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Atmospheric Infrared Sounder

L1C Status & Plans

Evan Manning

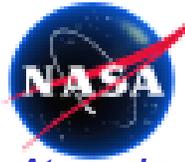


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Atmospheric Infrared Sounder

- L1C definition
- L1C steps
- L1C deliverables



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L1C definition

- L1C is a level of processing beyond L1B, which attempts to recreate what an ideal instrument would have observed.
- In other words, L1C removes instrument artifacts. Anything we find ourselves saying to users, “When you use AIRS radiances you have to be aware of ...”:
 - Calibration errors
 - Ideally this would be done in L1B
 - Bad channels
 - Spectral shifts
 - Spectral gaps/overlaps
- For future L1C releases it might also include spatial resampling to fix Cij and the non-uniform spatial overlap of FOVs.
- L1C is what a naïve user would want to see.
 - But some NIST traceability is lost, so climate users may prefer to stick to L1B, plus L1C-type information about bad channels, non-Gaussian noise, and spectral shifts.



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L1C Steps

- L1B non-Gaussian noise characterization
- Radiometric correction
- Cleaning
- Gap Filling
- Spectral shift determination
- Spectral shifting



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L1B Non-Gaussian noise characterization

- L1C can exploit information on non-Gaussian noise to determine which channels to replace.
- L1B users would also like to know which channels are most suspect.
- Work on my SPIE paper showing residuals between reconstructed and observed radiances gives us new insight into what would make a good set of metrics.

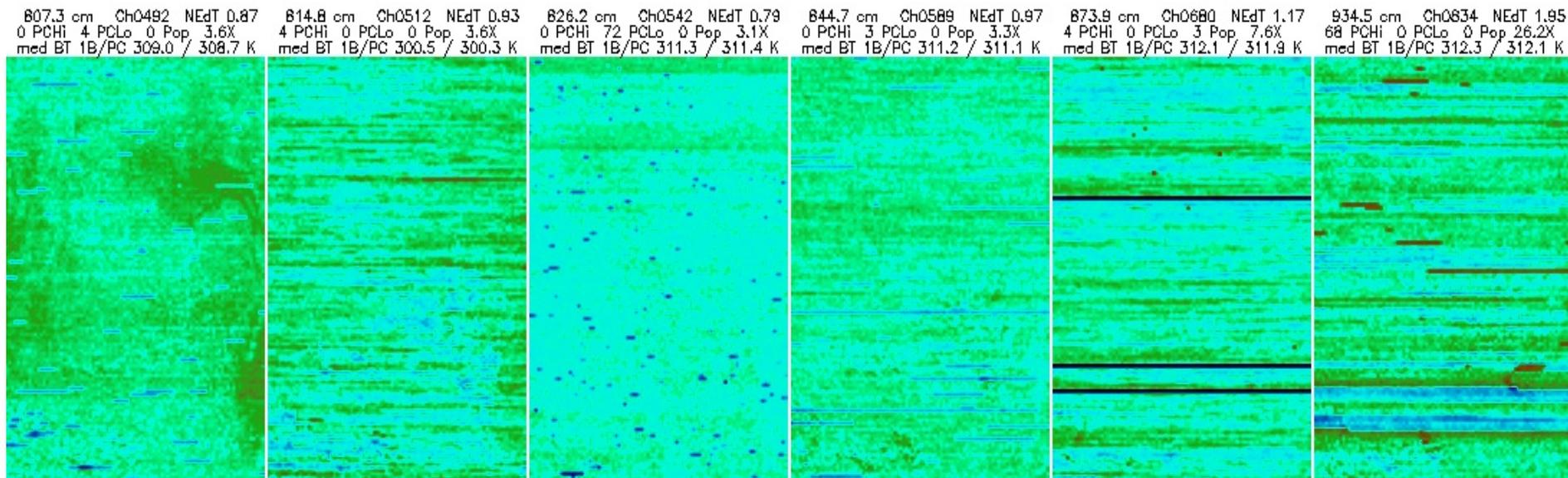


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Reconstruction residuals for problem channels



- These are the 7 channels that passed ordinary L1B Quality Control with NEdT < 2 K but were flagged in this granule with at least one event where observed BT differed by at least 5 K from the PCA reconstruction.
 - Presumably there are more below this detection threshold
- key observations:
 1. These are all channels where the NEdT is raised at least 3x above the best neighboring channels
 2. There is a distinct stripy appearance to all.
 - Narrow stripes where the detector “popped” briefly
 - Broad stripes where these events infected the calibration coefficients



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3 metrics for non-Gaussian noise

These 3 metrics should collectively help users find non-Gaussian noise:

- Noise factor above baseline
 - Set a baseline expected noise level for each channel when it is working perfectly.
 - Higher by $\sqrt{2}$ for A-only or B-only channels
 - Calculate NEdT/baseline NEdT
- Individual stripe identification
 - Find individual lines where the radiances for ~ 20 spots on one line are consistently above or below both neighbors
- Overall “stripiness”
 - Statistical measure of how much more variability there is along-track than across-track



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Radiometric Correction

- Margie Weiler provided a formula that can recalibrate L1B data by un-applying the original coefficients and applying new ones.
- It is currently configured with N40rab.
 - But N40rab clearly does not remove the artifacts that are most troubling.
 - This could be updated before v6.0 L1C release
- It will be more difficult to make radiometric corrections for some of the other issues we are currently investigating:
 - Non-Gaussian noise in calibration views
 - Charge retention
 - Glint in spaceview
 - Nonzero scene BT in spaceview



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Cleaning

- Cleaning replaces radiances for bad channels with a value calculated using redundant information from other channels
- First step is “buddy system”
- Second step is principal component reconstruction

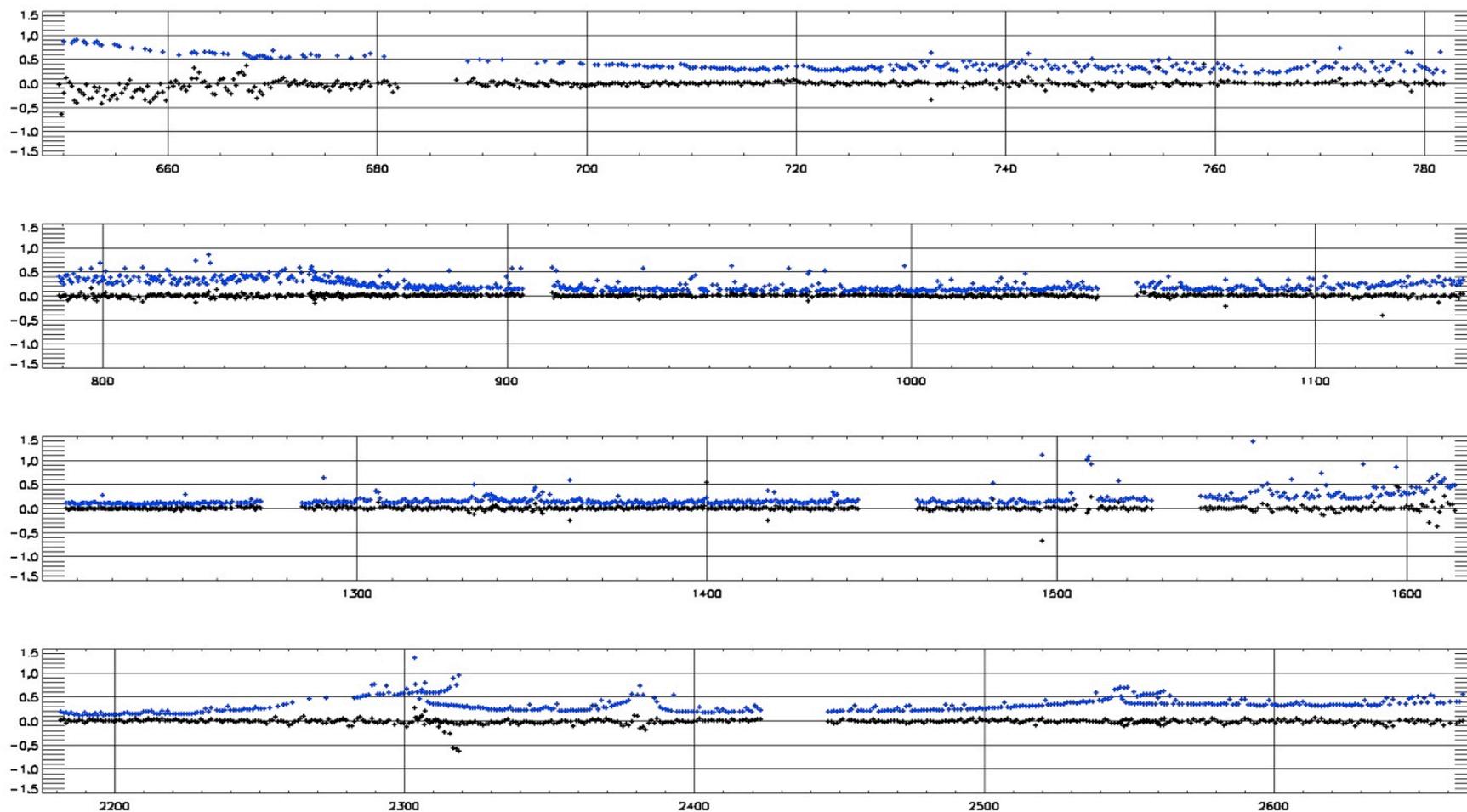


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Bias and Standard Deviation of Reconstruction Error (K) as a function of frequency (cm^{-1})





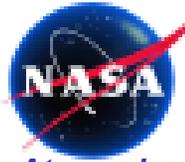
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Cleaning issues

- How many PCAs to use?
- Currently some bad radiances slip through
 - Tighten up criteria for cleaning using the new non-Gaussian metrics
 - Add a second-pass which replaces all channels with more than 2 K (TBD) difference from reconstructed value
 - This requires the reconstruction to be very accurate in all cases.
- Add non-Gaussian metrics on the reconstruction differences.



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Gap Filling

- Gap filling calculates approximate radiances for channels filling the gaps between modules.
 - It also eliminates overlaps.
 - The new channel set has 2665 channels instead of 2378.
- While a standalone implementation exists, it is not yet part of the L1C PGE.

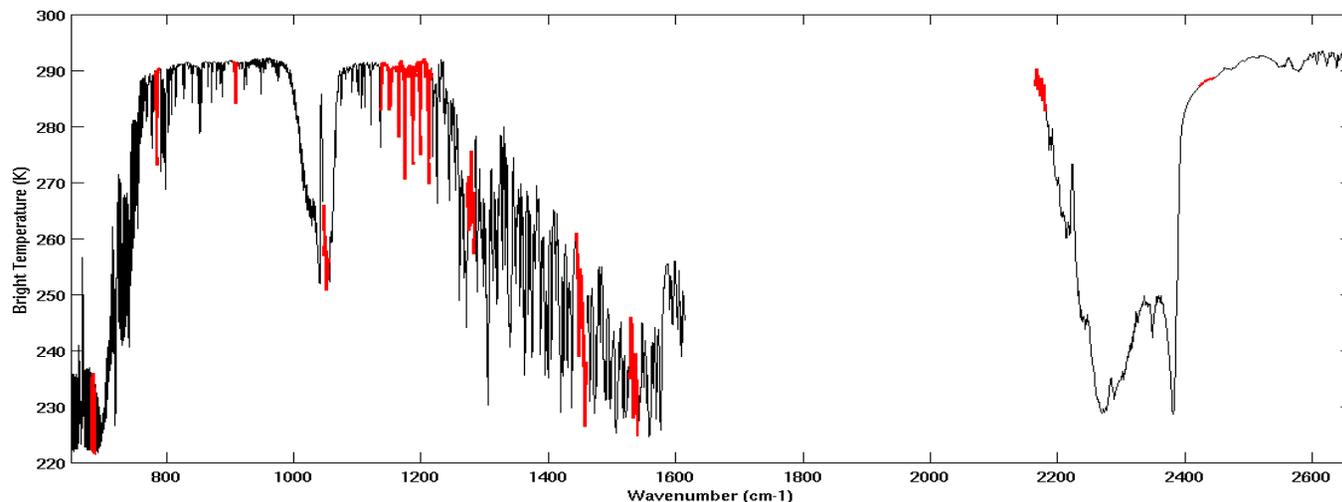


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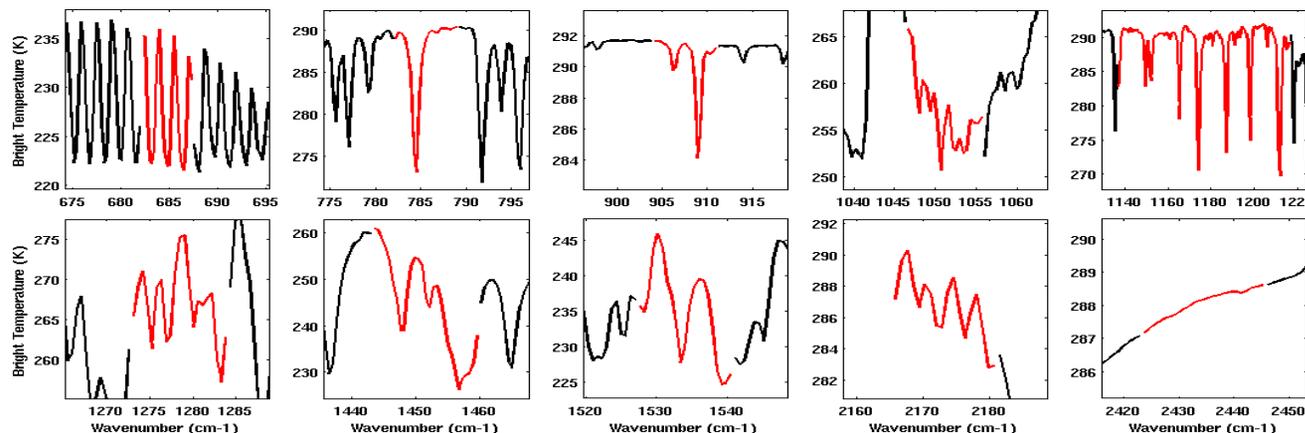
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Gap filling results from Yibo Jiang



Sample spectrum from the full spectrum training set. The black lines represent the existing channels, and the red lines are the gap channels.



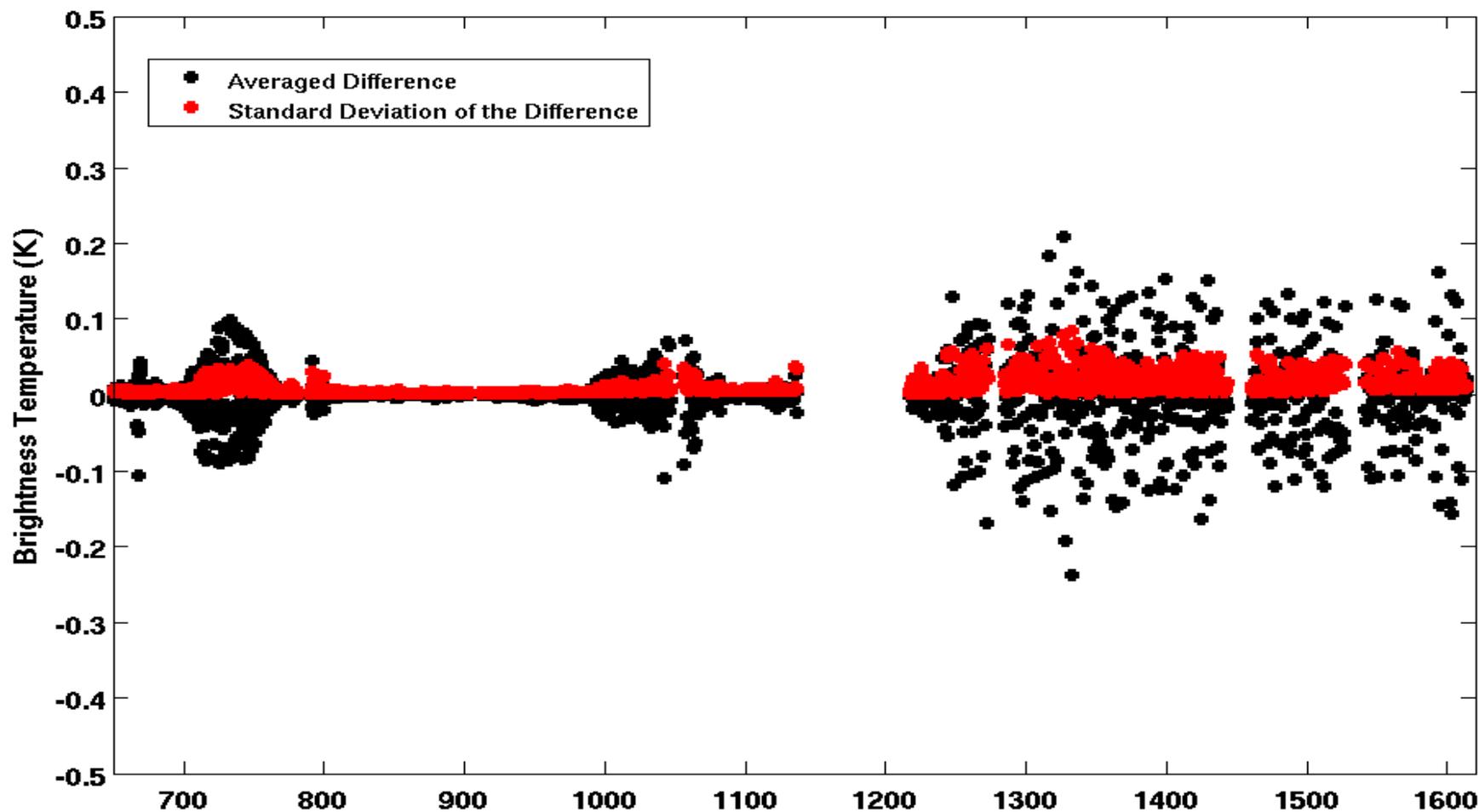


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Gap filling results from Yibo Jiang



The averaged difference and standard deviation of the difference between the gap-filled spectra and the IASI spectra from one day measurements over Atlantic ocean.



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Spectral shift determination

- A model of spectral shift as a function of time was developed at UMBC.
- We incorporated it in L1C, but instead of allowing the modules to move independently, we use UMBC's M-10 values for all modules.
- This model is incorporated in v6 L2, which uses the calculated shifts in its RTA calls.
- A simpler set of look-up tables will be developed so all users can have a good frequency set for any observation without using the entire optical model

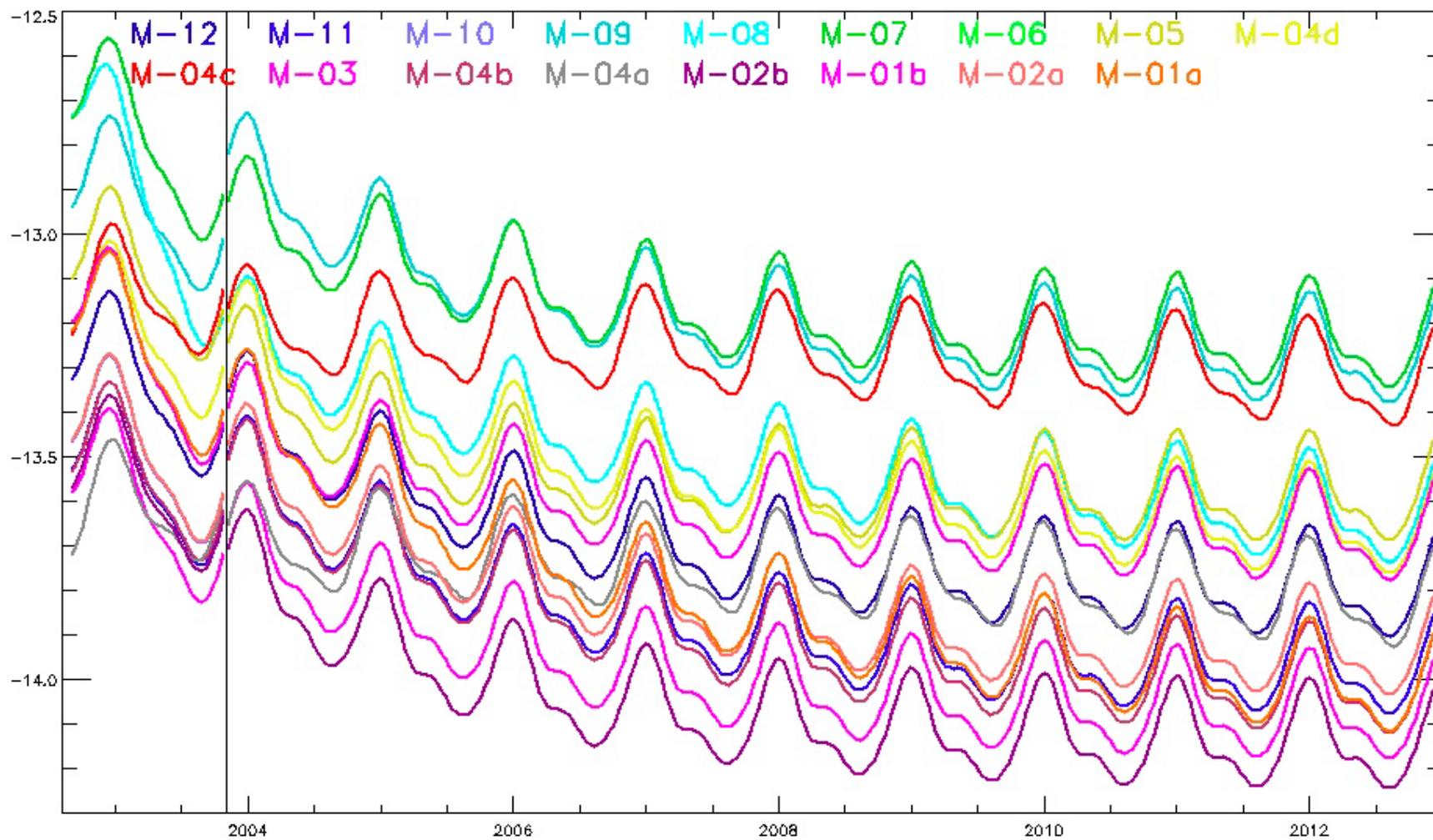


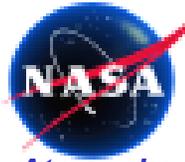
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UMBD model shifts seasonal/long term by module





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Spectral shifting

- L1C has a spline spectral shifting algorithm on the original 2378-channel set, with an additional bias correction because spectral lines aren't cubic at AIRS spectral resolution.
 - It performs well except at the ends of modules.
 - Needs to be modified to support the expanded channel set
 - The extra channels will help with the ends of modules.
 - Larrabee Strow is working on this

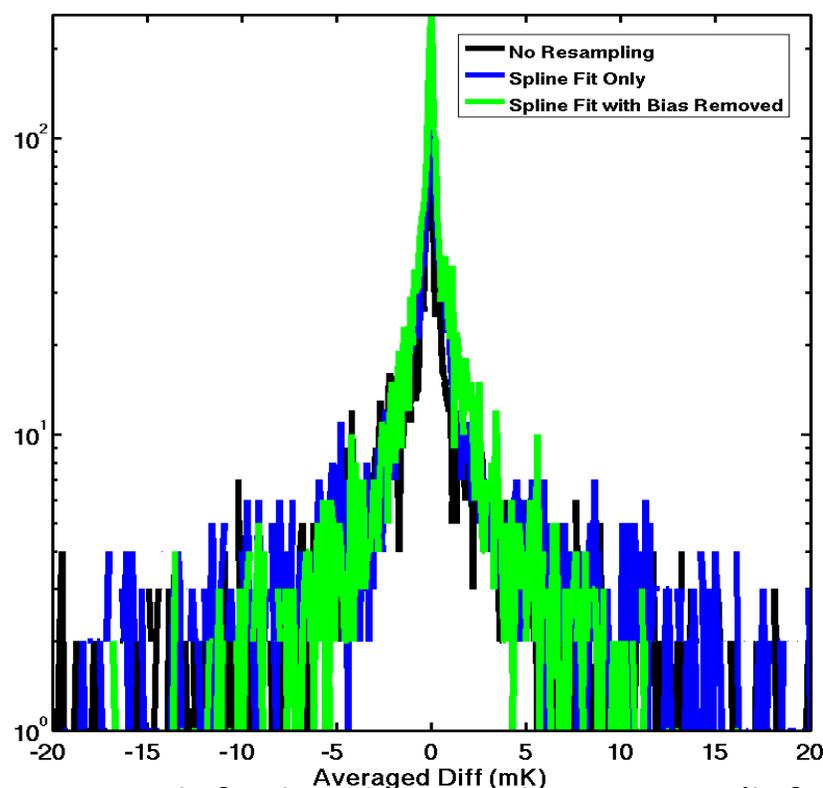
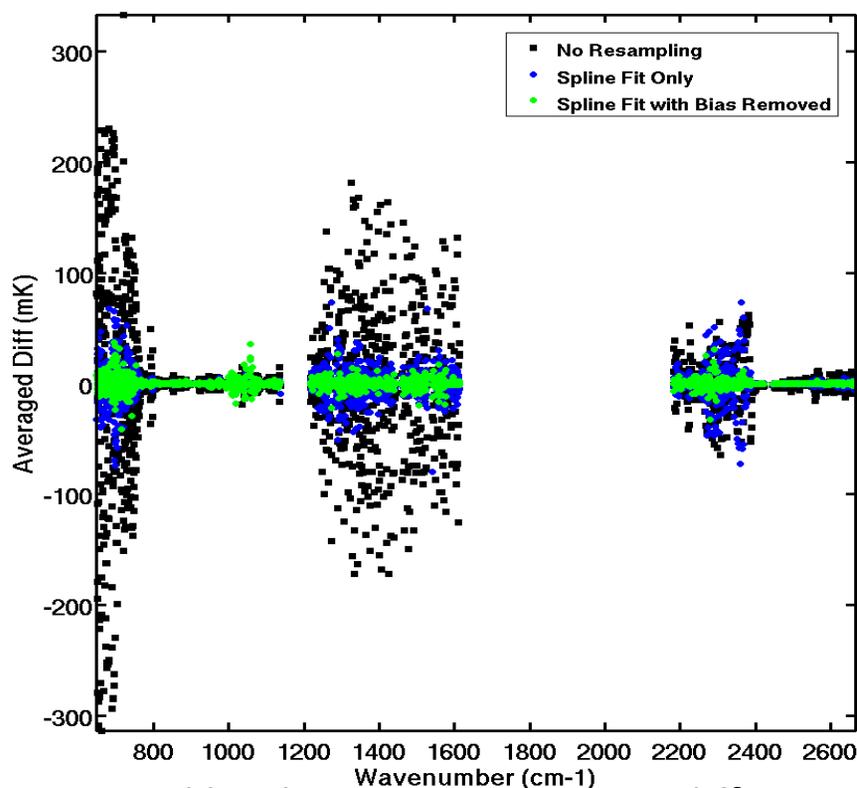


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Spectral resampling results from Yibo Jiang



Averaged brightness temperature difference between shifted and original spectrum (left panel) and its distribution (right panel) of the brightness temperature vs. frequency from model spectra with no resampling (black dot or line), spline fit (blue dot or line), and spline fit with bias removed (green dot or line).



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L1C deliverables

- L1C products are HDF-EOS swath files identical to L1B products except that they have a larger channel set and add a few fields telling which channels were cleaned or filled, why, and giving PCA reconstruction stats and spectral shifts.
 - These products will be available at GDISC
 - There will also be a program available so users can convert their L1B locally at their facility
- There is also a need to distribute small products for L1B users who just want ancillary info on spectral shifts and/or non-Gaussian noise metrics.
 - In v7 this info should be part of L1B.