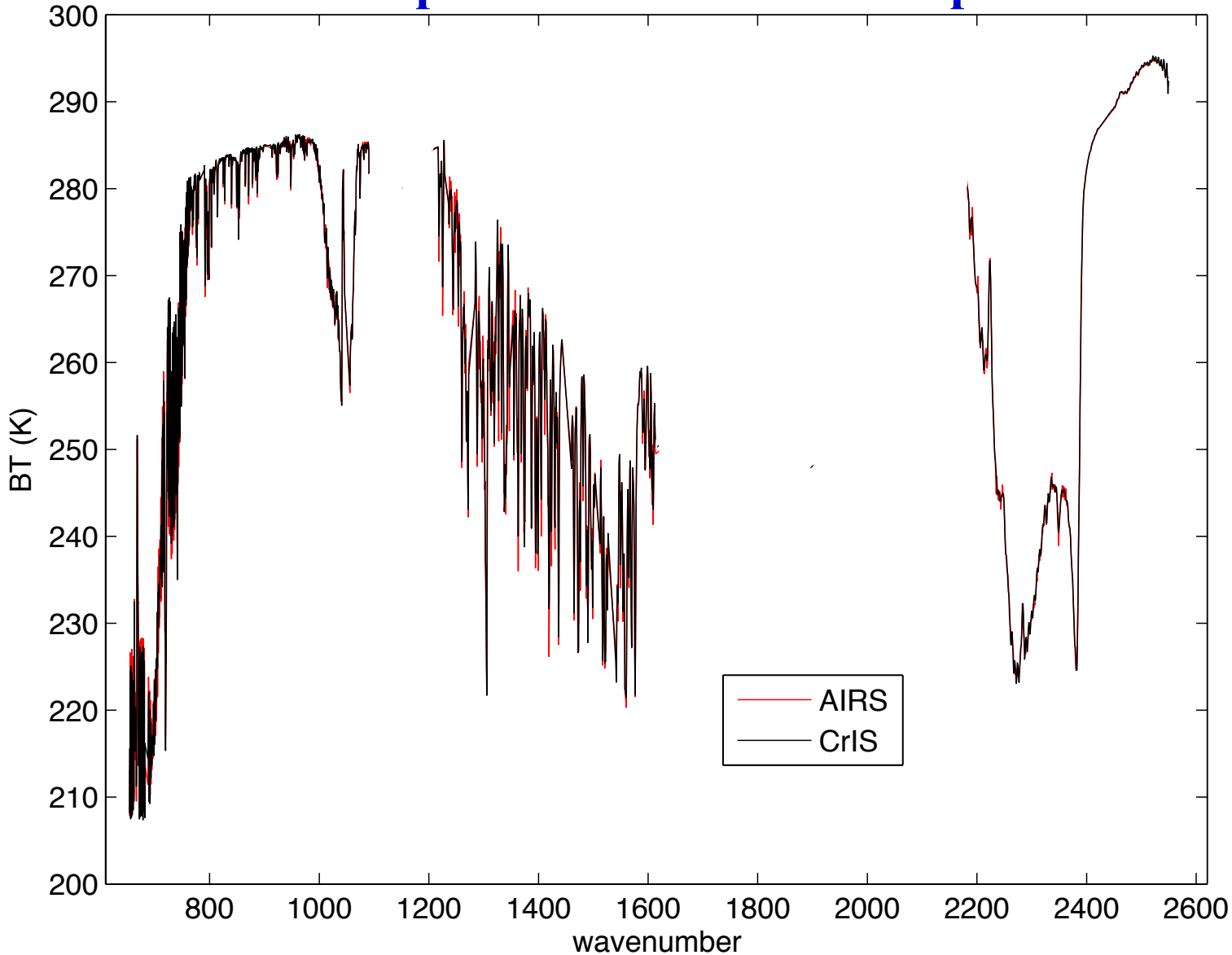
- Analogous to other prior SNO type comparisons
- AIRS and CrIS data within large ellipsoids gathered (~100 km dia at nadir)
- Mean spectra and StdDev of spectra recorded
- Data screened by time matchup, view angle, etc and weighted by scene variability to examine biases
- Spectral manipulations performed to view channel-by-channel differences

*25 Feb overlaps,*
*Scan angles ≤ 30°*
*&*
*Scan angle dif ≤ 5°*



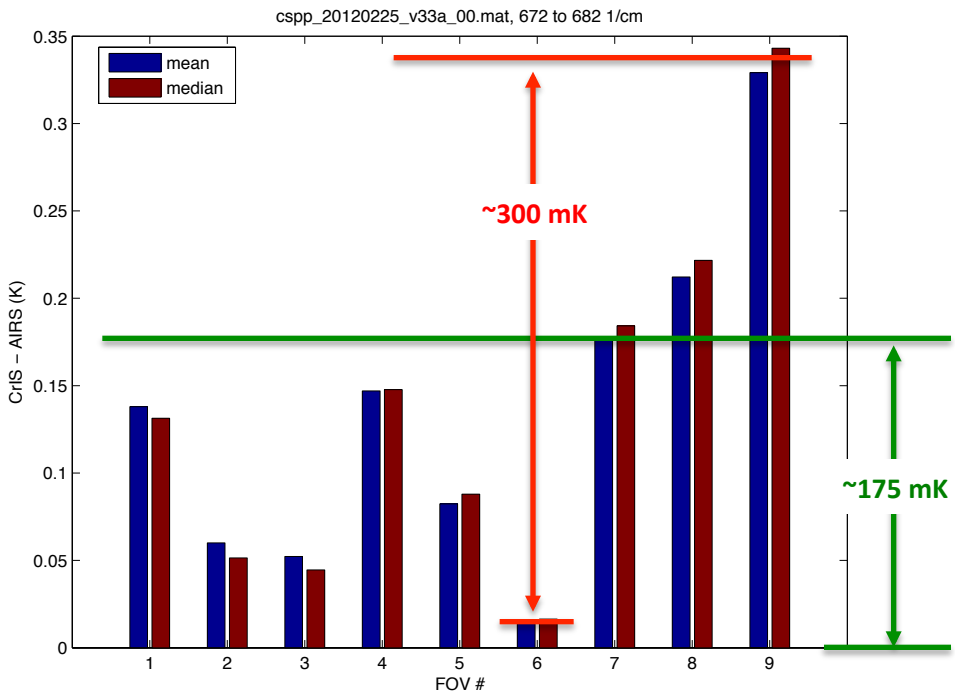
# Preliminary Comparison to AIRS

## Mean spectra for 25 Feb overlaps

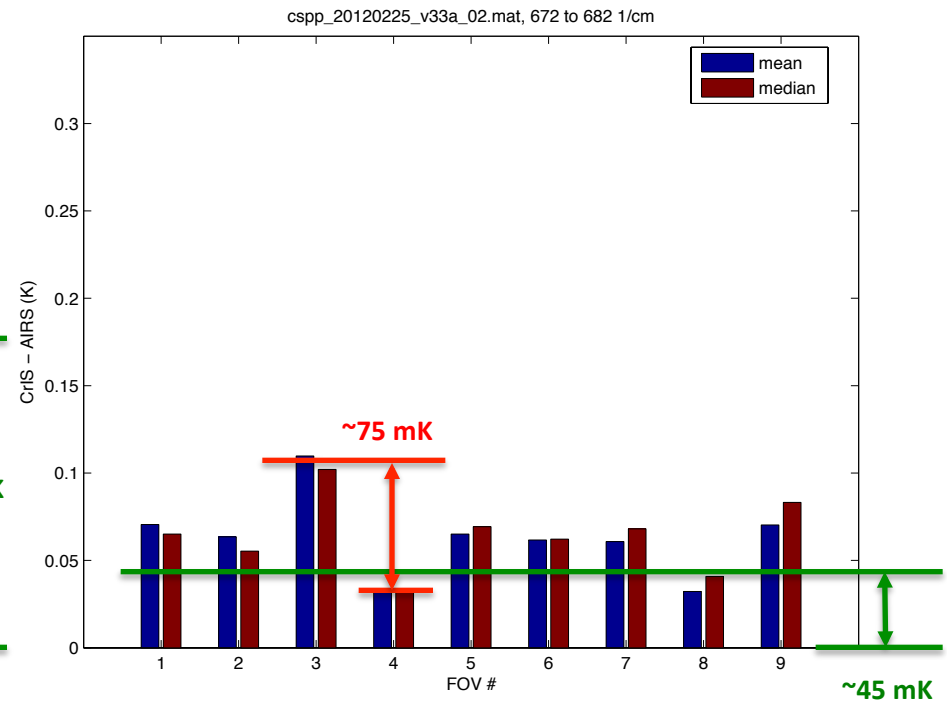


# Improved LW $a_2$ from On-orbit Analyses:
## FOV-to-FOV Consistency also reduces difference from AIRS

### TVAC $a_2$ values




### On-orbit $a_2$ values

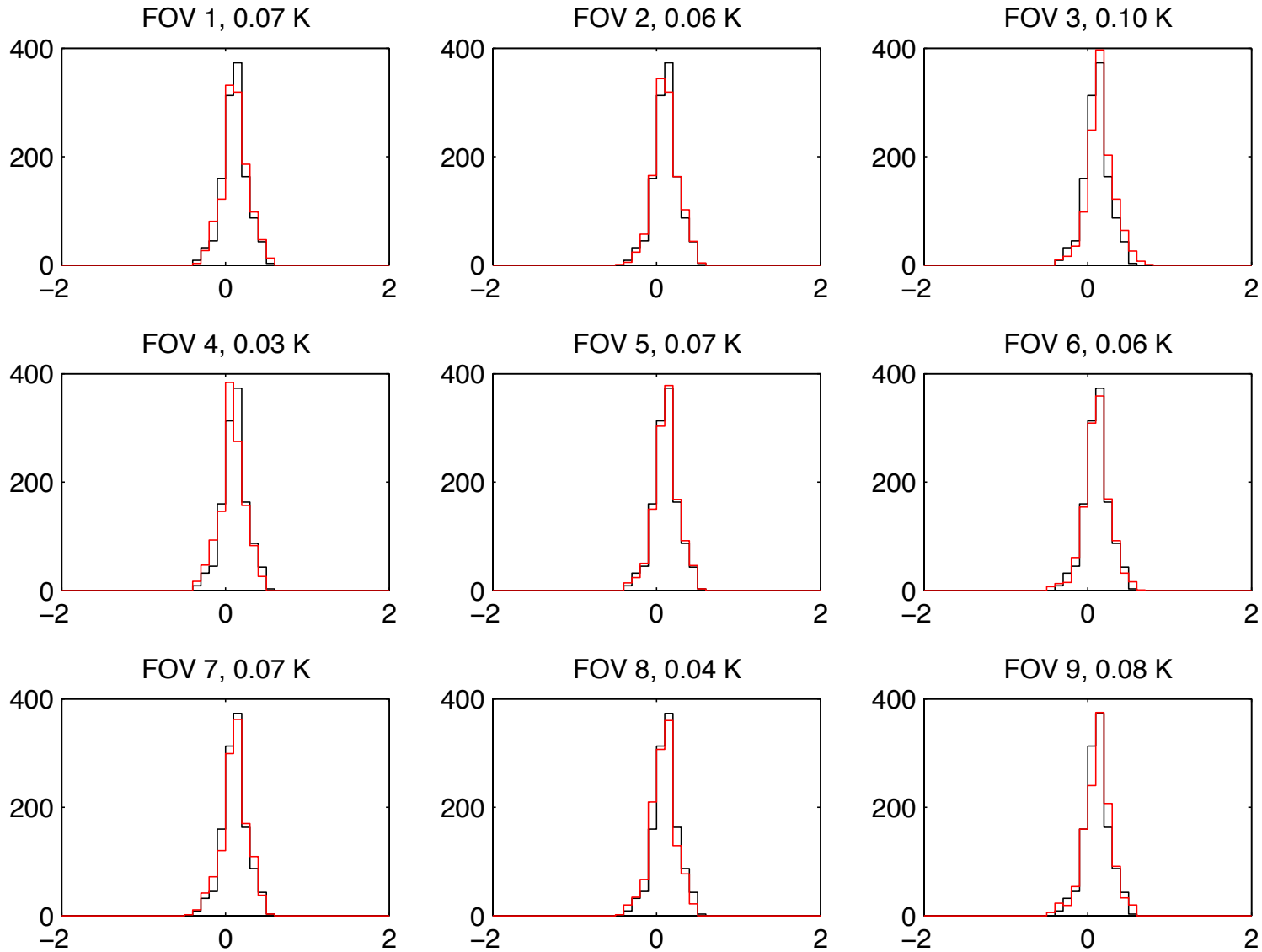



LW CO2: **FOV-2-FOV range** and **median difference from AIRS**

***Resulting Differences from AIRS are quite small***

# *CrIS minus AIRS BT(K) Differences Well Behaved*

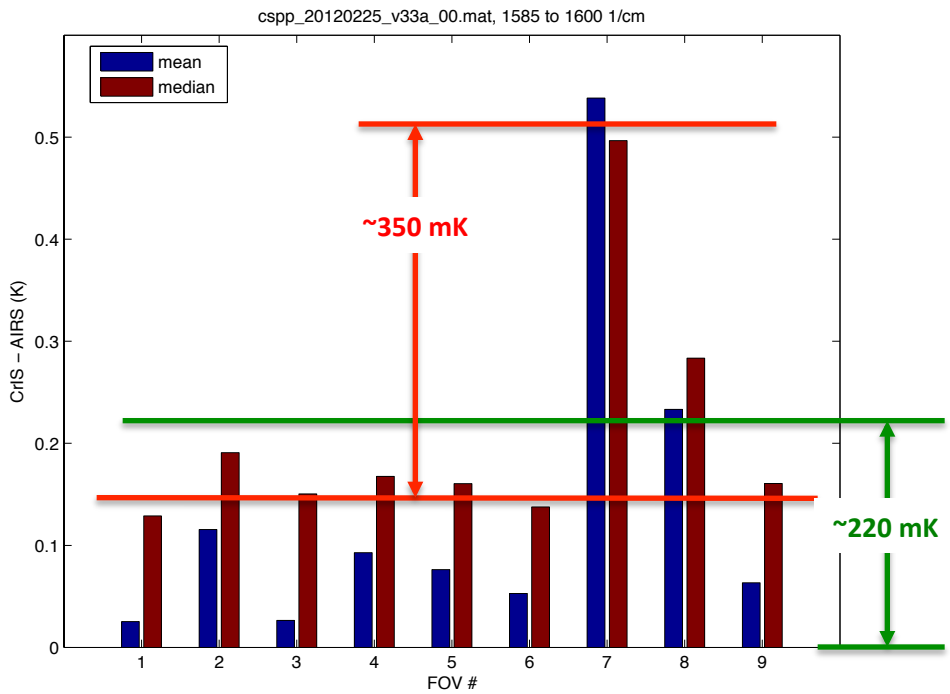
## *LW @ 672-682 cm$^{-1}$*



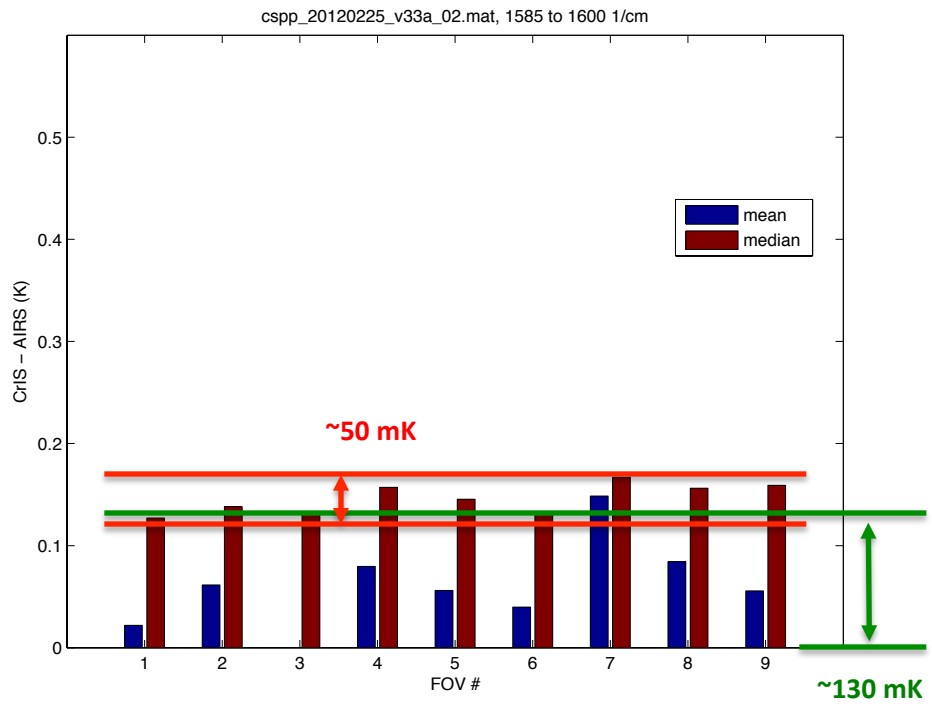

***Black = All FOVs (same in all panels)***

# Improved MW $a_2$ from On-orbit Analyses:
## FOV-to-FOV Consistency also reduces difference from AIRS

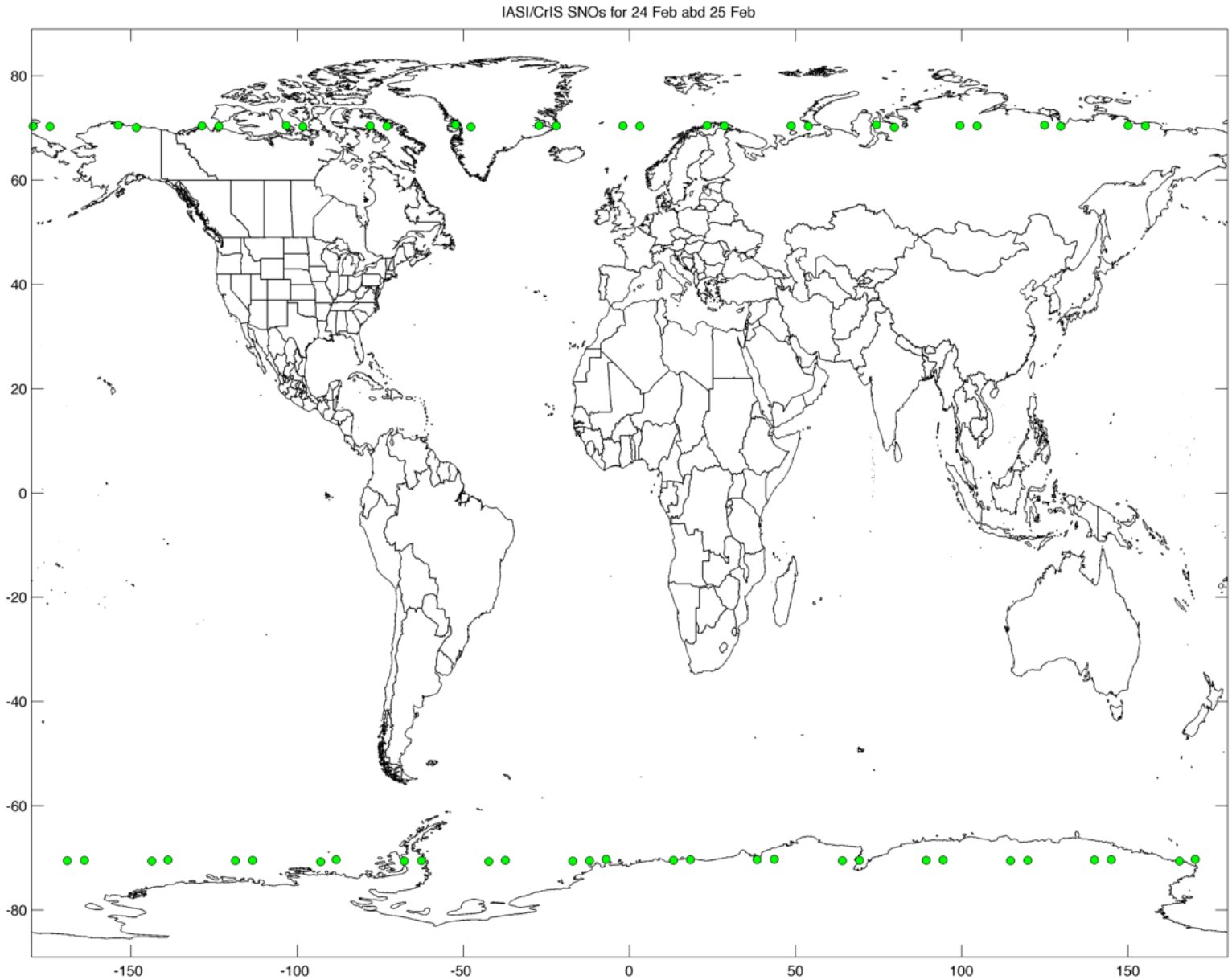
### TVAC $a_2$ values

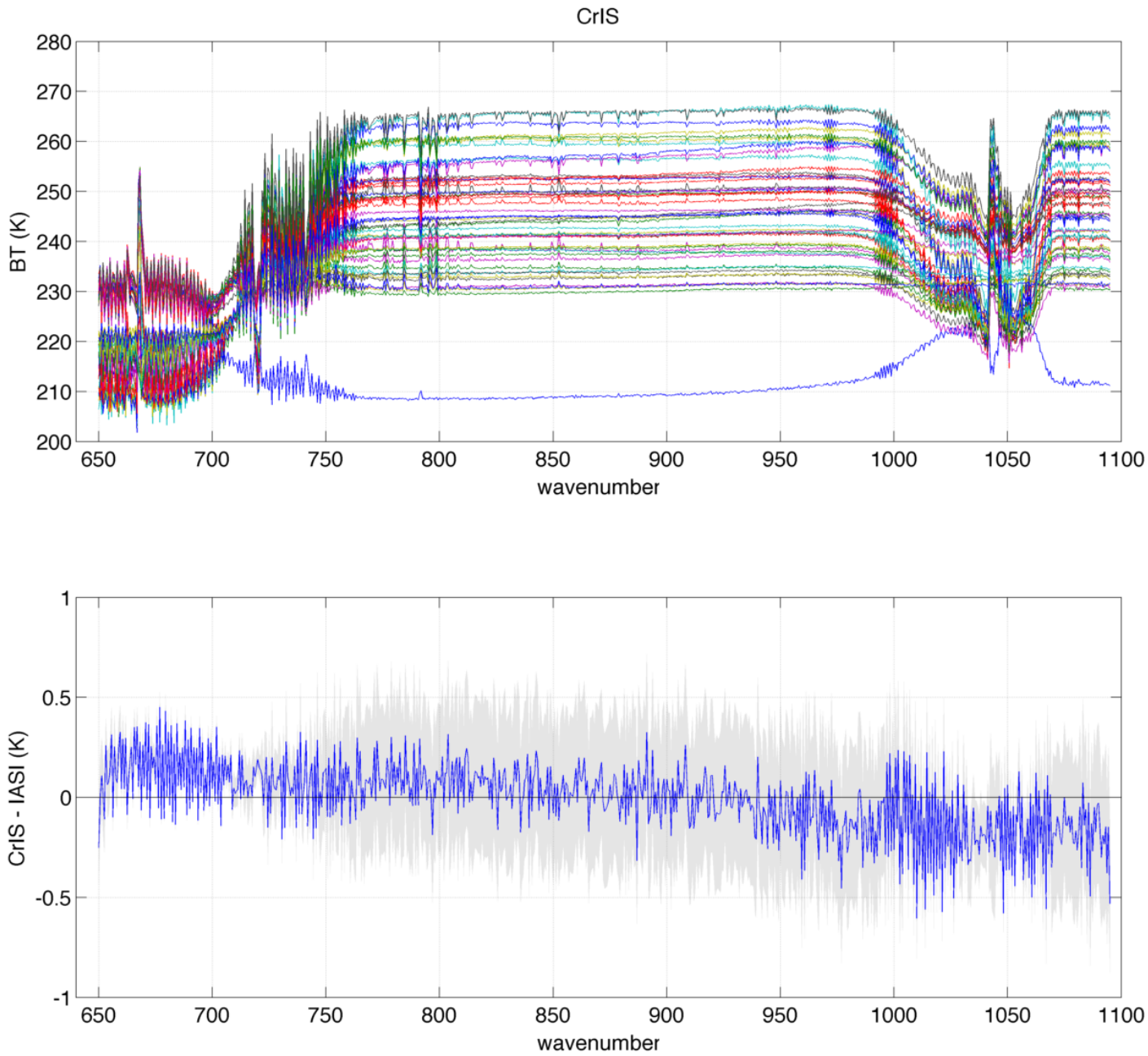



### On-orbit $a_2$ values

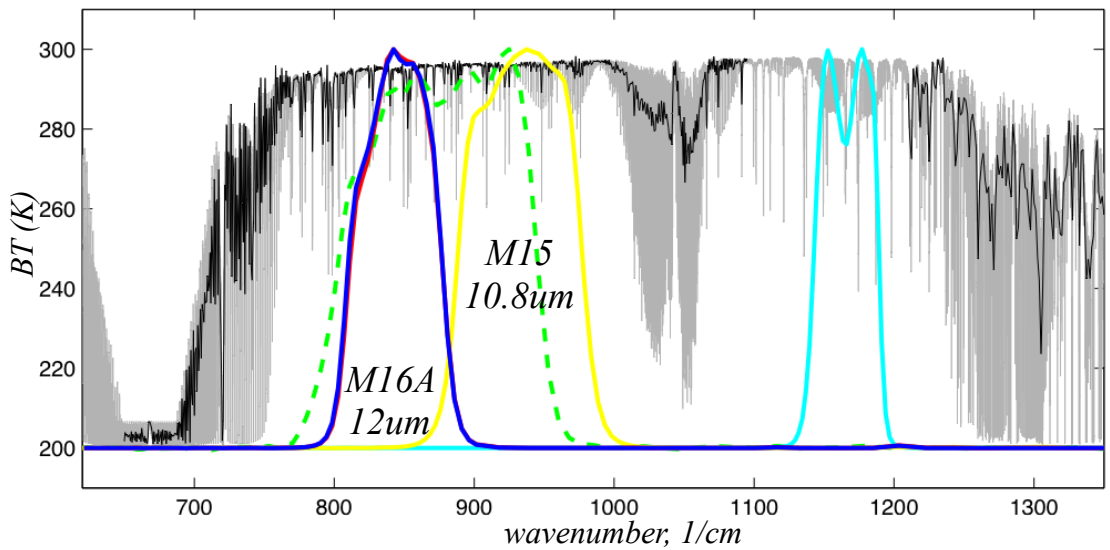


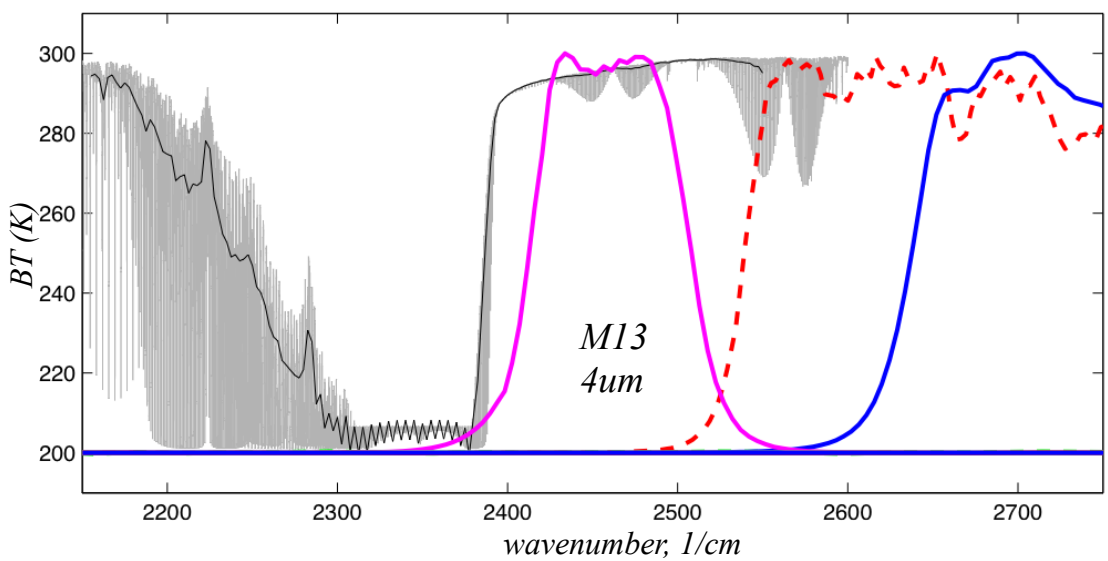

MW WV: **FOV-2-FOV range** and **median difference from AIRS**


IASI/CrIS SNOs for 24 Feb abd 25 Feb
80
60
40
20
0
-20
-40
-60
-80
-150
-100
-50
0
50
100
150


CrIS
BT (K)
280
270
260
250
240
230
220
210
200
650
700
750
800
850
900
950
1000
1050
1100
wavenumber
CrIS - IASI (K)
1
0.5
0
-0.5
-1
650
700
750
800
850
900
950
1000
1050
1100
wavenumber

# *Monochromatic spectrum, CrIS spectrum, and VIIRS SRFs*

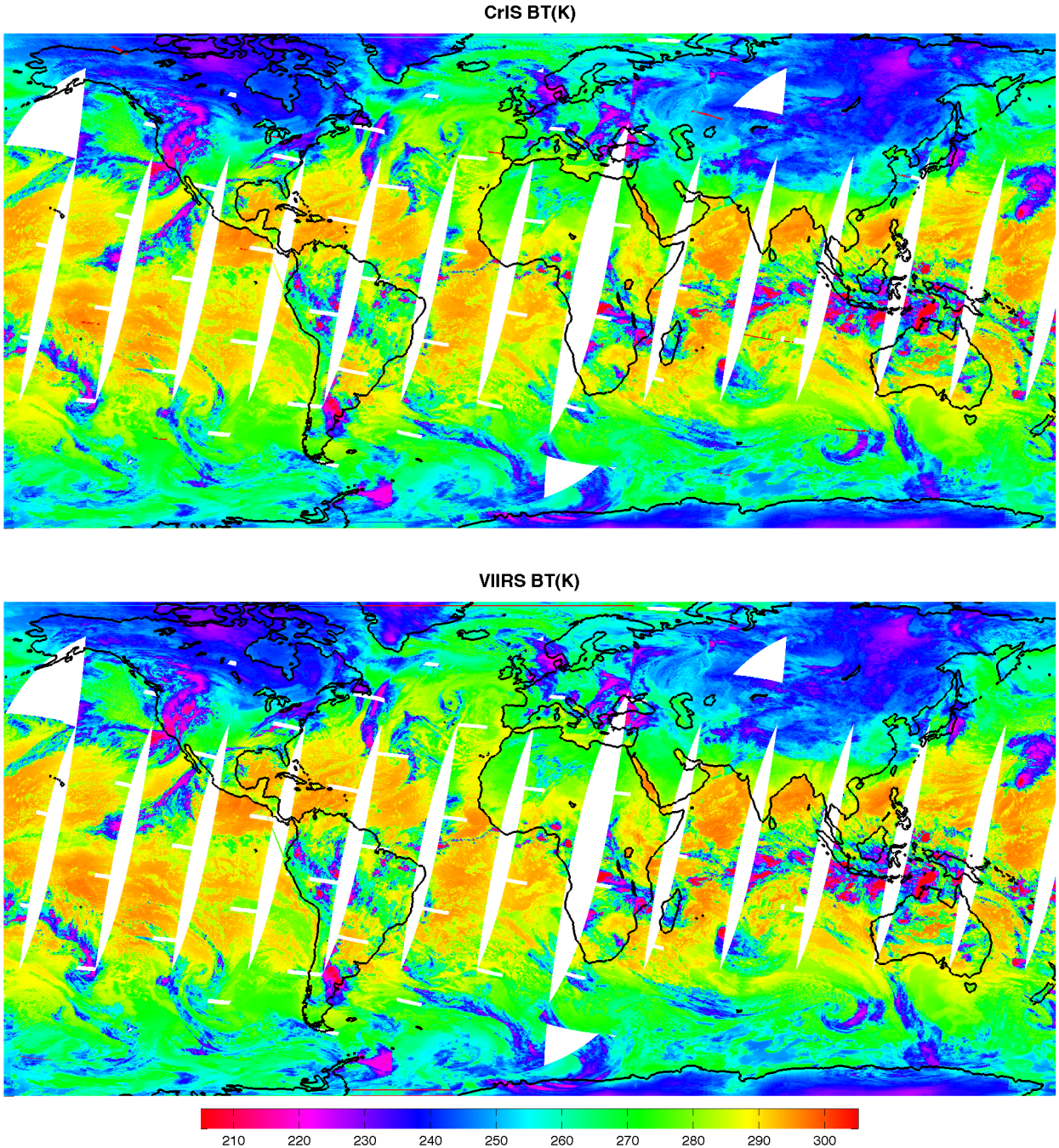


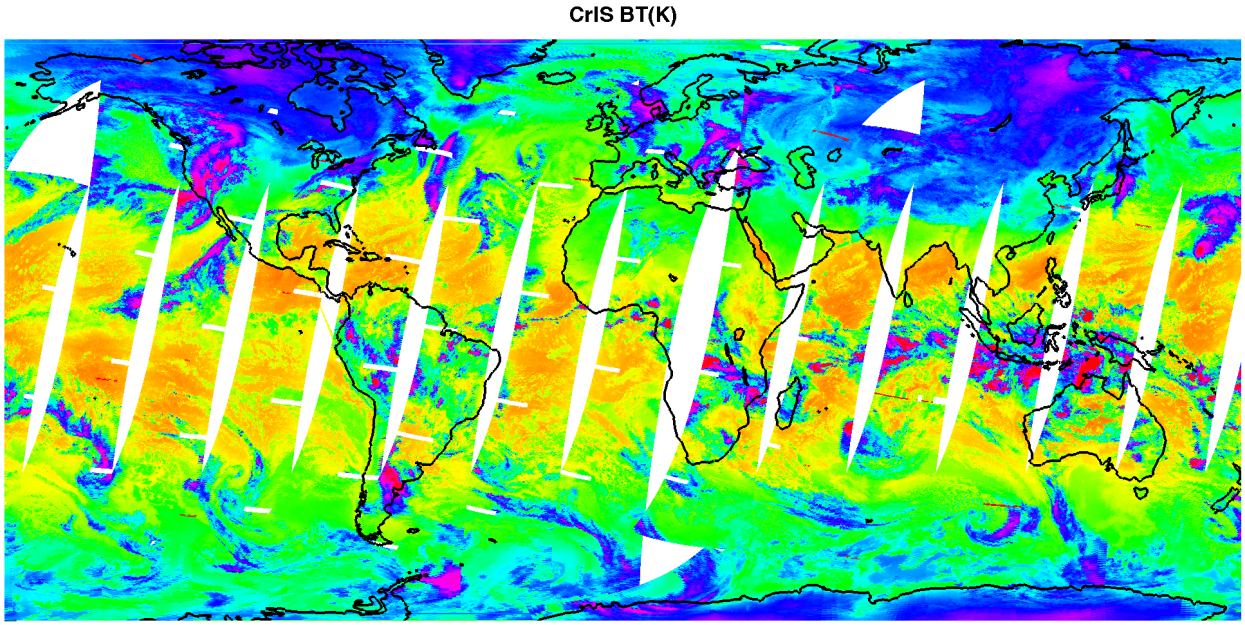
*CrIS convolved w/ VIIRS SRF (top)*

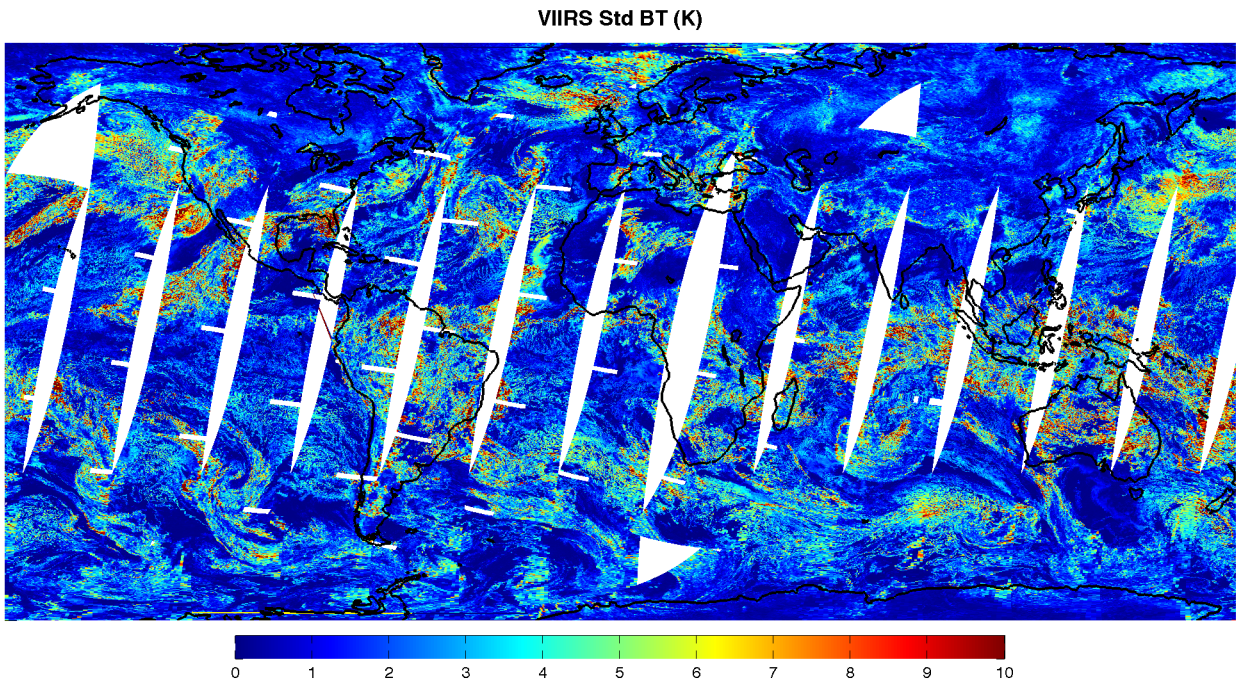
*and*

*VIIRS mean w/ in CrIS FOVs (bottom)*

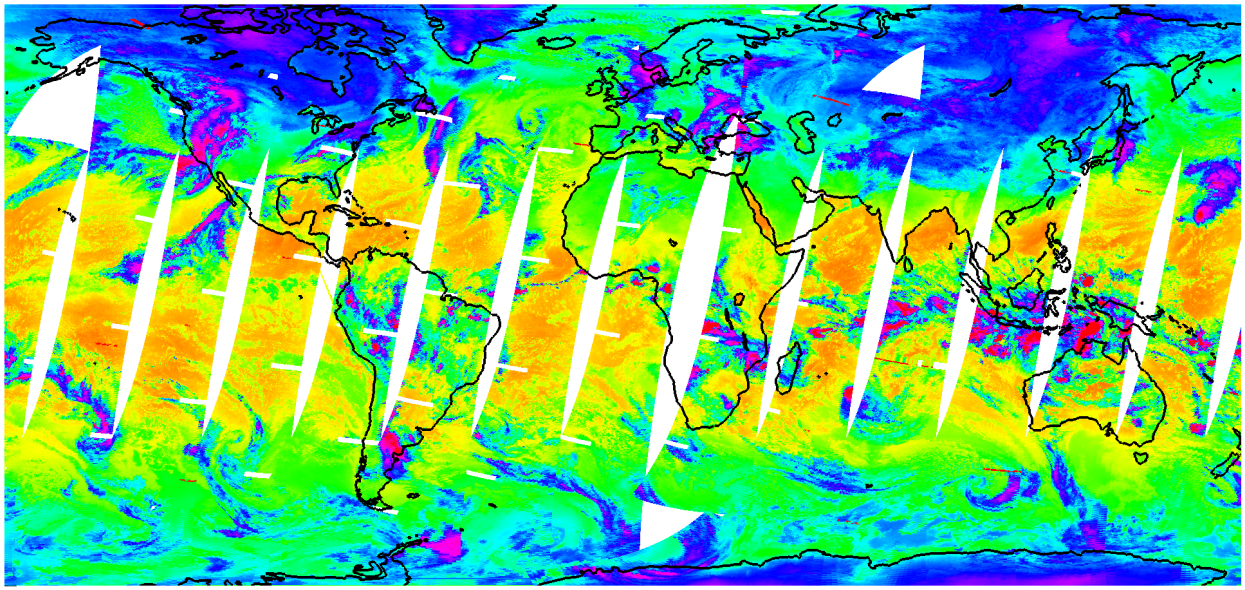


*Standard Deviation of VIIRS w/in CrIS FOVs*



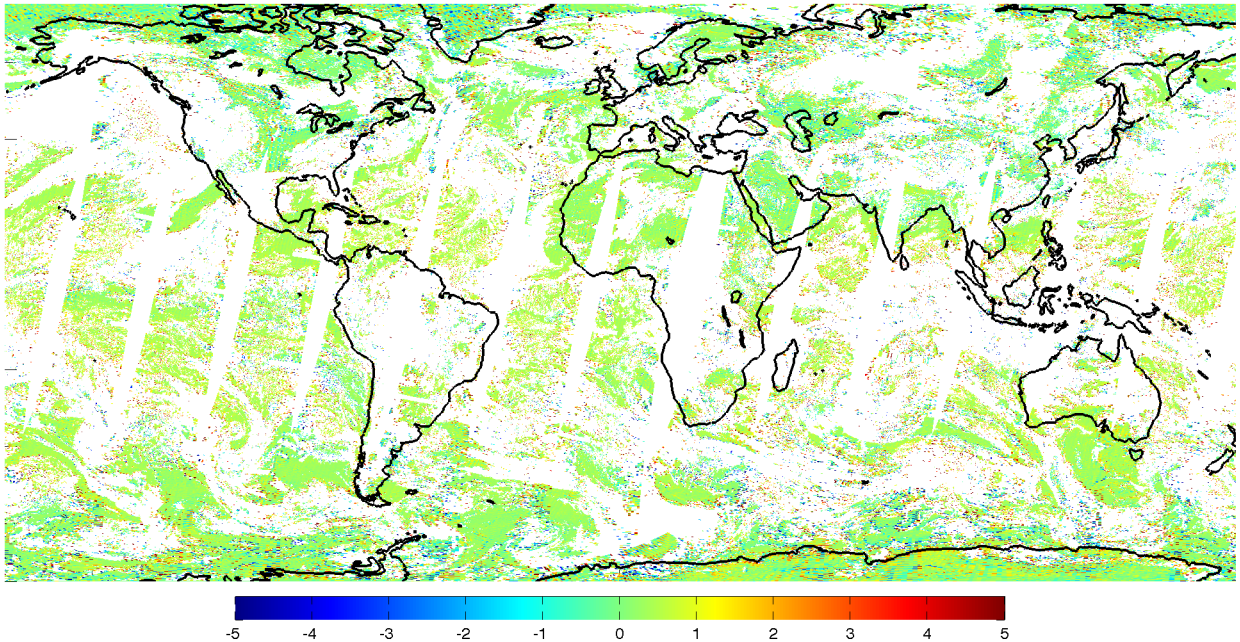



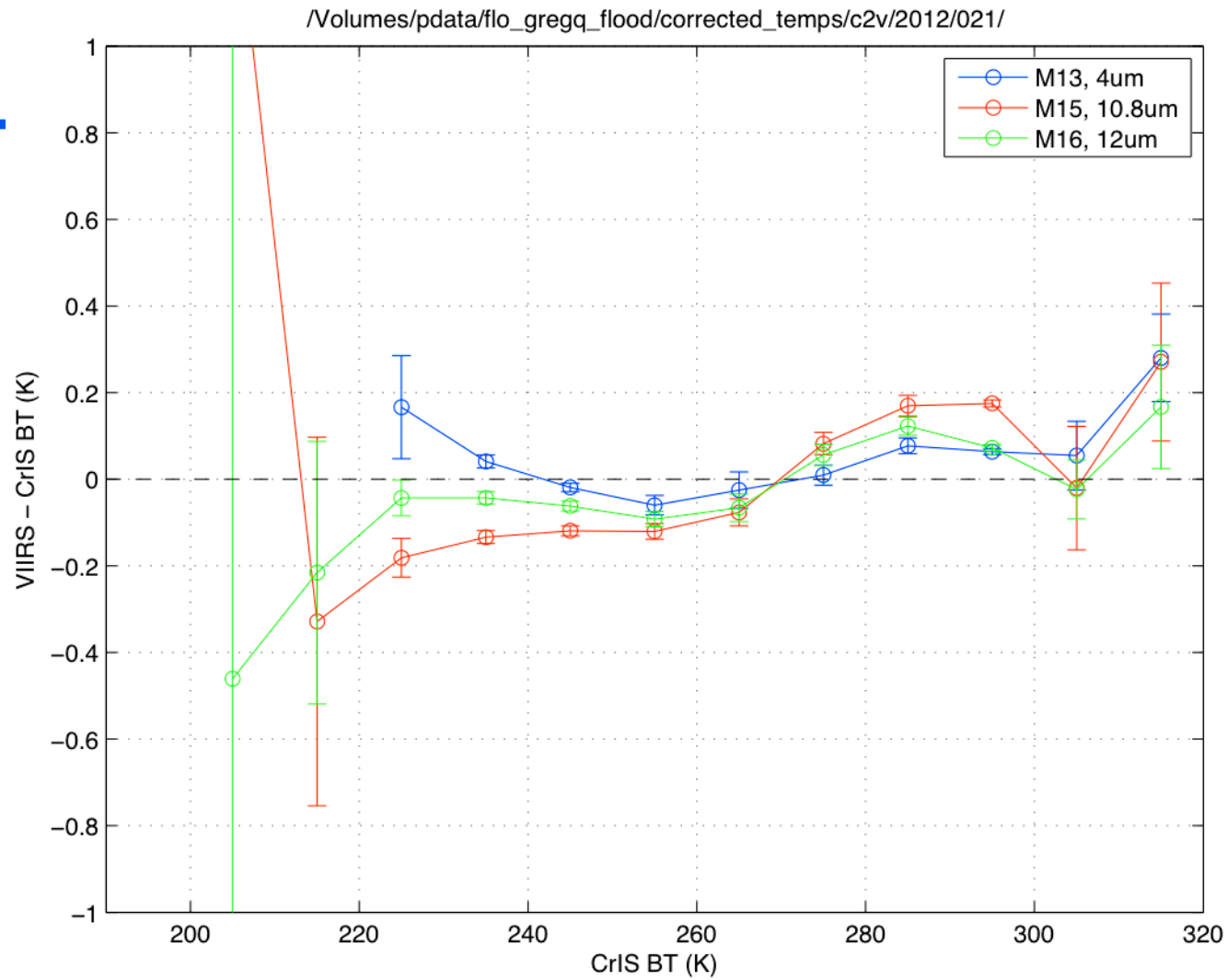
CrIS BT(K)



VIIRS - CrIS BT(K)

*VIIRS minus CrIS for:*
*ImPart <1*
*VIIRS Std < 1*
*VIIRS N > 50*




/Volumes/pdata/flo_gregq_flood/corrected_temps/c2v/2012/021/
M13, 4um
M15, 10.8um
M16, 12um
VIIRS – CrIS BT (K)
CrIS BT (K)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
200
220
240
260
280
300
320