AIRS/CrIS Radiance Inter-Calibration: Tests of Trends Using Time Series Combining Both Sensors

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Overview

- A Hyperspectral IR climate record depends on sensor continuity
- Spectral : AIRS, CrIS, IASI SRFs/ILS Very Different
- Radiometric : Differences in the 0.3K or less range, great starting point.
- Spatial : AIRS footprint slightly smeared relative to CrIS, slight impact on extrema.
- Sampling : AIRS/CrIS sample the globe at slightly different times and atmospheric paths. Strategies to mitigate exist.
- We examine radiometric differences between AIRS and SNPP/NOAA20 CrIS, using both SNOs and statstical sampling.

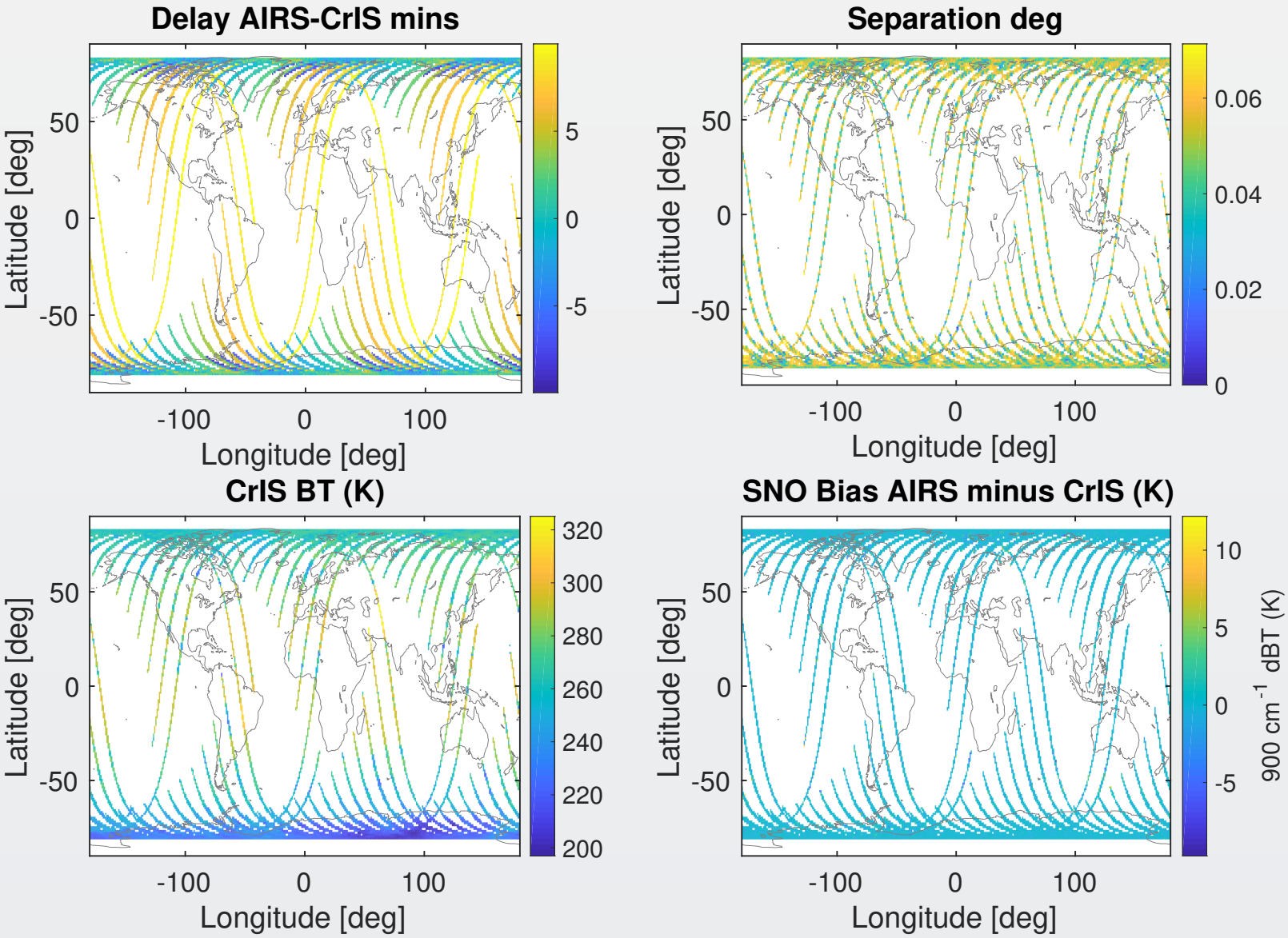
Spectral Considerations

- Convert AIRS to the CrIS ILS/SRF. Presently using NSR, will switch in future to something close to 0.8/0.6/0.4 OPD “CrIS Hybrid”, or “CHIRP”
- Need AIRS L1c (at the DAAC) for production of AIRS2CrIS products.
- Conversion of IASI2CrIS is essentially trivial since IASI L1c gaussian apodization is far from zero at 0.8 cm path difference, so conversion to 0.8 sinc ILS is robust.

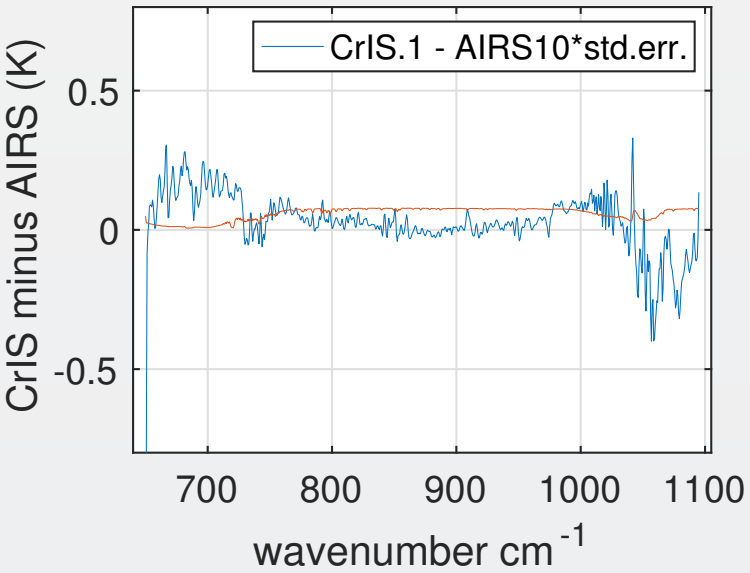
Radiometric Considerations

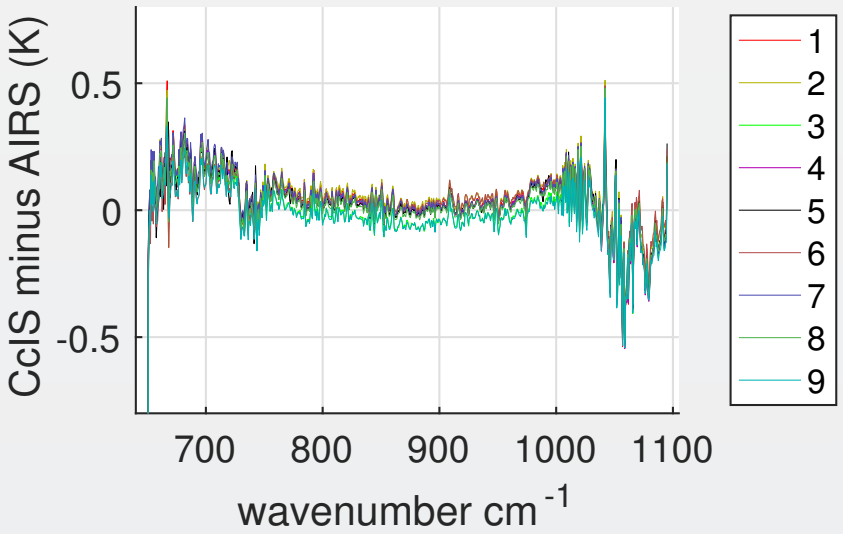
- AIRS CrIS SNO's global, but heavily weighted to high latitudes
- At minimum, we want best statistical match between sensors. We use equal-area weighted set (1% of 2016 scenes) sampled over all scan angles.
- All scan angle required to keep AIRS and CrIS mean sampling times as close as possible.
- AIRS and CrIS have slightly different mean scan (secant) angles. Easy to correct AIRS to CrIS mean secant, magnitude ~0.2K
- We get very good agreement between SNOs and statistical comparisons, giving us some confidence that the instrument differences are not too scene dependent.

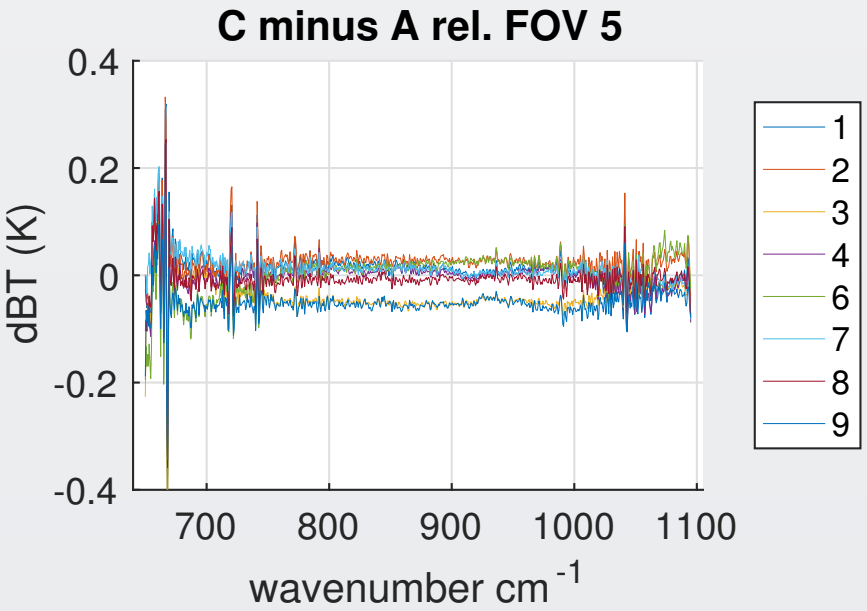
Example of One Month of AIRS:CrIS SNOs: Maps



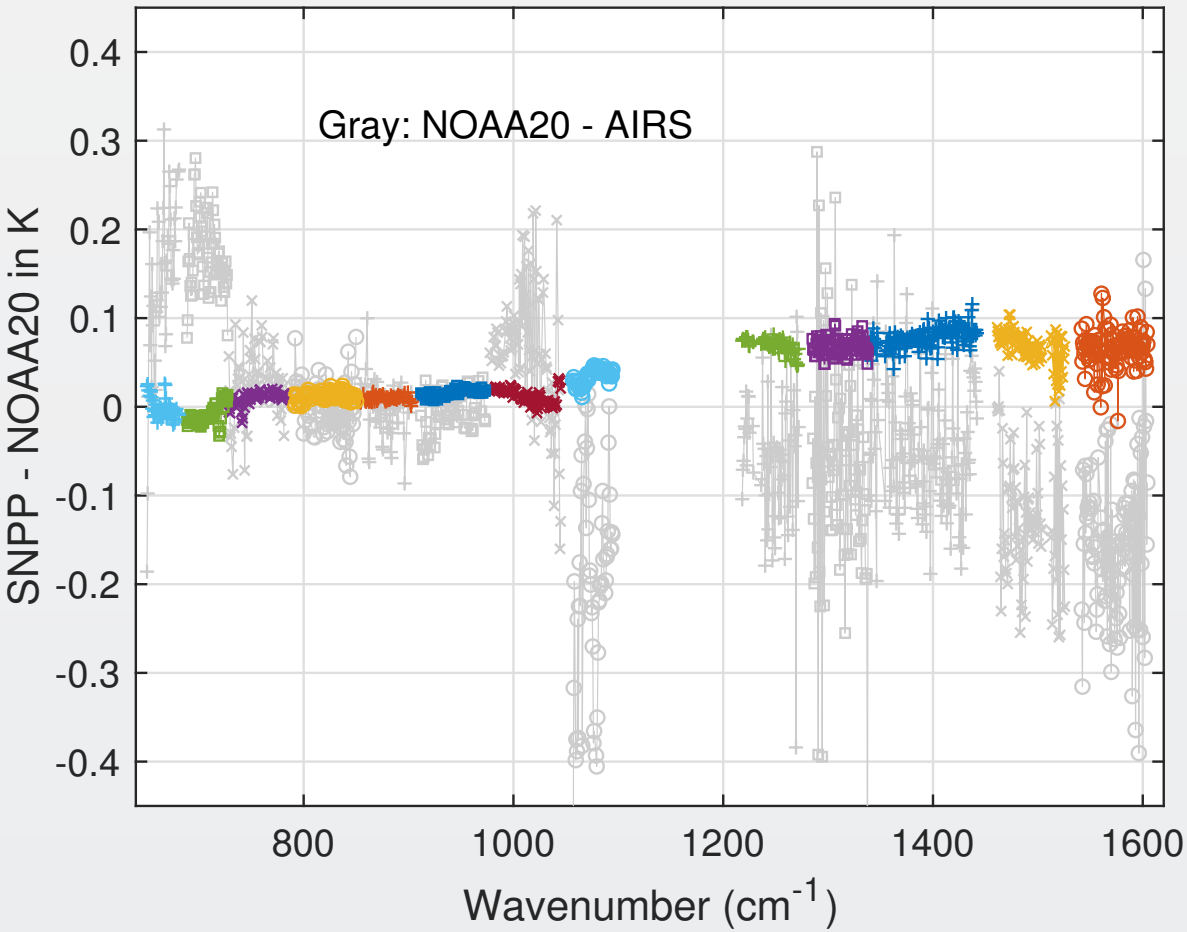
Example of One Month of AIRS:CrIS SNOs: Bias





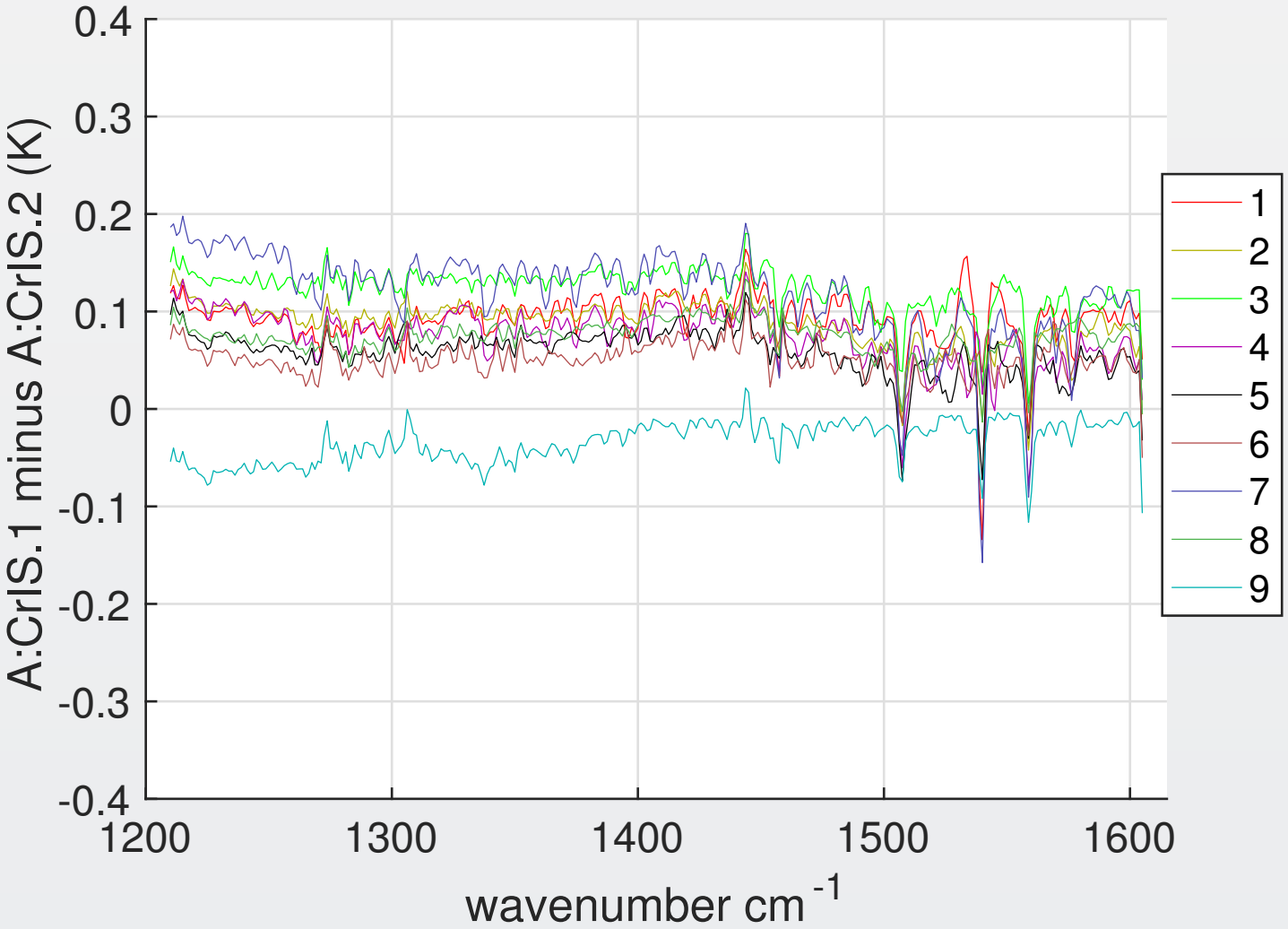


NPP vs N20 CrIS Using AIRS for Transfer



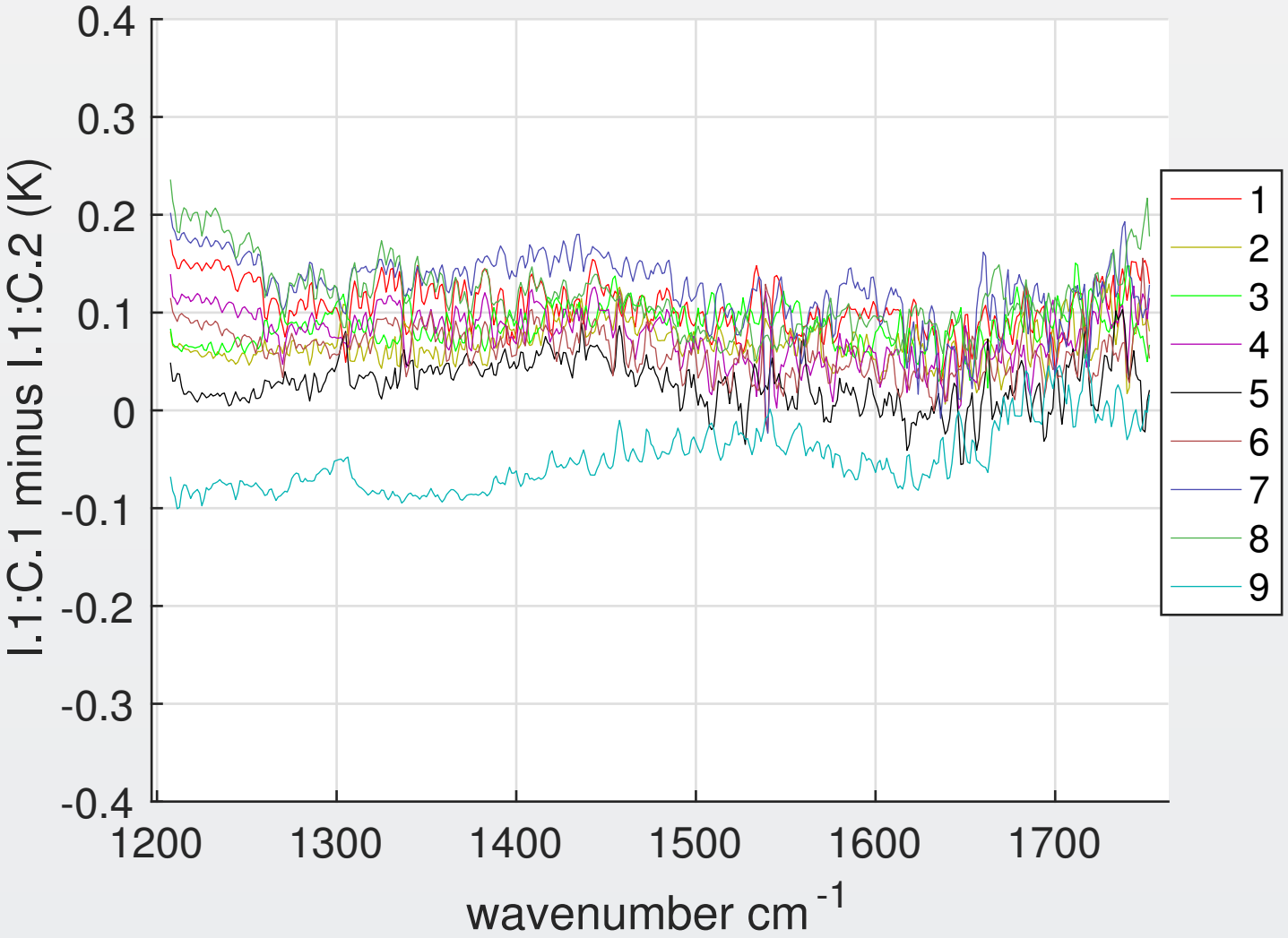
- AIRS is used as a cross-calibration transfer standard since no SNOs between SNPP and NOAA20
- CrIS and AIRS calibrations still being worked by respective teams

NPP.CrIS and N20.CrIS Differences by FOV (via AIRS)



Bad AIRS channels past 1500 wavenumbers not masked out...

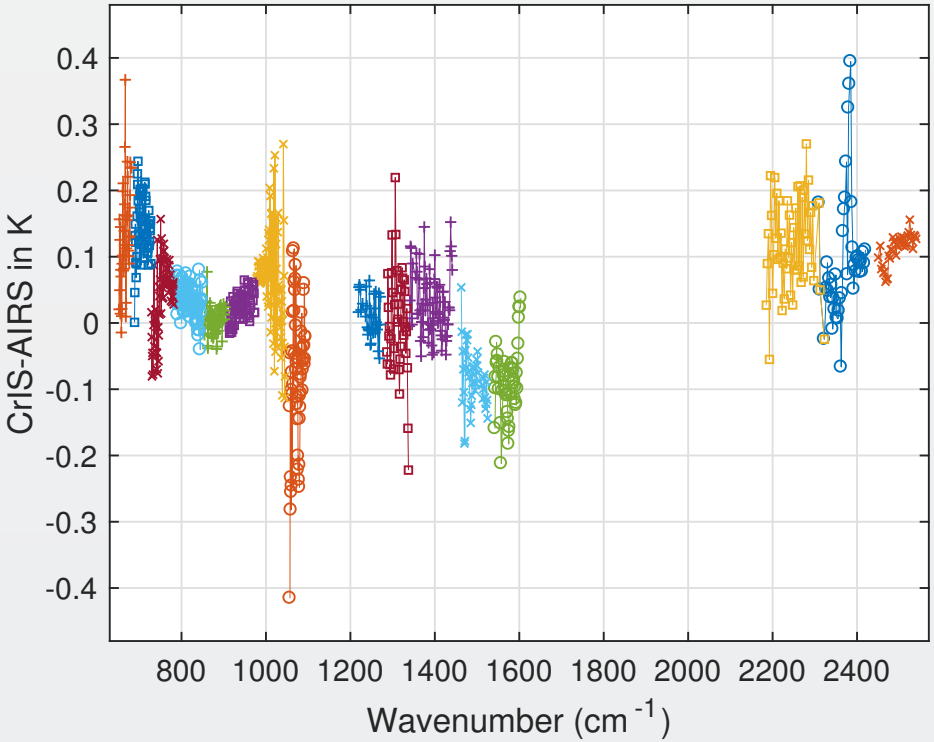
NPP.CrIS and N20.CrIS Differences by FOV (via IASI)



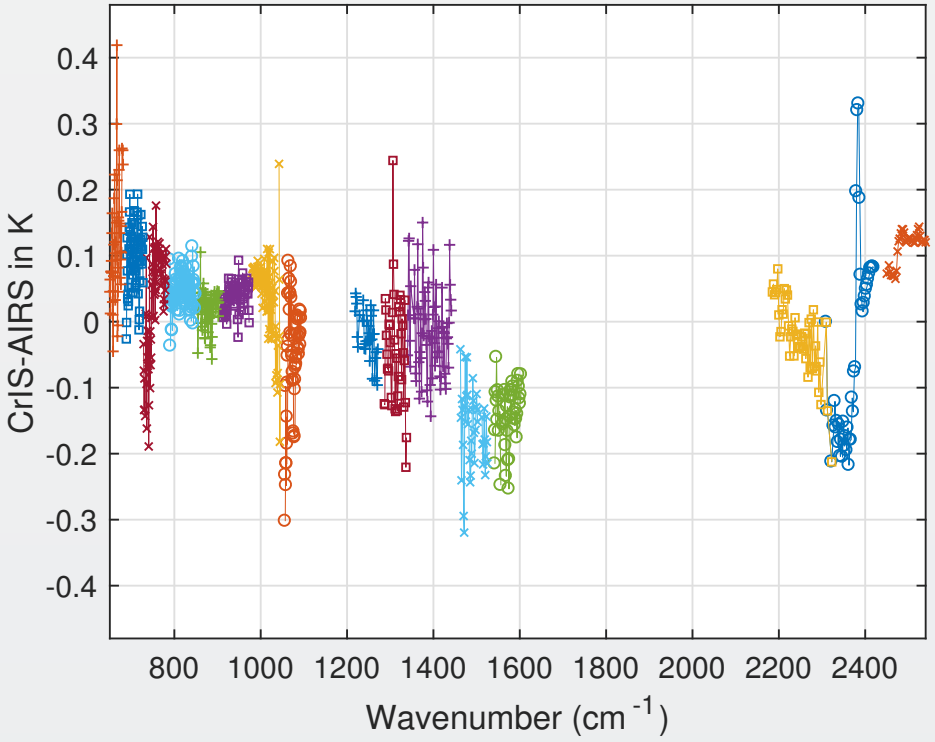
Very similar to differences using AIRS (previous slide)

AIRS:NPP.CrIS SNO and Random Stats Biases

2016 SNOs



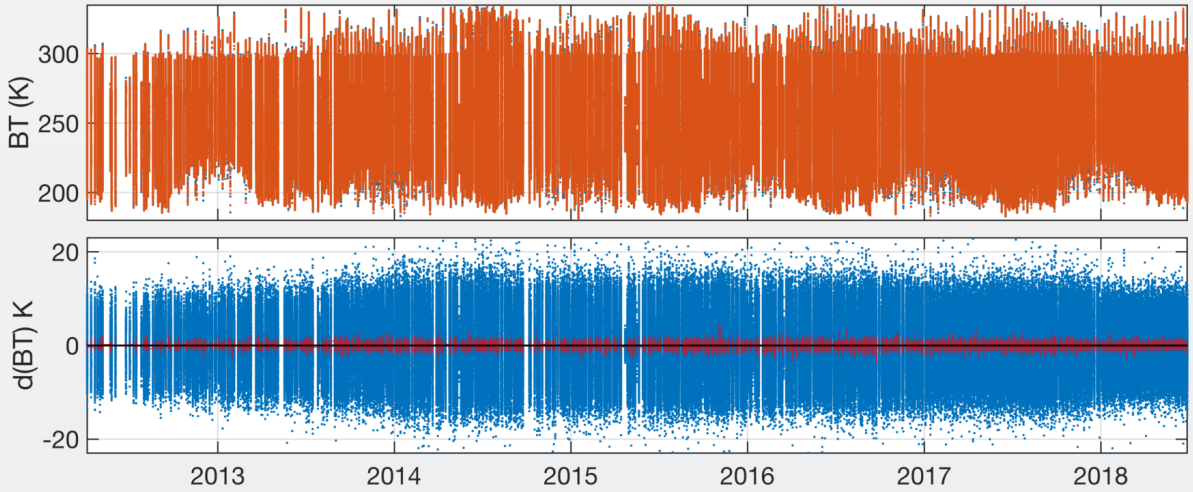
2016 Stats



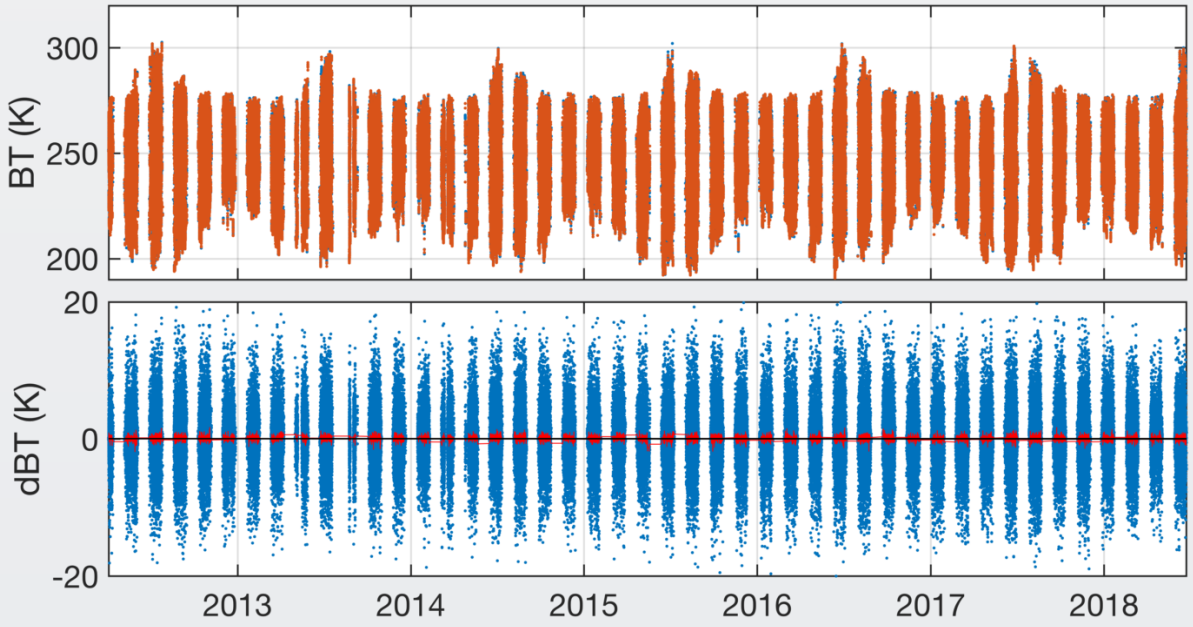
- SNOs and random comparisons are in good agreement.
- Statistical comprisons are corrected larger mean secant viewing angle of CrIS

Multi-year Mission Overlap Permits Bias Trending

CrIS vs AIRS



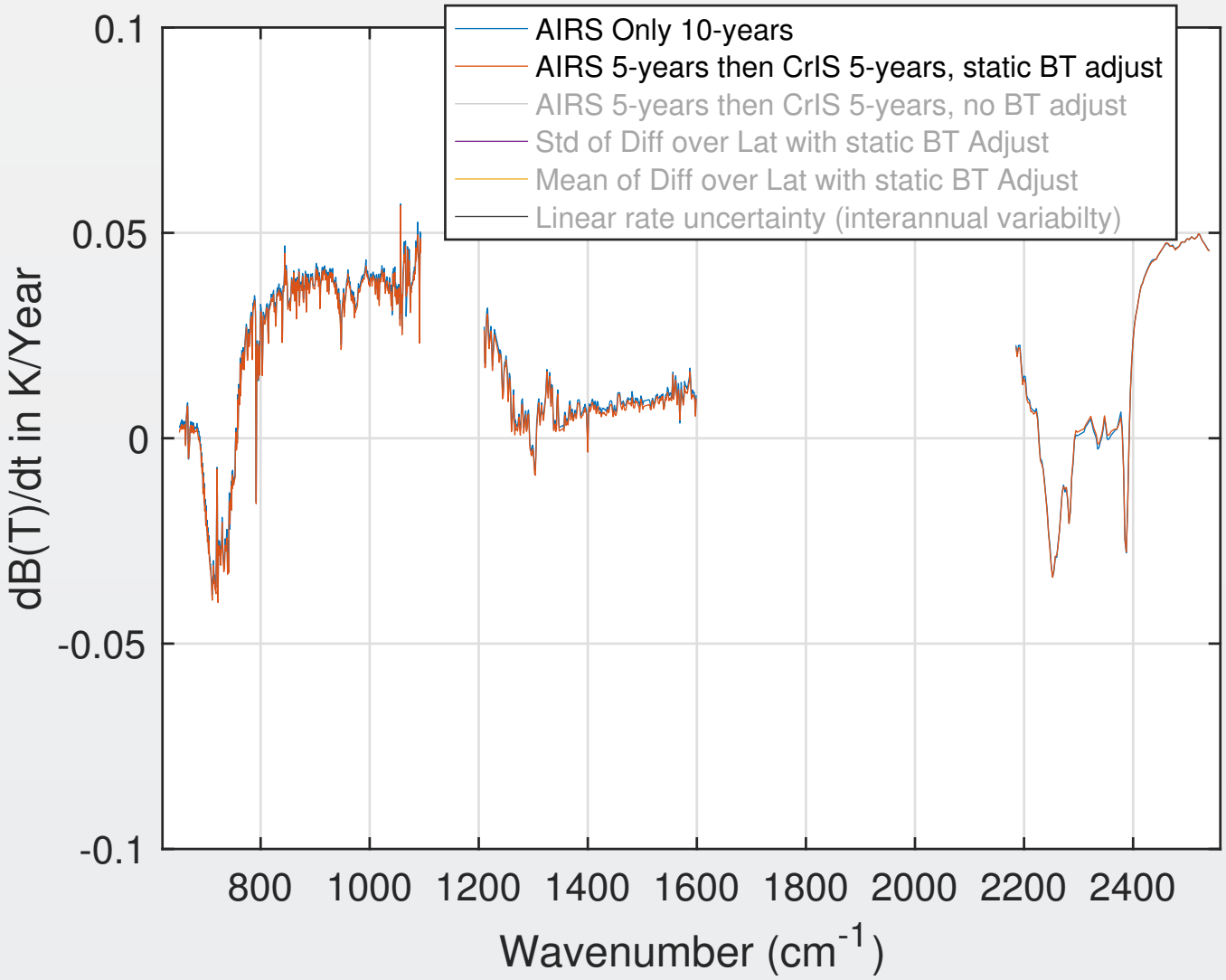
CrIS vs IASI



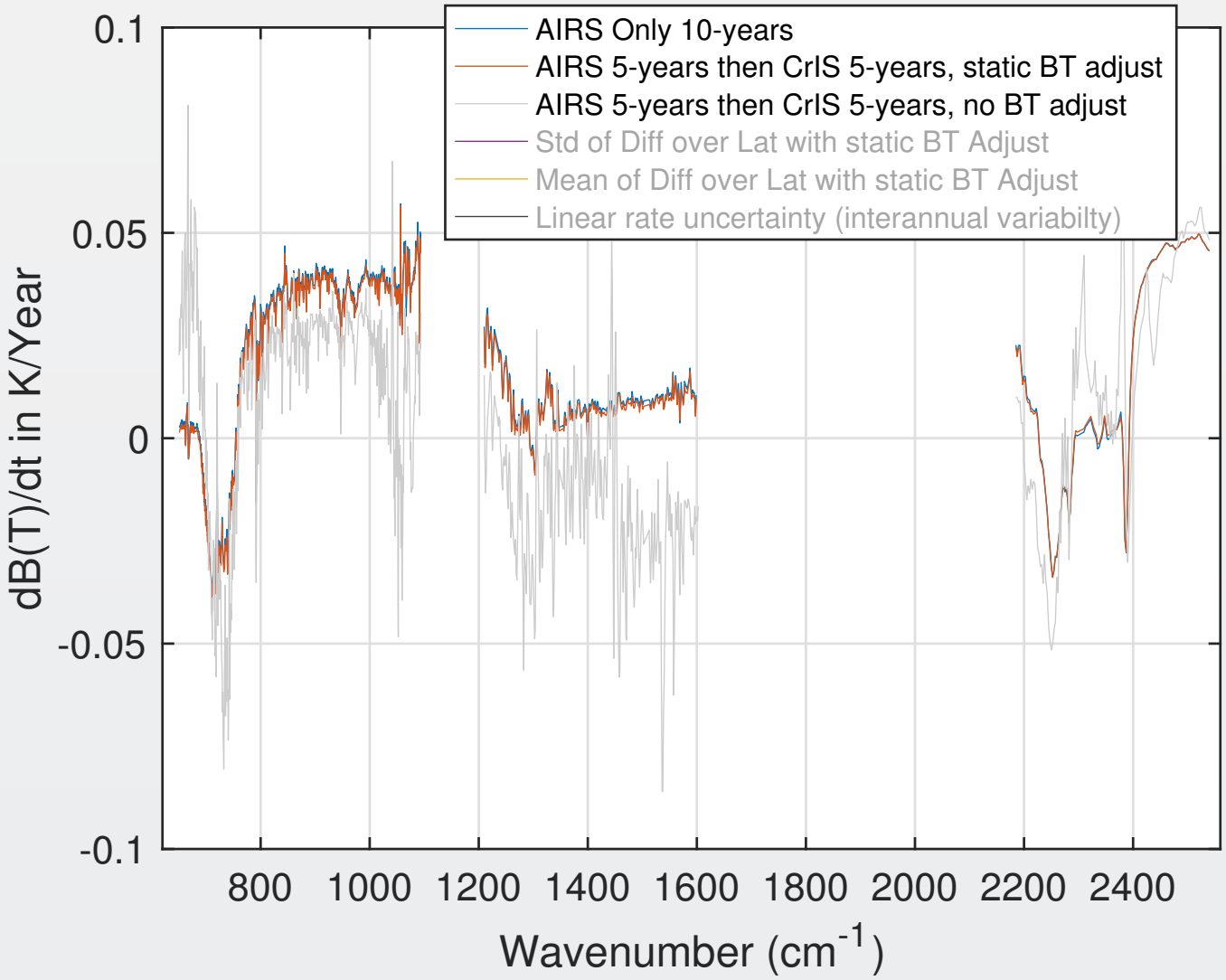
A "CHIRP" Time Series Test

- Need to connect AIRS to CrIS for long-term hyperspectral sounder time series
- We are proposing “CHIRP”, where AIRS is converted to some form of the CrIS ILS (0.8/0.6/0.4 OPD).
- Here we do a simple first test: (using CrIS NSR ILS)
  - Create a 10-year time series with AIRS (converted to CrIS ILS: AIRS2CrIS)
  - Create a 5-year time series with CrIS
  - Radiometrically adjust (bias) AIRS2CrIS to CrIS using a single static global bias offset (see earlier slides)
  - Merge 1st 5-years of AIRS2CrIS with the CrIS 5-year time series to create a CHIRP test time series
  - Intercompare trends from these two time series
- Final time series: AIRS2CrIS is 2007-2012, CrIS is 2012-2017

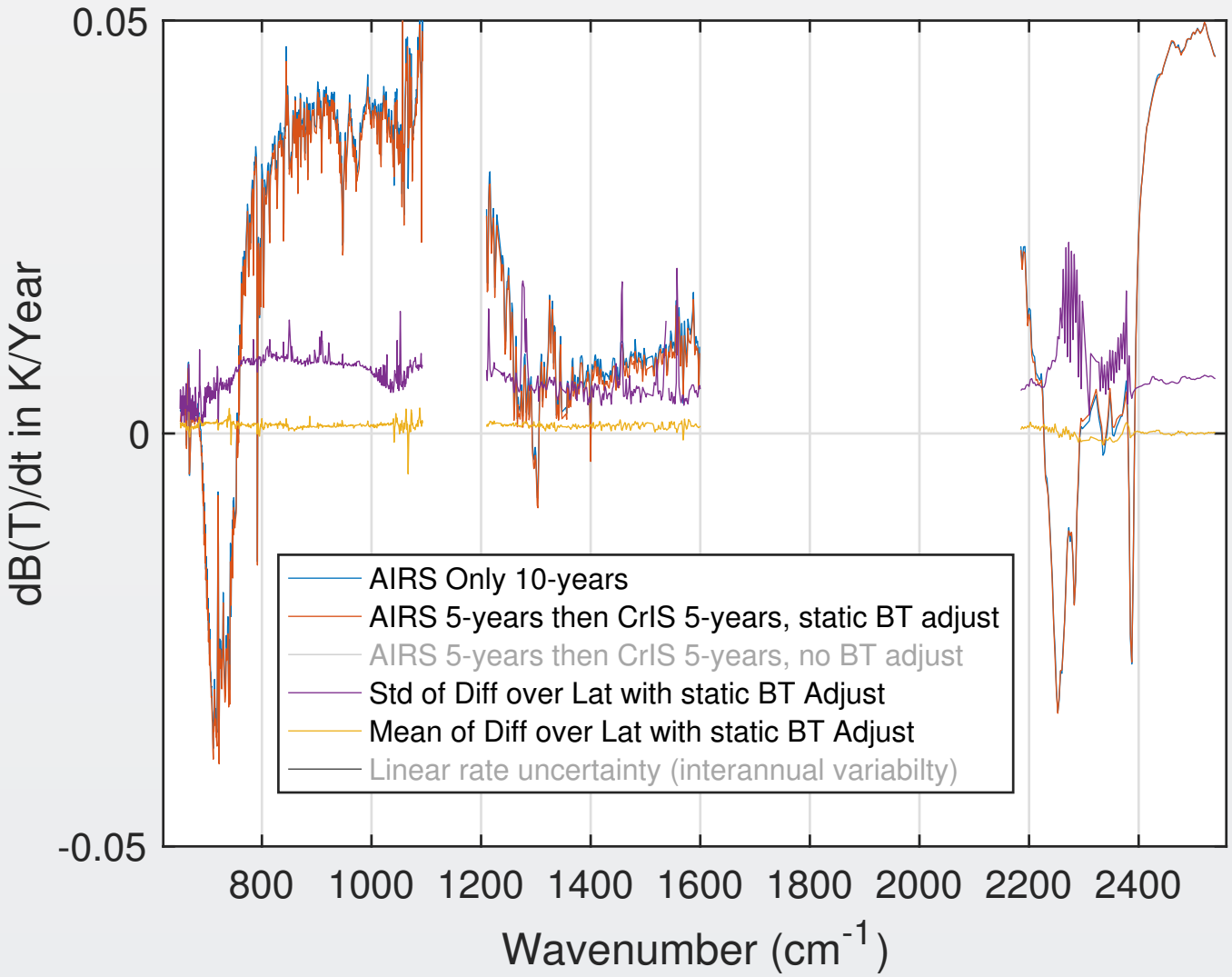
AIRS/CrIS Hybrid Time Series Trends



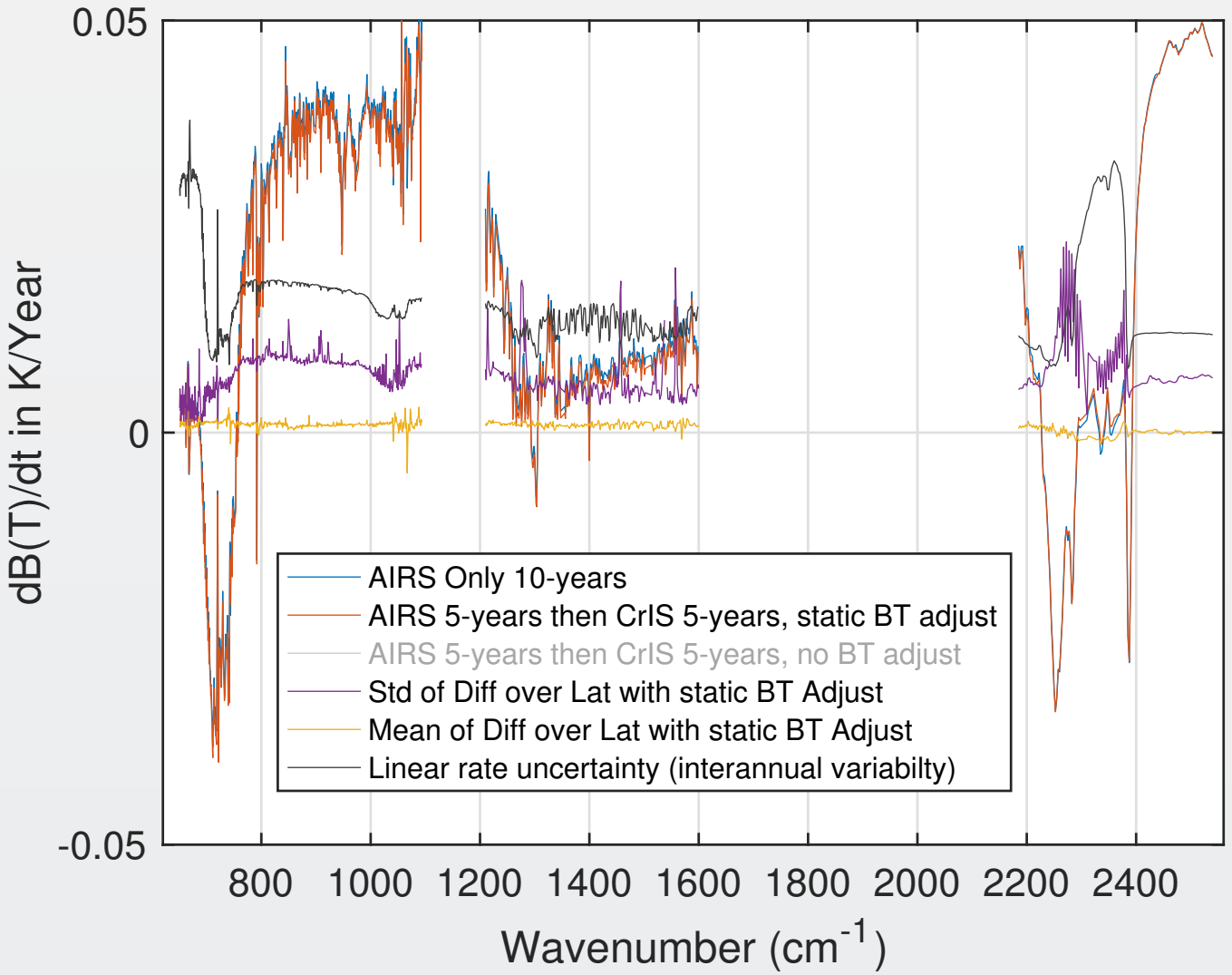
AIRS/CrIS Hybrid Time Series Trends: Without Adjust



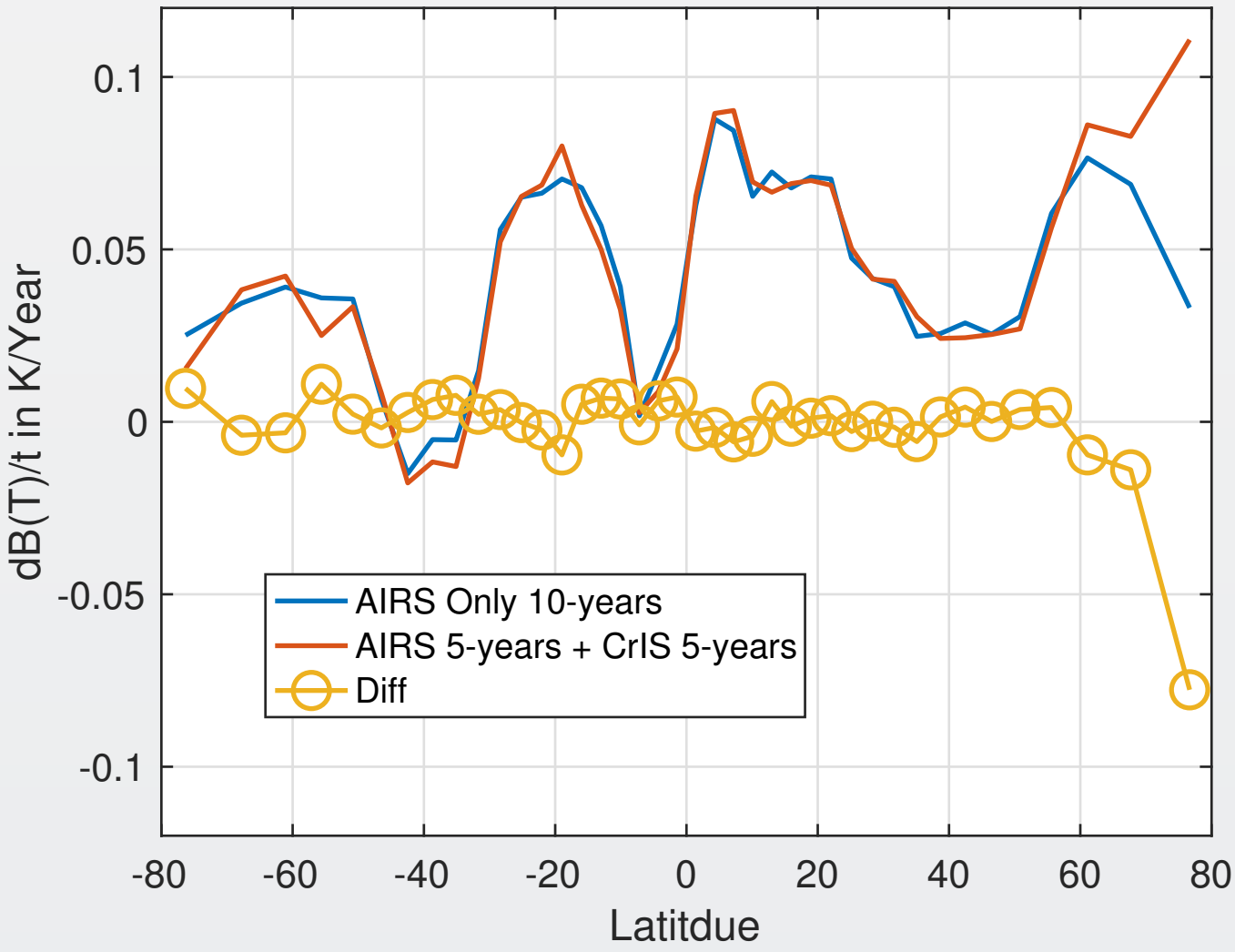
AIRS/CrIS Hybrid Time Series Trends: Std/Means over Latitude



AIRS/CrIS Hybrid Time Series Trends: Add Interannual-Variability



Latitude Dependent Trends of 902 cm^{-1} Window Channel



Note issue in Arctic. Maybe too low sampling (due to equal area?).

Summary

- Radiometric differences are small between all instruments, but large at the climate level.
- We use SNOs and large random (equal area weighted) statistical samples to inter-calibrate (radiometry).
- Instruments all appear very stable, so these differences can be account for.
- (If) we have enough overlap (true so far) the uncertainty in instrument differences is /very/ small, maybe <0.03K?
- Over 5-years that is <0.01K.
- Early hybrid (“CHIRP”) time series tests are encouraging.