AIRS-CrIS SNO Observations: AIRS L1C Conversions to CrIS

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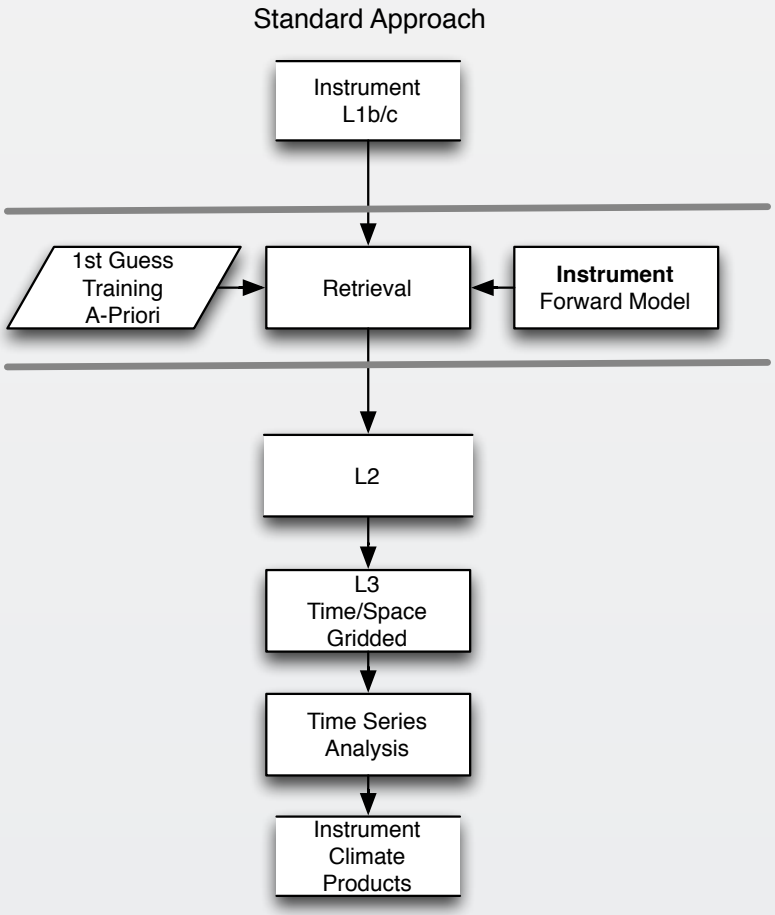
Status of AIRS and CrIS Intercomparisons

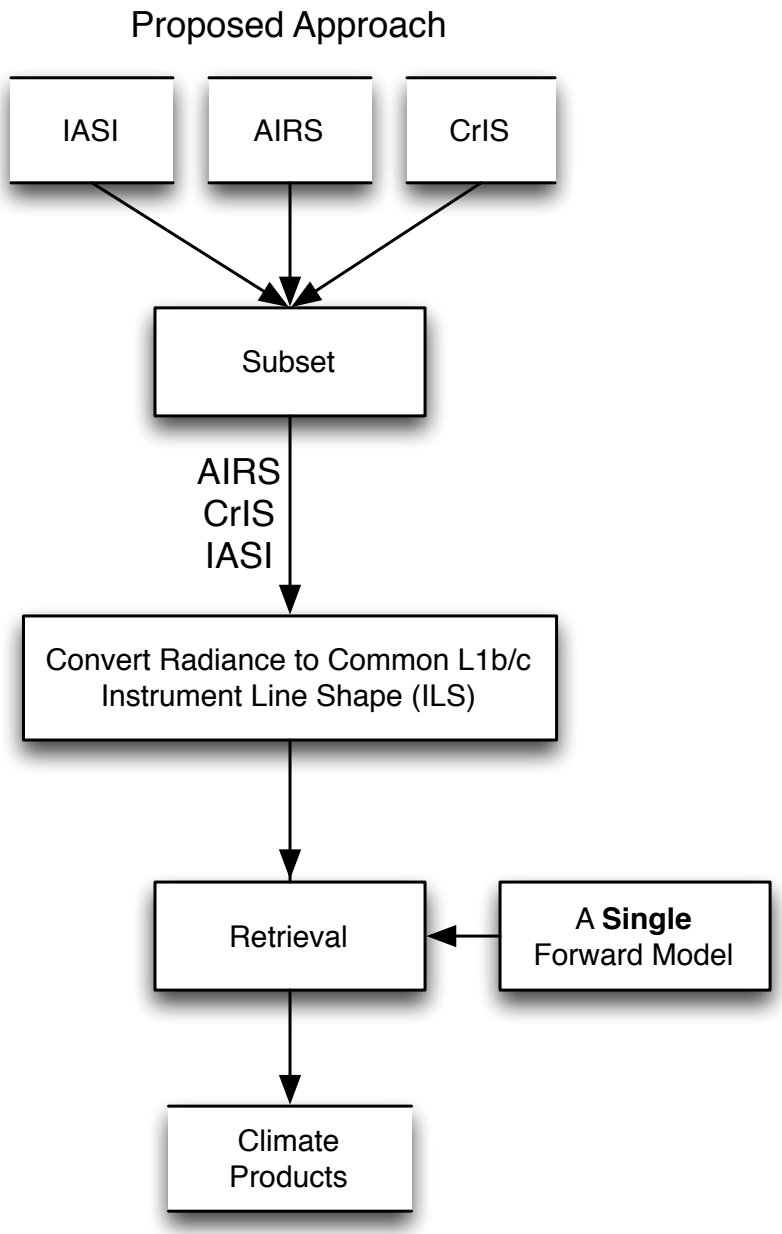
- CrIS L1b a moving target: shown here is NOAA IDPS. We are moving to NPP L1b (UW/UMBC CCAST Algorithm.)
- CCAST improved over NOAA IDPS, expect continued improvements over the next 6+ months.
- We (UMBC) can easily integrate changes from all parties and re-process complete mission in several days. (Available on our web site).
- AIRS L1c is integral to channel-by-channel comparisons between AIRS and CrIS.
- *Full AIRS L1c at DAAC would speed this work considerably.*
- Intercomparison work suggests a possibly robust way to continue the AIRS record with CrIS

Robust and Traceable AIRS Long-Term Trends

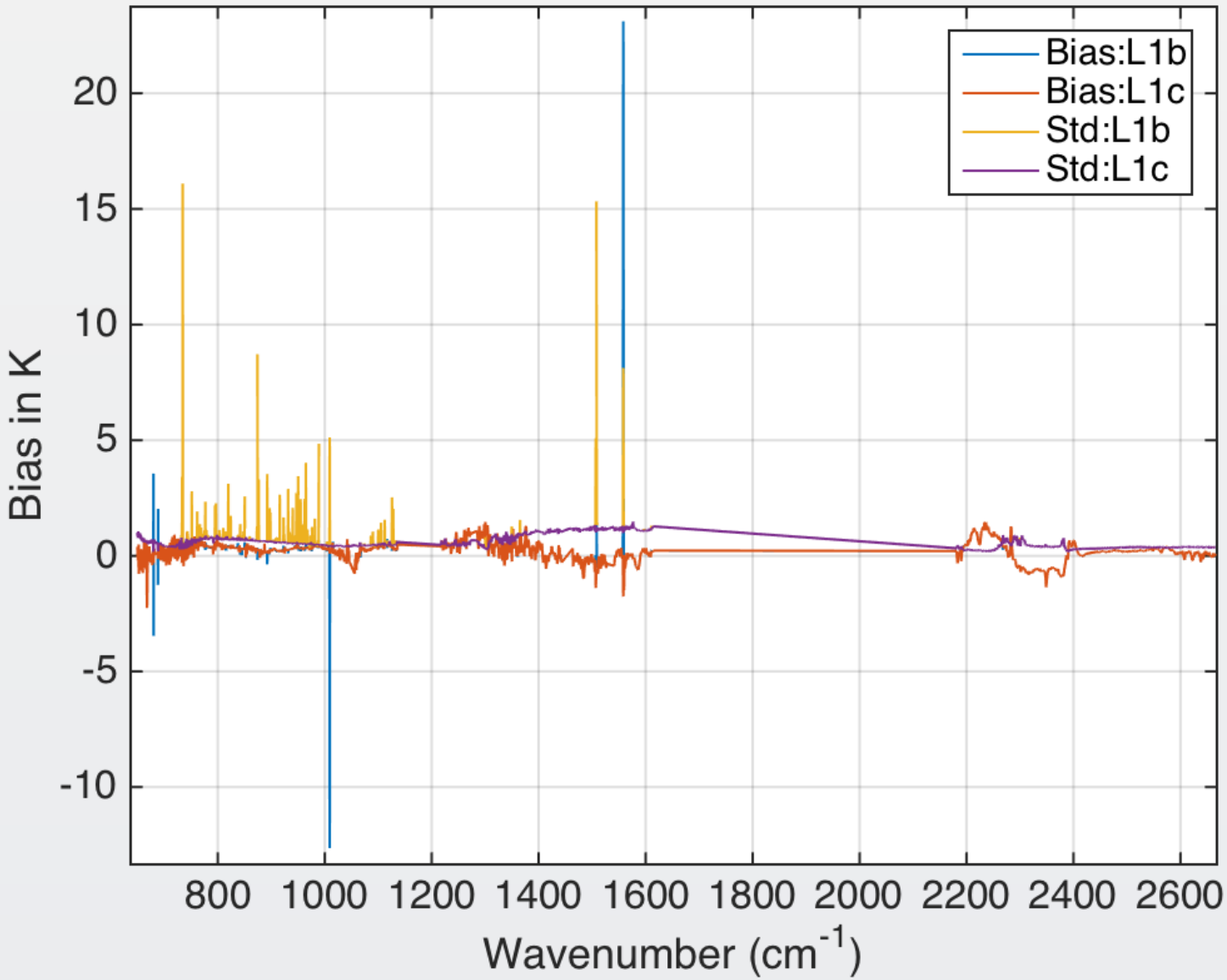


Repeat for each instrument: AIRS, CrIS, IASI
Ensure continuity among products

Repeat the above process for each instrument, merge products that used different forward models, with different spectral resolutions.



L1c Validation: ECMWF Bias Using AIRS L1c



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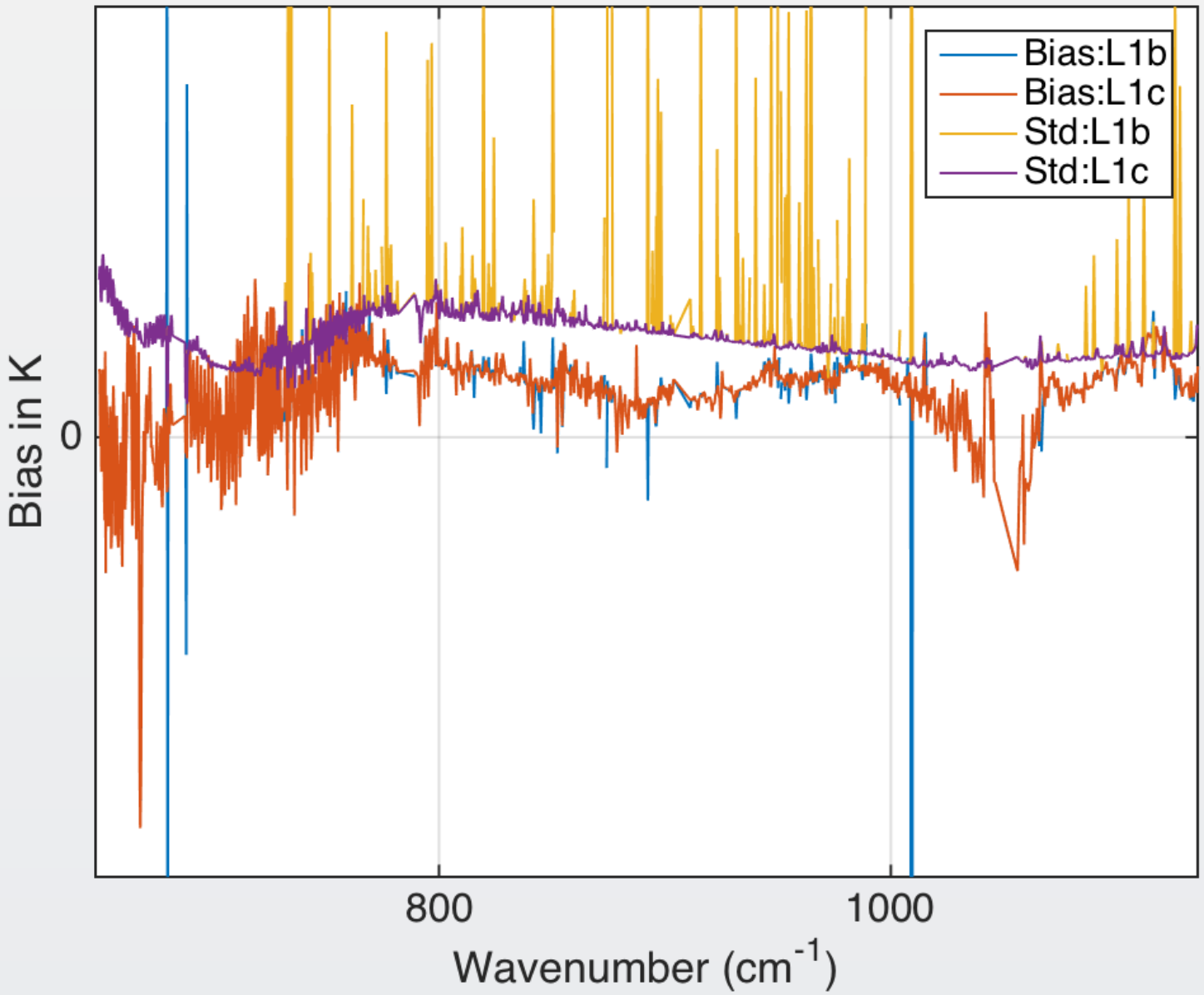

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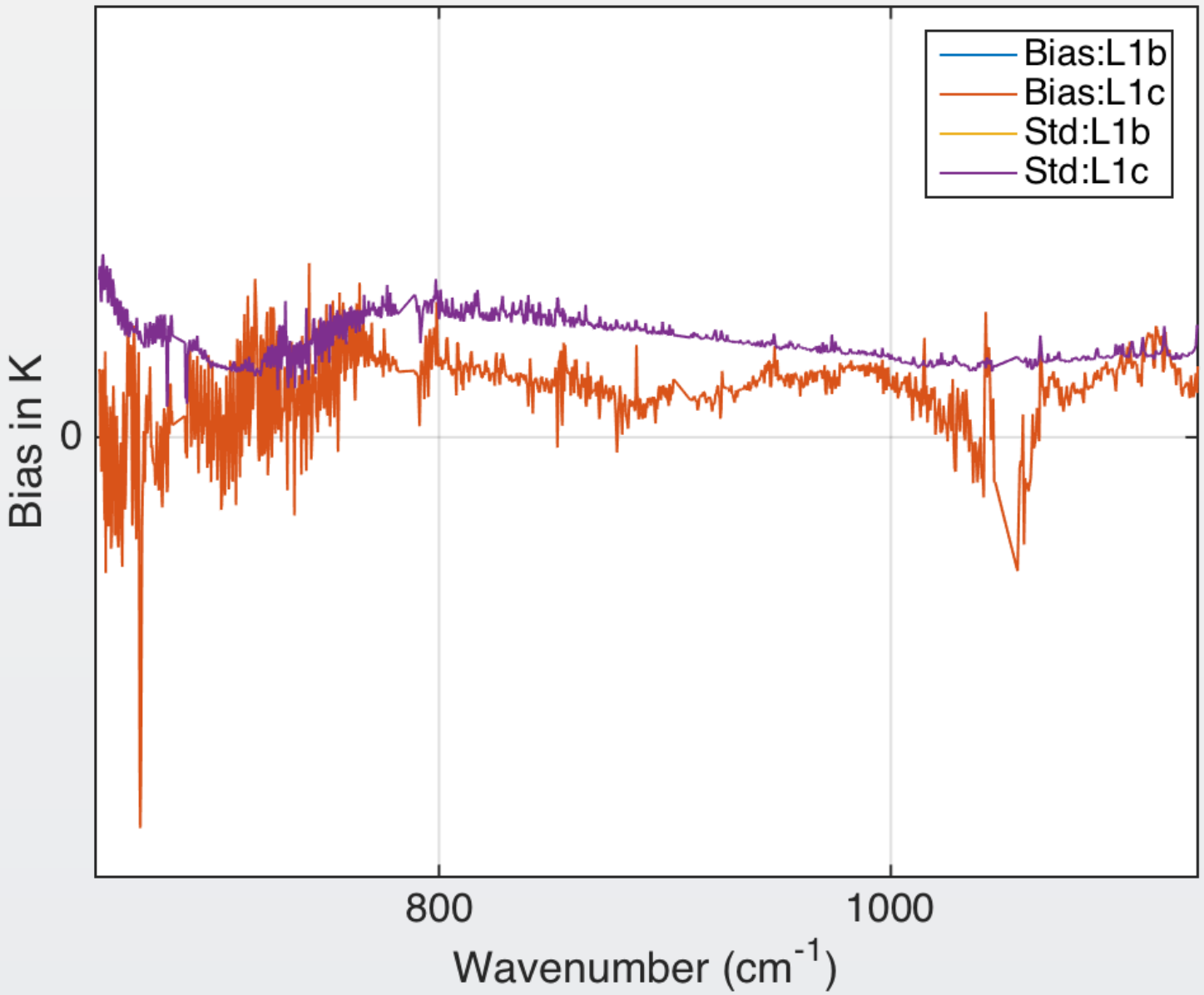
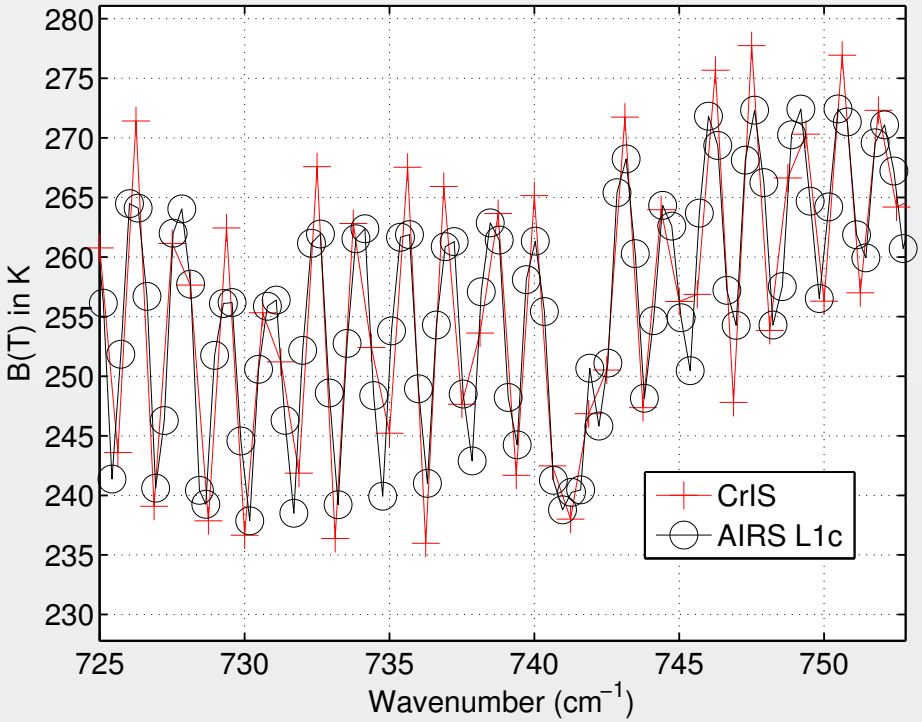
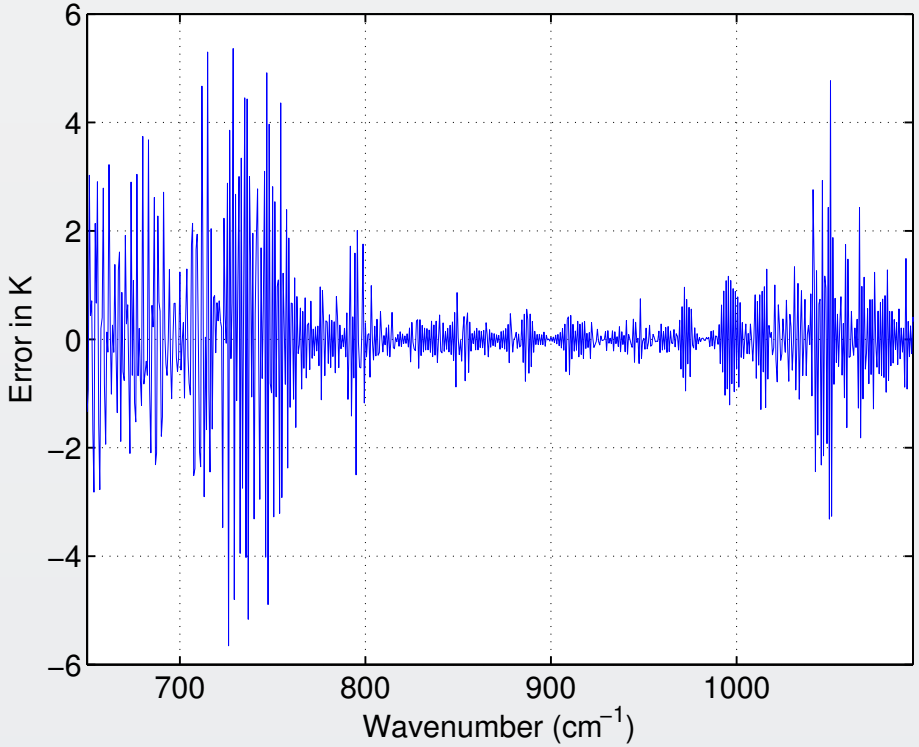


AIRS L1c: Mismatch due to ILS Differences

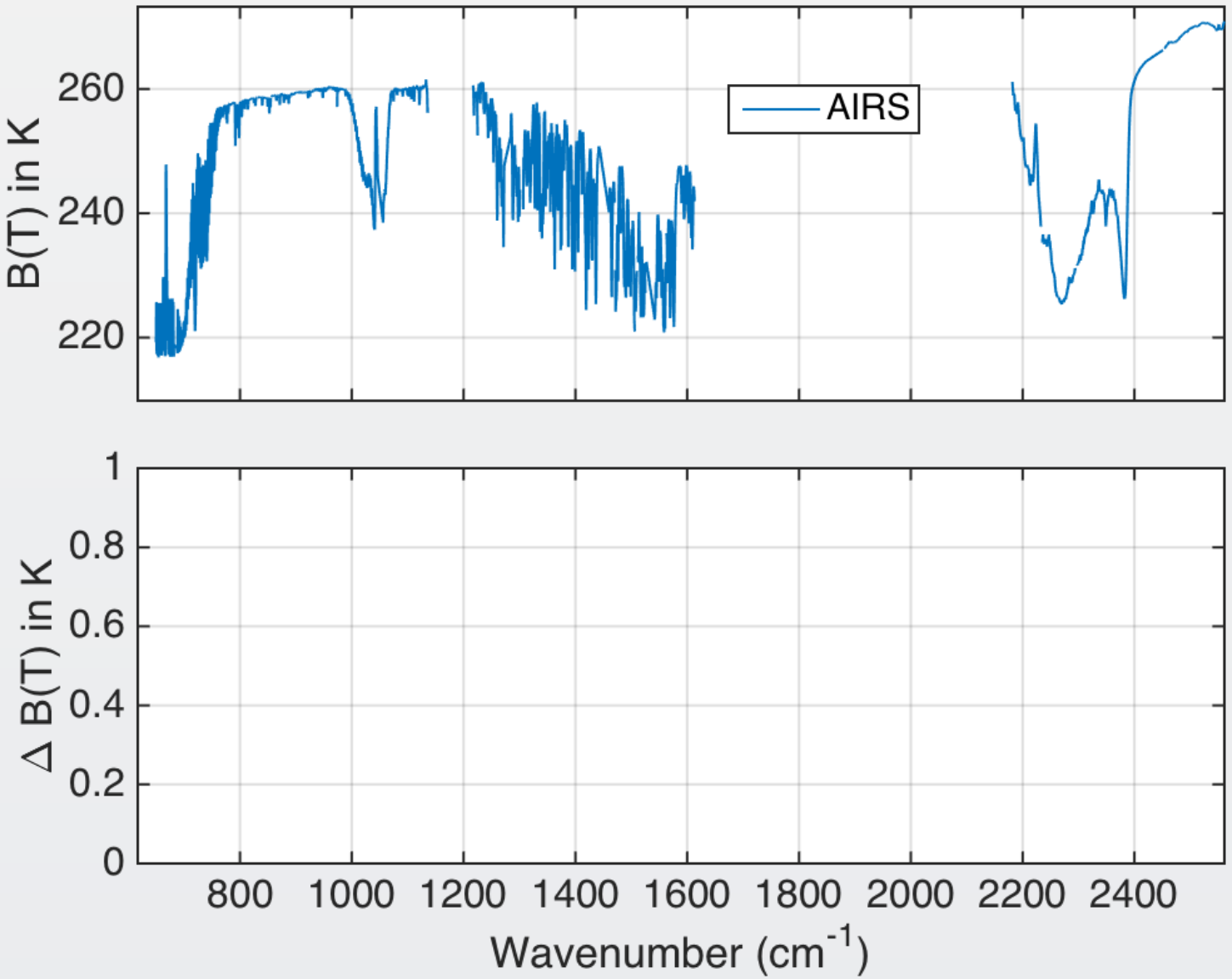
Sampling of AIRS vs CrIS ILS



B(T) error using just ν interpolation



L1c for AIRS Conversion to CrIS



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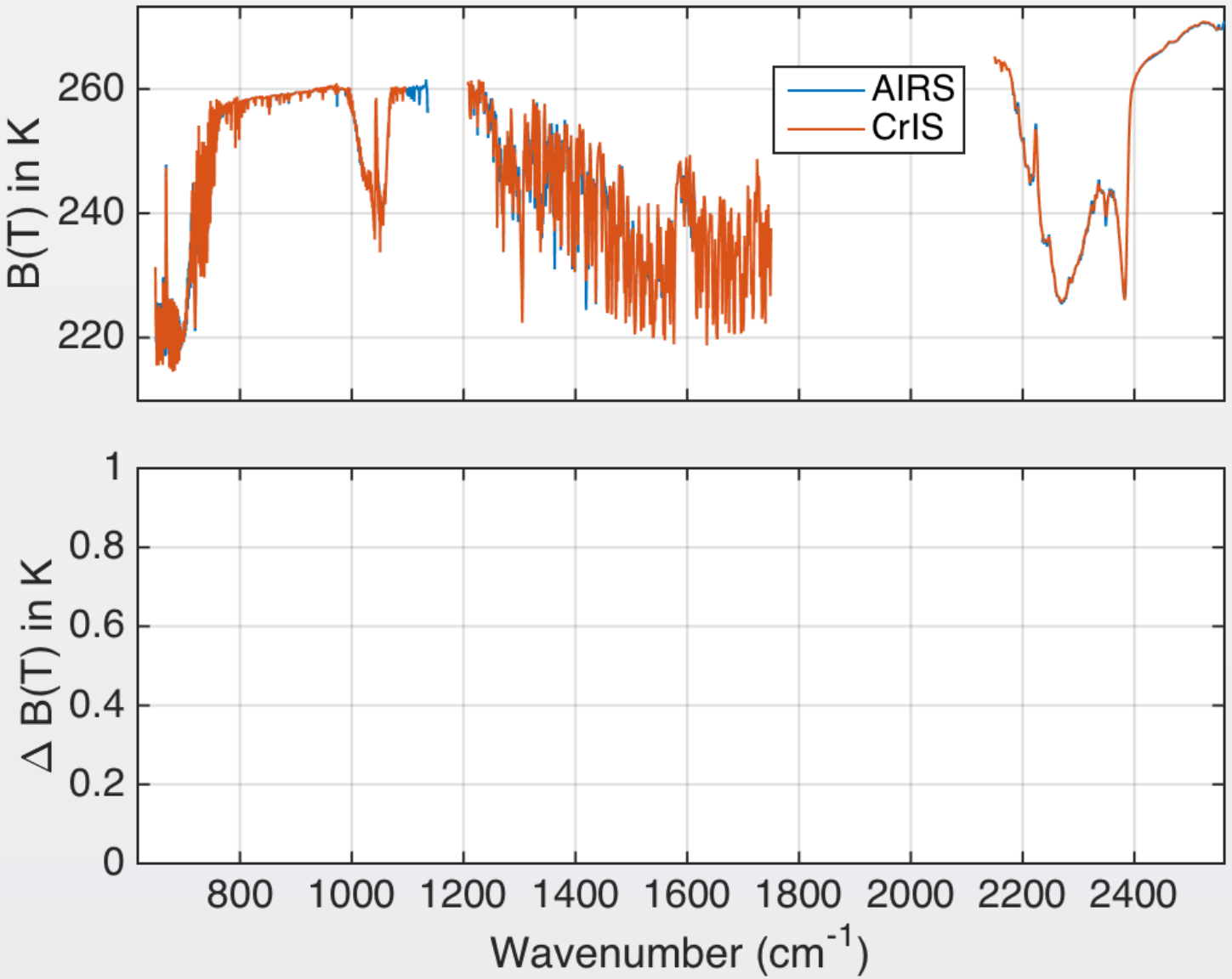

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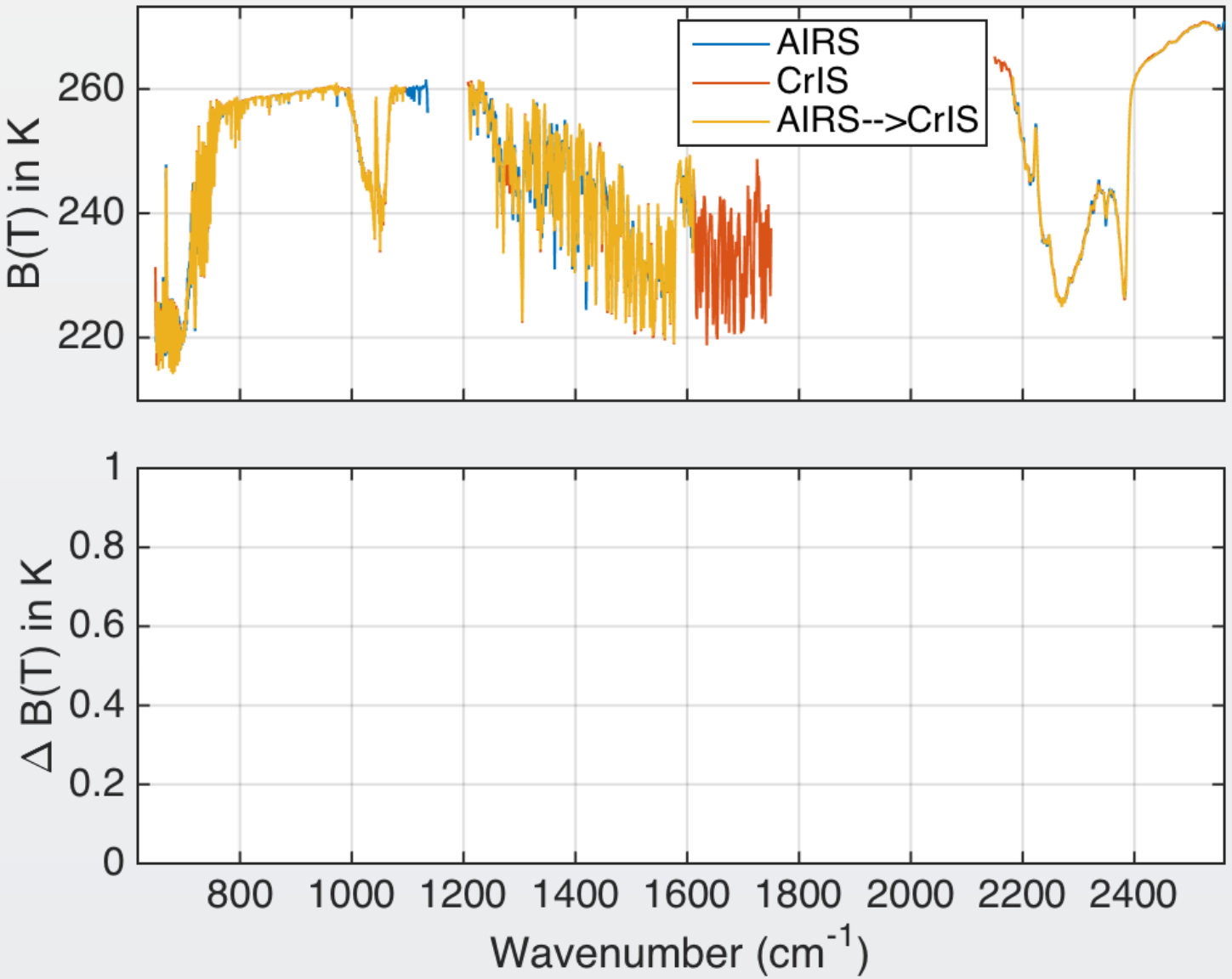

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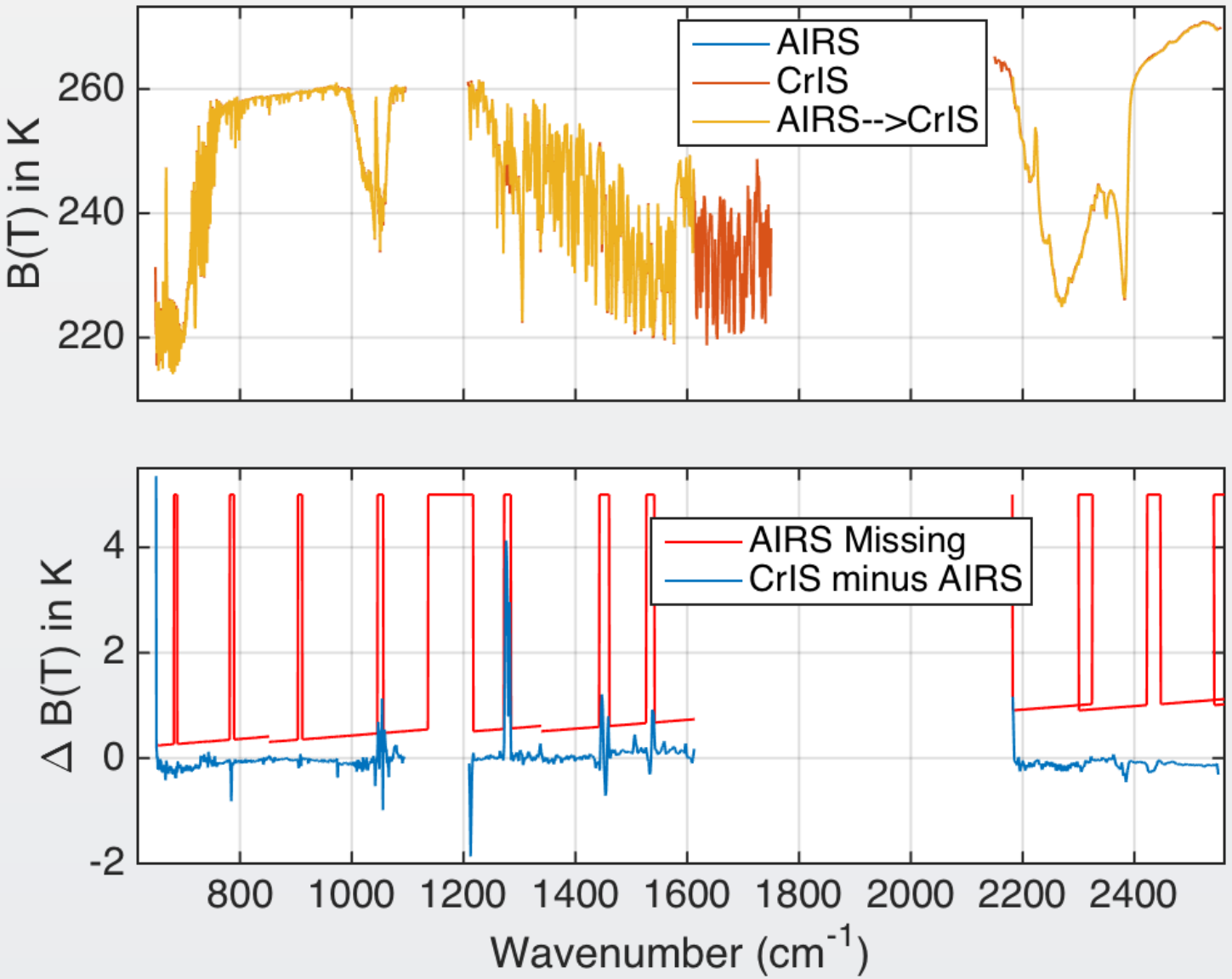

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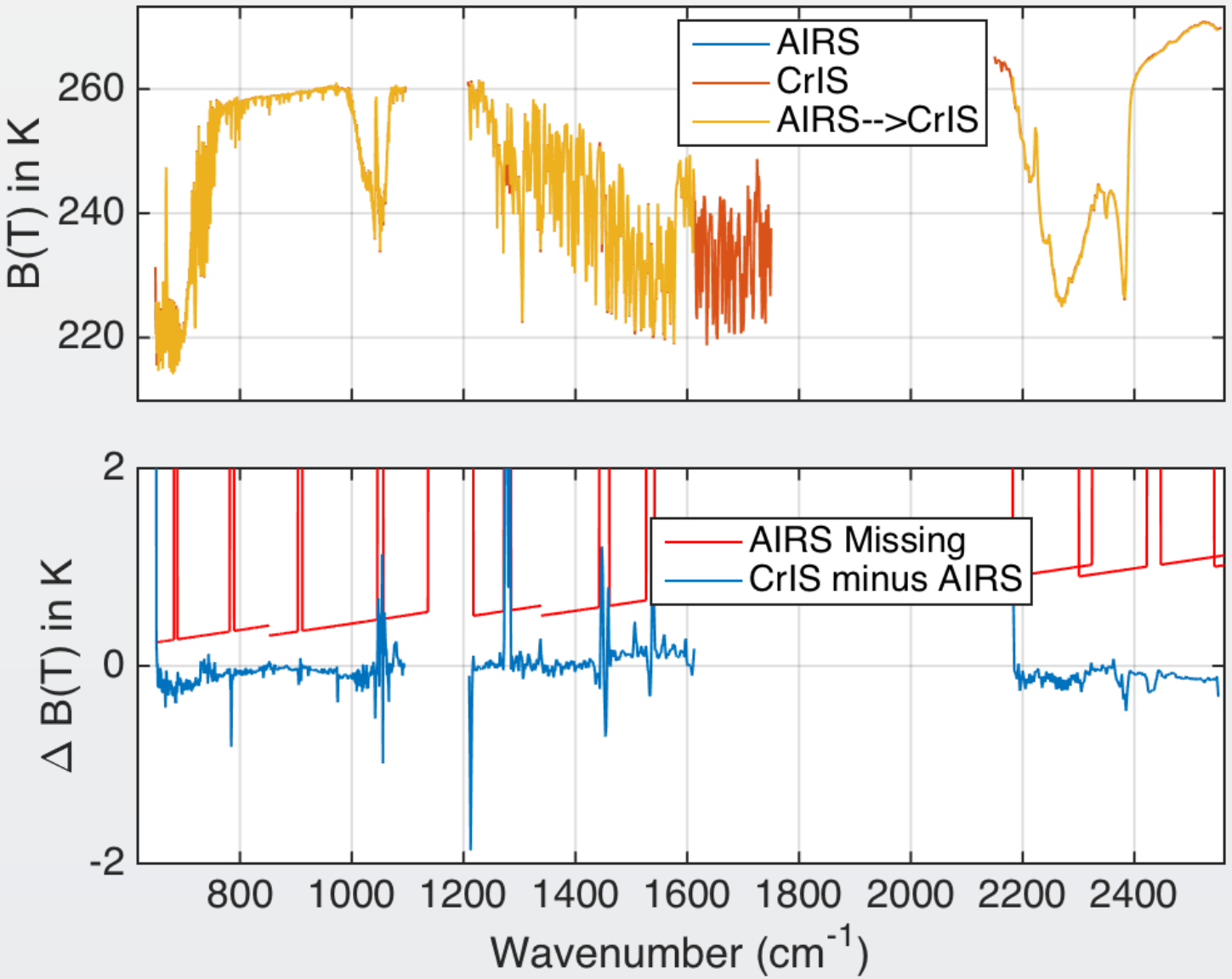

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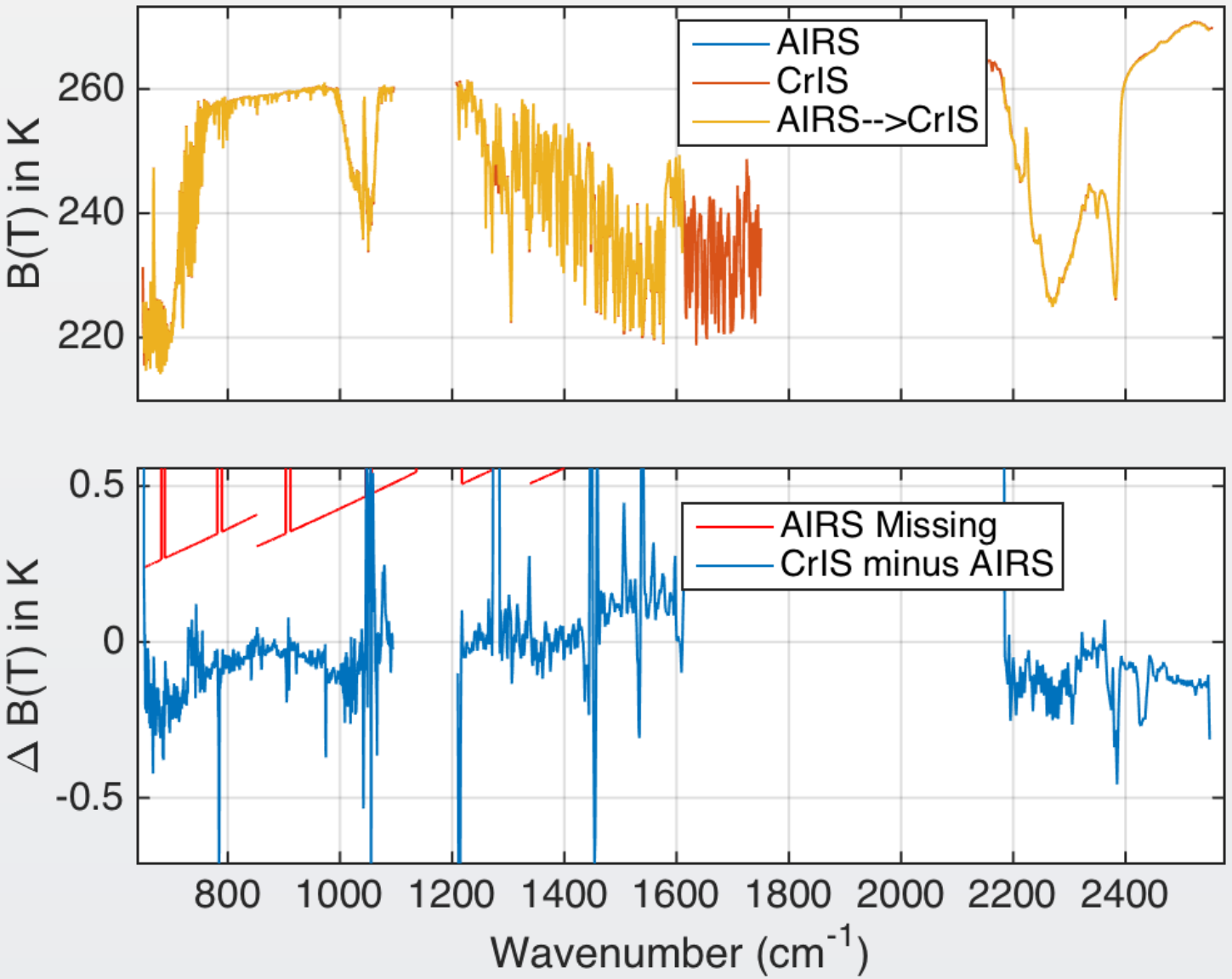

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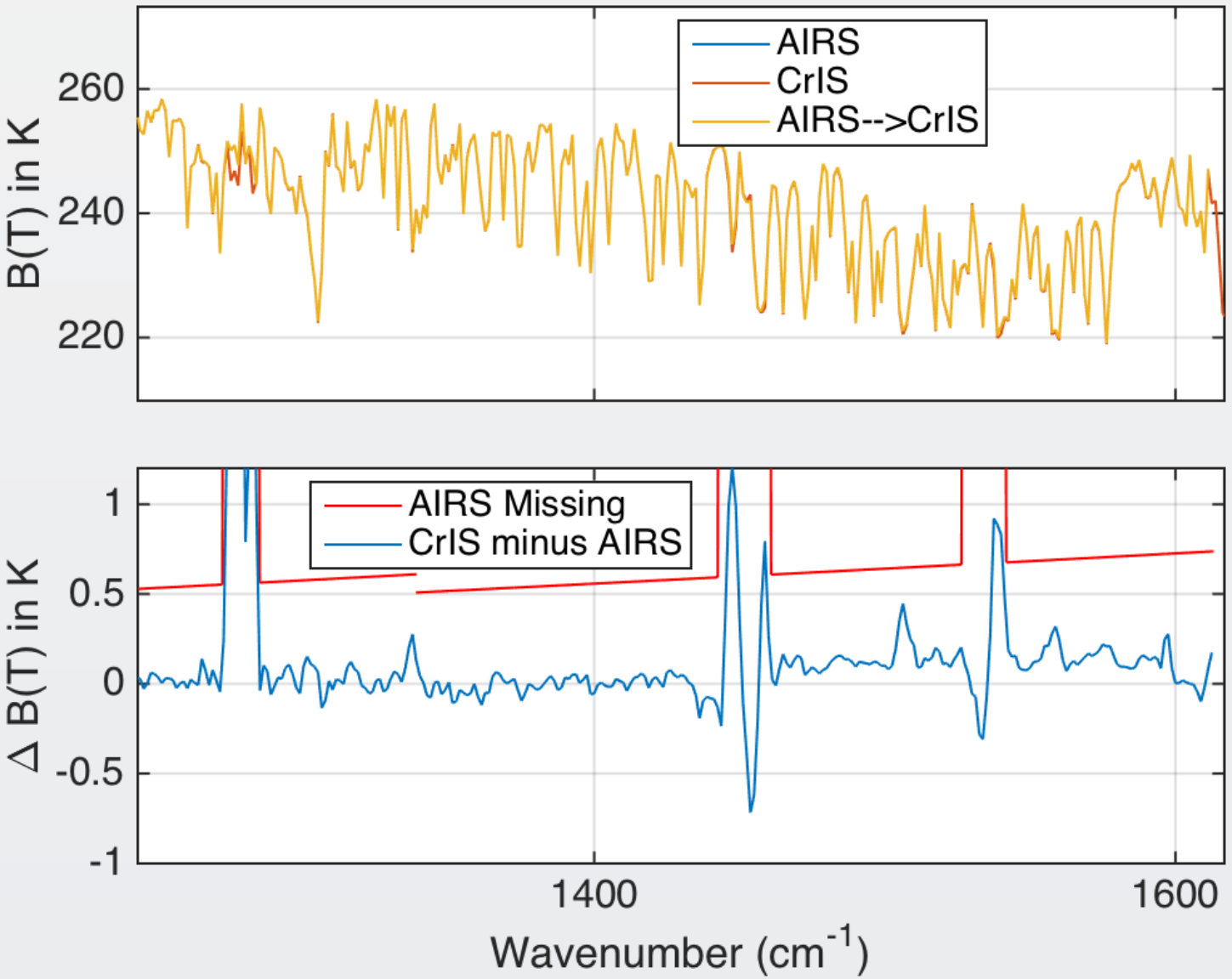
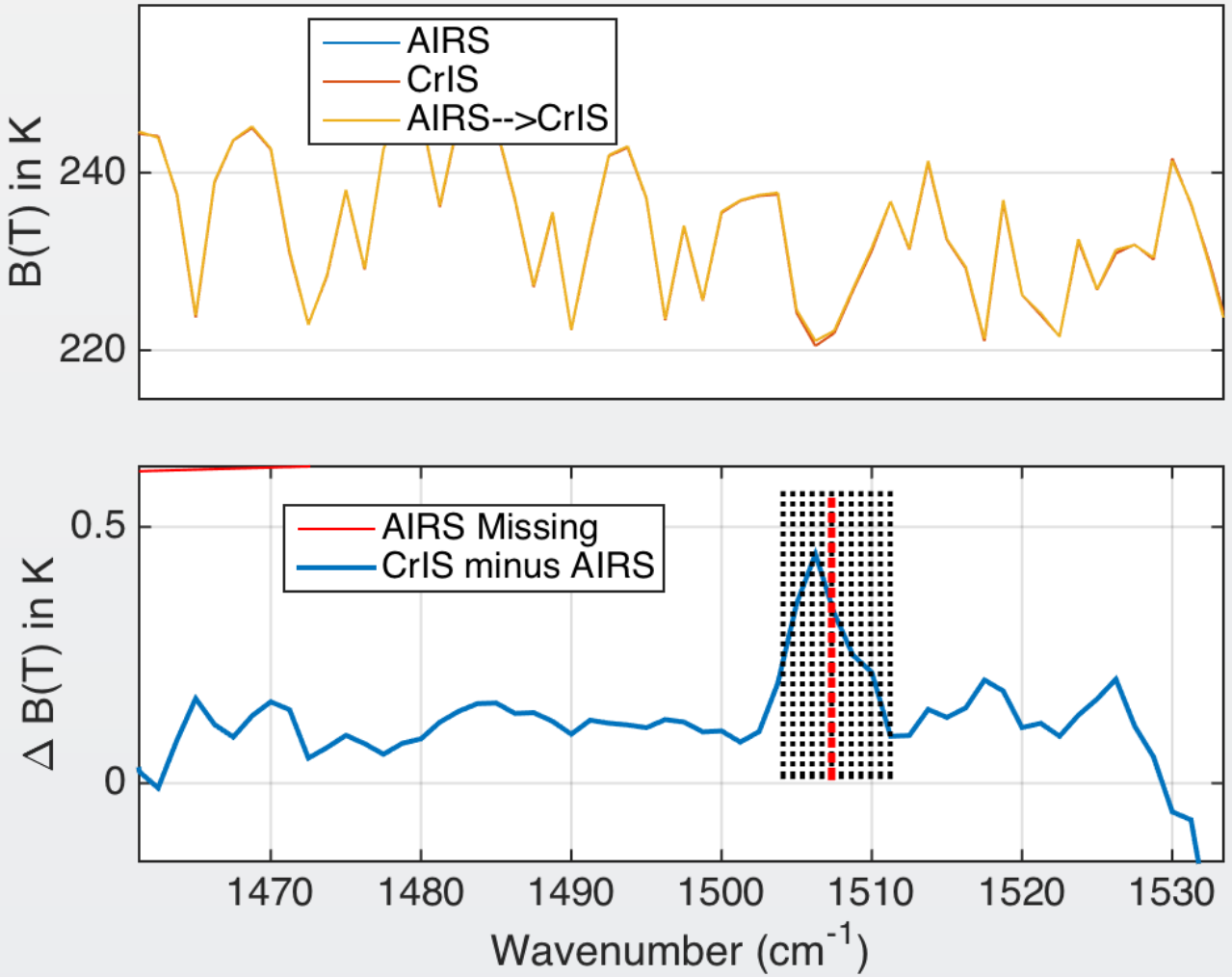


Closer Look: SNO Difference at 1507 cm^{-1}

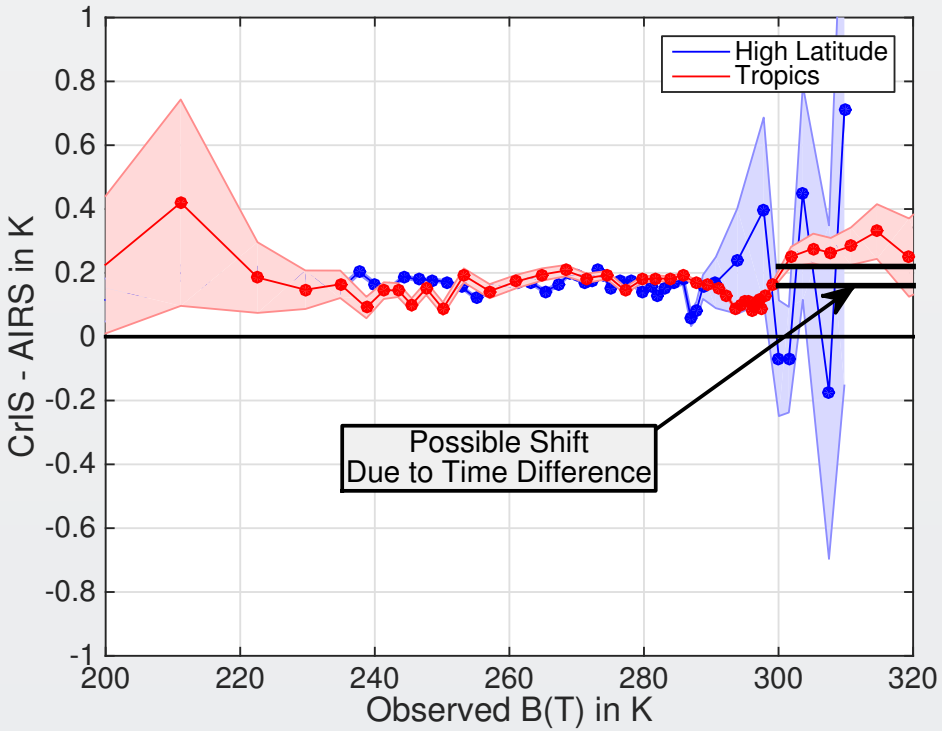


Bottom panel shows bad AIRS channels near 0.4K SNO difference.
Black is “bad SRF”, Red is dead channel!

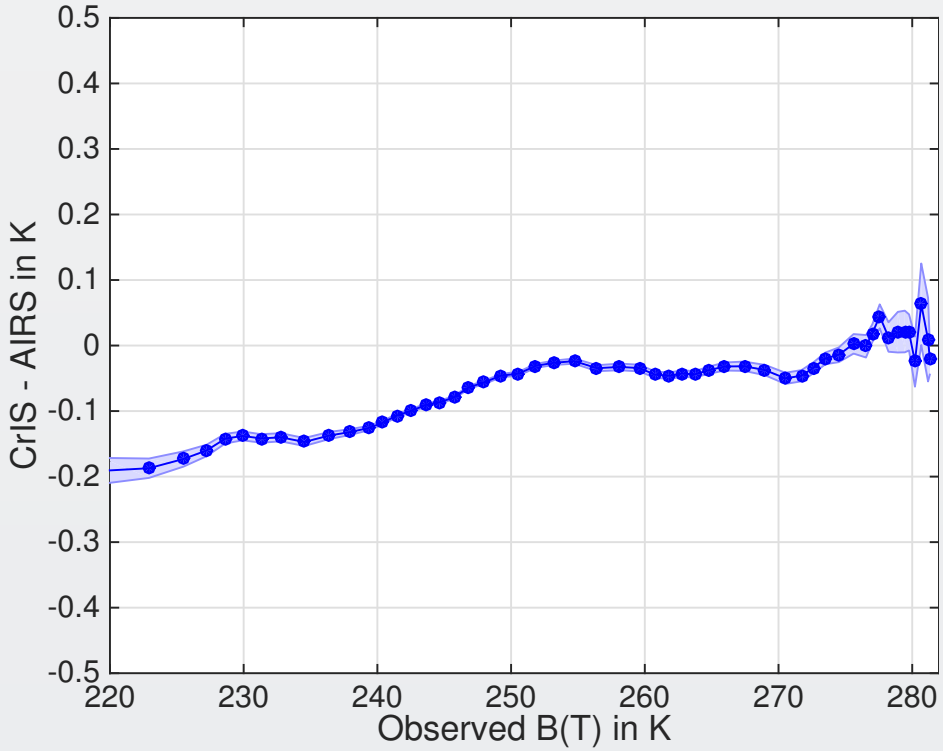
CrIS - AIRS SNOs versus Scene Temperature

Detector non-linearity can cause scene dependent differences among sensors. Here we show longwave (for year 2013) CrIS minus AIRS SNO differences for window and deep water line channels. The AIRS 1593 cm^{-1} channel ILS has been converted to the CrIS ILS.

900 cm^{-1}

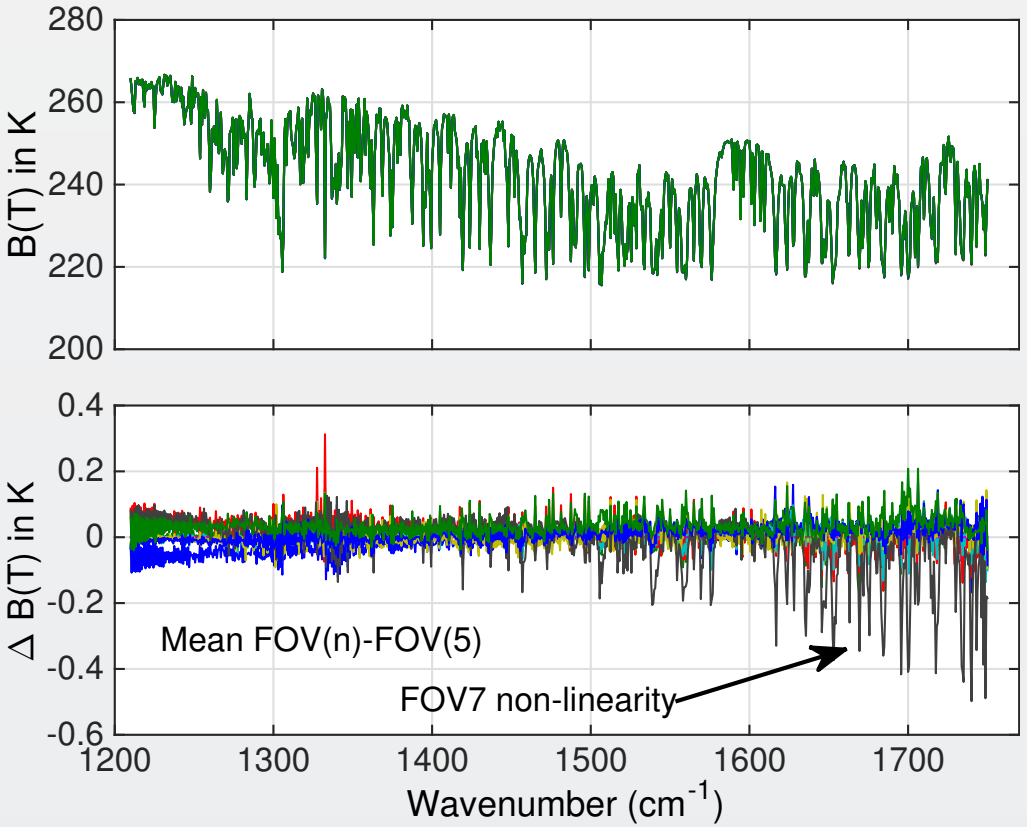


1593 cm^{-1}



All CrIS FOVs are included here, non-linearity likely causing slope at 1593 cm^{-1}. Clearly, AIRS/IASI/CrIS already agree ~0.2K with no adjustments! SNO should allow adjustments (when needed) with high precision.

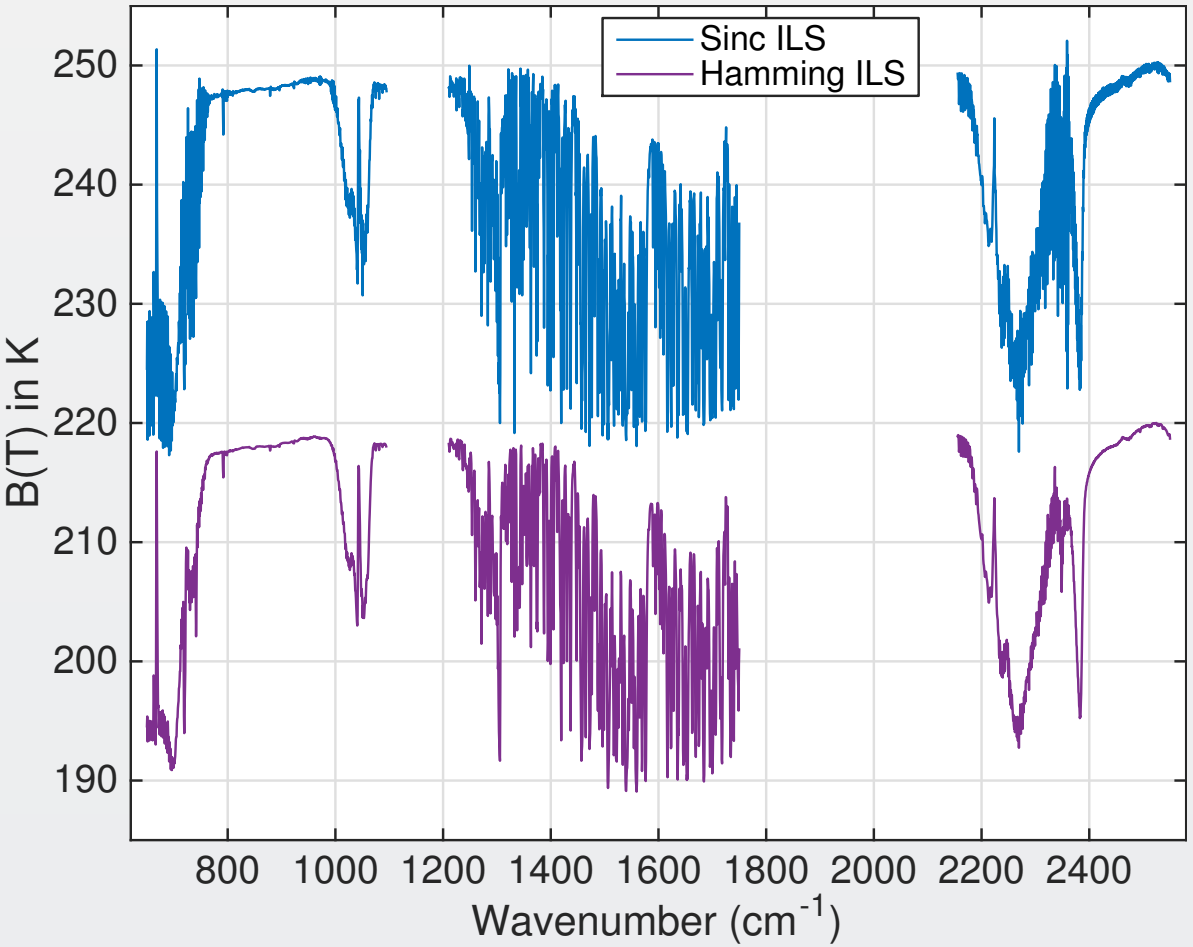
Off-Axis FOV Apodization Corrections



With high spectral resolution, adjustment of off-axis observations to equivalent on-axis is more difficult. Results from Dec 6-10, 2014 data shown here show this is working well.

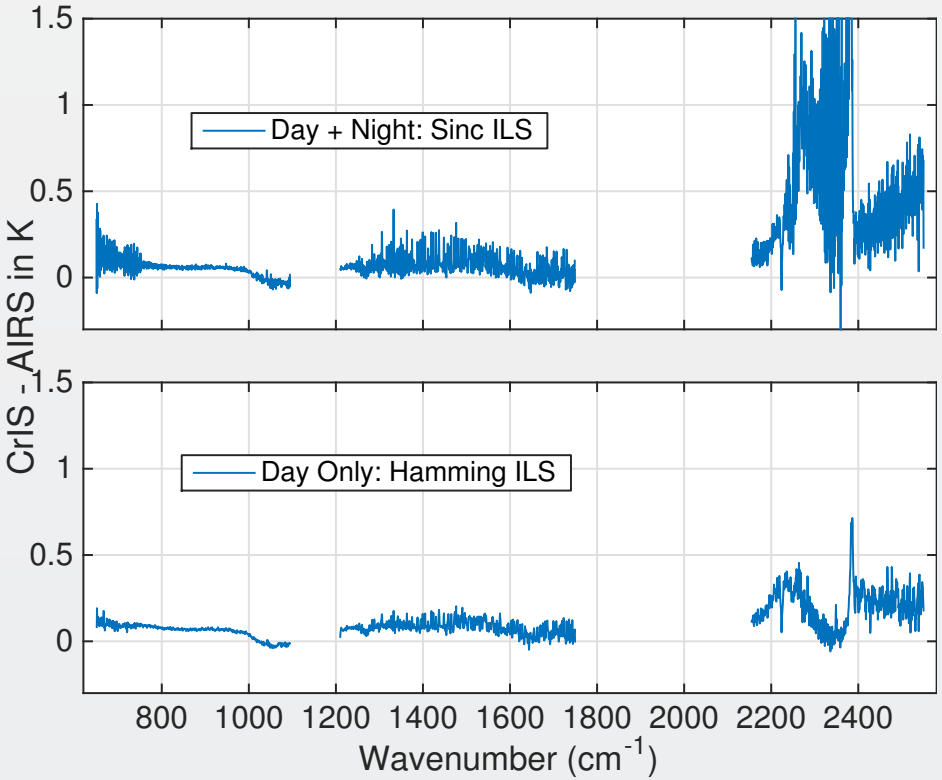
Higher spectral resolution produces colder scenes in deep water lines. FOV7 highly non-linear, will require further adjustments.

CrIS Hi-Res and IASI SNO's, Dec. 5-6, 2014



SNOs only at high latitudes, near +78, -78 degrees.
Differences between CrIS and IASI too small to see here.

CrIS/IASI SNO's, Dec. 5-6, 2014:



- Ringing in longwave: several contributions (IASI->CrIS, CrIS ringing, IASI?)
- Non-linearity in either instrument could effect low-BT mid-wave water lines. (CrIS FOV7)
- Low shortwave BT's enhances errors in differences. Higher daytime temperatures (due to non-LTE) reduces difference in day only.

Proposed climate record will use lower panel ILS (possibly reduced even more)

Long-Term Trends

Radiance based trending; then convert to geophysical variables

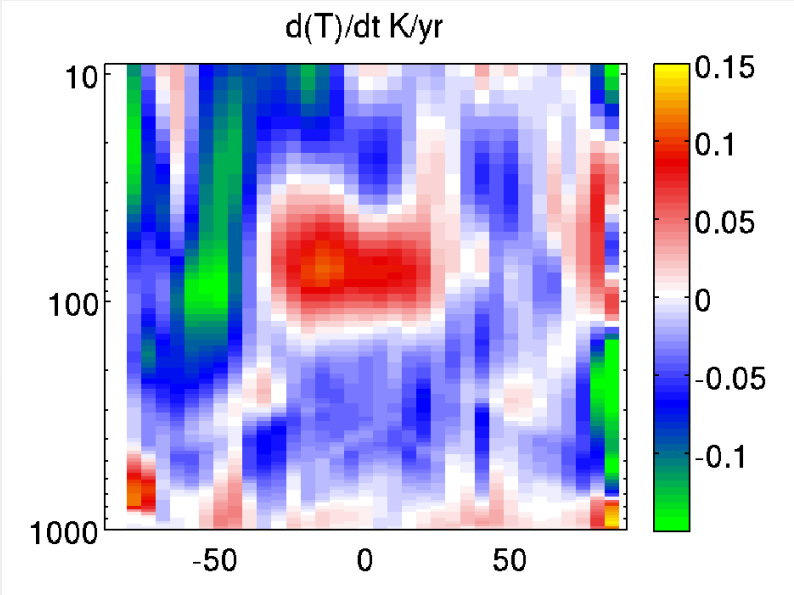
- Robust measurement of long-term climate trends will likely require AIRS + CrIS (with IASI coming later)
- Requires instrument stability (AIRS shown to be $<$ 0.001K/year)
- CrIS 2-year stability very good, will evaluate 3-year stability soon.
- Requires instrument overlap for correction of calibration differences
- Inter-annual variability is mostly regional
- What do we see so far (10 years)?

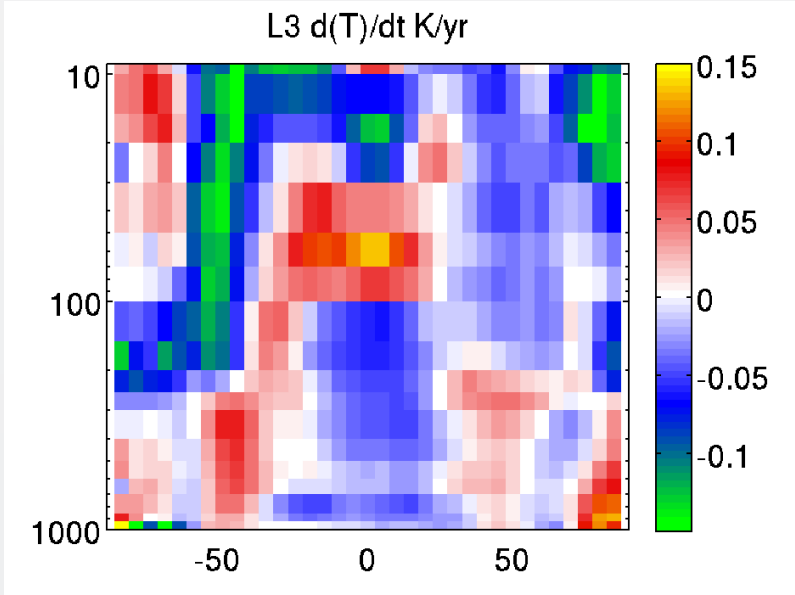
Two 10-Year Rates

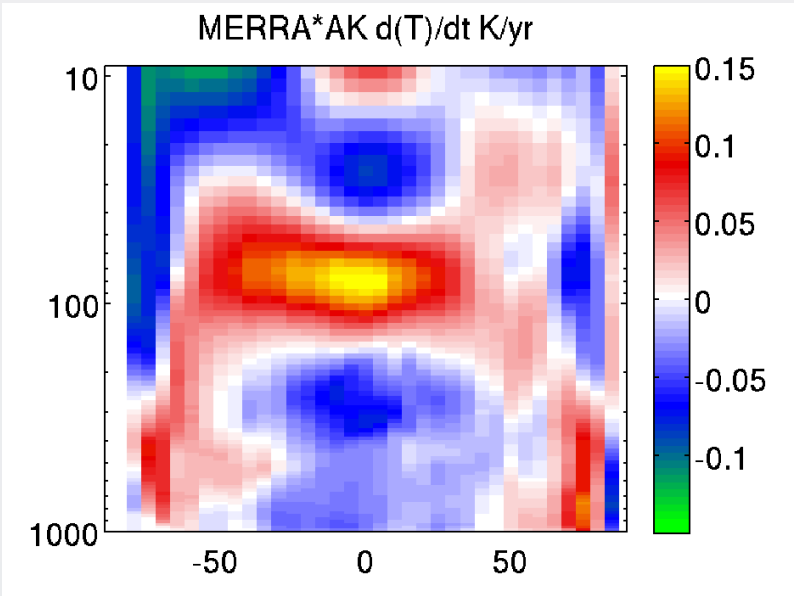
I call them rates, because geophysical variability...

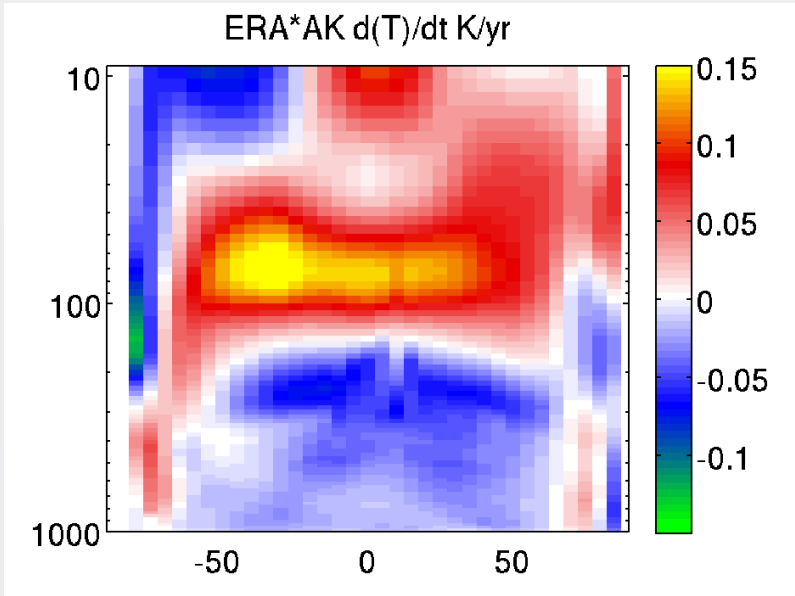
UMBC Temperature vs ERA-Interim, MERRA, AIRS L3

Retrievals from 10-Year zonal mean linear radiance rates



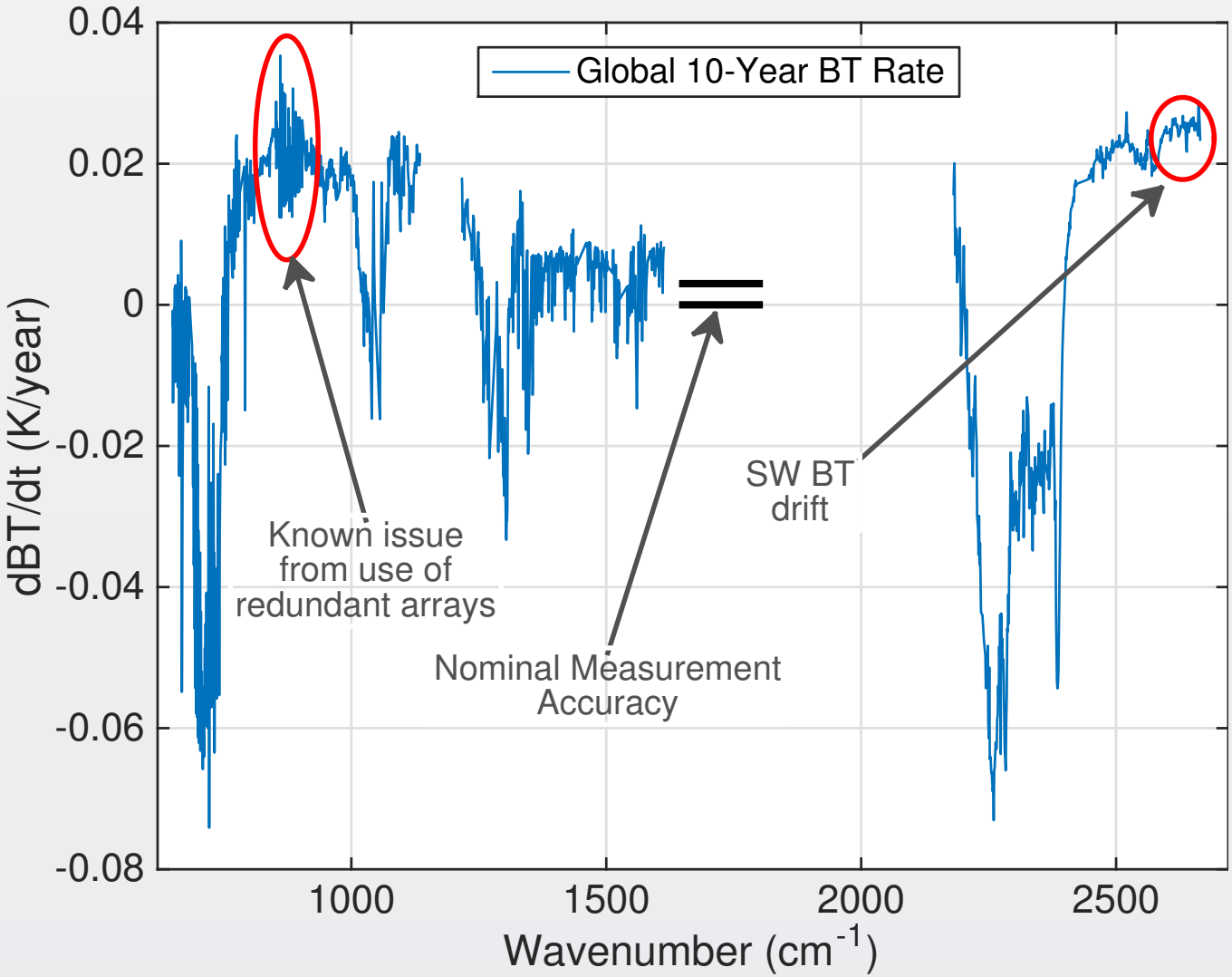






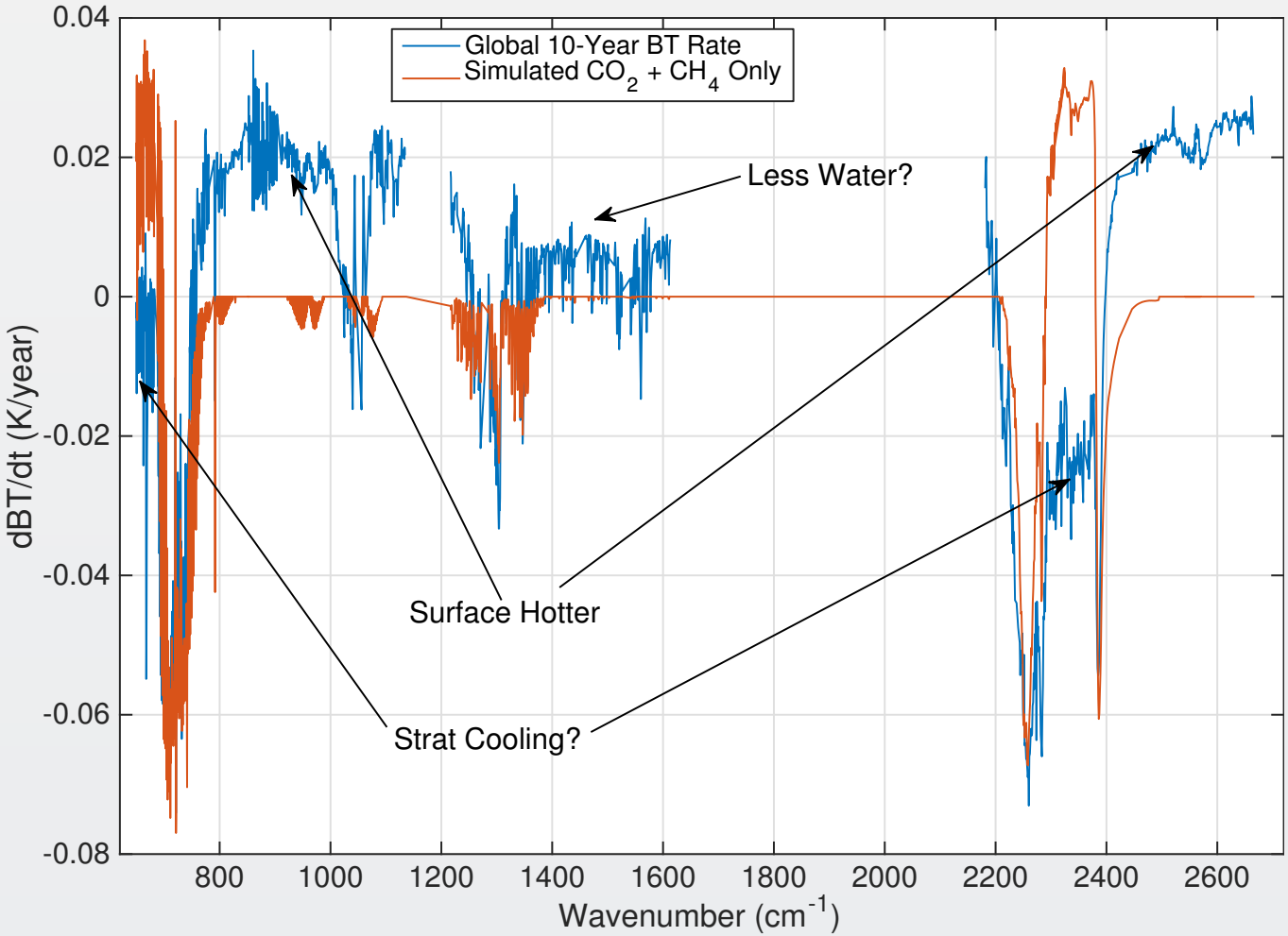
Globally Averaged AIRS 10-Year All-Sky BT Rates

Area Weighted. Geophysical uncertainties not done yet!



Global Averaged AIRS 10-Year All-Sky BT Rates

Comparison to All-Sky Simulations, but only changing CO_2 + CH_4.



Little mid-trop ΔT, decrease in mid-trop H_2O ~ 0.1%, surface T +0.02K. Main observation: Stratospheric cooling? Measurement error ~ 0.003K?, geophysical variability higher.

Conclusions

- Operational sensors have the stability needed for climate
- In-orbit overlap should allow stitching records with uncertainty equivalent to 0.1K/decade. Some risk.
- CrIS (and AIRS) calibration improvements can be made, key is that the *standard deviation* of these differences is small!
- Demonstrated re-analysis level results with all-sky retrievals derived from radiance trends
- This approach allows a much more rigorous error analysis needed for community acceptance of satellite derived climate change.