Cross-track Infrared Sounder Intercalibration Studies

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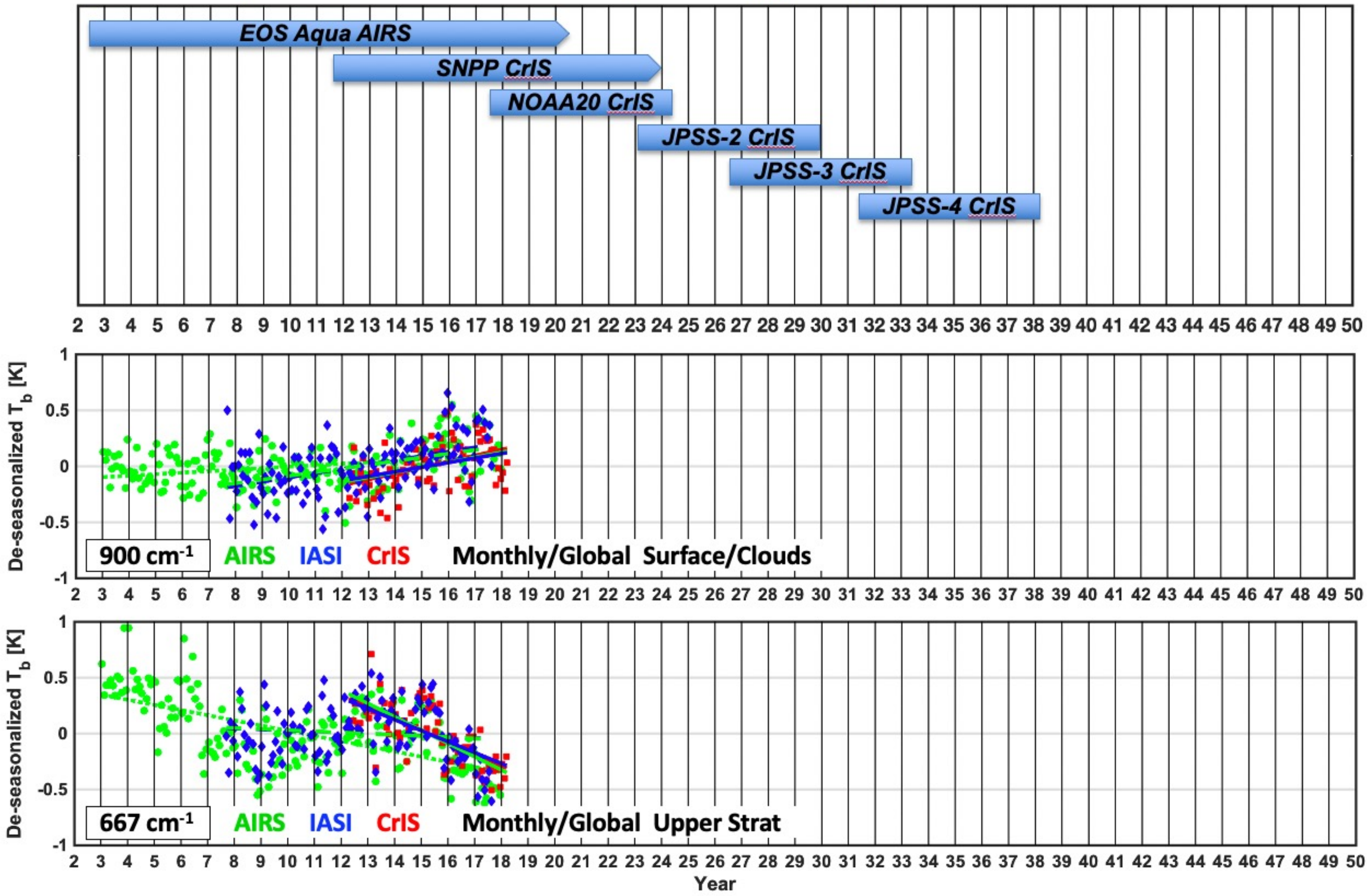
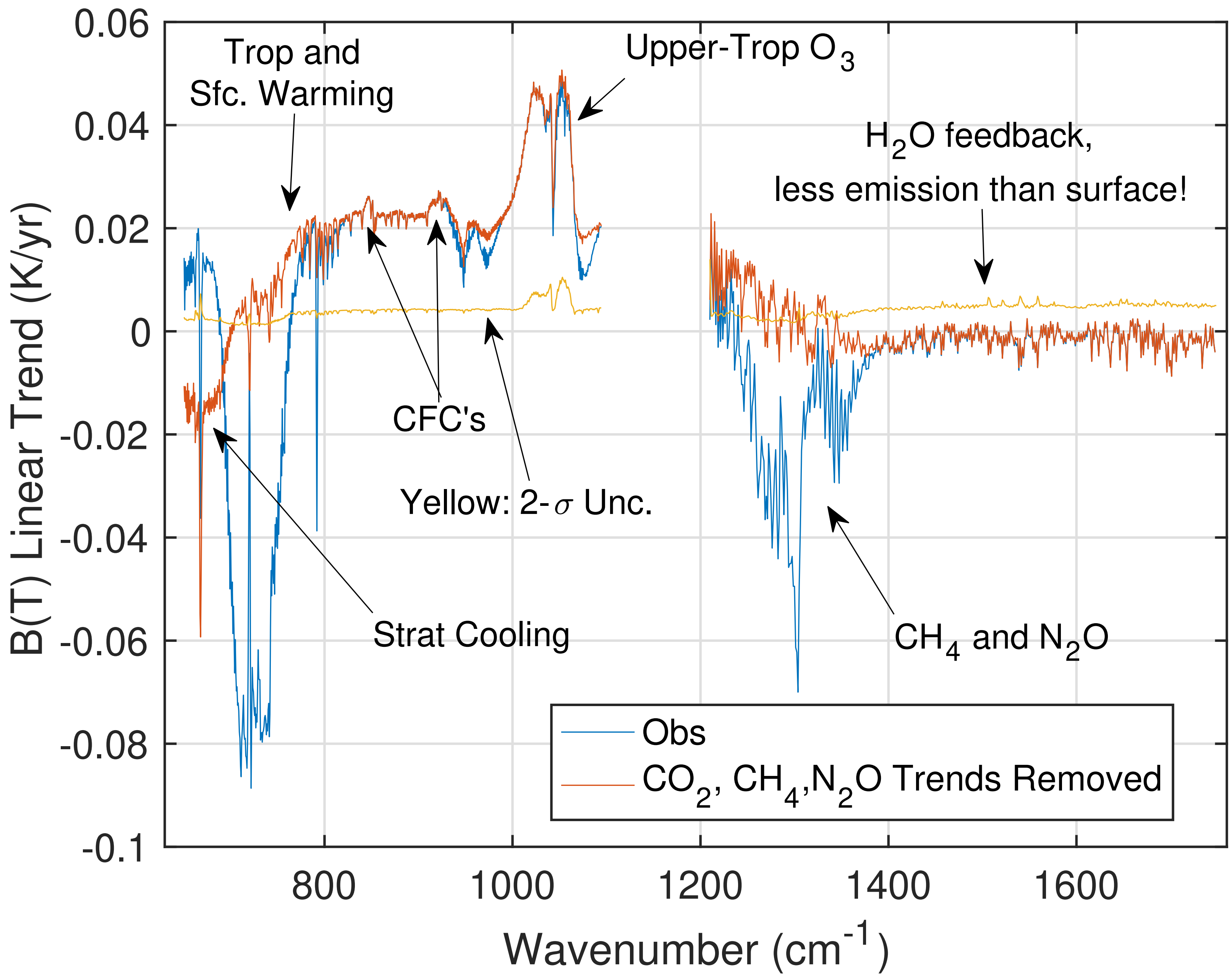
Outline

- Recent SNOs analysis and paper
- NOAA-21 Intercalibration results
- Spectral Ringing

Example Radiance Trends from Hyperspectral IR Sounders





Larrabee Strow
et al.

SNOs Analysis / Results

Comparison of the AIRS, IASI and CrIS Infrared Sounders Using Simultaneous Nadir Overpasses: Novel Methods Applied to Data from Oct 1st, 2019, to Oct 1st, 2020
by Michelle Loveless et al.
Submitted to JGR Earth and Space Science (ESS)

- **Time Symmetrization**

- **Uncertainty propagation (spatial match-up, temporal match-up, sensor noise, sensors calibration). CrIS uncertainty product + Noise covariances**

- **Example Results**

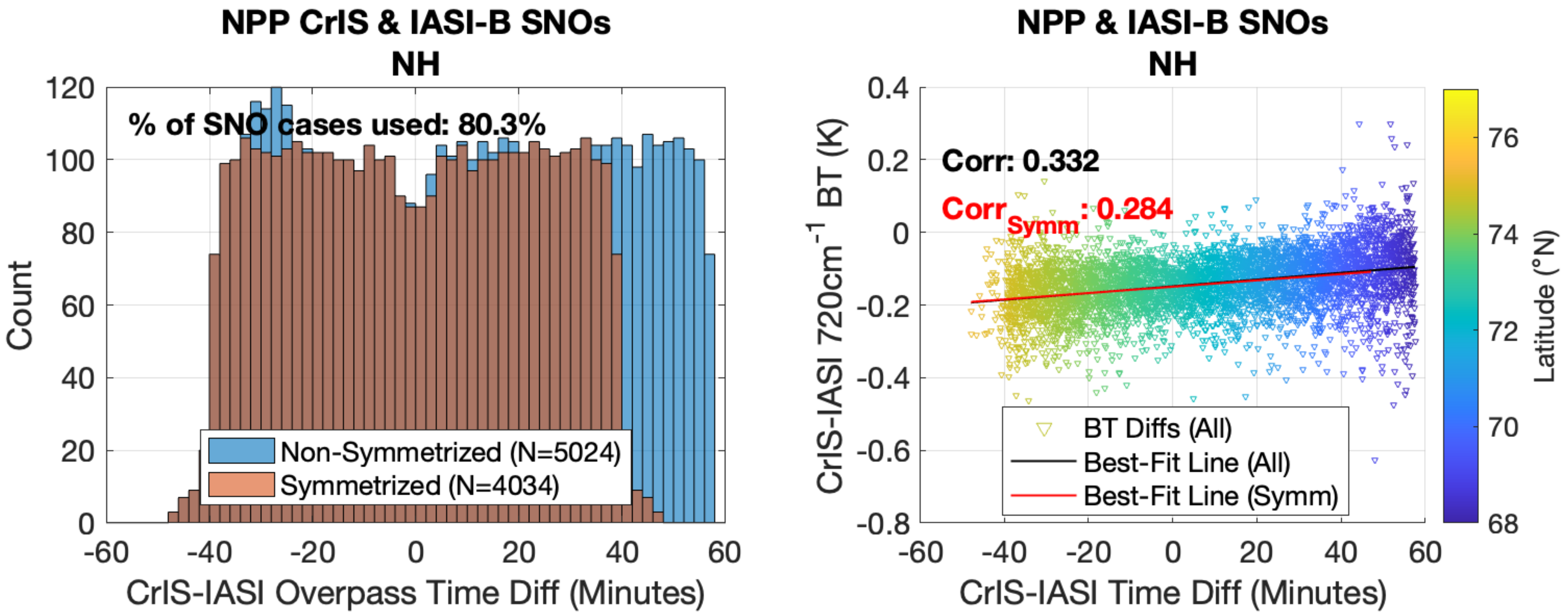


Figure 1. SNO Time Difference Symmetrization**:** (**left**) symmetrized and non-symmetrized histograms of SNPP minus IASI-B overpass time differences for the NH with the percent of SNO cases retained after symmetrization listed at the top; (**right**) SNPP and IASI-B 720 cm^{-1} BT differences plotted against the CrIS minus IASI-B time difference for the NH colored by latitude overlaid by a best fit line with correlation of the BT 720 cm^{-1} differences and time differences listed in the top left corner.

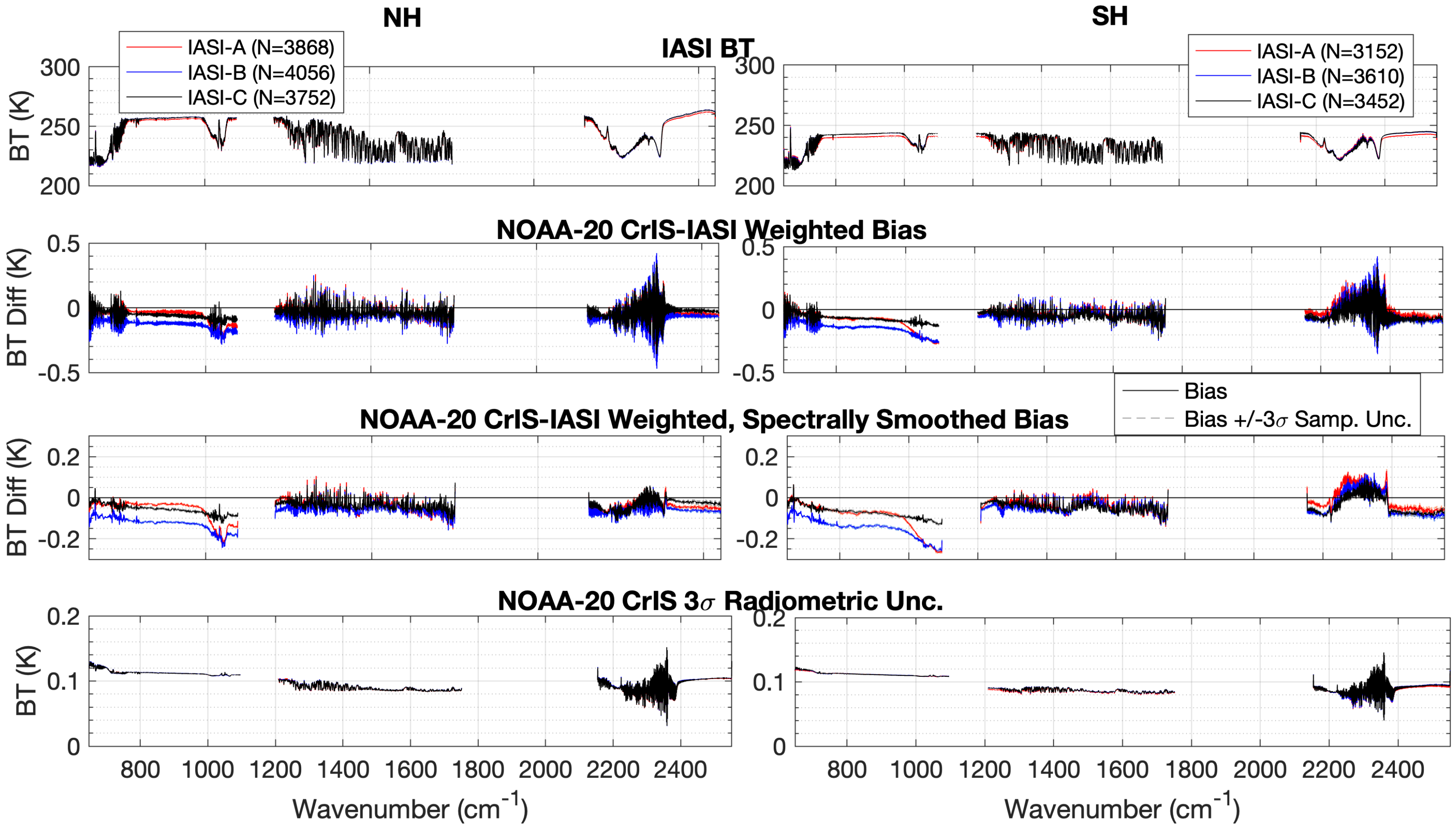


Figure 3. NOAA-20 CrIS and IASI-A/B/C SNO comparisons. Same as Figure 2 except for NOAA-20 CrIS. Again, note the biases plus or minus the the 3σ sampling uncertainty are not distinguishable from one another on the given axis scales.

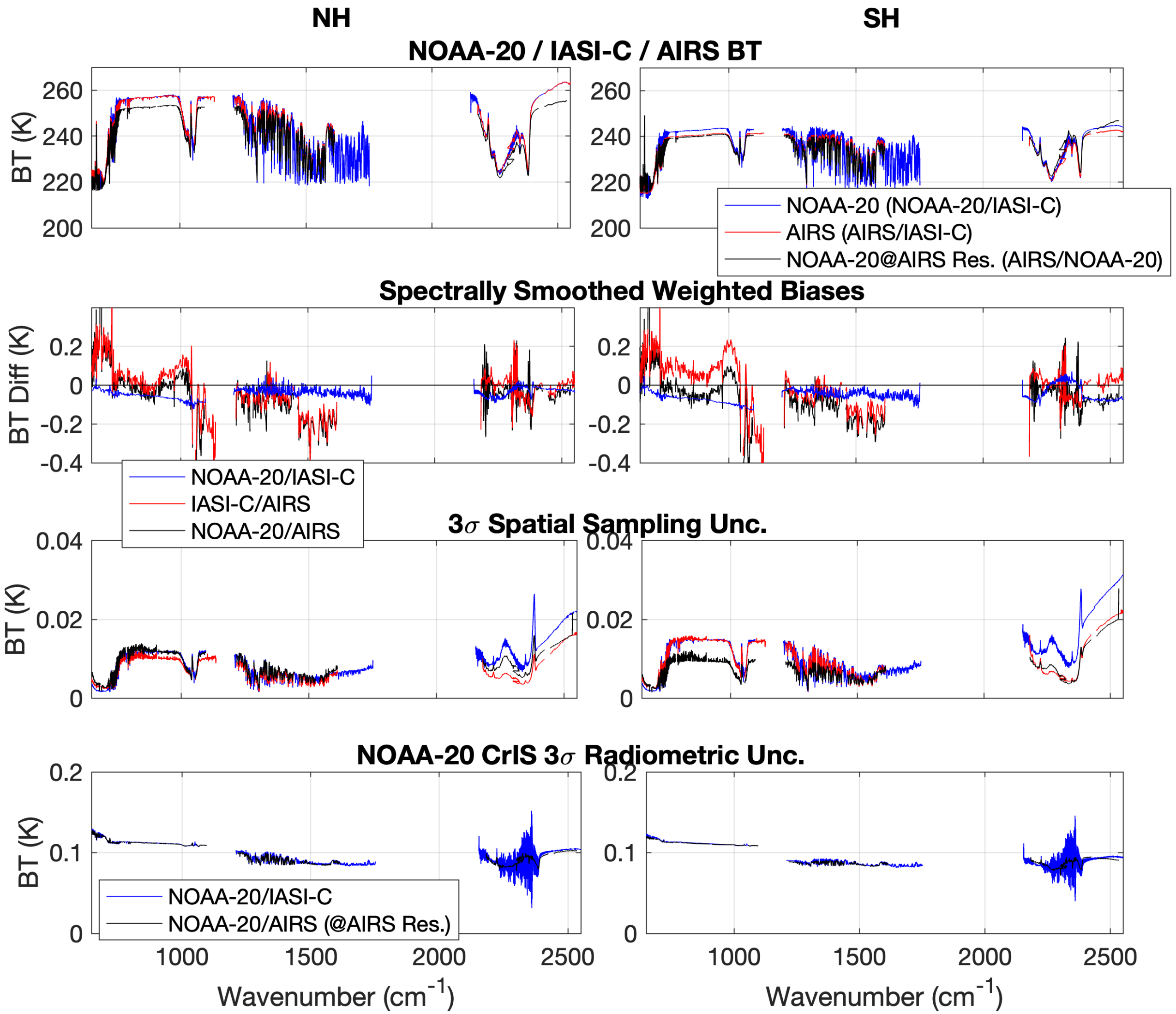
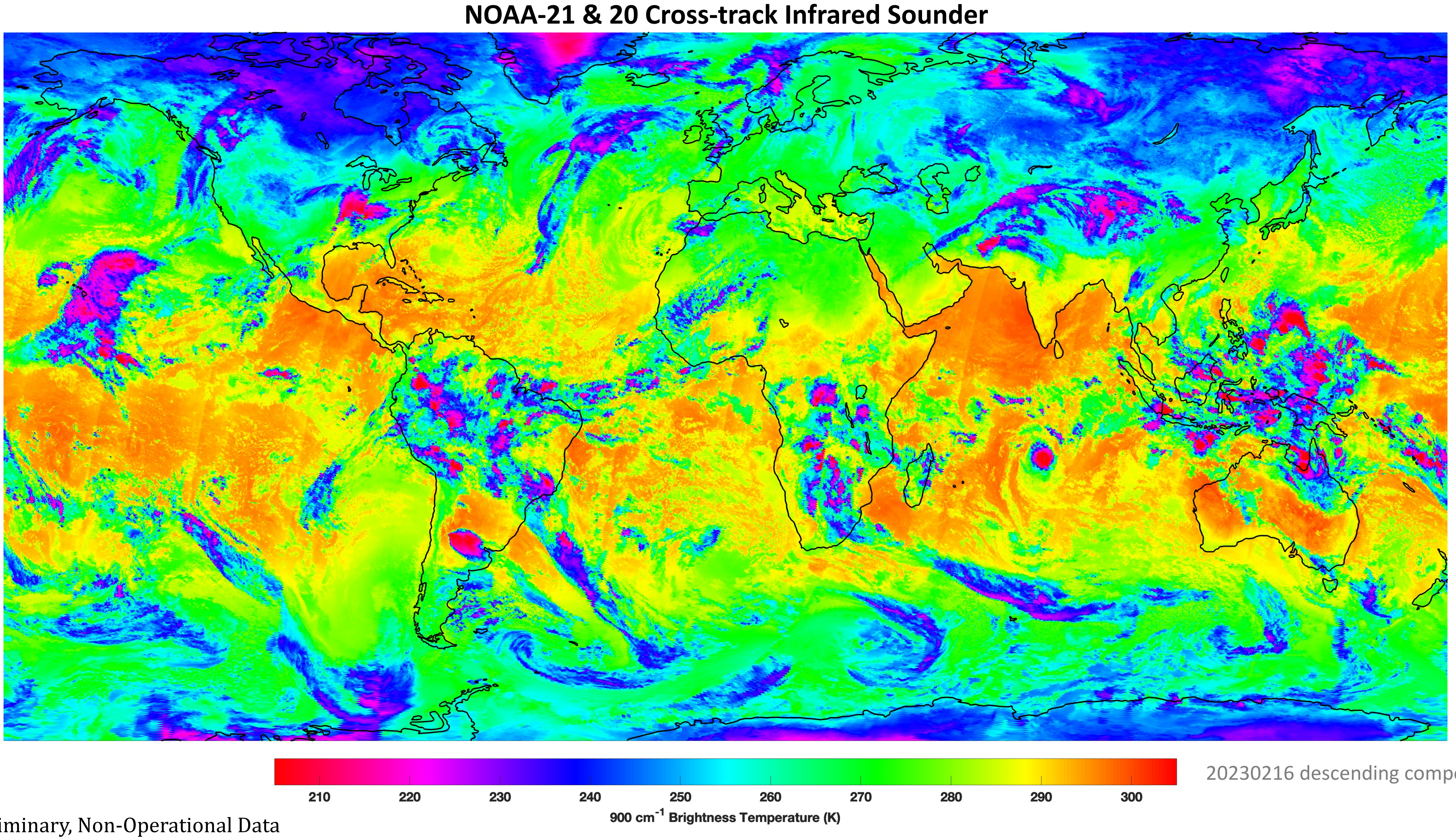


Figure 8. Three-way comparisons of NOAA-20 CrIS, IASI-C, and AIRS. NH (left) and SH (right) results are shown for the (top) mean BT, (2nd from top) spectrally smoothed biases, (2nd from bottom) 3σ sampling uncertainty, and (bottom) NOAA-20 CrIS 3σ radiometric uncertainty.

Example/Preliminary NOAA-21 CrIS Intercal Results



20230216 descending composite

NOAA-21 Preliminary, Non-Operational Data

FOV-2-FOV Relative Radiometric Daily Mean

Hamming Apodized

Longwave　　　Midwave　　　Shortwave

NOAA20

Y-scale: +- 250mK

NOAA21

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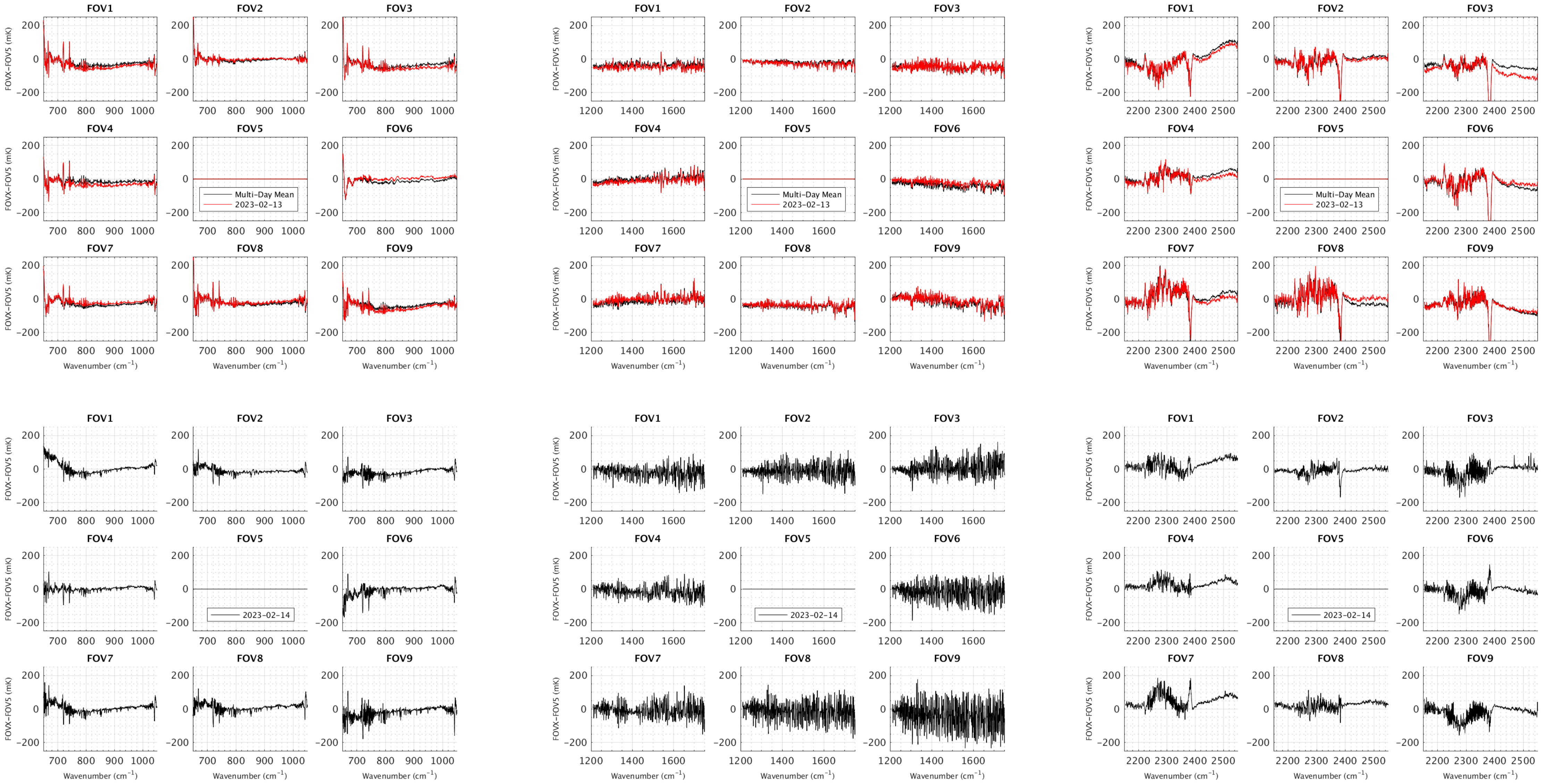

NOAA-21 Preliminary, Non-Operational Data

Differences are small and well behaved; MW “hash” is spectral (out-of-date, fixed alredy)

Clear Sky Observed minus Calculated

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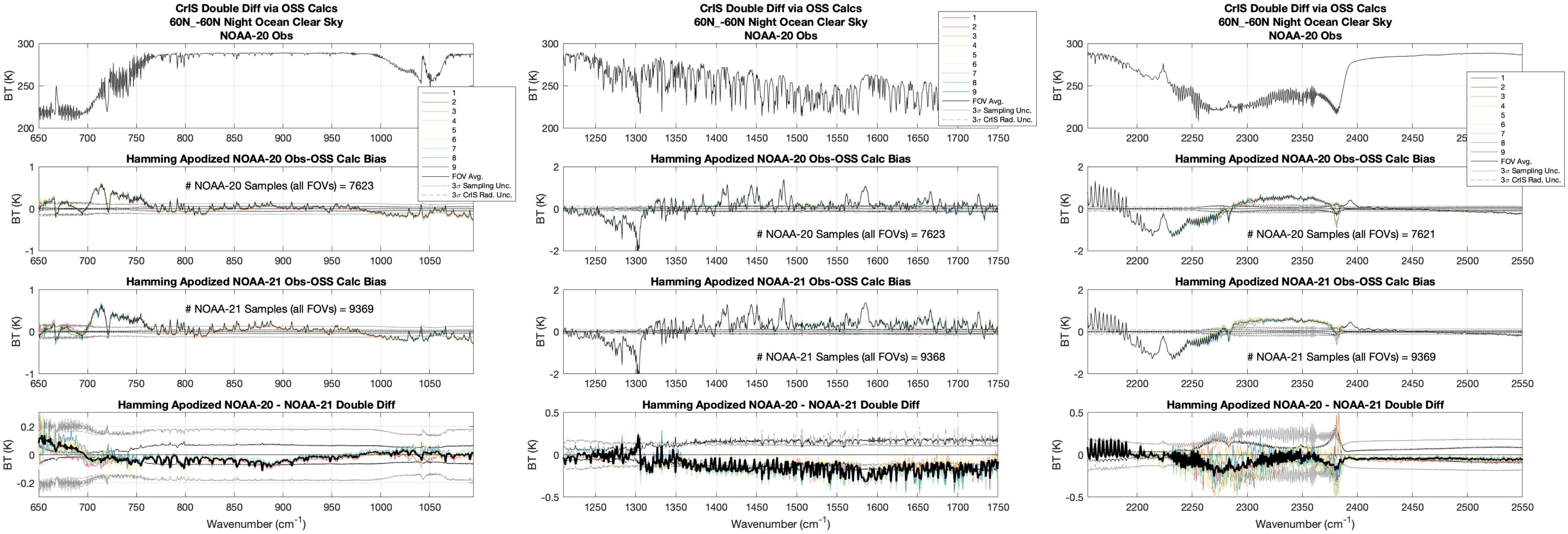
NOAA20, NOAA21, and NOAA-20/NOAA-21 Double Difference

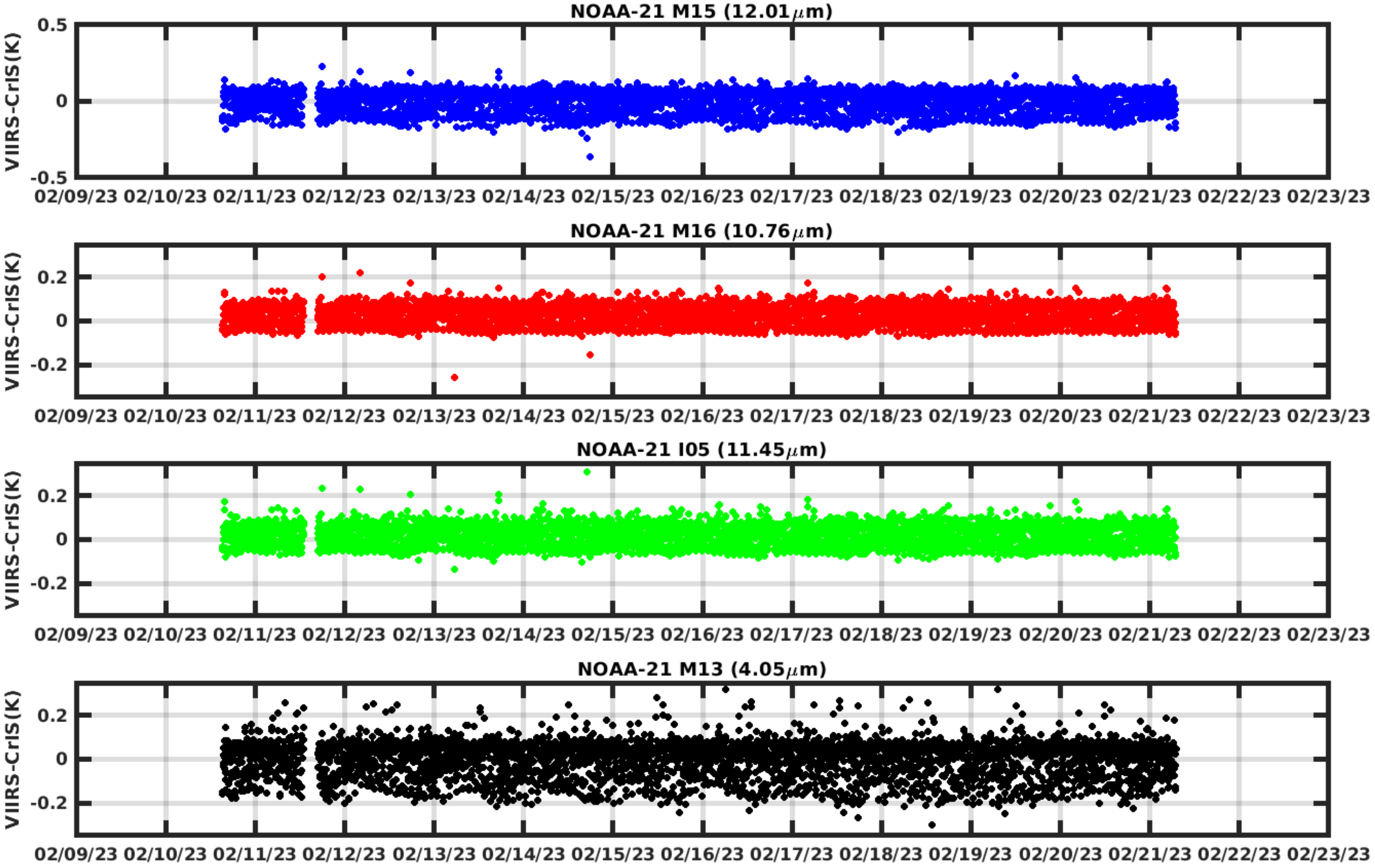


Consistent Obs-Calcs for NOAA-20 and NOAA-21, and small NOAA-20/NOAA-21 differences, with little FOV dependence

NOAA-21 Preliminary, Non-Operational Data

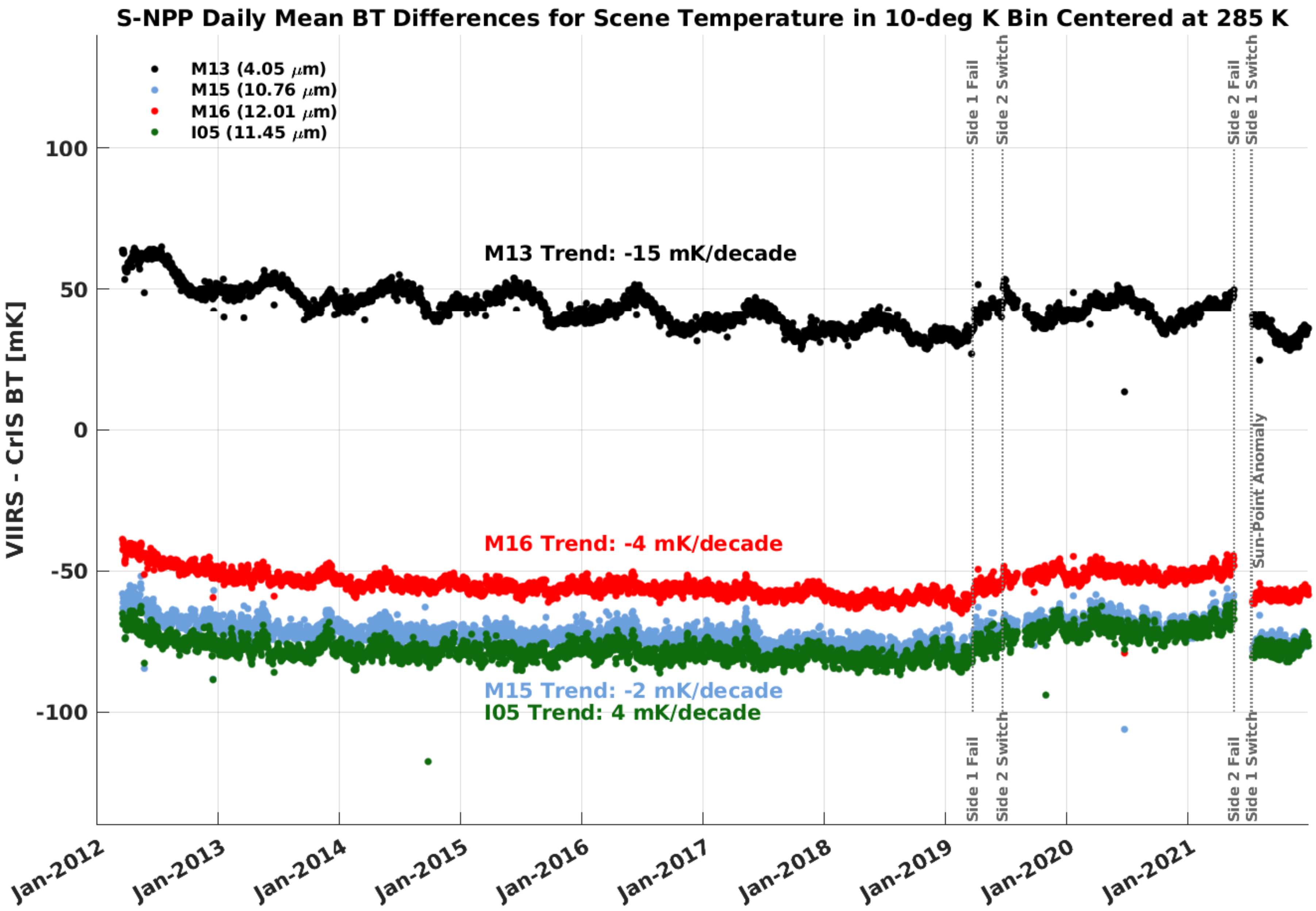
Example CrIS/VIIRS Comparisons

Time Dependence



Consistent and small residuals since turn-on

NOAA-21 Preliminary, Non-Operational Data



10 years of SNPP ... several mK/decade level agreement

Example CrIS/VIIRS Comparisons

Signal Level Dependence, by FOV

M13 4.05 μm
M15 10.76 μm
M16 12.01 μm
I05 11.45 μm

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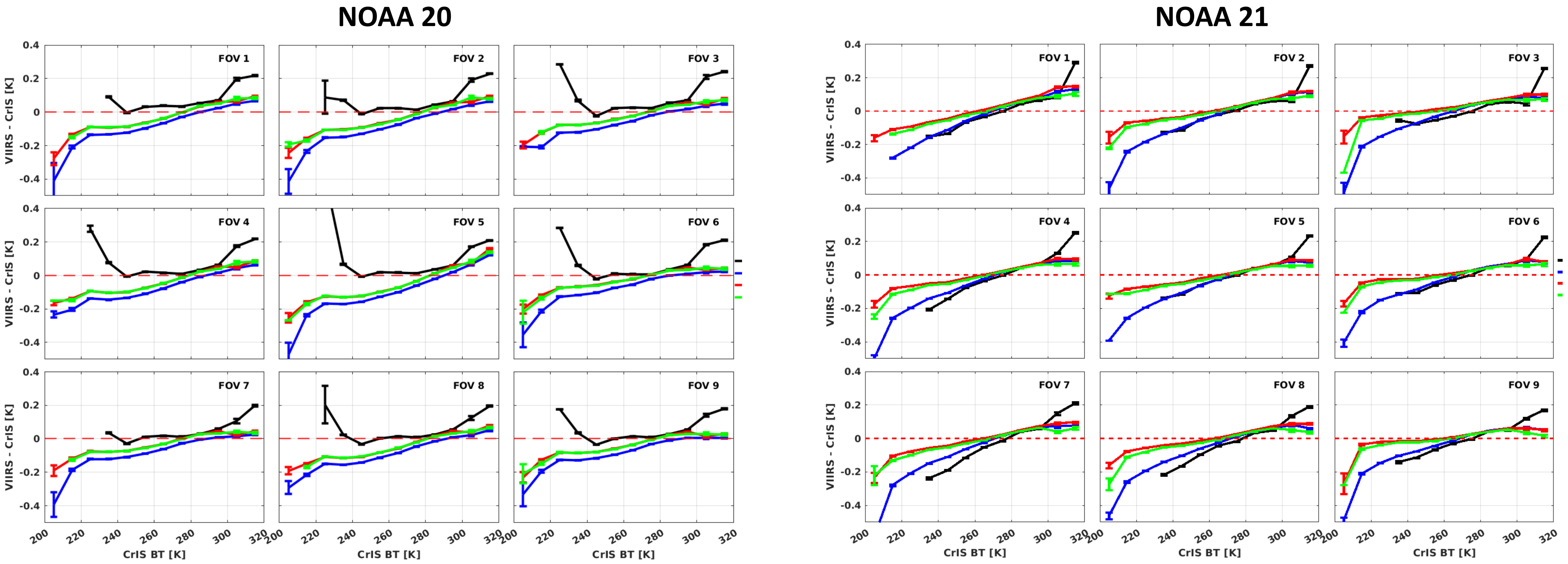
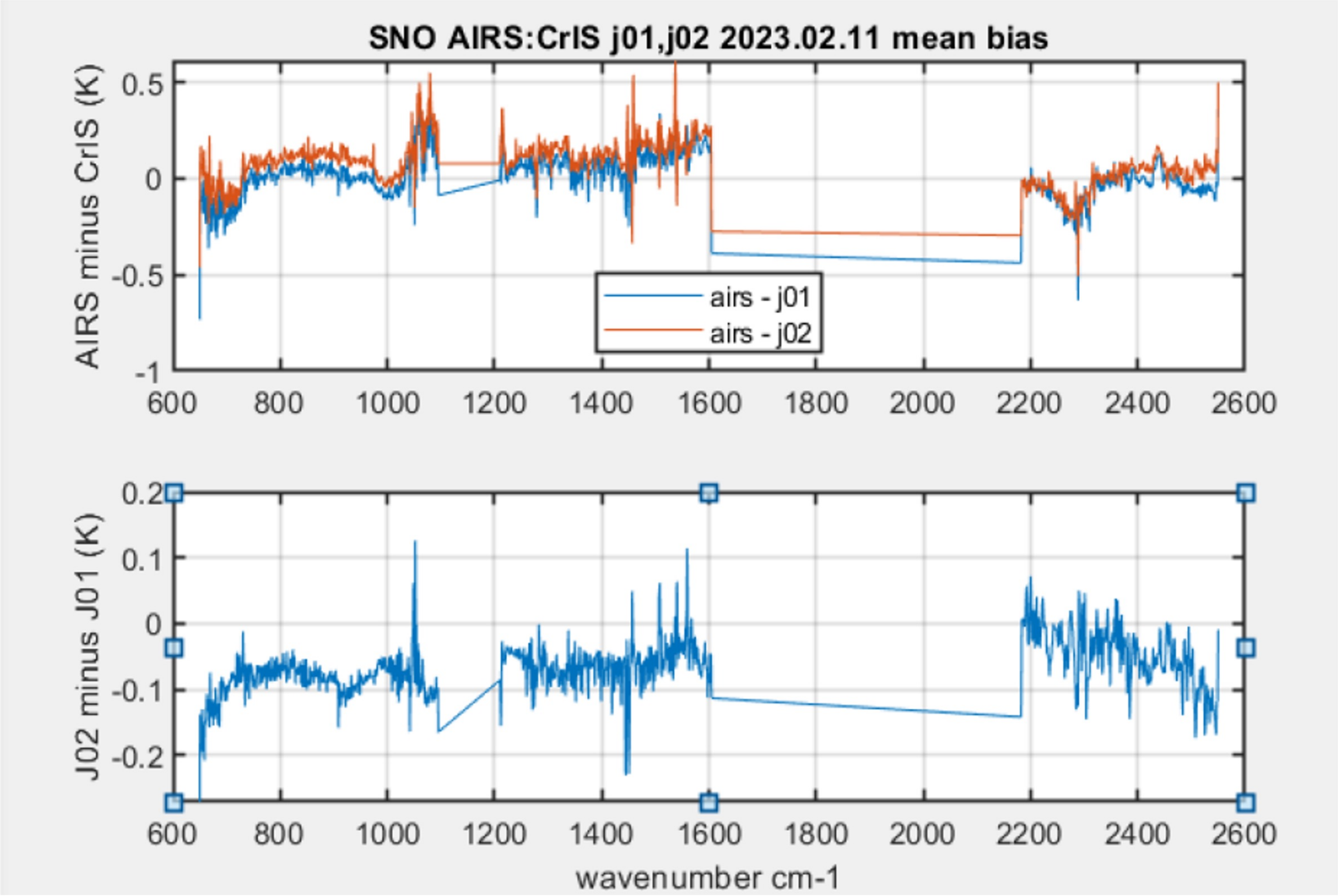


Similar behavior as NOAA-20, and similar behavior among FOVs

NOAA-21 Preliminary, Non-Operational Data

- AIRS and NOAA-20,21 converted to CHIRP ILS
- Ignore spikes, they are from AIRS
- SNO single differences on top (statistical errors very low)
- Double SNO diffs remove AIRS: (AIRS - J01) - (AIRS - J02) = J02 - J01

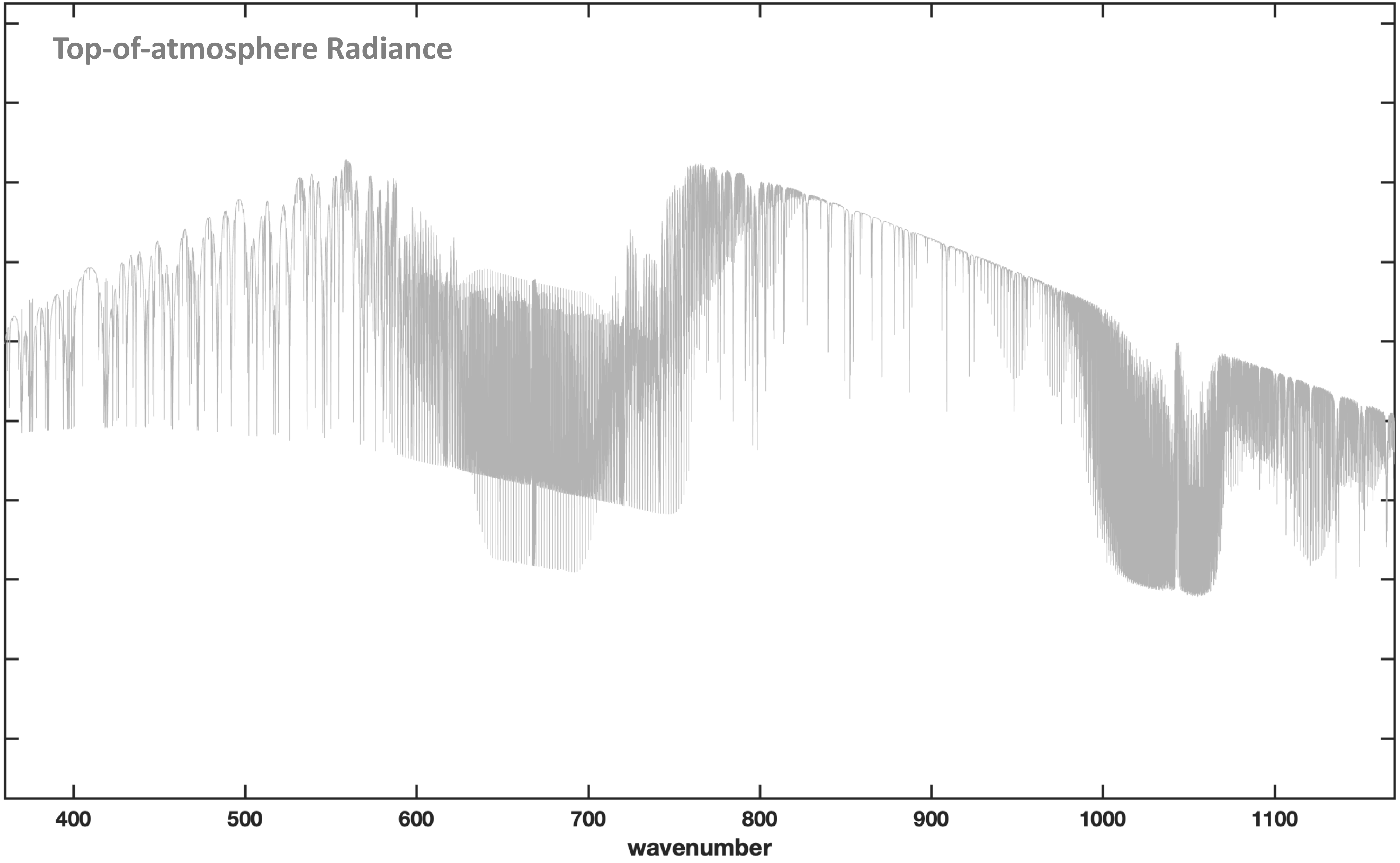


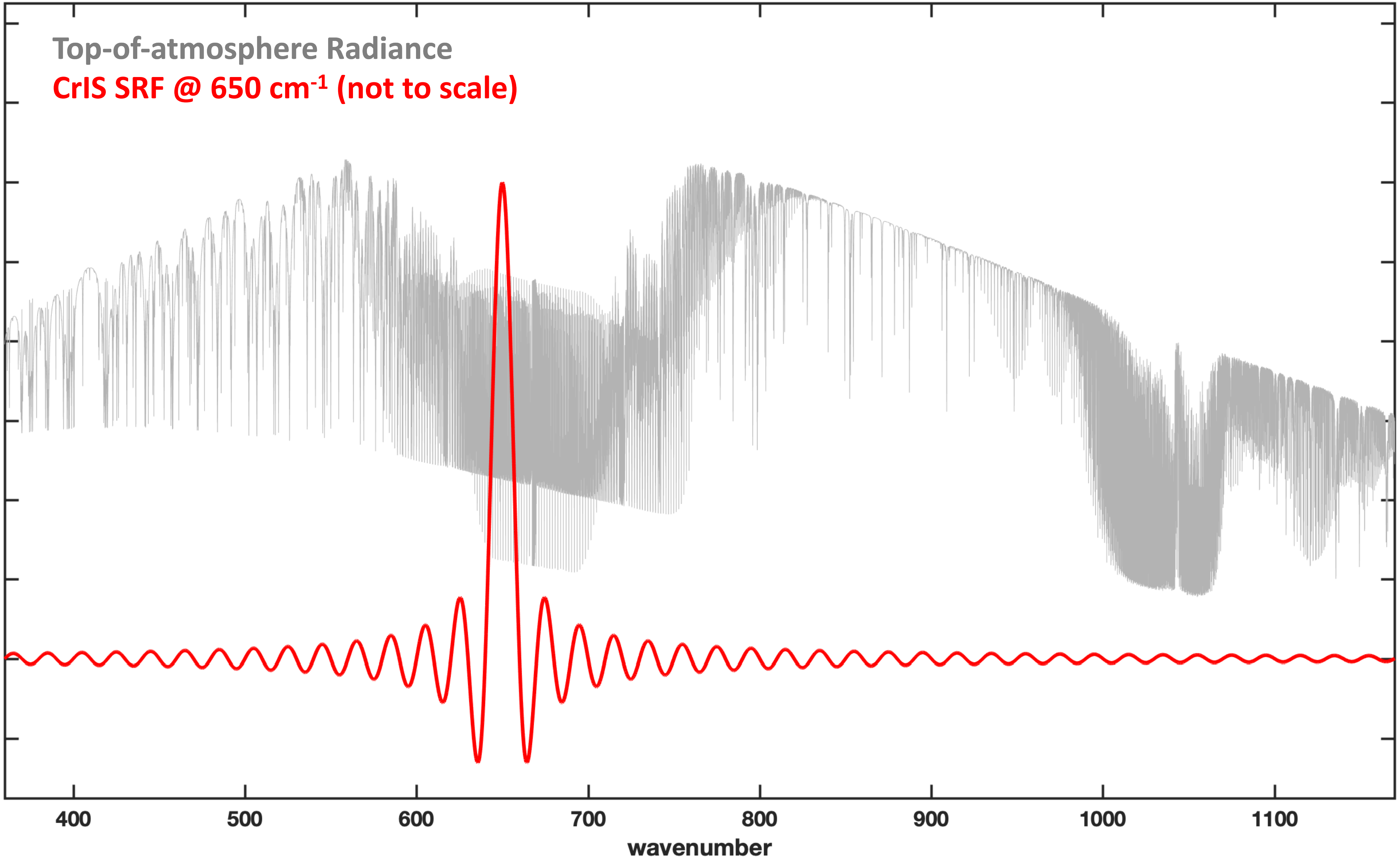
From Larrabee Strow et al.

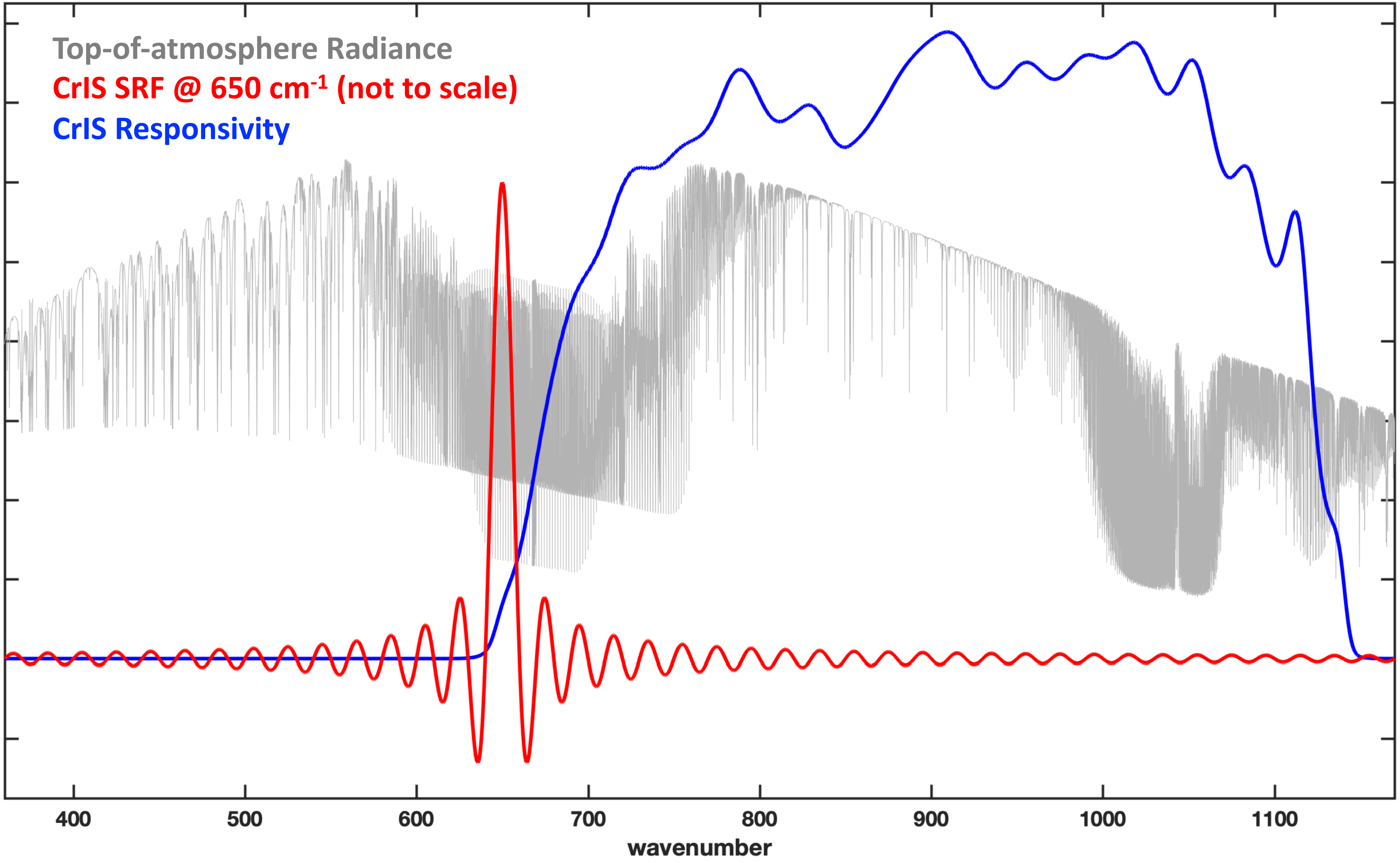
NOAA-21 Preliminary, Non-Operational Data

Spectral Ringing
(Relevance to Obs-Calcs and Intercalibration)

Borg et al., Simulation of CrIS Radiances Accounting for Realistic Properties of the Instrument Responsivity That Result in Spectral Ringing Features" Remote Sensing 15, no. 2: 334.


Top-of-atmosphere Radiance
400
500
600
700
800
900
1000
1100
wavenumber


Top-of-atmosphere Radiance
CrIS SRF @ 650 cm-1 (not to scale)
400
500
600
700
800
900
1000
1100
wavenumber



Top-of-atmosphere Radiance
CrIS SRF @ 650 cm-1 (not to scale)
CrIS Responsivity
400
500
600
700
800
900
1000
1100
wavenumber

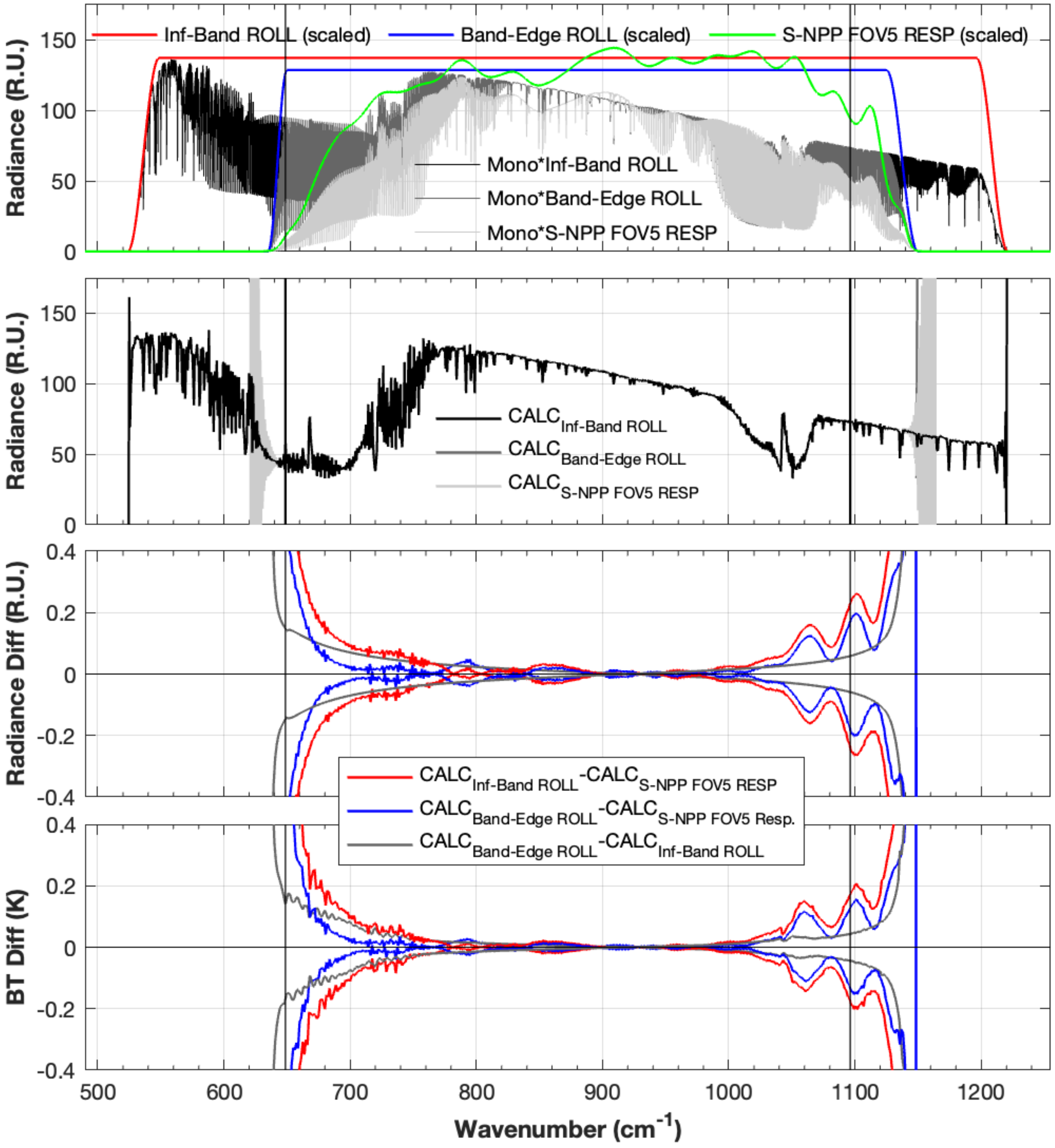


Figure 3. Calculated ringing effects for S-NPP LW band for an example clear sky spectrum. Monochromatic calculated spectrum multiplied by infinite-band (black) and band-edge (dark gray) rolloffs and CrIS FOV5 responsivity (green) overlaid by scaled rolloffs (red and blue) (top panel); CrIS FSR spectra with infinite-band and band-edge rolloffs and responsivity applied (second from top panel); envelope of the ringing, defined as the difference between the calculations with different rolloffs applied or with the responsivity applied, in radiance units (third panel from top) and in brightness temperature (bottom panel). The differences in the bottom two panels quantify the combined effects of finite band limits and non-flat responsivity (red), just non-flat responsivity (blue), and just finite band limits (gray).

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