CrIS Satellite Inter-Calibration

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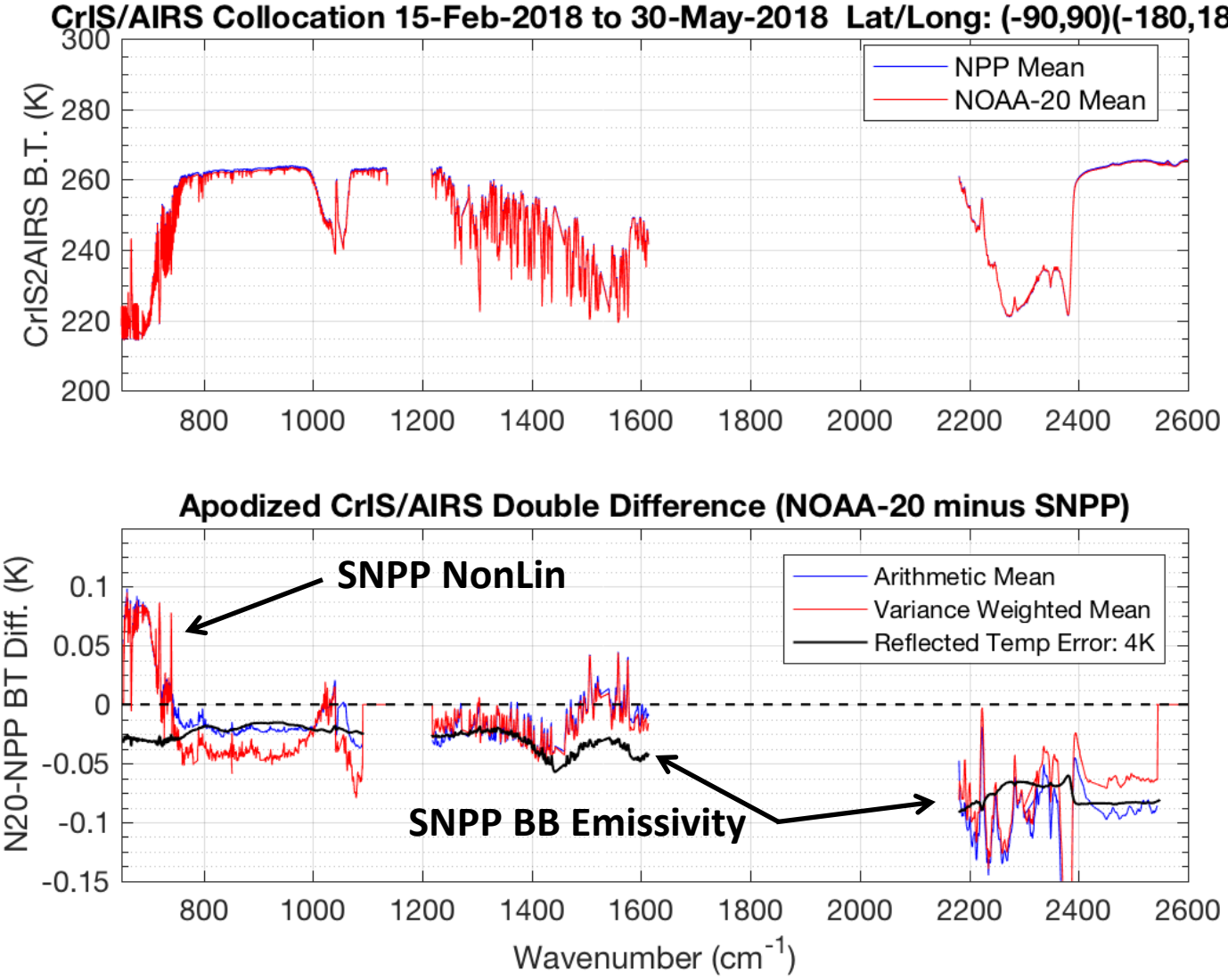
NASA Science Team Meeting
5 October 2018

Topics

1. SUMMARY SLIDE – removing CrIS to CrIS biases
2. How does NOAA-20 CrIS compare to SNPP CrIS?
3. Big Circle SNO (100 km diameter) Results
4. What is the CrIS FOV-to-FOV consistency?
5. CrIS Polarization Correction Assessment
6. Future Work

SUMMARY SLIDE: CrIS to CrIS Differences and Intended Improvements

Lesson's learned from SNPP (NPOESS) CrIS was applied to TVAC calibration of NOAA-20 (JPSS) CrIS

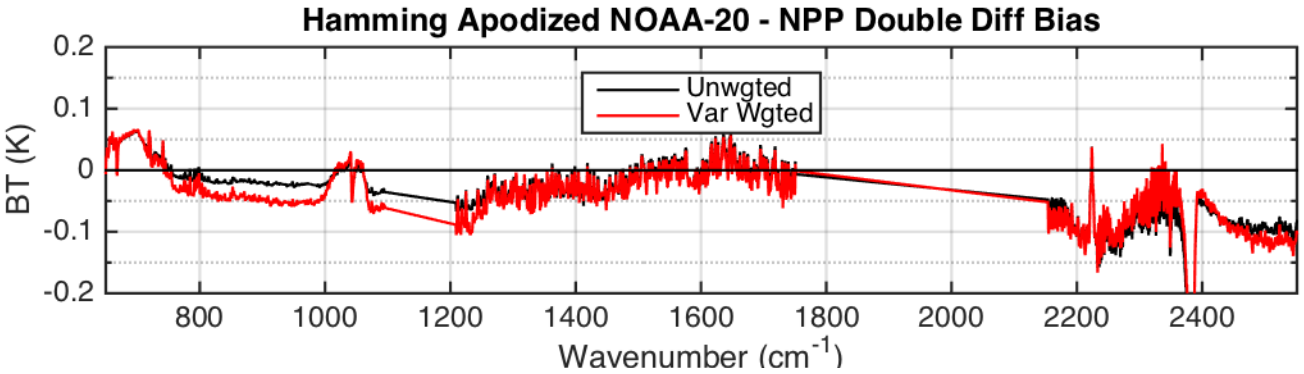


NOAA-20 CrIS Inter-Cal Questions and Answers

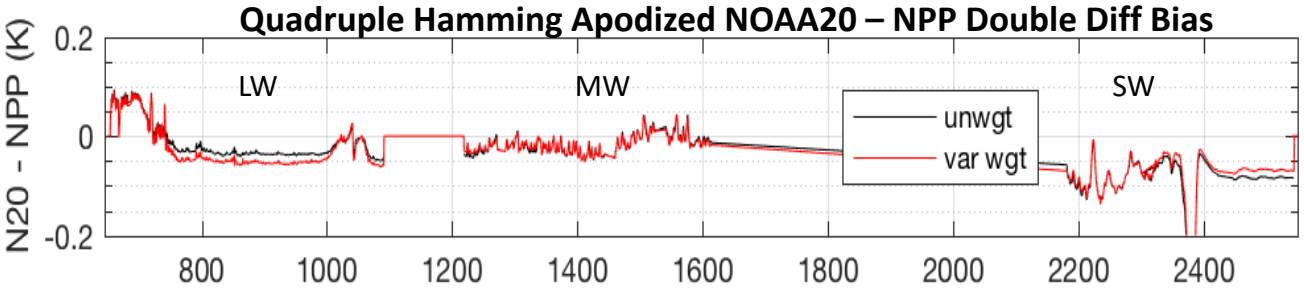
Q: What is the radiance bias of NOAA-20 CrIS relative to SNPP CrIS?

A: Expressed in terms of equivalent brightness temperature, the relative bias for the apodized spectra used in NWP is **< 0.15 K** for all channels in all bands, except for 2383 cm^{-1} where NOAA-20 is an improvement over SNPP.

NOAA20 - SNPP CrIS via IASI-B
(~ 75 N)
(using IASI2CrIS)

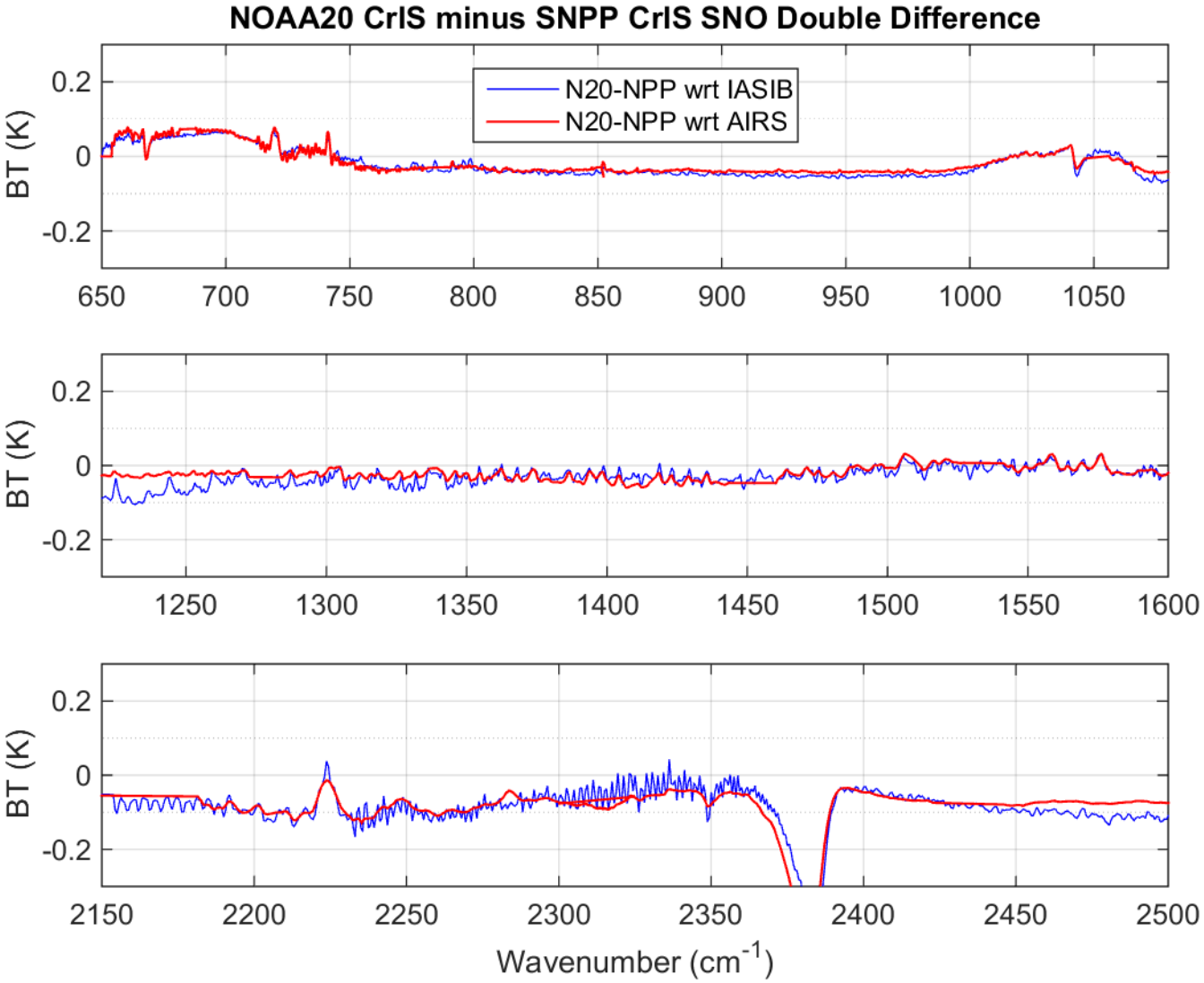


NOAA20 - SNPP CrIS via AIRS
(global)
(using CrIS2AIRS)



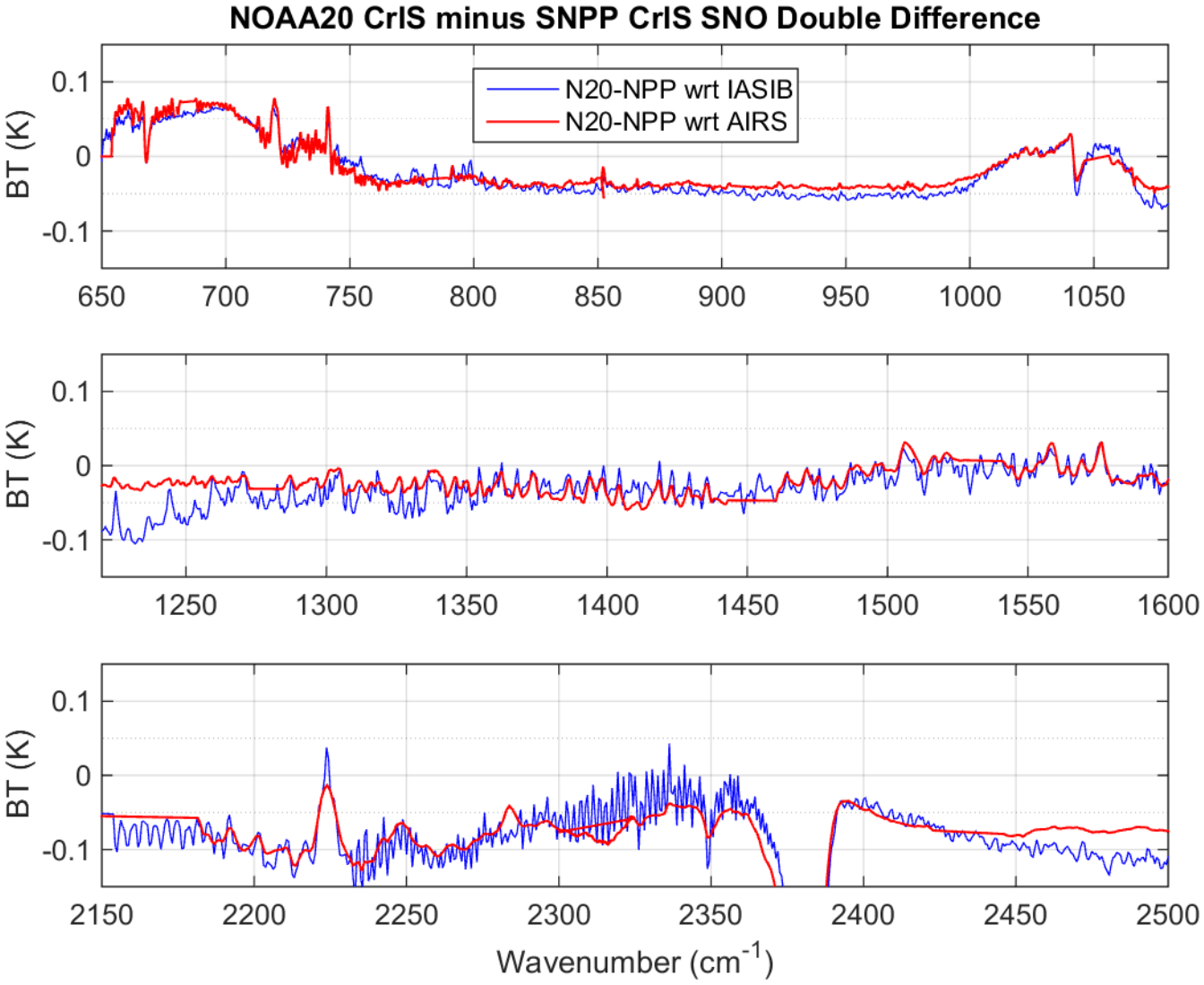
Unwgt = Arithmetic Mean; Var Wgt = Mean weighted by scene variance

Comparing Variance Weighted “global” CrIS2AIRS to “Arctic” IASI2CrIS



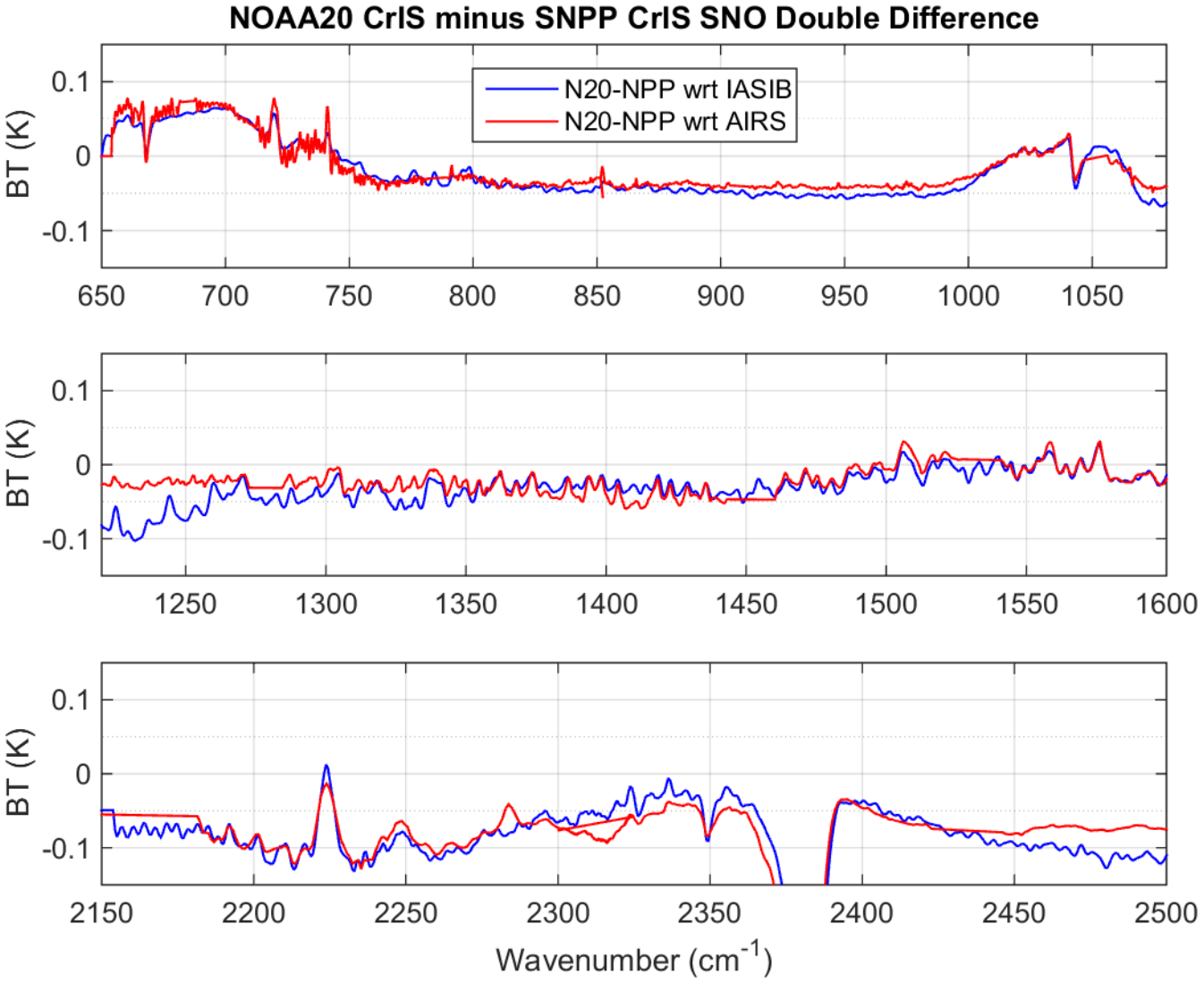
Overlay of previous plot on same vertical scale. Next figure is zoomed in.

CrIS2AIRS Spectral Resolution is lower than IASI2CrIS Resolution



Disagreement is mainly due to higher spectral resolution of IASI2CrIS

Hamming Smoothed IASI2CrIS to match CrIS2AIRS Spectral Resolution



Remarkable DD agreement between independent estimates – Order 0.01K

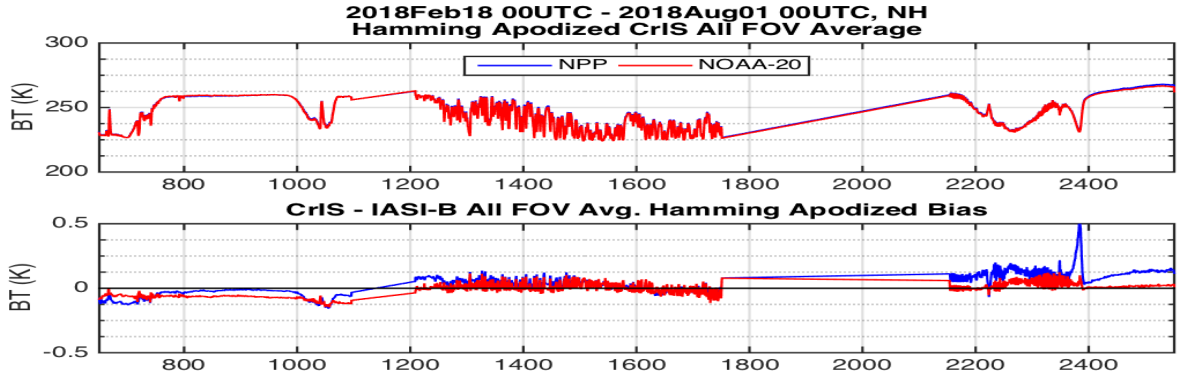
Goal is to tune all differences to zero for all bands! (Mainly SNPP adjustments)

NOAA-20 CrIS Inter-cal Questions and Answers

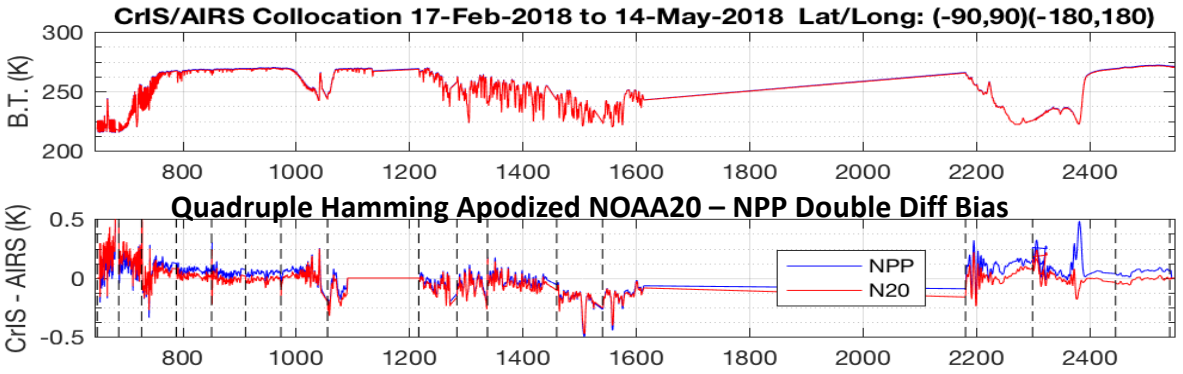
Q: How do SNPP and NOAA-20 compare with current on-orbit meteorological satellite hyperspectral infrared sensors?

A: A preliminary assessment of the first six months of NOAA-20 data indicates mean agreement of NOAA-20 CrIS with METOP-B IASI to within 0.5K for polar zones and with NASA AIRS to within 0.5K for global, tropical, mid-latitude, and polar zones.

NOAA20 - SNPP CrIS via IASI-B
(~ 75 N)
(using IASI2CrIS)

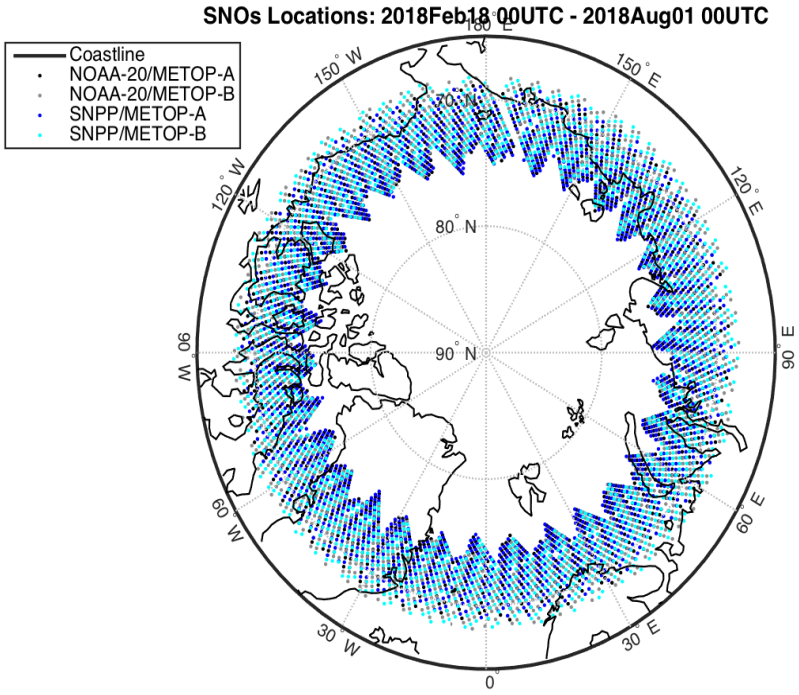


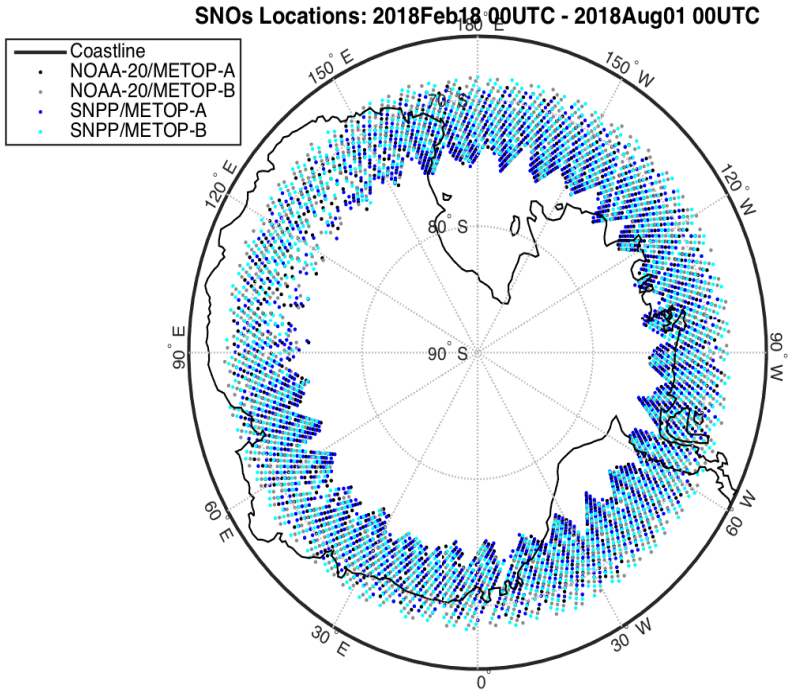
NOAA20 - SNPP CrIS via AIRS
(global)
(using CrIS2AIRS)



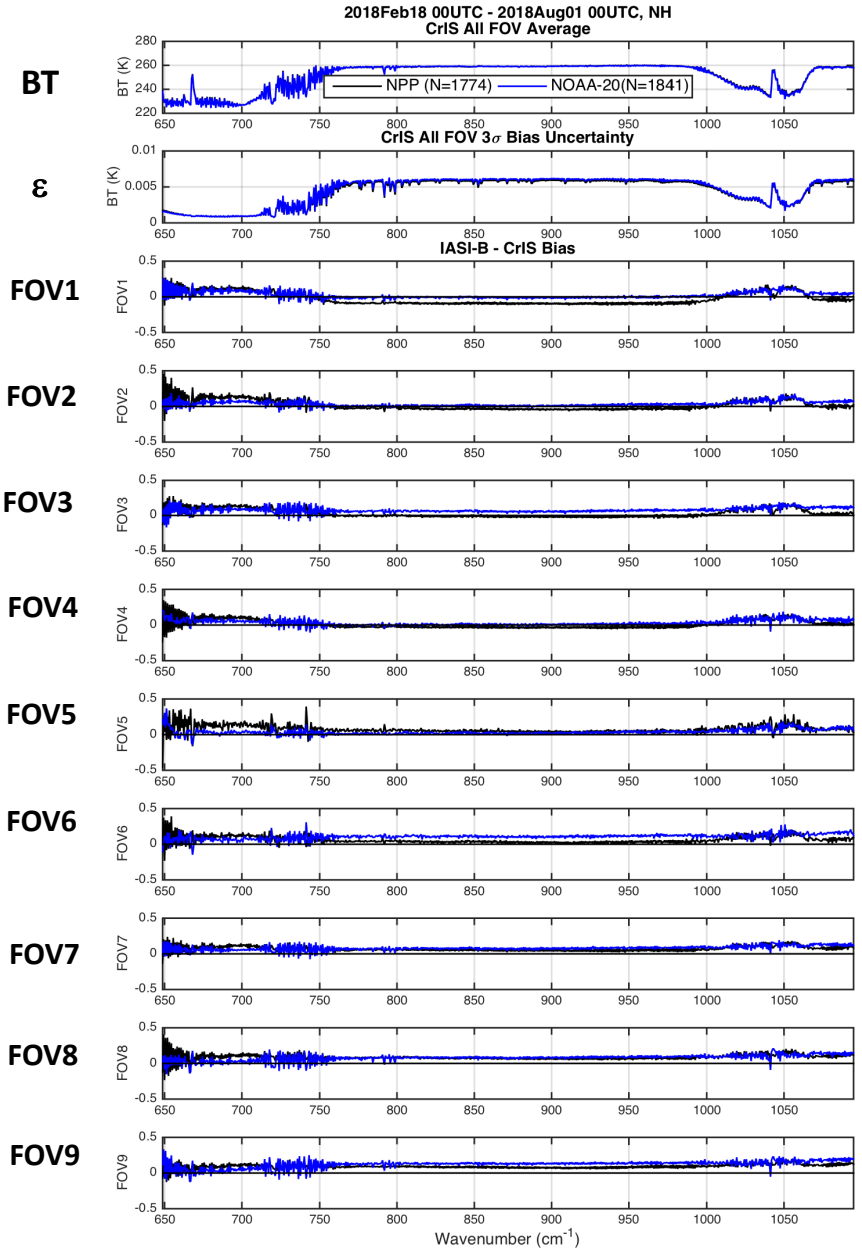
(vertical dashed lines indicate AIRS linear detector array boundaries)

CrIS/IASI SNOs





CrIS minus IASI-B Individual FOVs

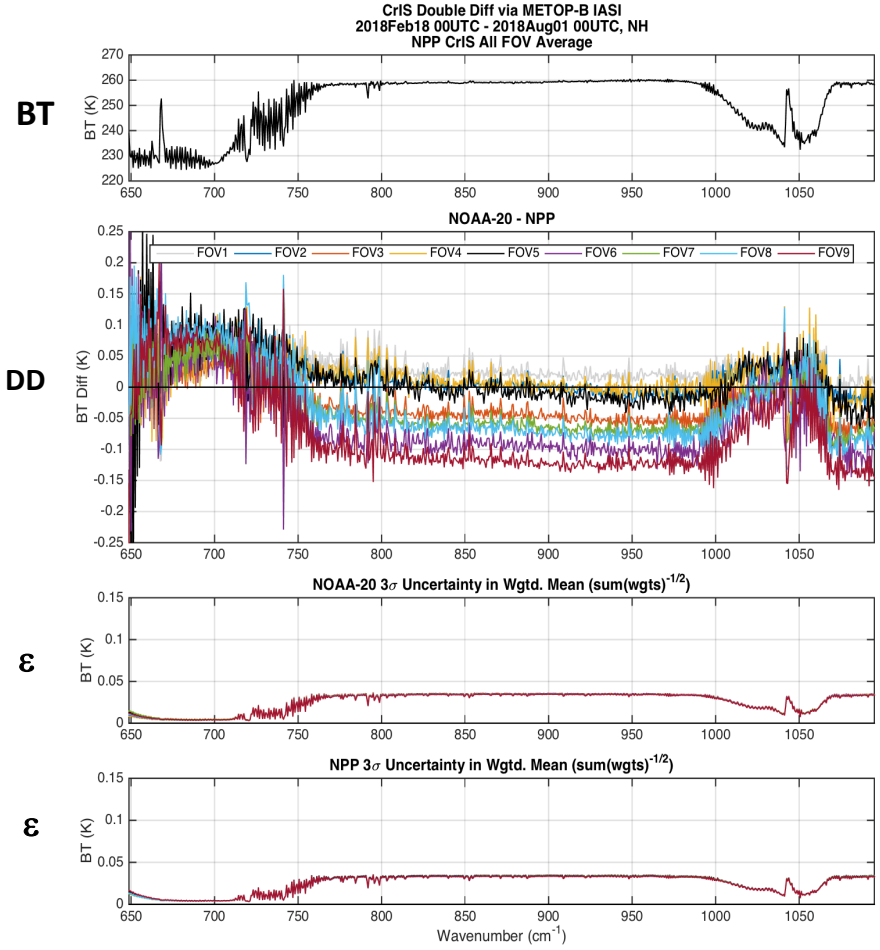


(Diff Y-scale is +- 0.5 K)

CrIS Longwave Band: Unapodized FSR

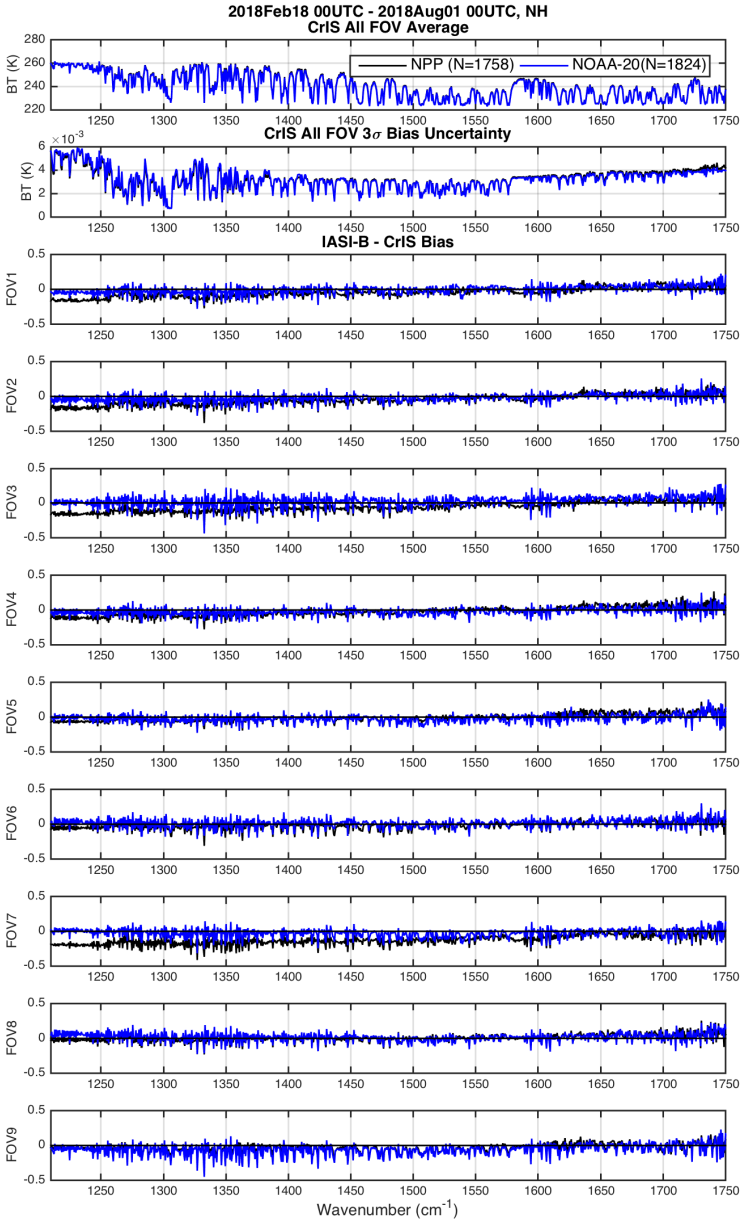
- ***LW N20 – SNPP agreement within 0.2 K***

NOAA-20 minus SNPP Double Difference via IASI-B



(Double Difference Y-scale is +- 0.25 K)

CrIS minus IASI-B Individual FOVs



BT

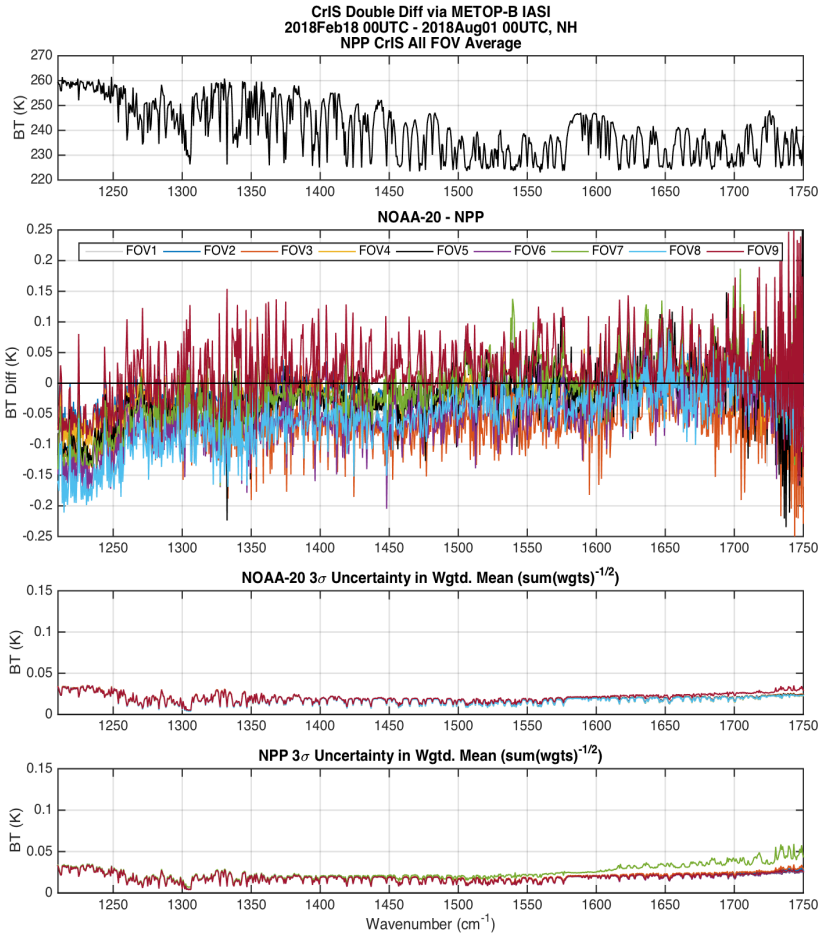
ε

(Diff Y-scale is +- 0.5 K)

CrIS Midwave Band: Unapodized FSR

- ***MW N20 – SNPP agreement within 0.2 K***

NOAA-20 minus SNPP Double Difference via IASI-B



BT

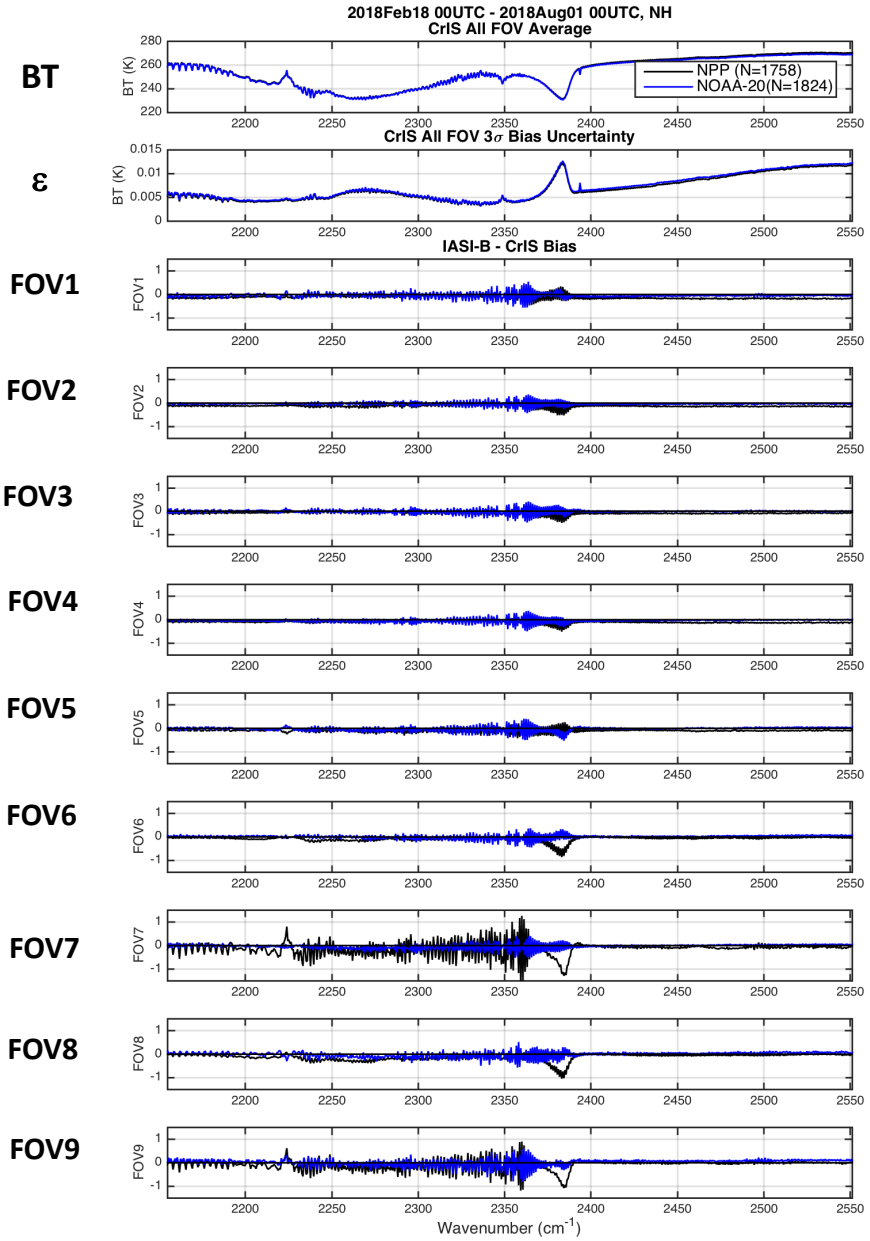
DD

ε

ε

(Double Difference Y-scale is +- 0.25 K)

CrIS minus IASI-B Individual FOVs

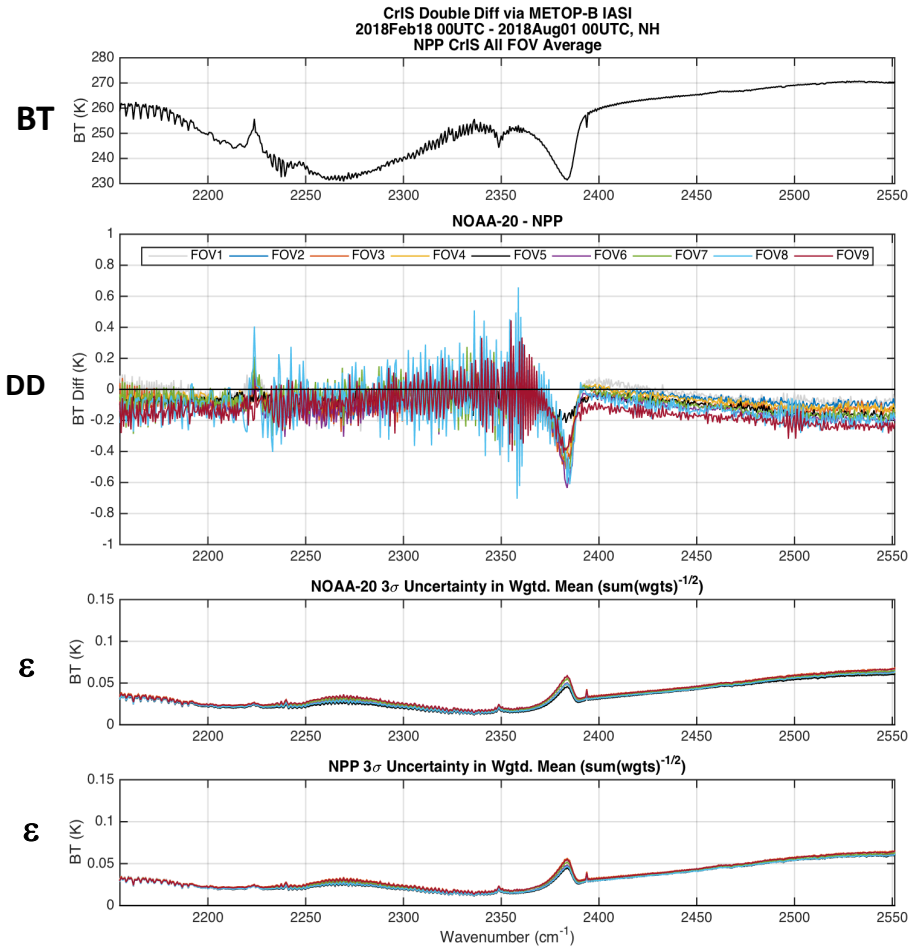


(Diff Y-scale is +- 0.5 K)

CrIS Shortwave Band: Unapodized FSR

- ***SW N20 – SNPP agreement within 0.6 K at unapodized resolution.***

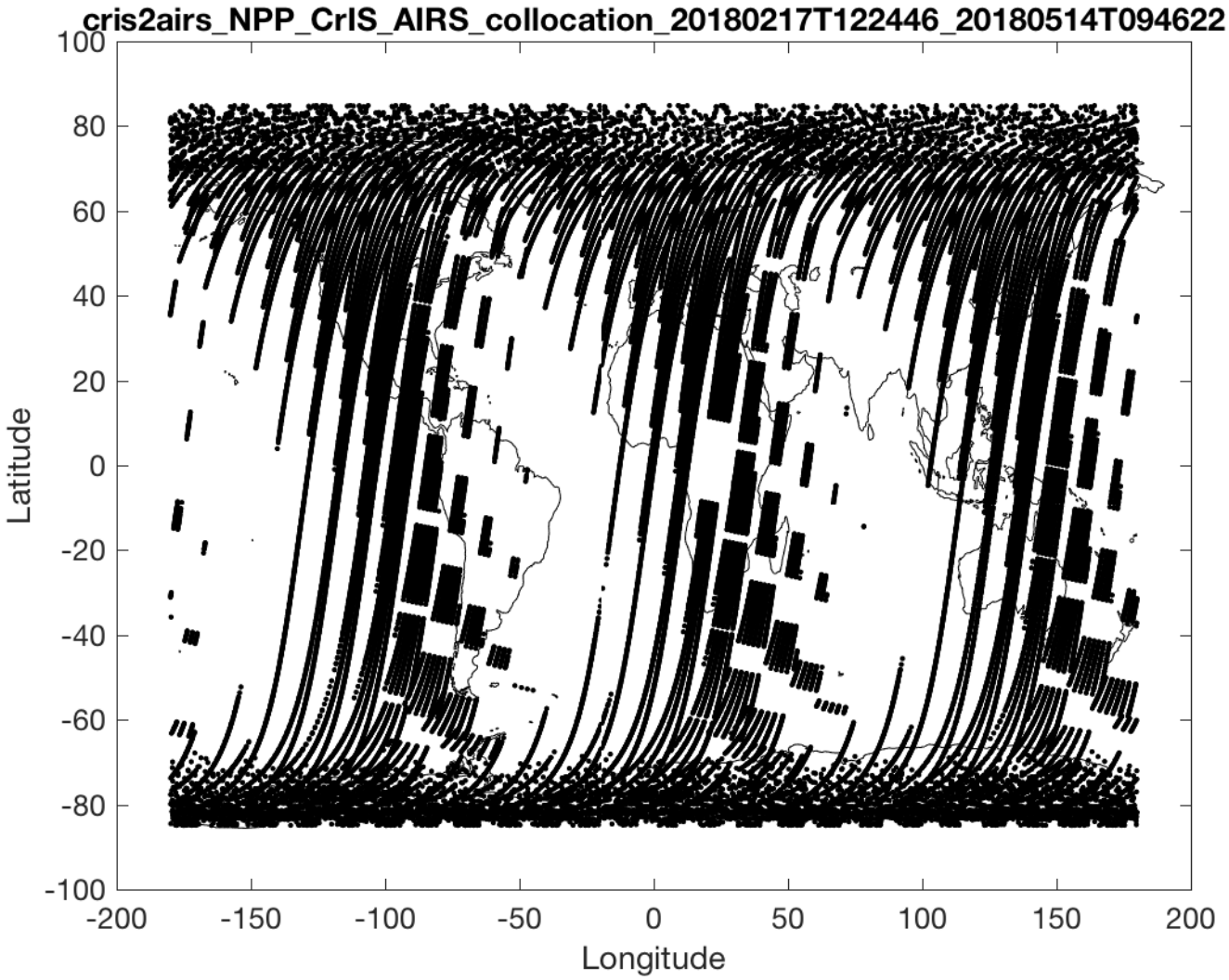
NOAA-20 minus SNPP Double Difference via IASI-B



(Double Difference Y-scale is +- 1 K)

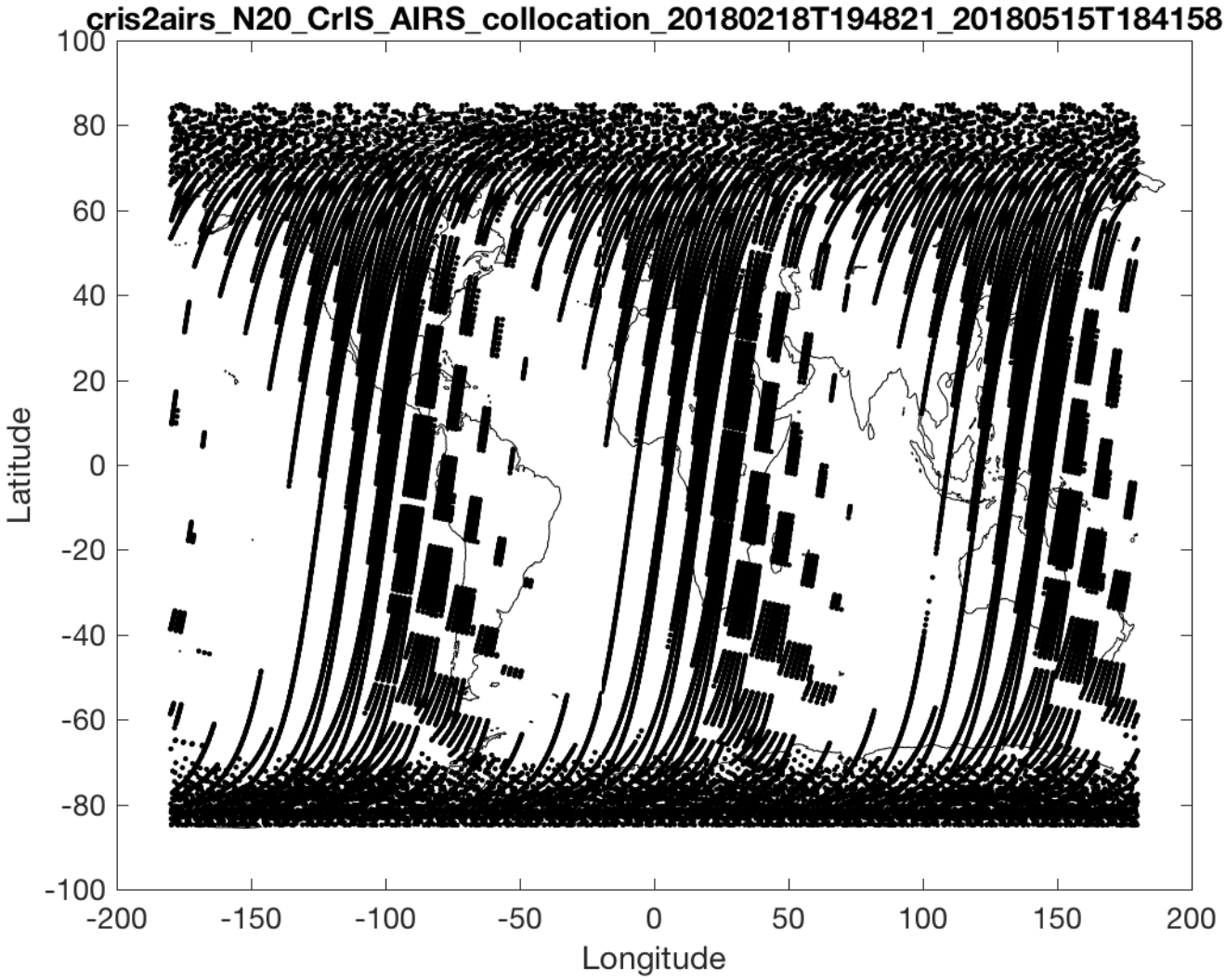
UW Big Circle Collocation of CrIS and AIRS

NPP

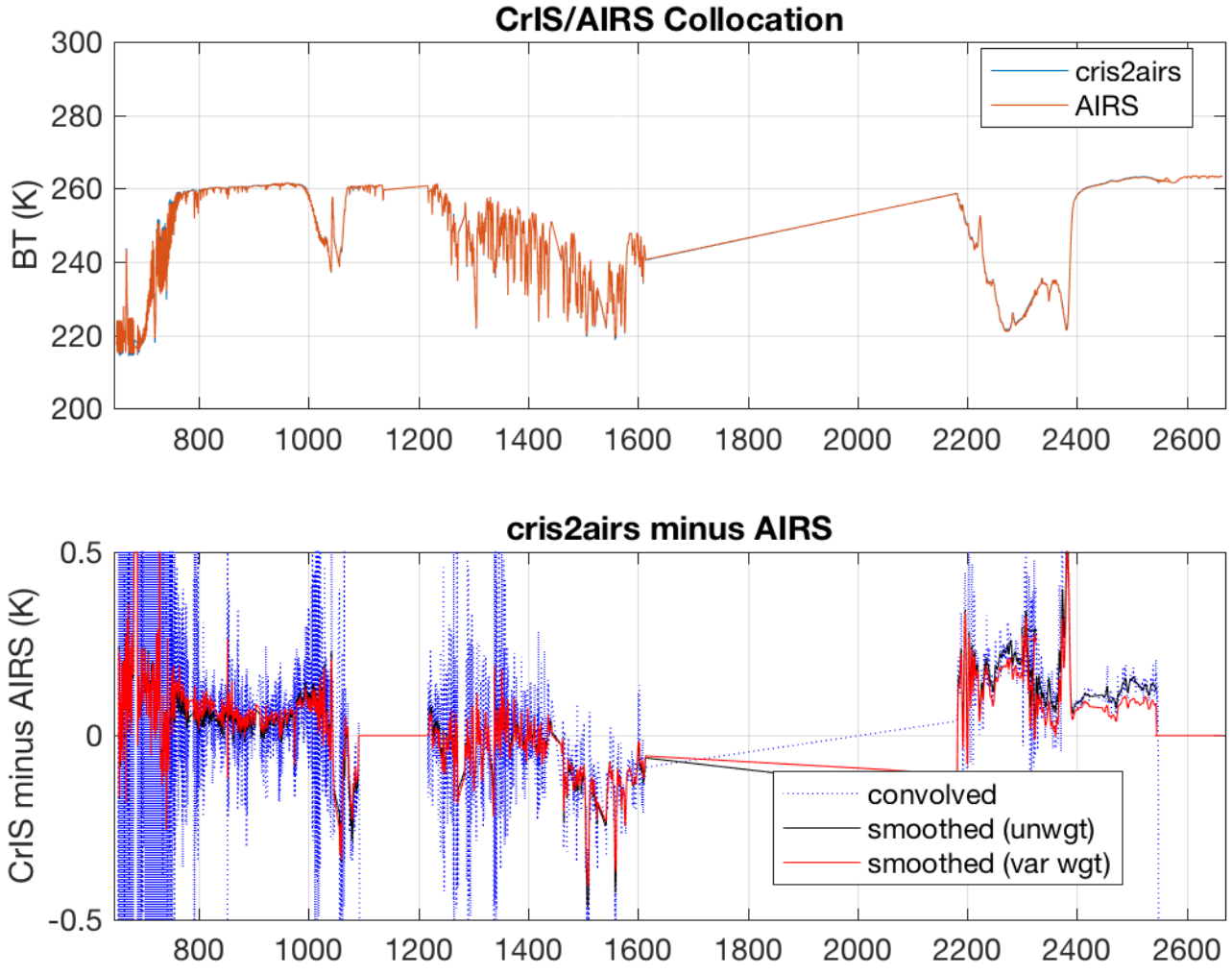


UW Big Circle Collocation of CrIS and AIRS

N20

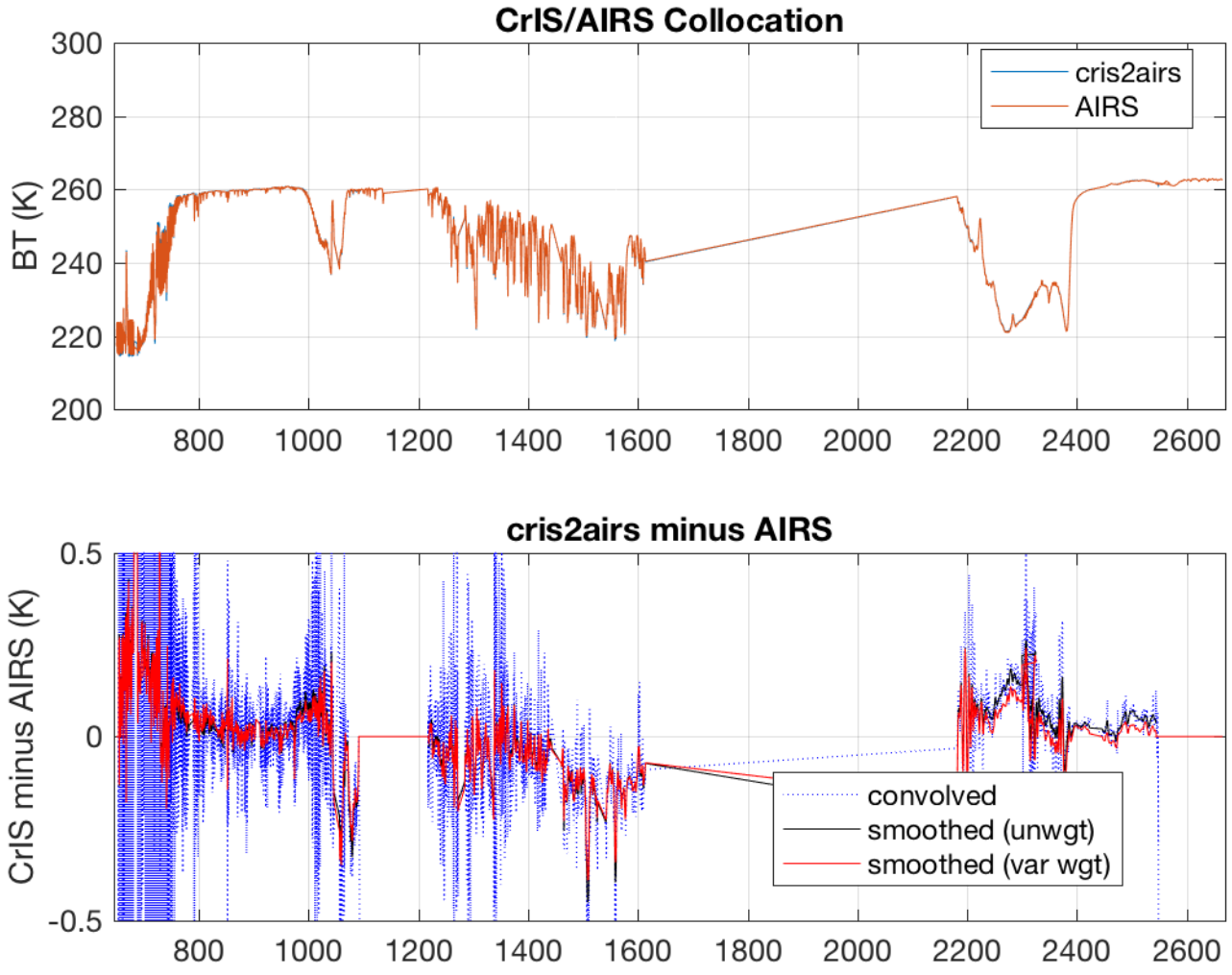


NPP



CrIS2AIRS applies AIRS SRFs to CrIS radiances and then heavily apodizes the difference.

N20



CrIS2AIRS applies AIRS SRFs to CrIS radiances and then heavily apodizes the difference.

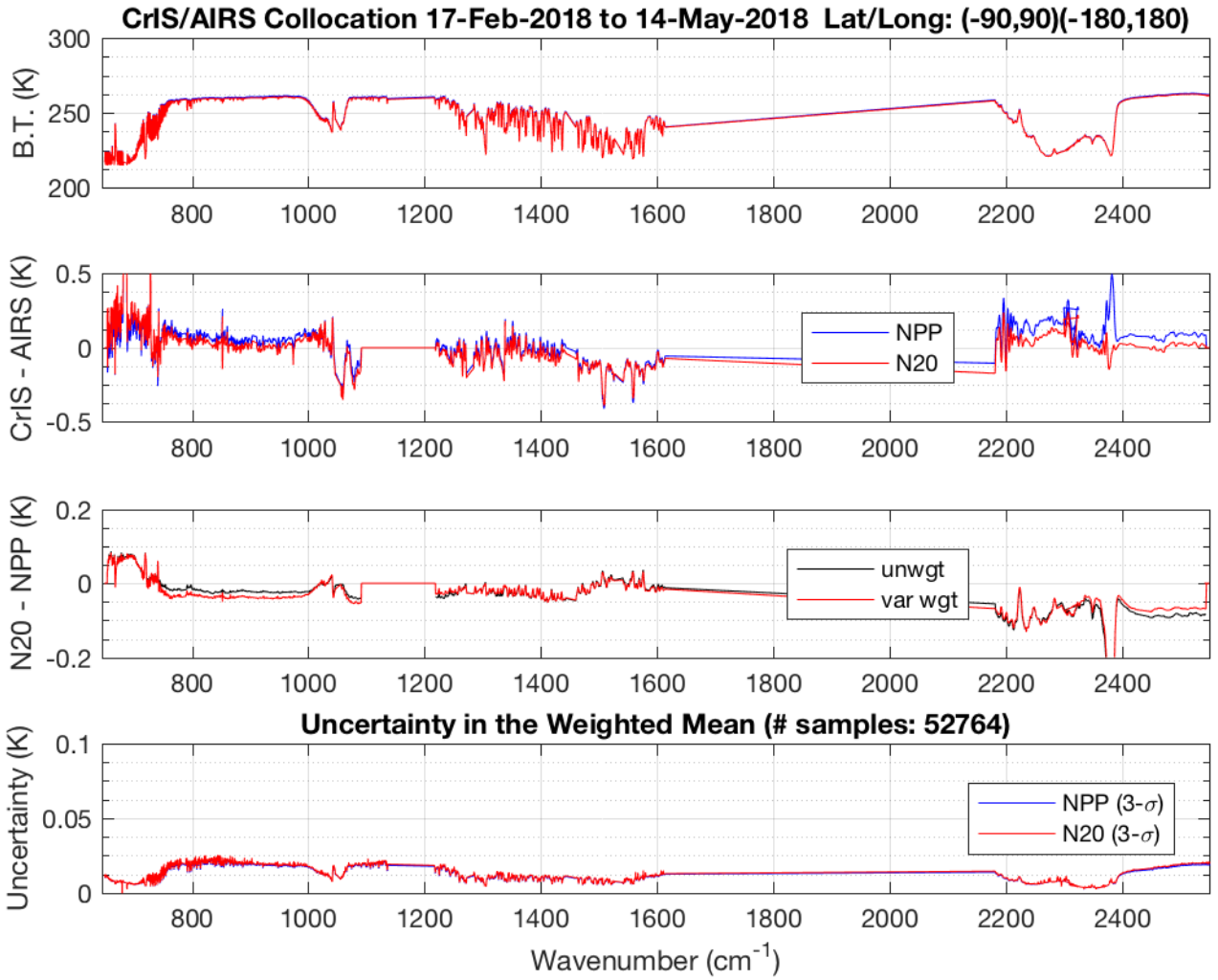
3x3 Mean of NOAA-20 CrIS relative to SNPP CrIS via NASA AIRS

B.T.

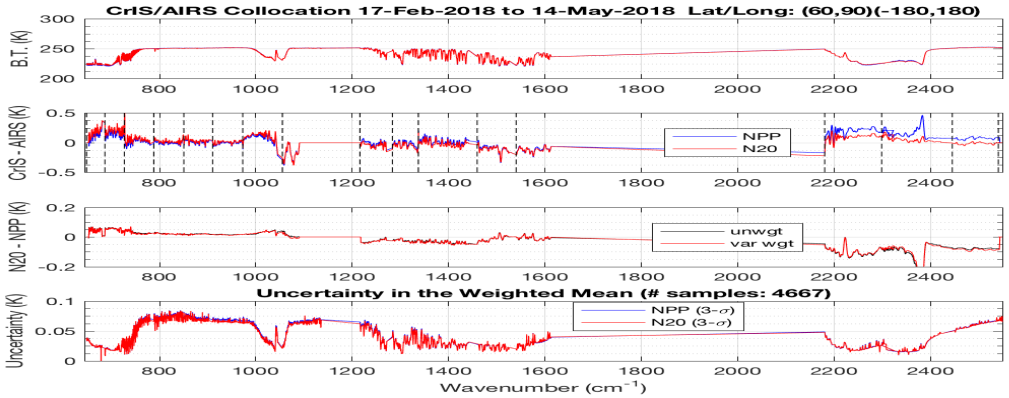
CrIS-AIRS

N20 CrIS – NPP CrIS Double Diff using AIRS

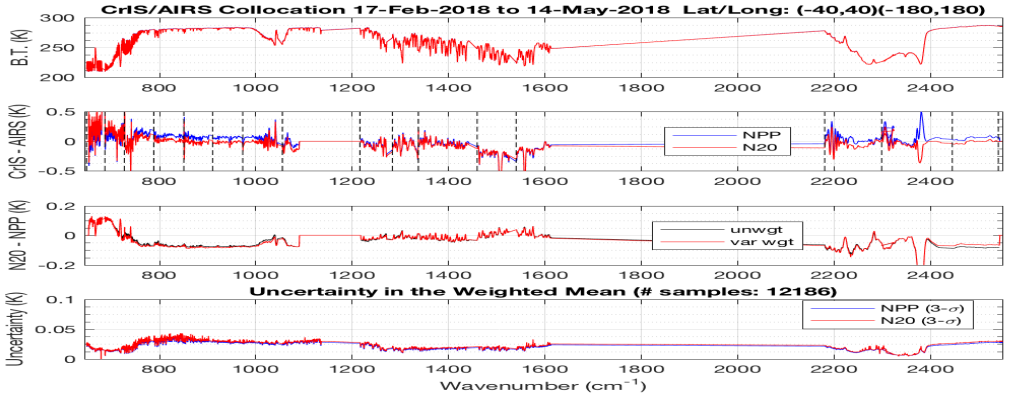
Uncertainty



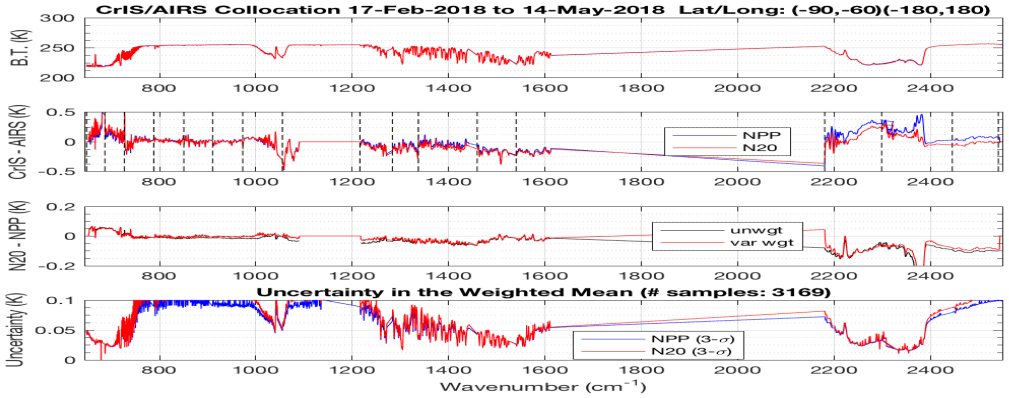
North Polar
60N-90N
Nighttime
Ocean/Ice



Middle Latitude
40S-40N
Nighttime
Ocean



South Polar
60S-90S
Nighttime
Ocean

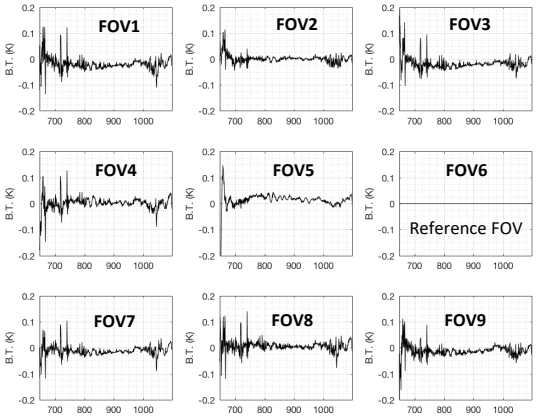


NOAA-20 CrIS Inter-Cal Questions and Answers

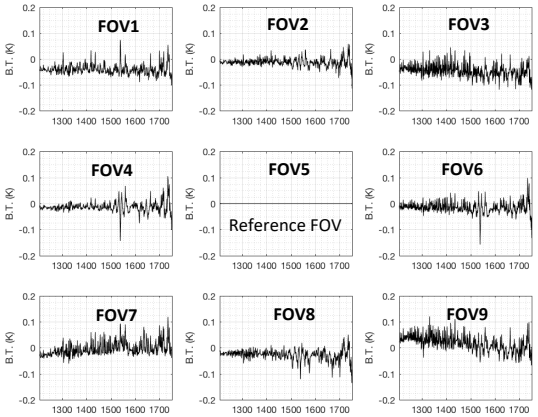
Q: Since CrIS has nine detectors in each band in a 3x3 array, what is the relative radiance bias among the nine Fields of View (FOVs) for NOAA-20 CrIS?

A: Expressed in terms of equivalent brightness temperature, the relative bias for the apodized spectra is **< 0.2 K** for all channels in all bands. *[Note that the nonlinearity coefficients in the LW band (FOV1-5,7-9) were adjusted to minimize the FOV-to-FOV BT differences relative to FOV6. The MW FOV9 nonlinearity was adjusted to minimize differences with FOV5 (a linear FOV). All other MW and SW FOVs are treated as linear.]*

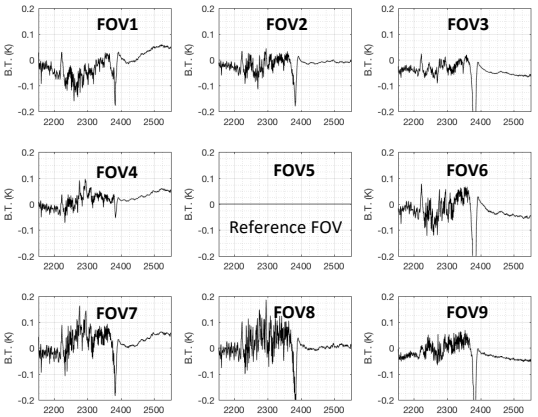
NOAA-20 Longwave



NOAA-20 Midwave



NOAA-20 Shortwave



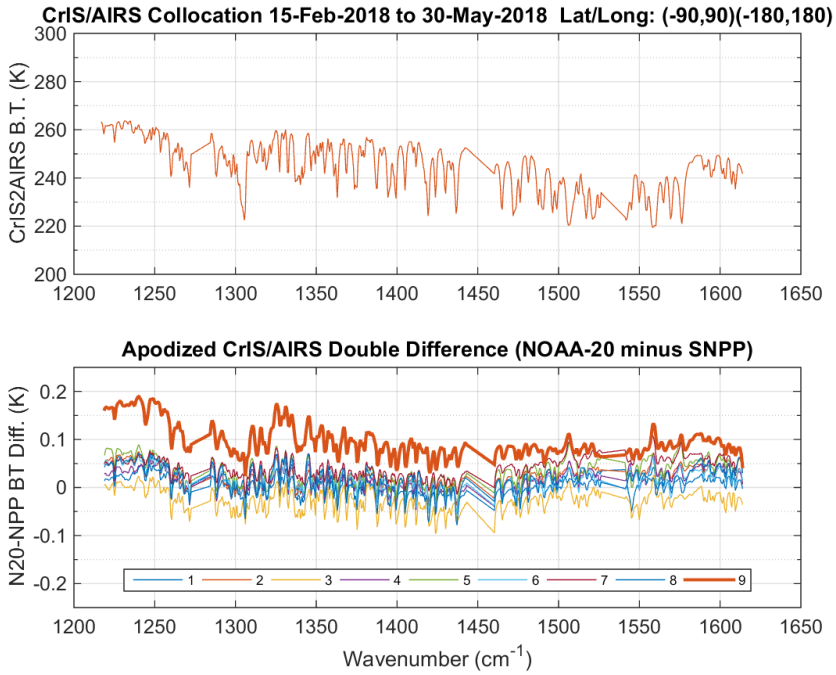
Vertical scale of plots is +- 0.2 K
Hamming apodized spectra.

NOAA-20 CrIS Inter-Cal Questions and Answers

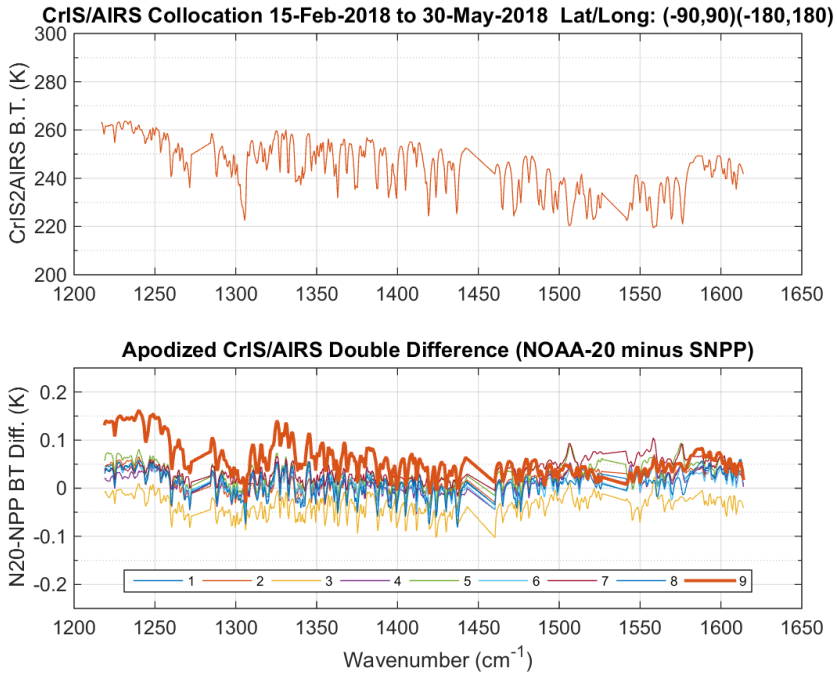
Q: Are there remaining issues with the MW band suggested by Inter-Cal?

A: An adjustment to the a2 quadratic parameter for NOAA-20 MW FOV9 is not able to remove an apparent offset. Non-zero cubic coefficient required?

Nominal MW FOV9 a2 value (EP114 and EP115)



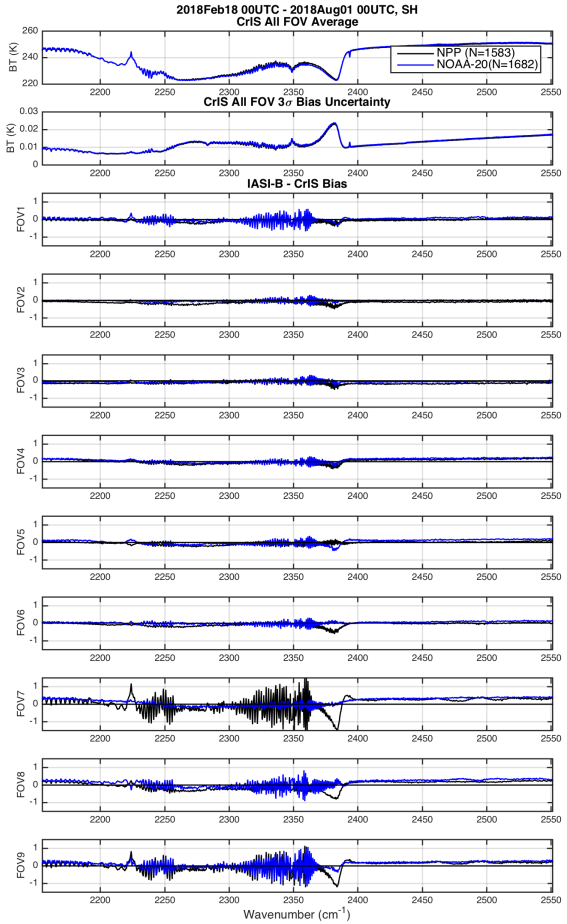
Nominal FOV9 a2 value increased by +6%

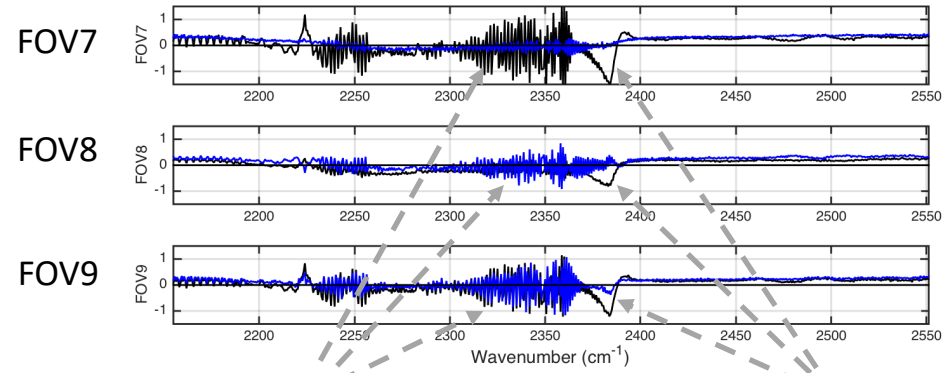


NOAA-20 CrIS Inter-Cal Questions and Answers

Q: Are there remaining issues with the SW band suggested by Inter-Cal?

A: Comparison of SNPP and NOAA-20 CrIS to IASI-B at FSR confirms improvement in SW line depths for CO and other gases for NOAA-20 over SNPP. This was also seen in FOV-2-FOV relative comparisons. Need to investigate how to improve SNPP line shape.





NPP (black)

NOAA-20 (blue)

These line features are amplitude errors not shifts!

This low resolution feature at 2383 cm^{-1} is not in NOAA-20.

Spectral line shape issues with FOVs 1, 7, 8, 9 relative to a common IASI spectrum.

NOAA-20 CrIS Inter-Cal Questions and Answers

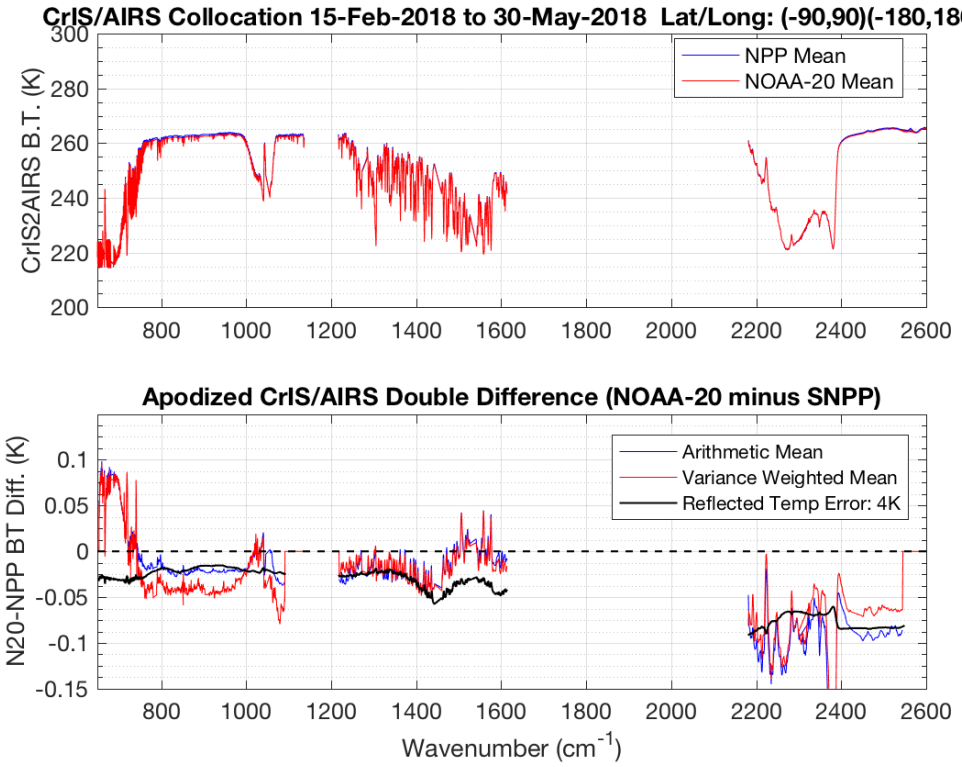
Q: What improvements in CrIS calibration are suggested by Inter-Cal?

A: The very high emissivity of the NOAA-20 CrIS on-board blackbody (ICT) can be used to refine the SNPP CrIS environmental model which has larger uncertainties due to a lower emissivity on-board blackbody.

Weighted and unweighted methods are used to estimate the mean in the NOAA20 – NPP double difference.

The black line represents a recalibration of the SNPP CrIS radiances assuming a positive offset of +4 K in the Scan Baffle temperature.

The CrIS scan baffle temperature has uncertainty of a similar magnitude during each orbit.



NOAA-20 CrIS Inter-cal Questions and Answers

Q: What is the expected impact of a CrIS polarization correction on satellite inter-calibration, i.e. does it remove any observed biases?

A: The polarization correction is in general small (<0.5K) but there is evidence that it improves the BT dependence of the stratospheric channels in the shortwave band of both SNPP and NOAA-20 CrIS relative to NASA AIRS. *[However, AIRS also has a polarization correction with uncertainty.]*

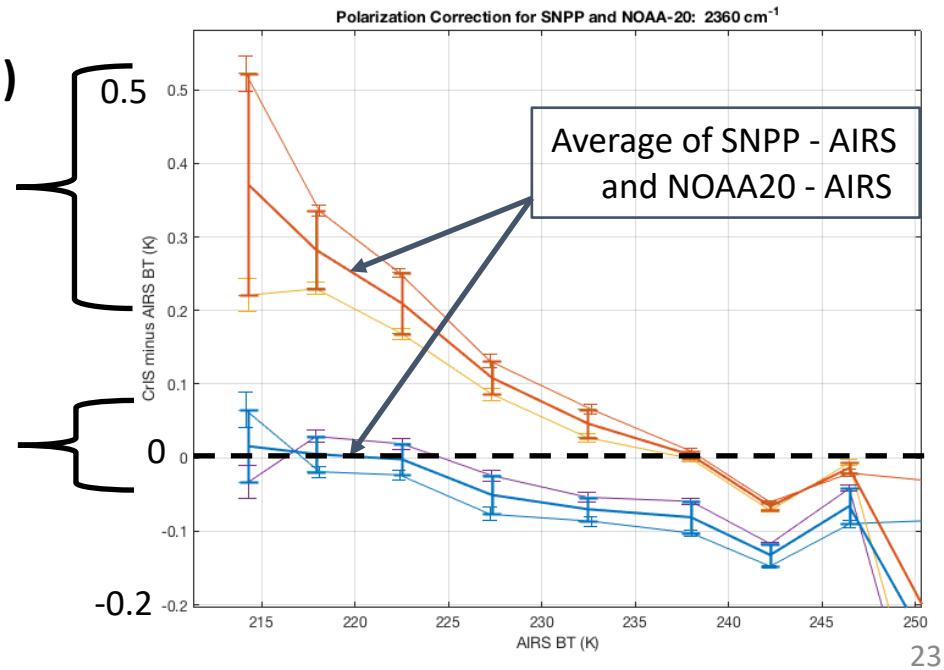
CrIS minus AIRS at 2360 cm^{-1} (4.2 μm)

Before Polarization Correction

~0.4K @ 215K

After Polarization Correction

~0.0 K @ 215K



Future Work

1. Adjust SNPP ICT blackbody environmental reflection model to include an orbital bias in scan baffle temperature. Use NOAA-20 as the reference since it uses a much higher emissivity on-board blackbody.

2. Adjust SNPP quadratic nonlinearity coefficients (a2) to remove bias in LW.

3. Test the inclusion of cubic nonlinearity in the SNPP FOV7 and NOAA20 FOV9.

4. Implement and validate the CrIS polarization correction for SNPP and NOAA20.

5. Investigate the SNPP shortwave band line amplitudes errors (order 0.2K) relative to NOAA-20 CrIS which appears to be significantly improved. (Why?)

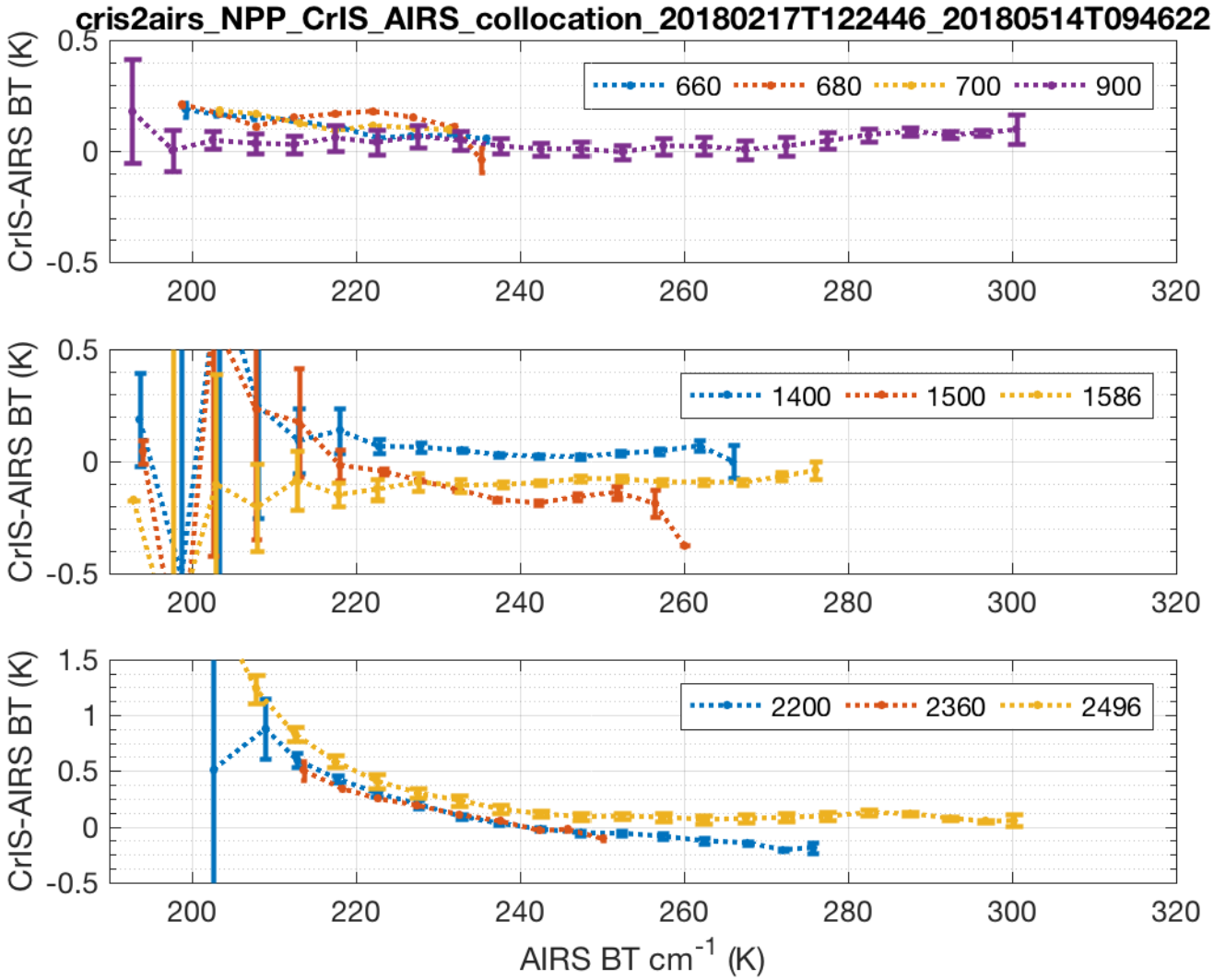
6. Incorporate improvements into NASA L1B software for future release and report results to NOAA for potential inclusion in NOAA SDR algorithm.

BACKUP SLIDES

Scene Temperature Dependence for Selected Wavenumber Ranges

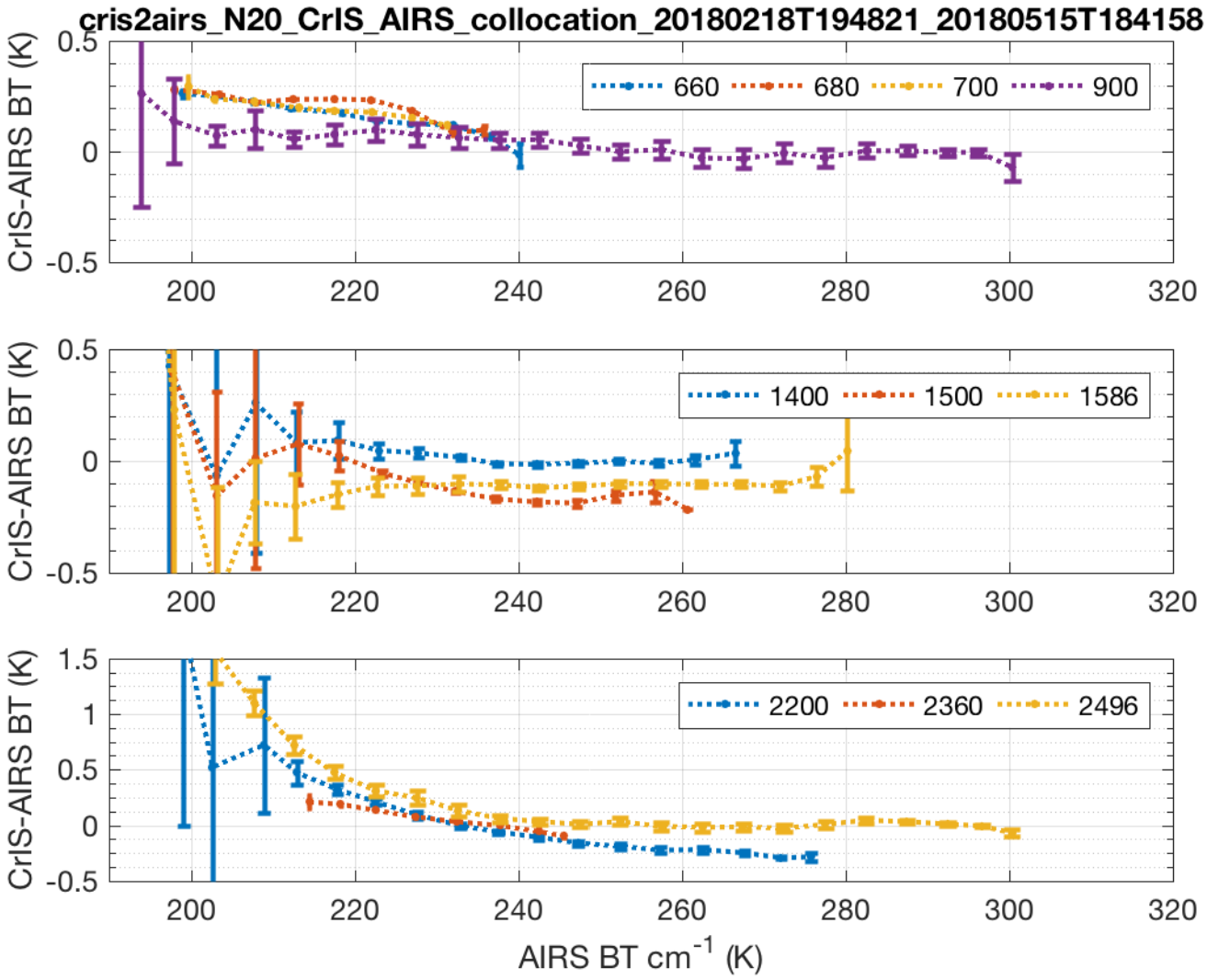
NPP

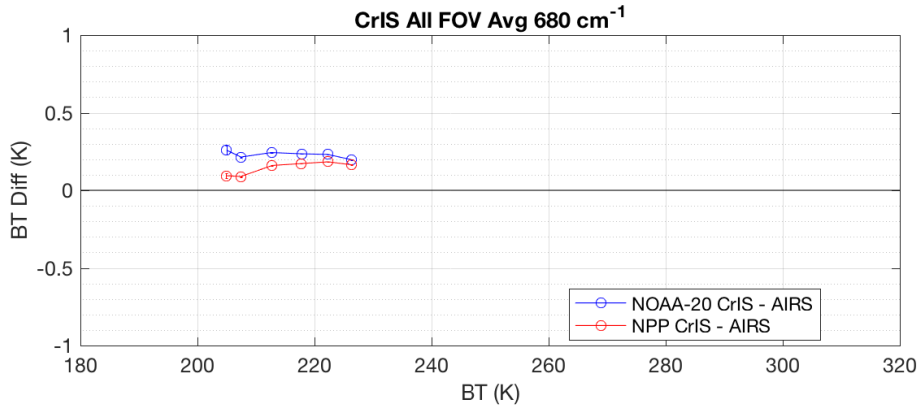
Without Polarization Correction

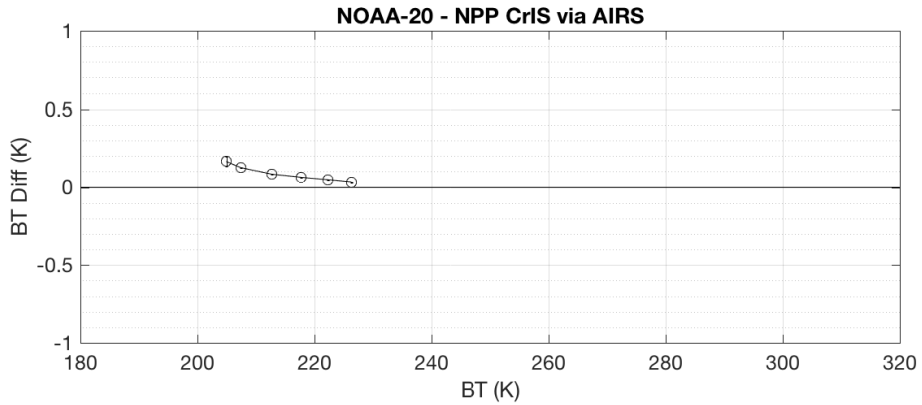


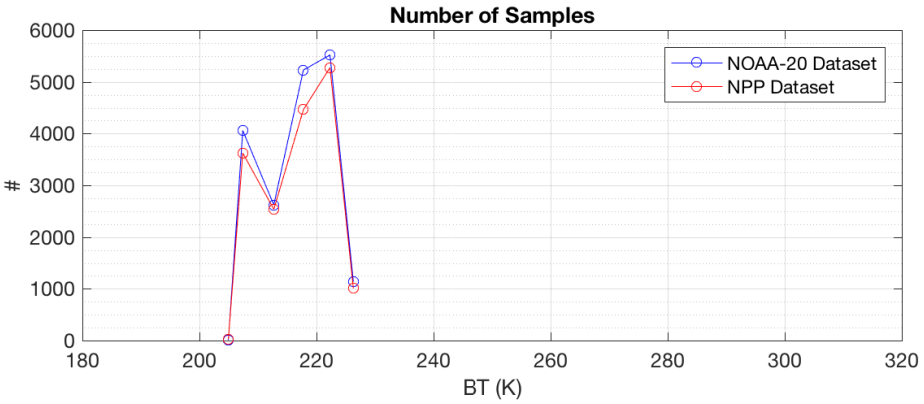
N20

Without Polarization Correction

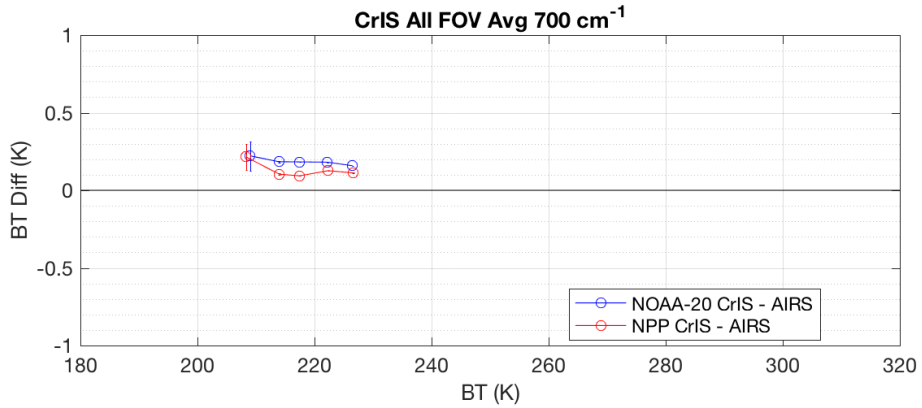


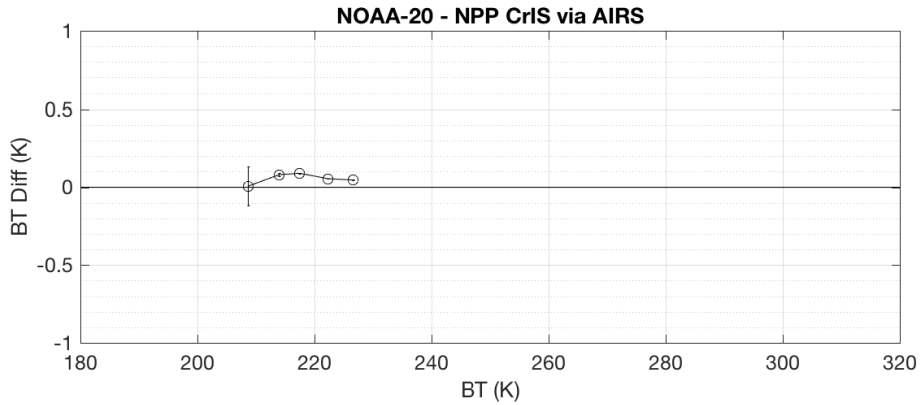


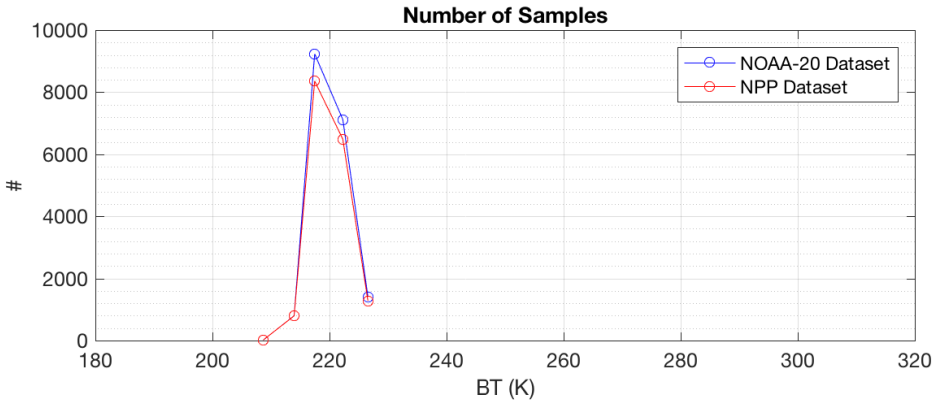




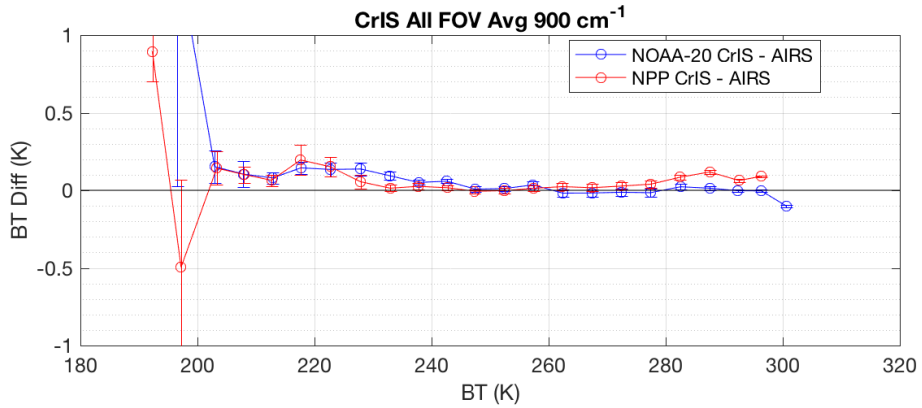
Without Polarization Correction

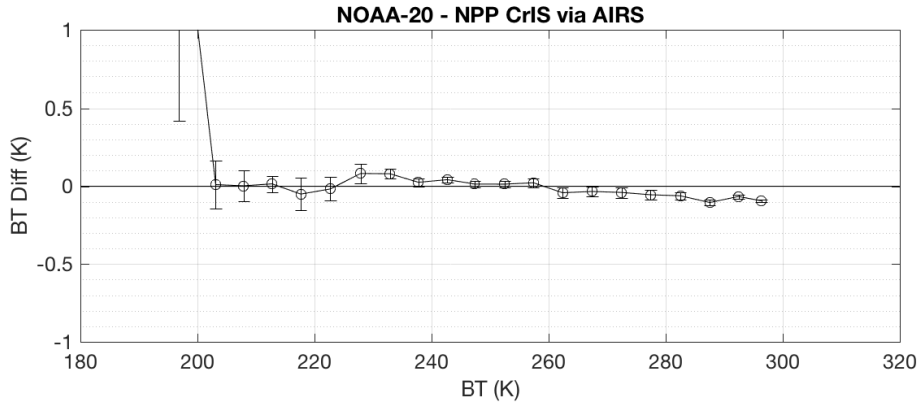


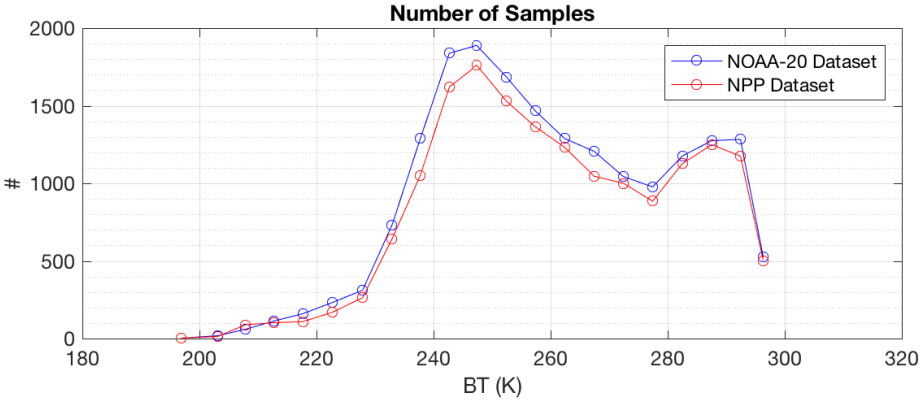




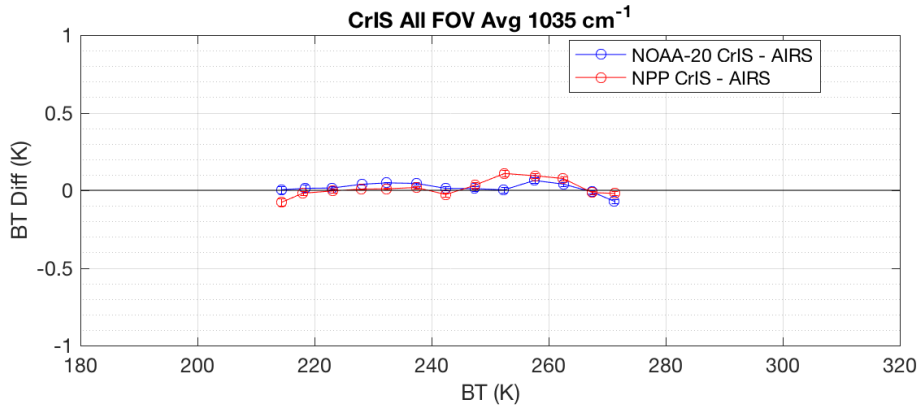
Without Polarization Correction

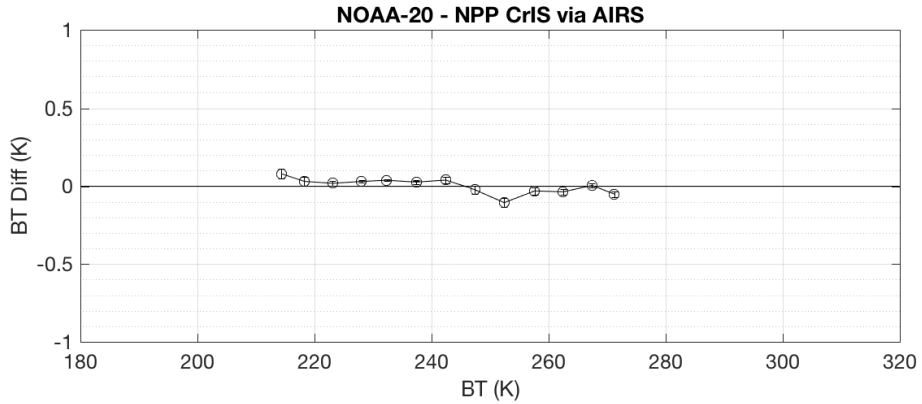


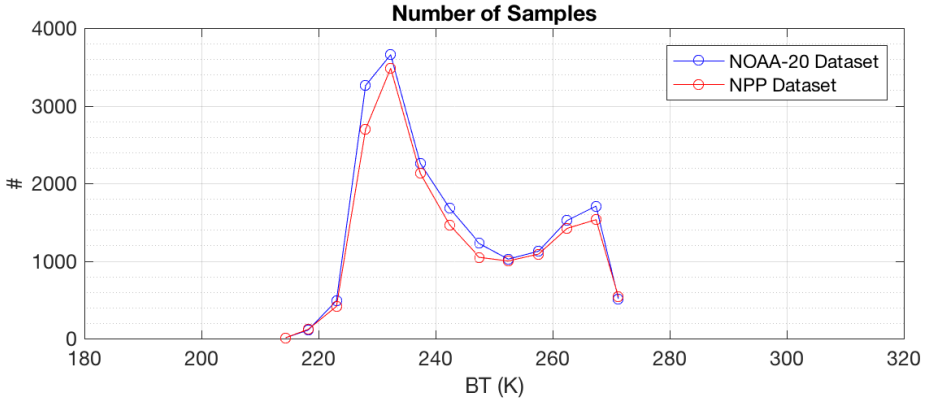




Without Polarization Correction







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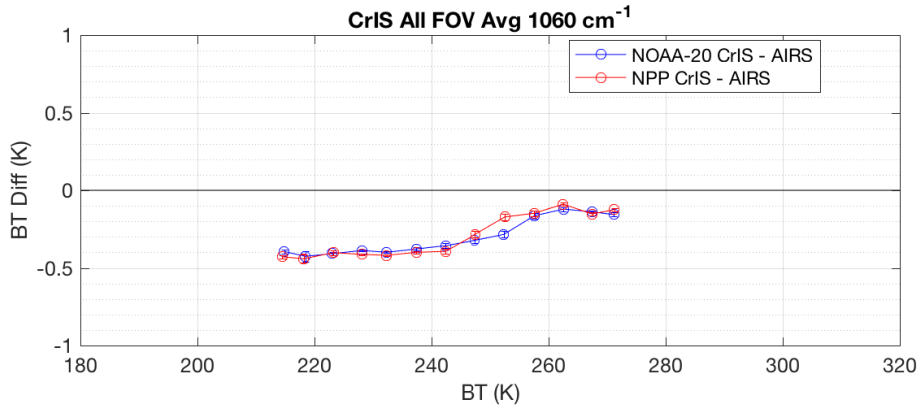

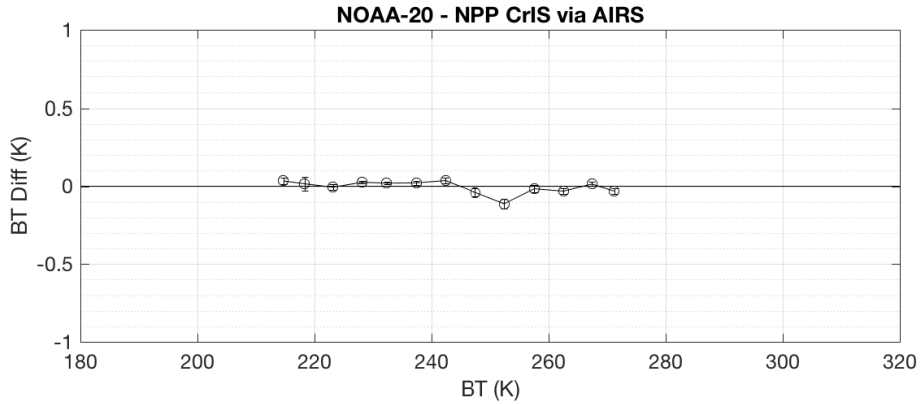

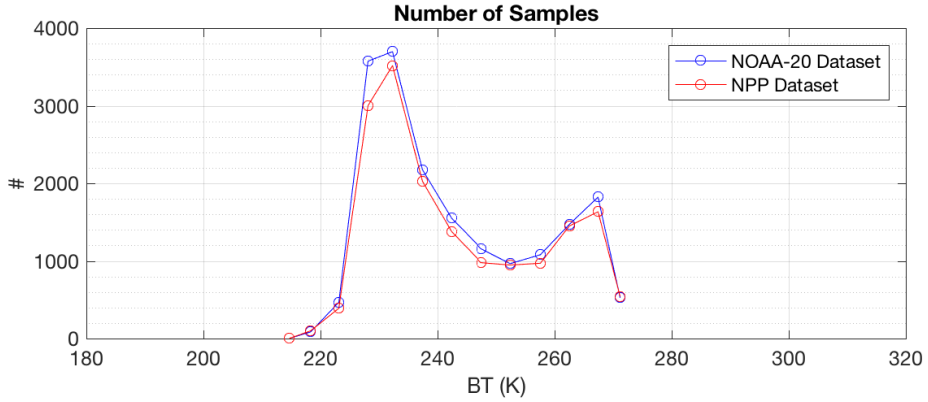

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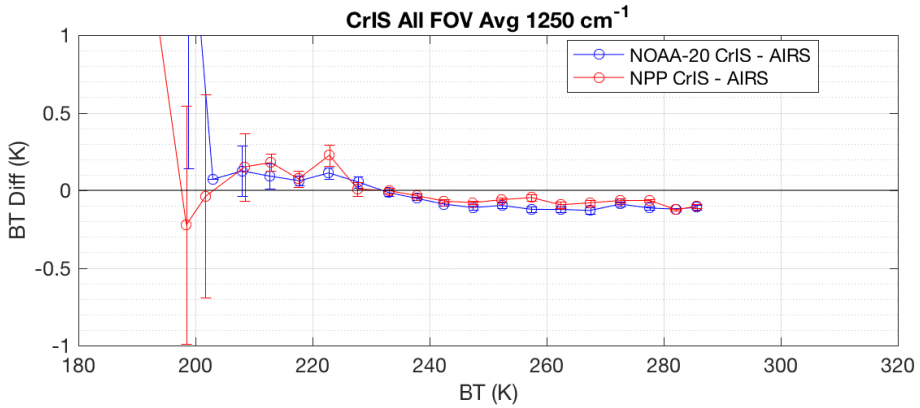

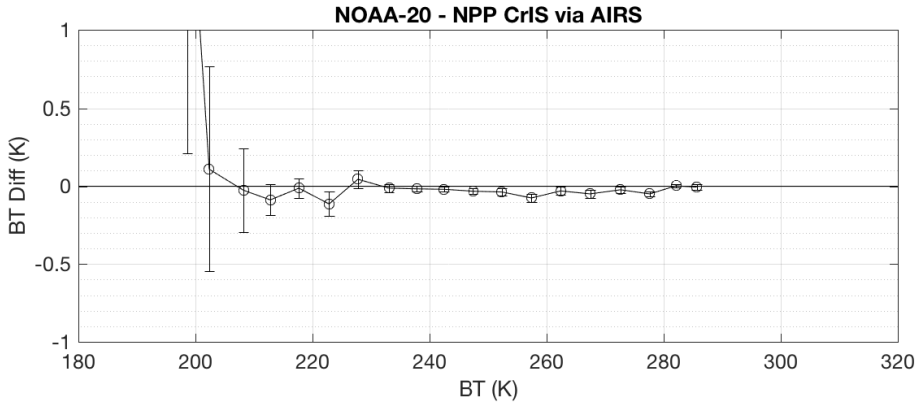

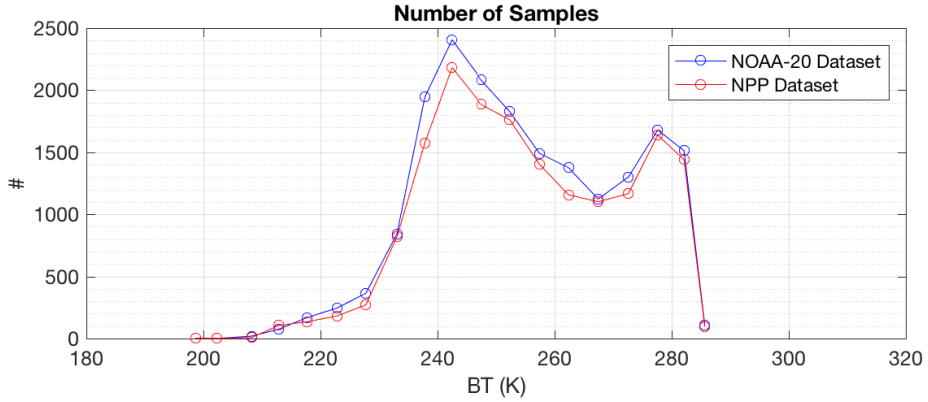

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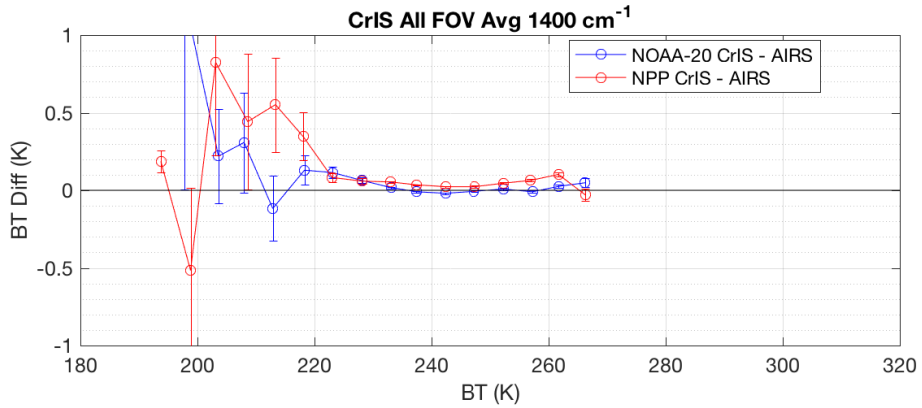

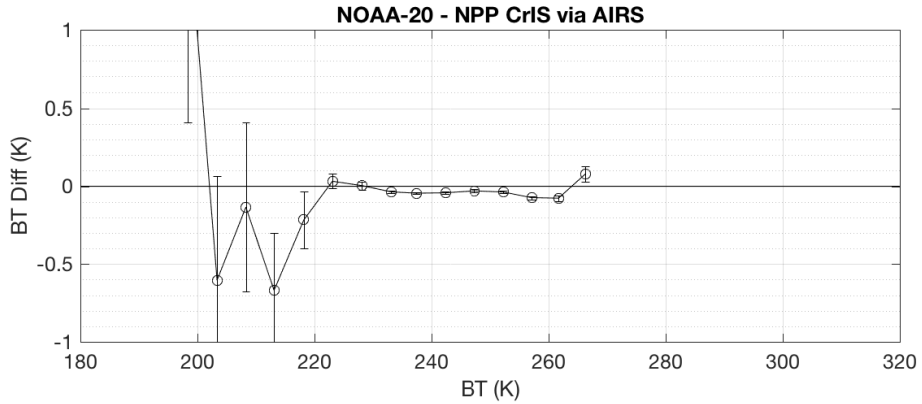

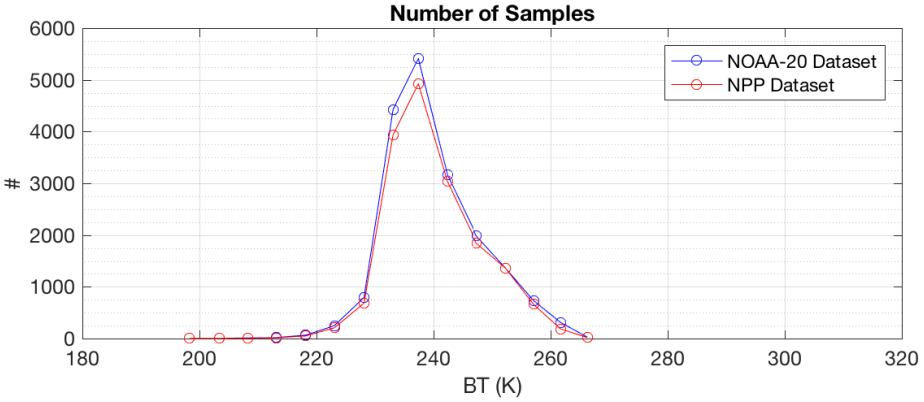

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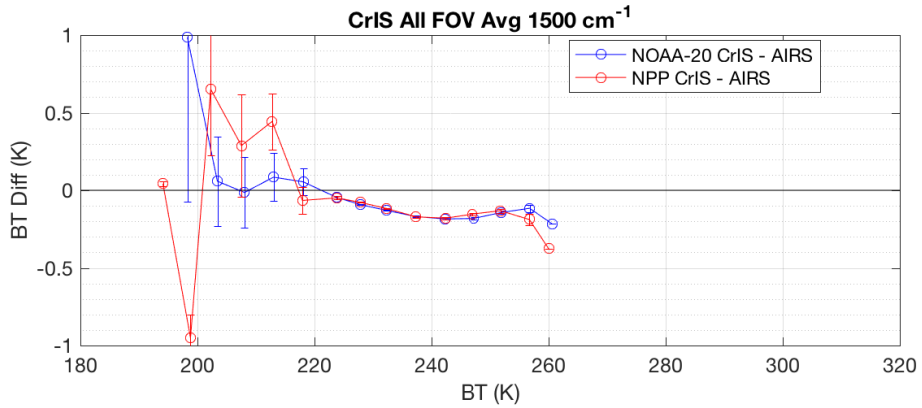

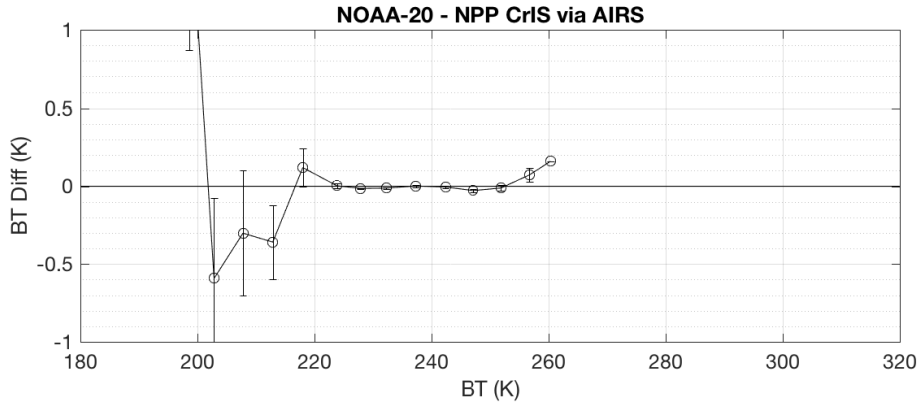

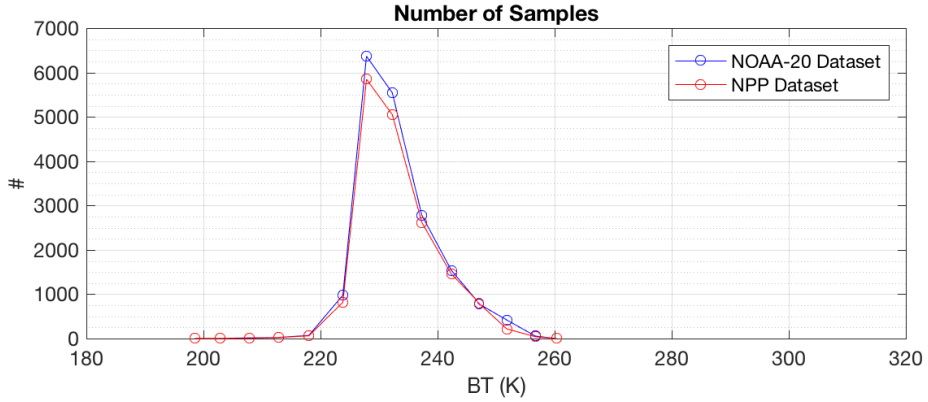

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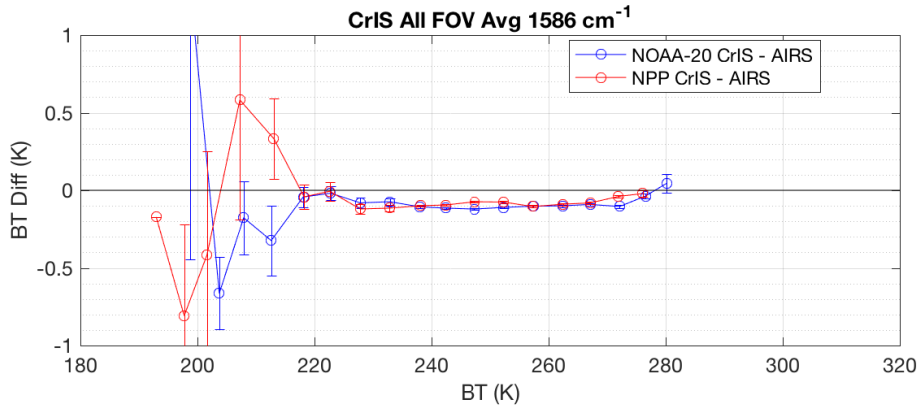

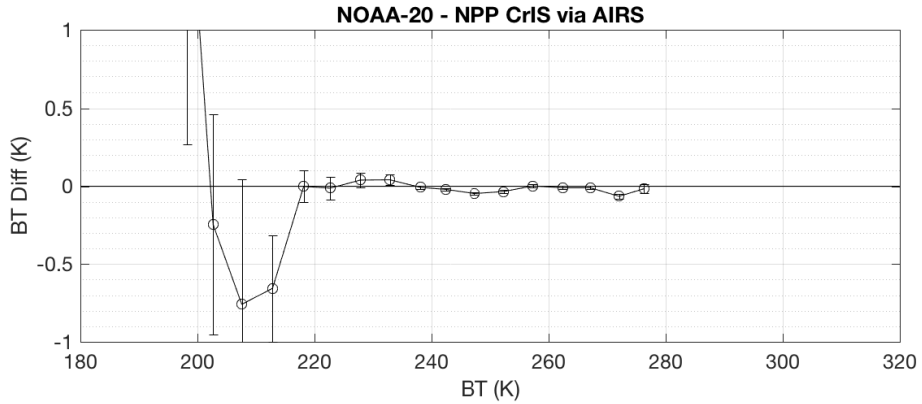

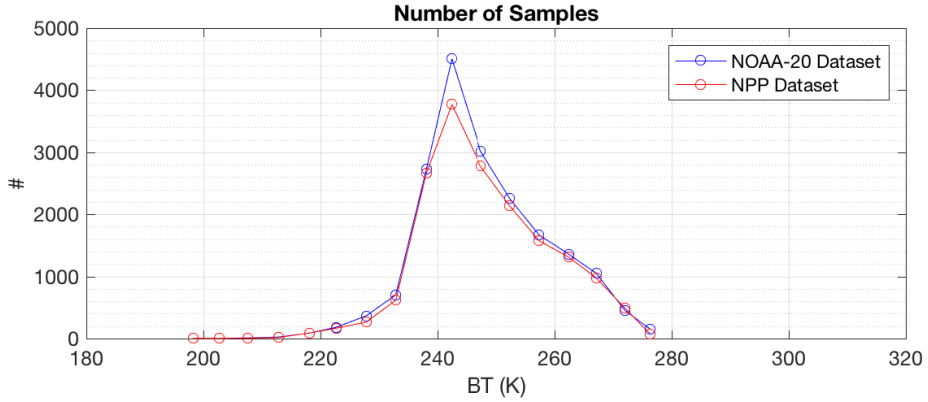

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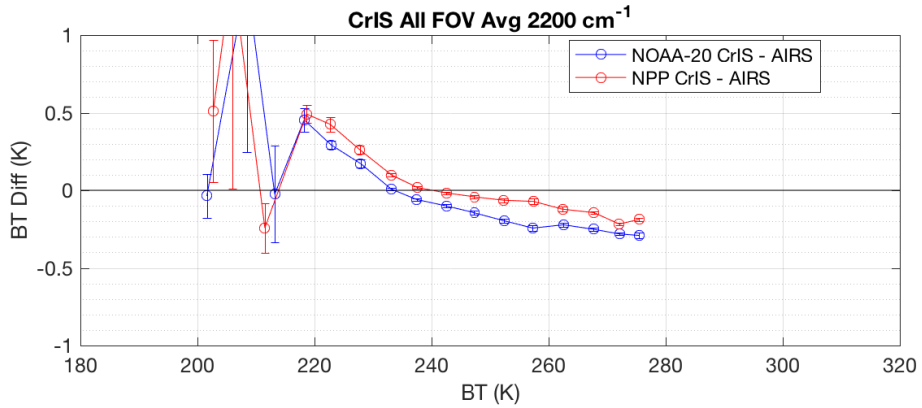

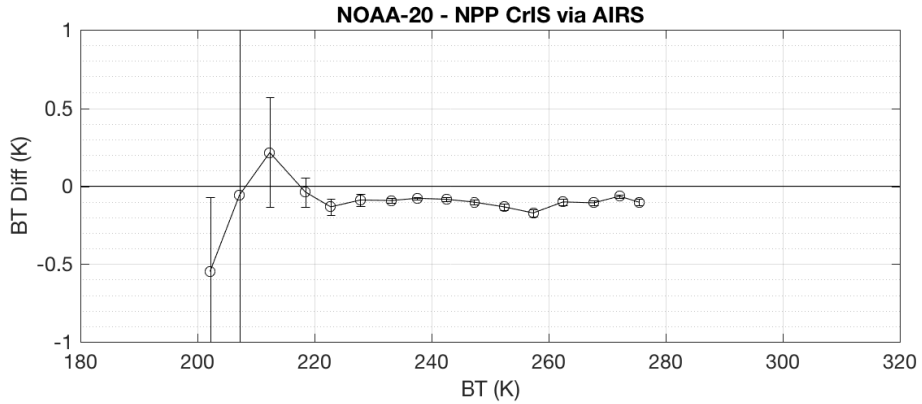

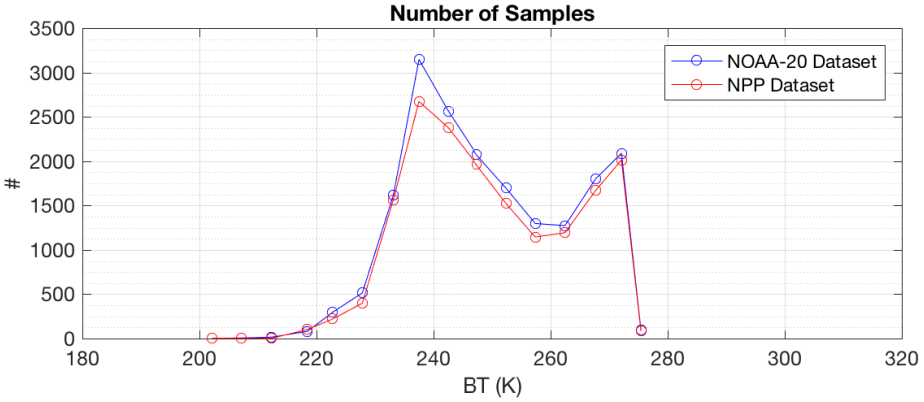

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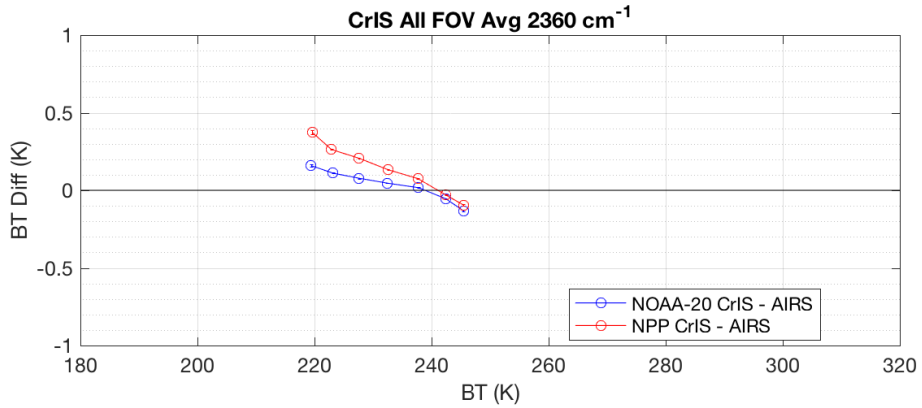

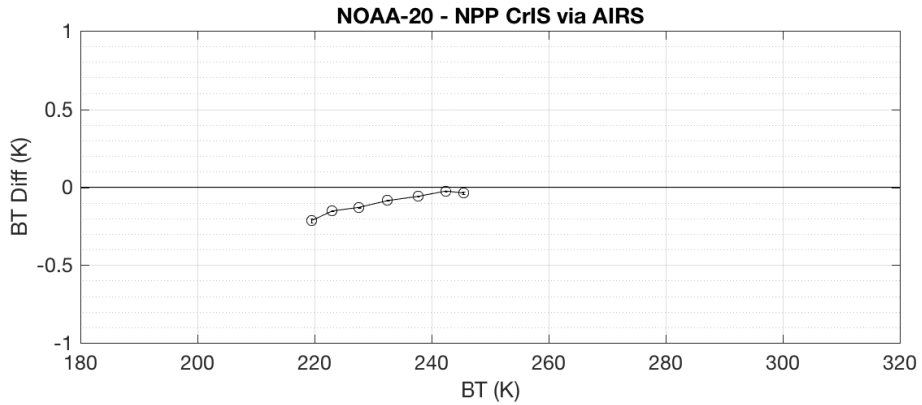

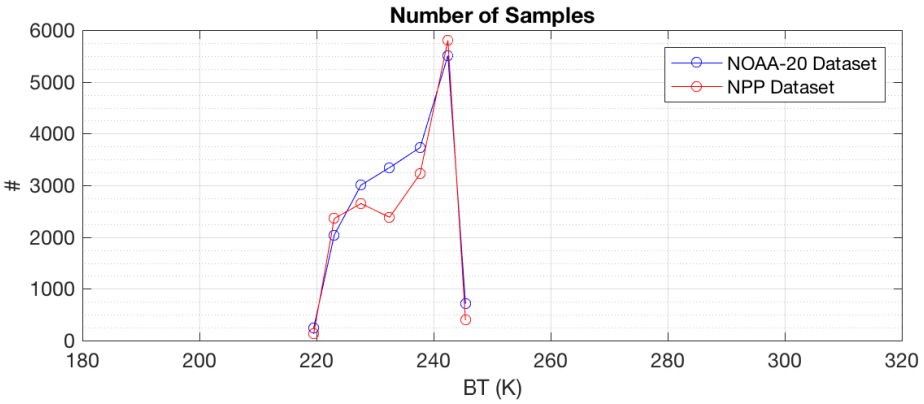

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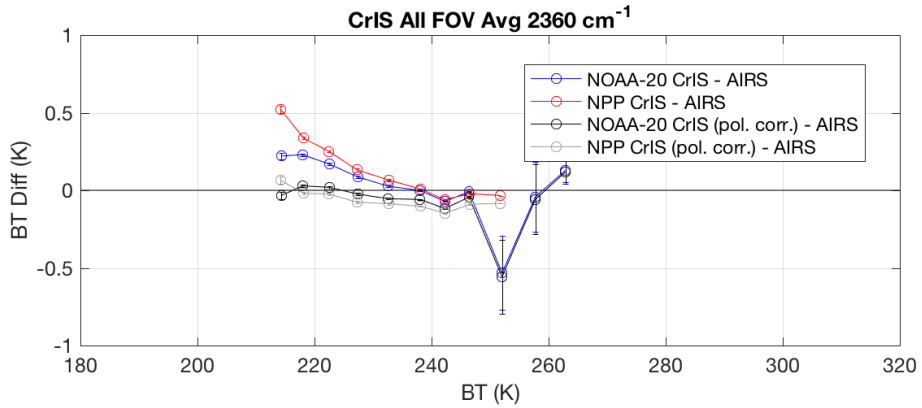
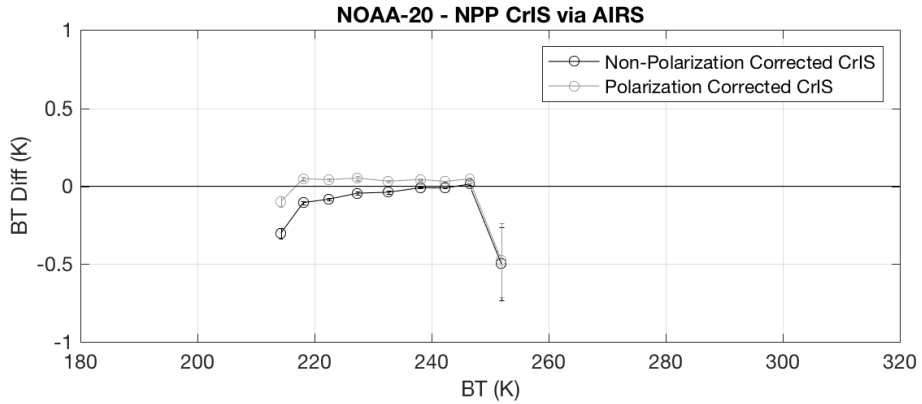
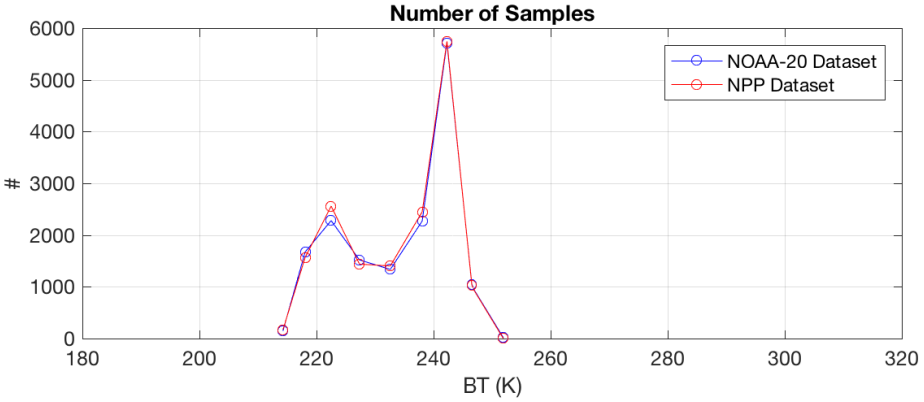
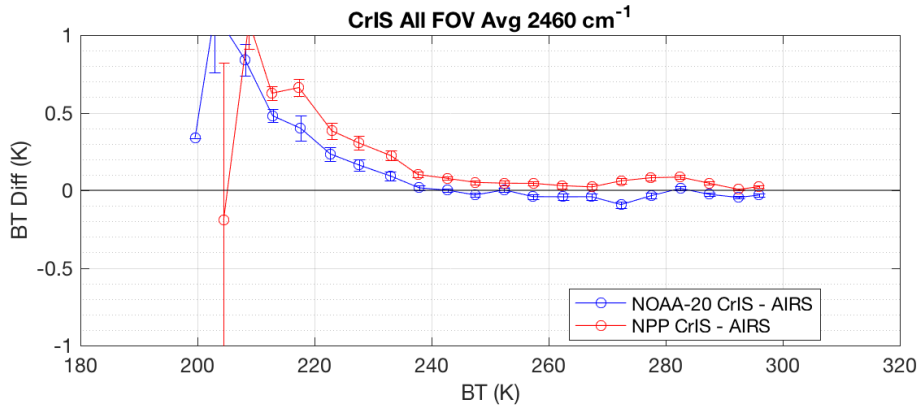
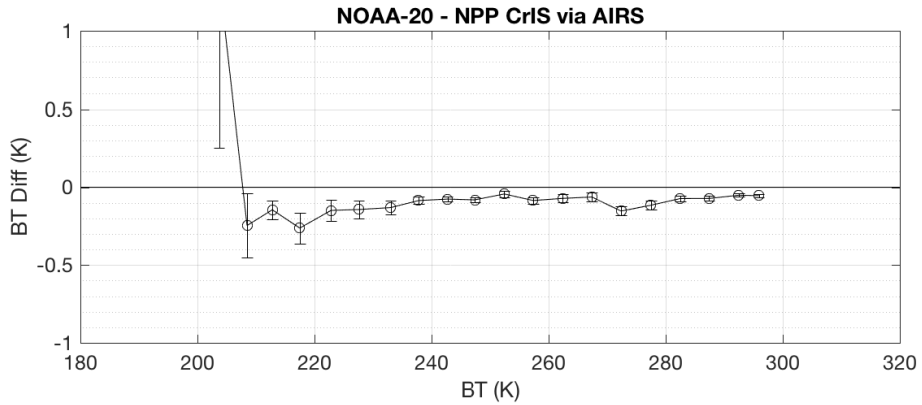


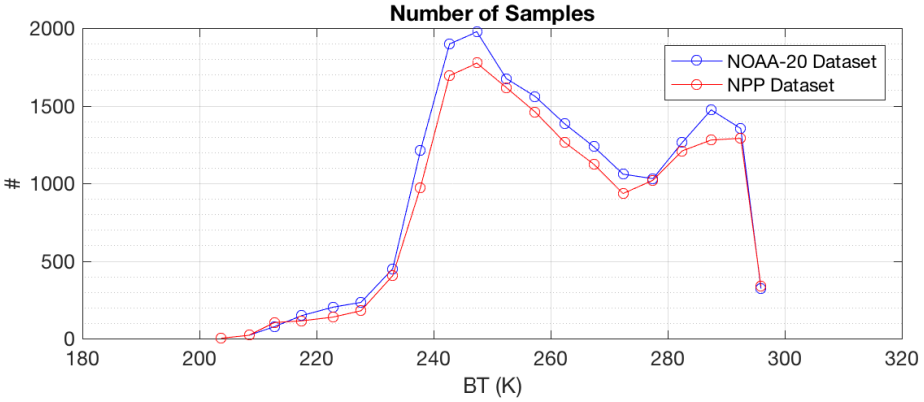




With and Without Polarization Correction







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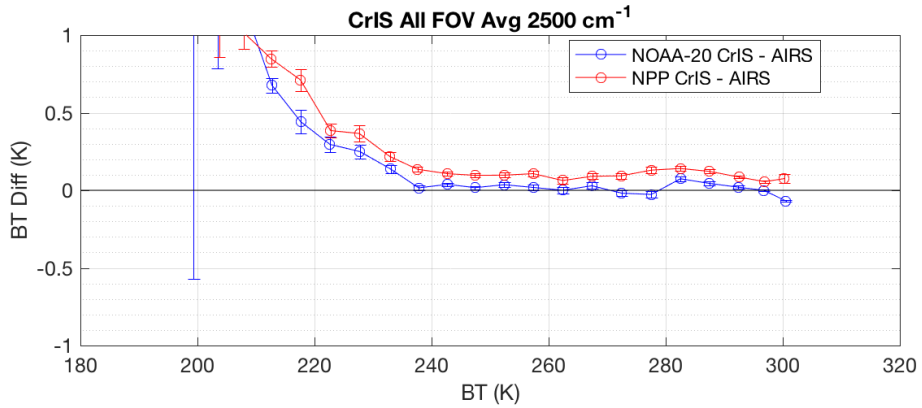

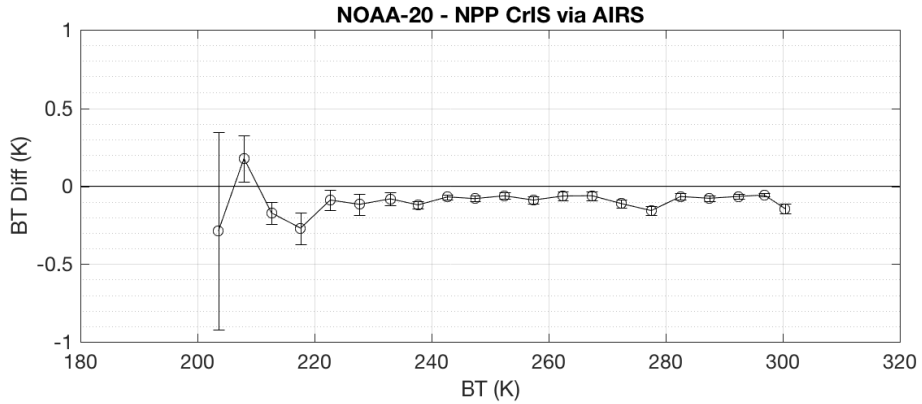

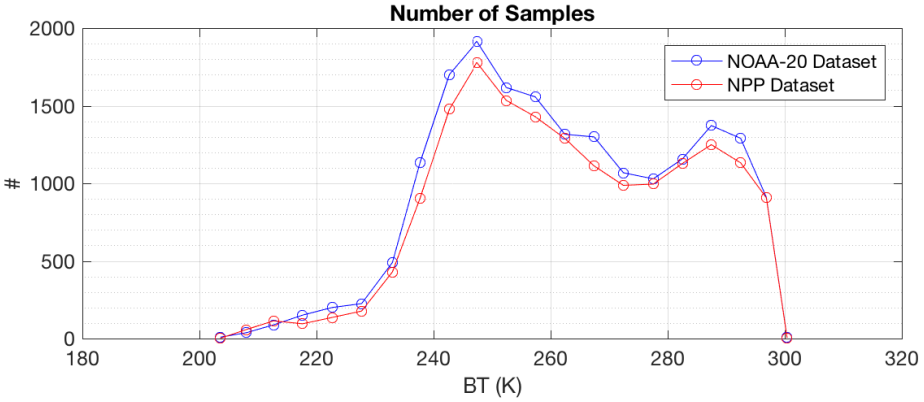

Without Polarization Correction