Exercise Results and Lessons for AIRS "Startup"

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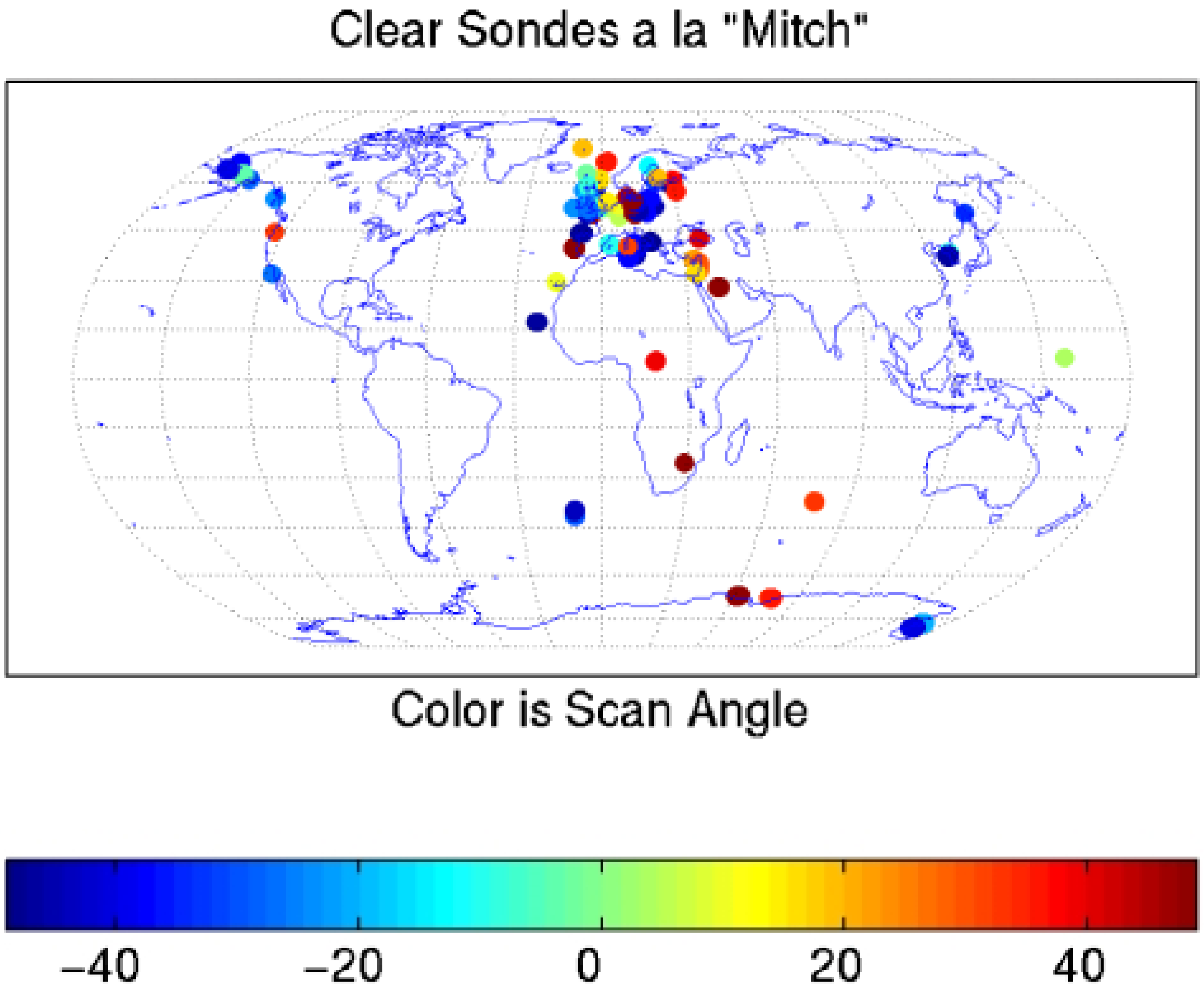
Overview

- Summary of exercise activities, timeline
- Existing L1b clear flags inadequate, so developed our own for ocean, night. (Following others.)
- Results of our clear flag
- Use of NCEP/ECMWF fields for early validation
- Expected form of biases compared to exercise
- How to make the next exercise more useful, and missing in-situ data.
- This exercise **extremely** use for UMBC in stimulating our software development. Still not concentrating on spectroscopic issues.
- Used RTP format extensively for the first time, presently being upgraded based on our experiences and others.

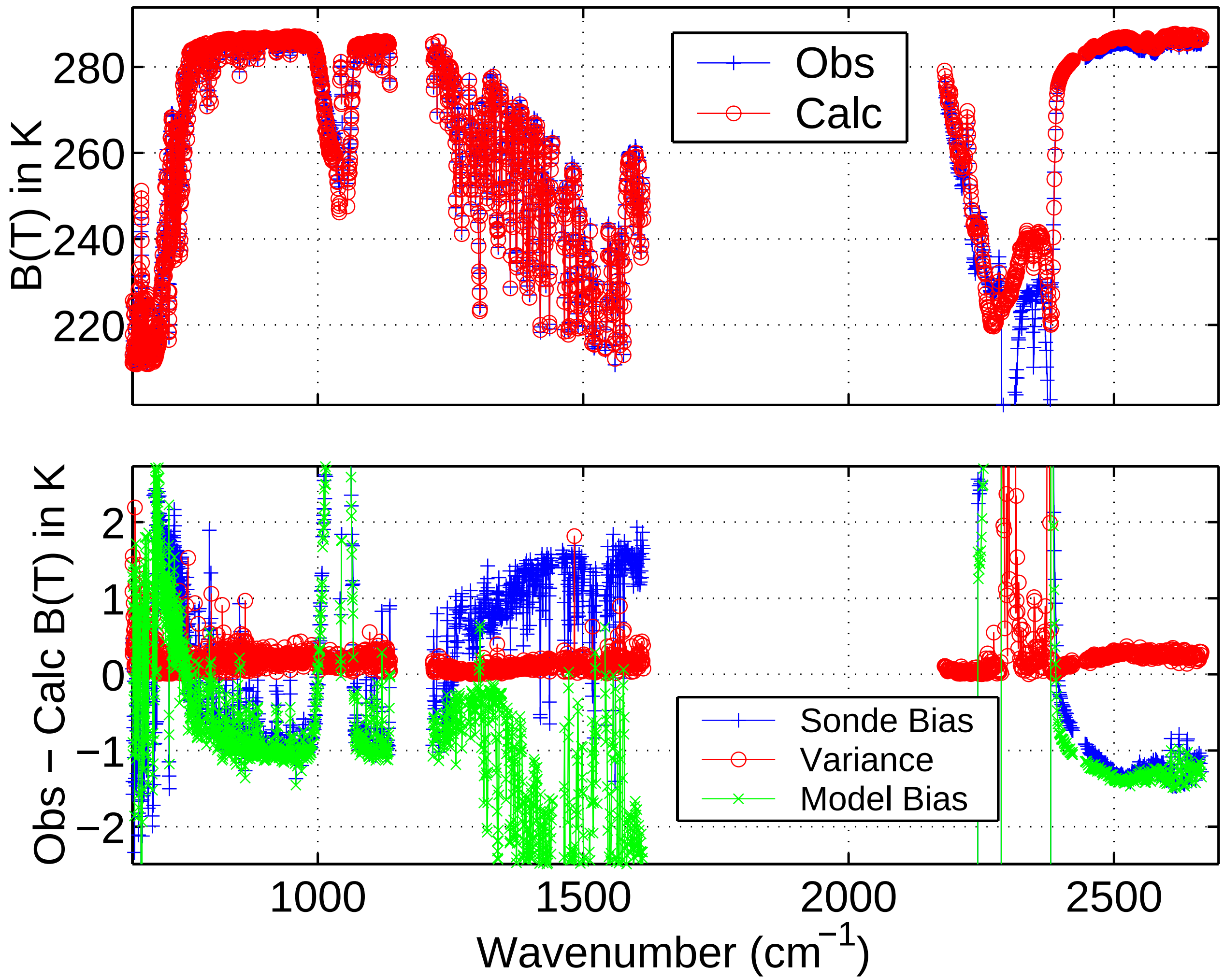
Exercise Summary/Timeline

1. Following JPL guidelines I worked to determine the bias error using sonde data. (Had trouble finding files...)
2. "Pre-Level 1" clear flag inadequate to start, so used 900/2616 cm^{-1} split-window flag with no atmospheric correction. Got a single hit, which correctly found biases in CO_2 region, not in windows.
3. Needed more statistics, so developed combination split window, NCEP SST based clear flag using forward model for atmospheric correction.
4. Spent most of remaining time getting this clear flag working and evaluating it. Can process 1 days worth of data in less than 1 hour on 1 processor. (Downloaded all granules at start of test.)
5. Believe our clear flag is sufficient for bias evaluation?
6. Re-did sonde matchups to "clear" FOVs, analysis incomplete. Will then re-evaluate ability to uncover bias.
7. Developing the clear flag stimulated some thoughts on how to derive better water continuum information from the ARM AERI data.

Map of Clear Matchups over Ocean (many cloudy)



Single Matchup Obs-Calcs



Clear Flag Definitions

The computed radiance, R_c is given by

$$R_c = \epsilon B(T_s)\tau_{atm} + \int B d\tau + \text{Reflected Thermal}$$

T_s is the NCEP SST, τ_{atm} the NCEP transmittance.

$$R_s^C = \epsilon B(T_s)$$

is the radiance if the atmospheric transmittance was zero.

$$R_{obs} = \epsilon B(T_s^t)\tau_{atm}^t + \int B^t d\tau^t + \text{Reflected Thermal,}$$

is the observed radiance, where the superscripts denote "true" quantities. $(R_c - R_s^c)$ is our estimate of the "atmospheric" part of R_{obs}. Our estimate of the sea surface temperature from an observed radiance is then

$$BT\left[\frac{R_{obs} - (R_c - R_s^c)}{\epsilon}\right] = T_s^t(est)$$

where $BT[]$ turns radiance into brightness temperature. $(R_c - R_s^c)$ is very small for 2616 cm^{-1} (few tenths of a K), but up to 4K or more at 900 cm^{-1}.

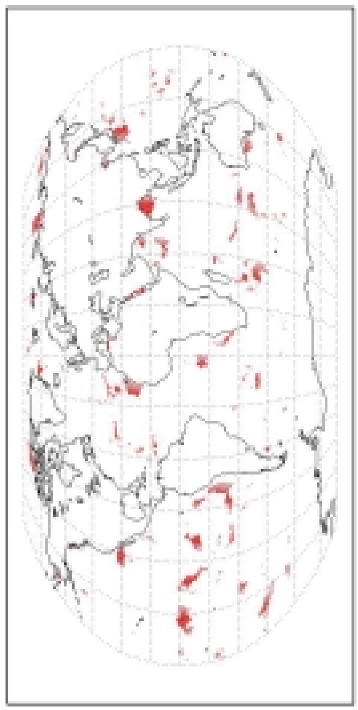
Define Clear Flag Quantities

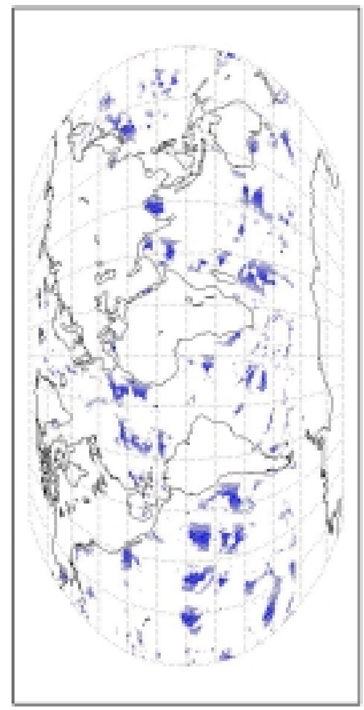
I compute $T_s^t(est)$ for the 900 and 2616 cm^{-1} channels. The clear flag is derived from FOVS that return true for the following three tests:

1. Is Mitch Goldberg's L2 flag (fov_clear_flag) set? (This saves computation time for us.)
2. $|T^t_{s,2616cm^{-1}}(est) - T_s| < 1K$
3. $|T^t_{s,2616cm^{-1}}(est) - T^t_{s,900cm^{-1}}(est)| < 0.5K$

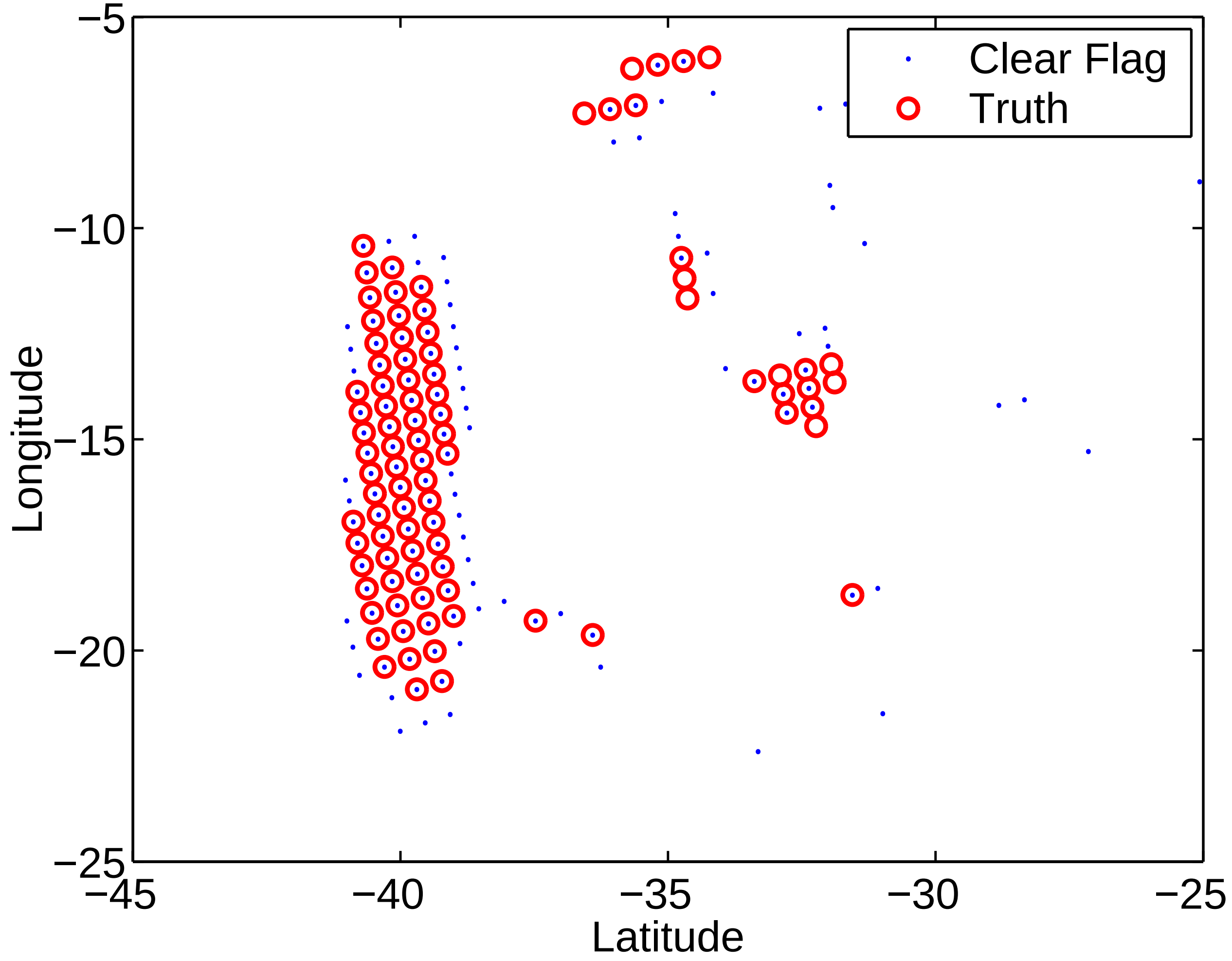
Since we know the true sea surface temperature Test-#2 above is quite good. However, in practice T_s will have 0.5 - 1K errors, and Test-#3 might be quite important, although it is less sensitive. Test-#2 will help get rid of outliers that could make it through Test-#3.

Sea Surface Clear Flag: Blue = Flag, Red = Truth

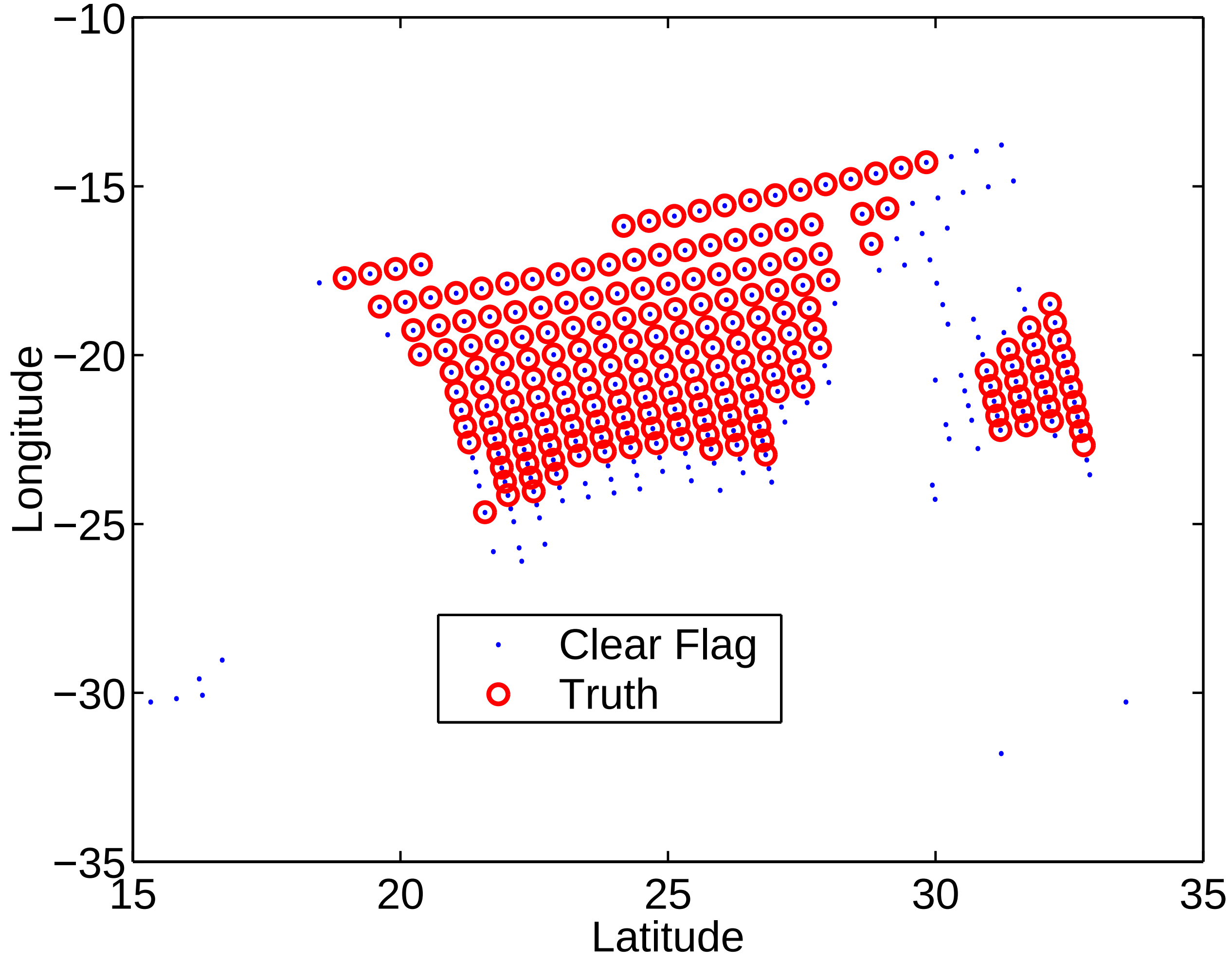




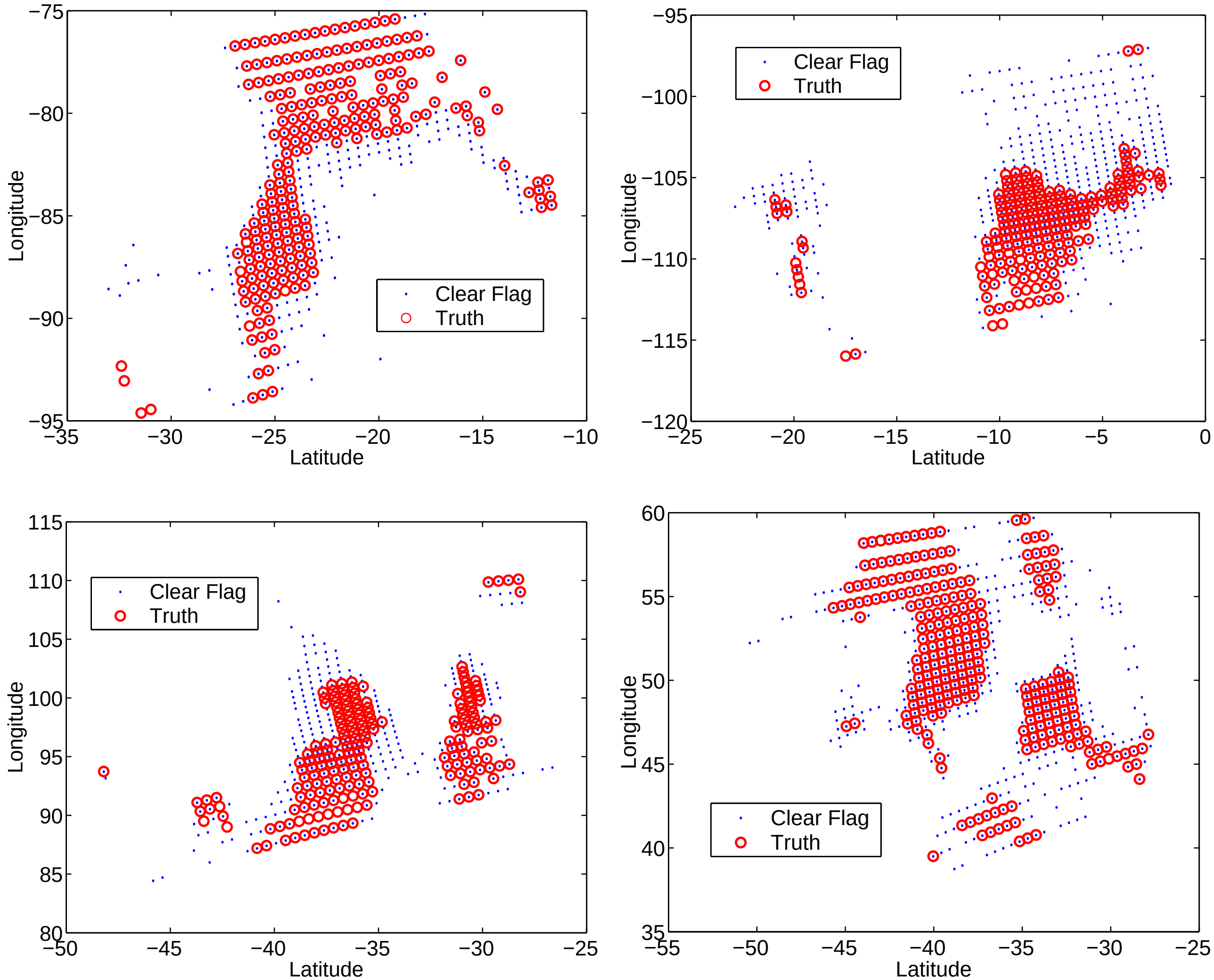
Granule 19 Clear Flags



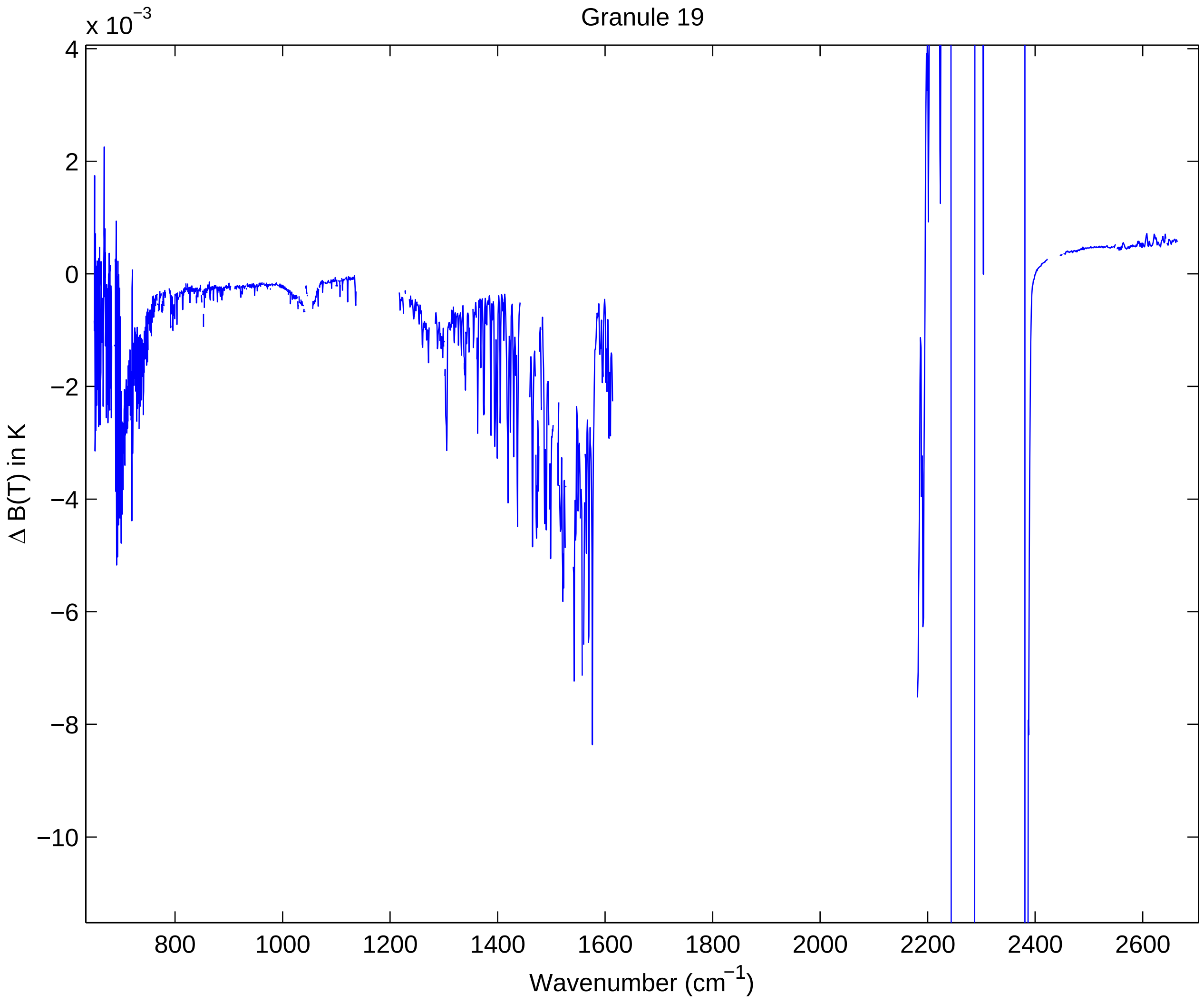
Granule 33 Clear Flags



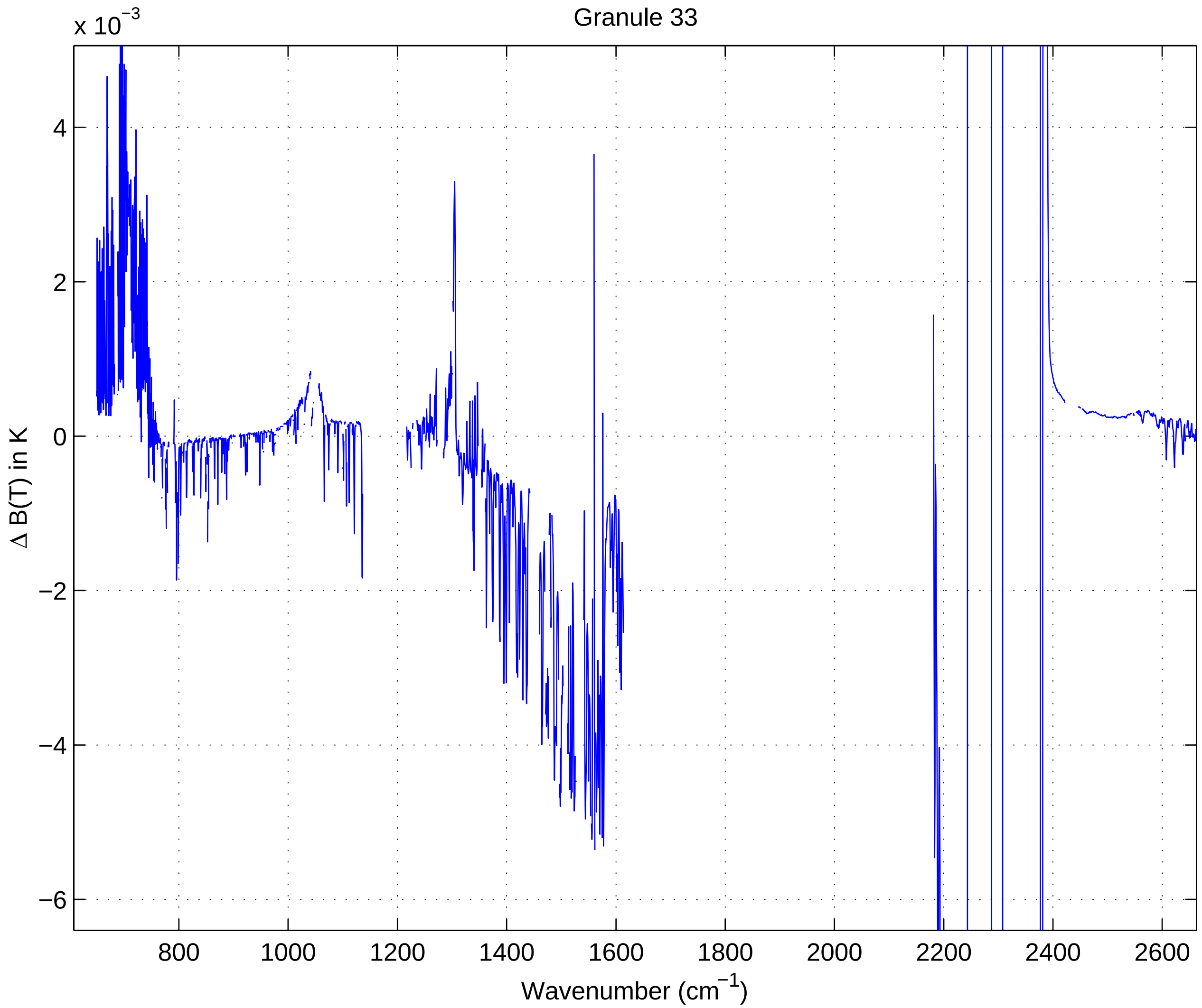
Granule 68, 84, 184, 217 Clear Flags



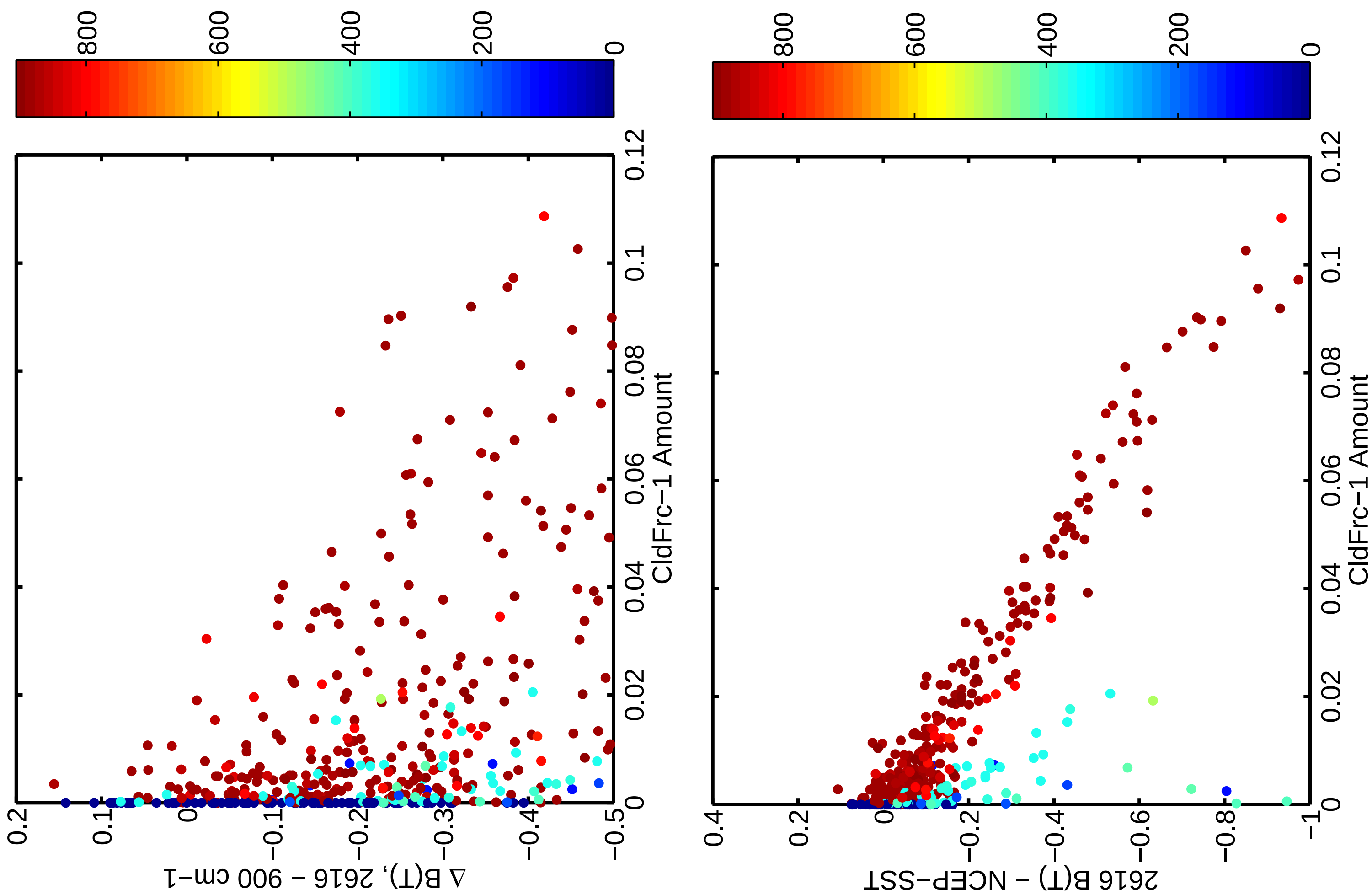
Granule 19 Bias Error



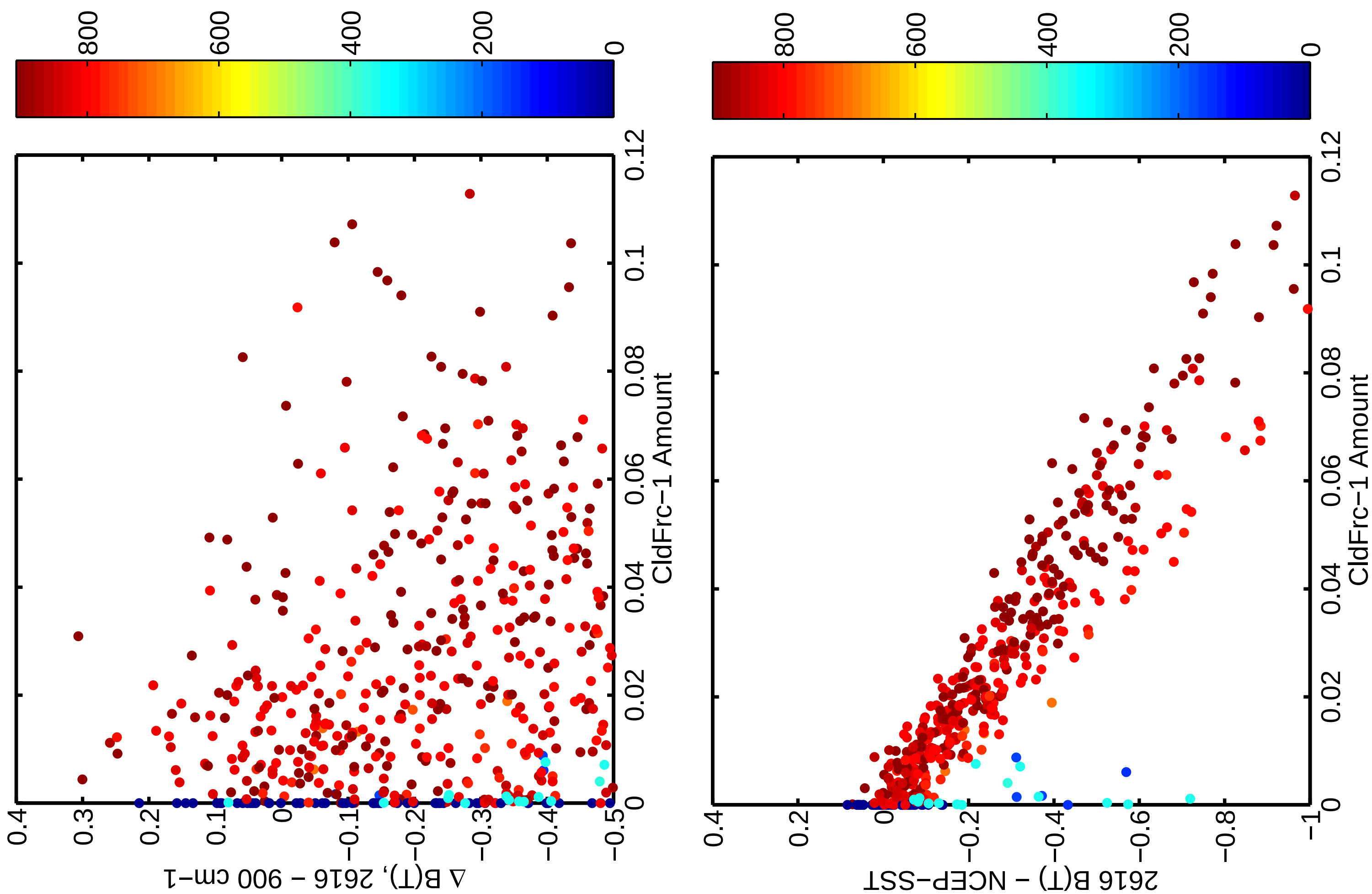
Granule 33 Bias Error



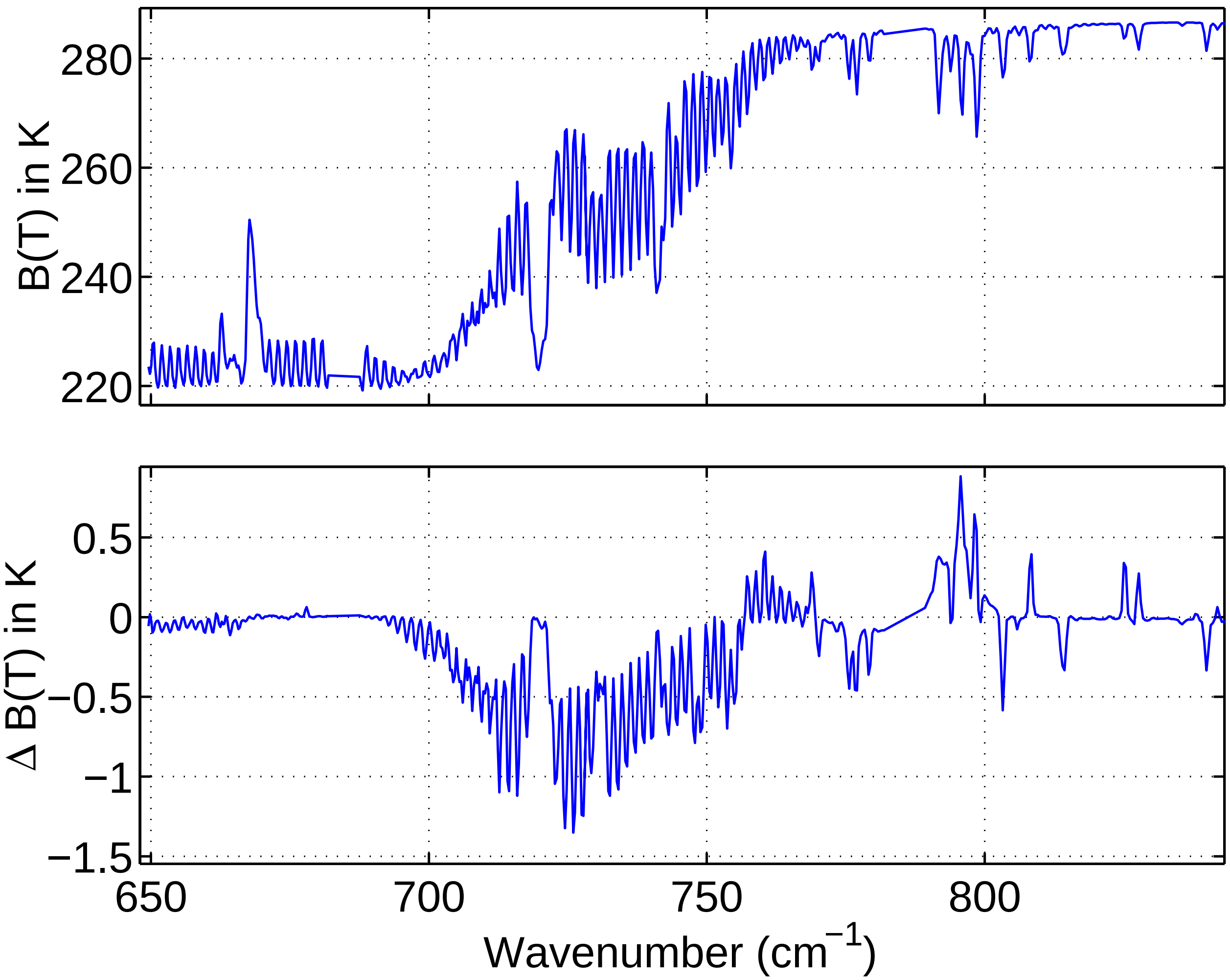
Clear Flag Errors vs Cloud Fraction, Granule 68



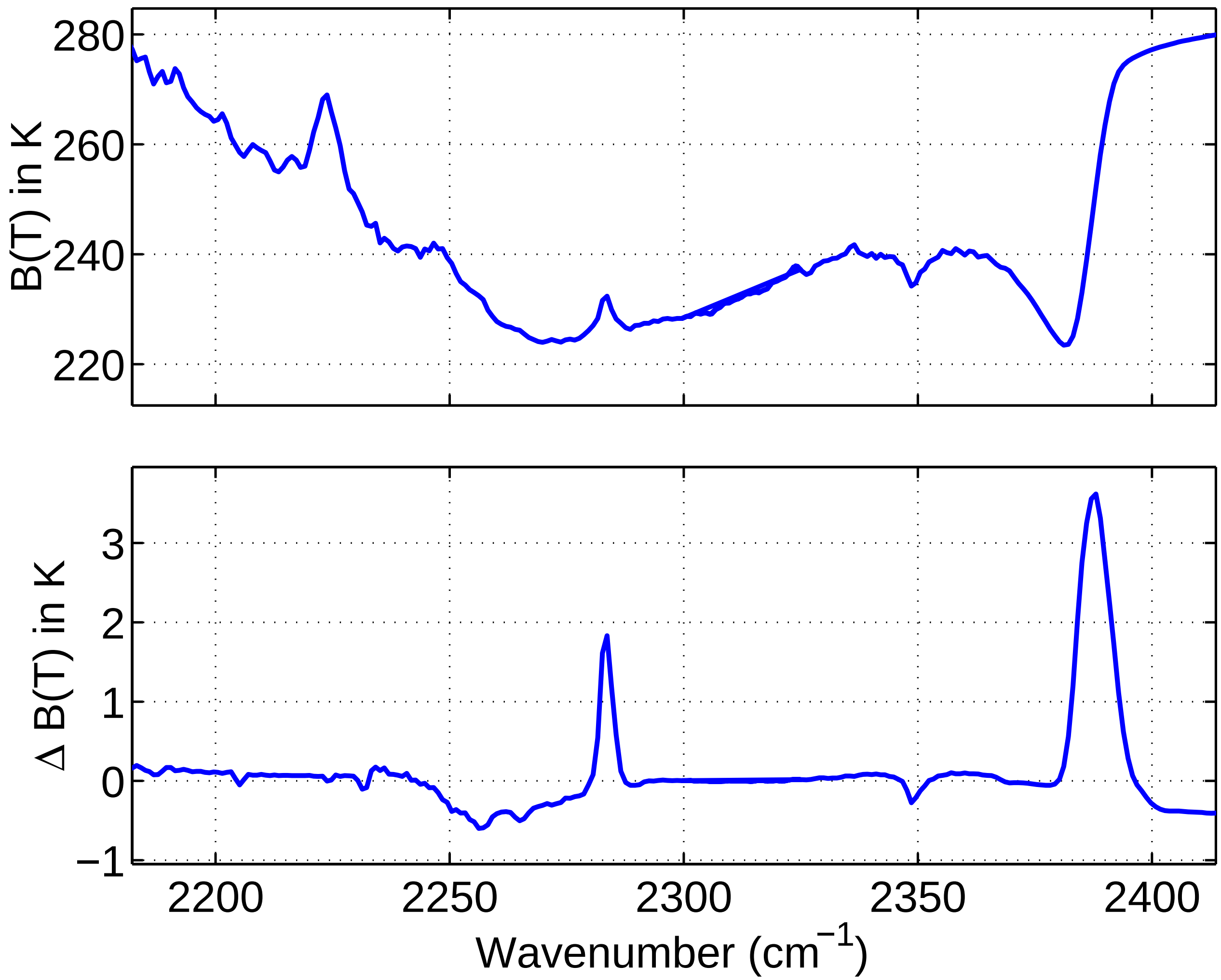
Clear Flag Errors vs Cloud Fraction, Granule 84



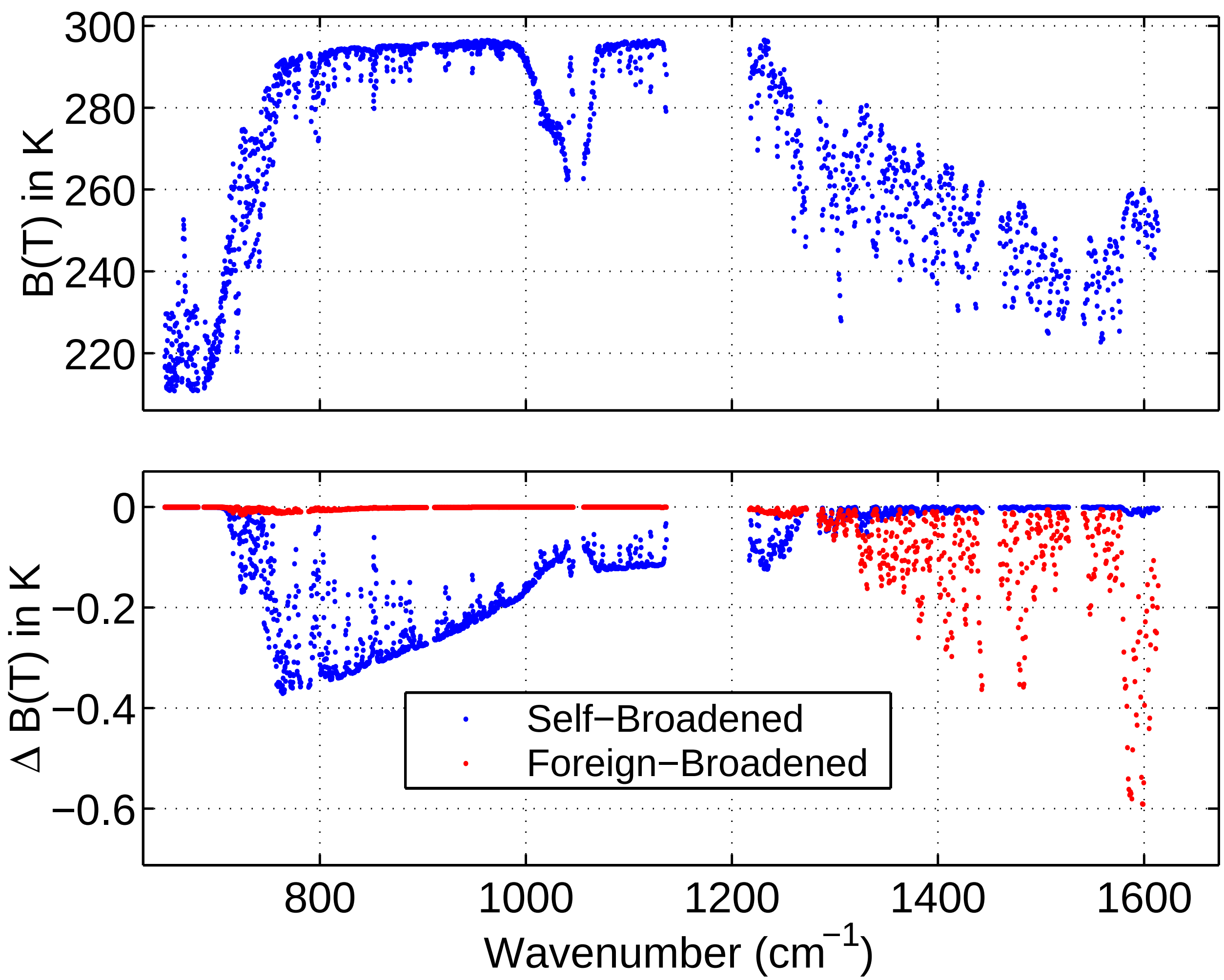
Possible Spectroscopic Errors, Long Wave



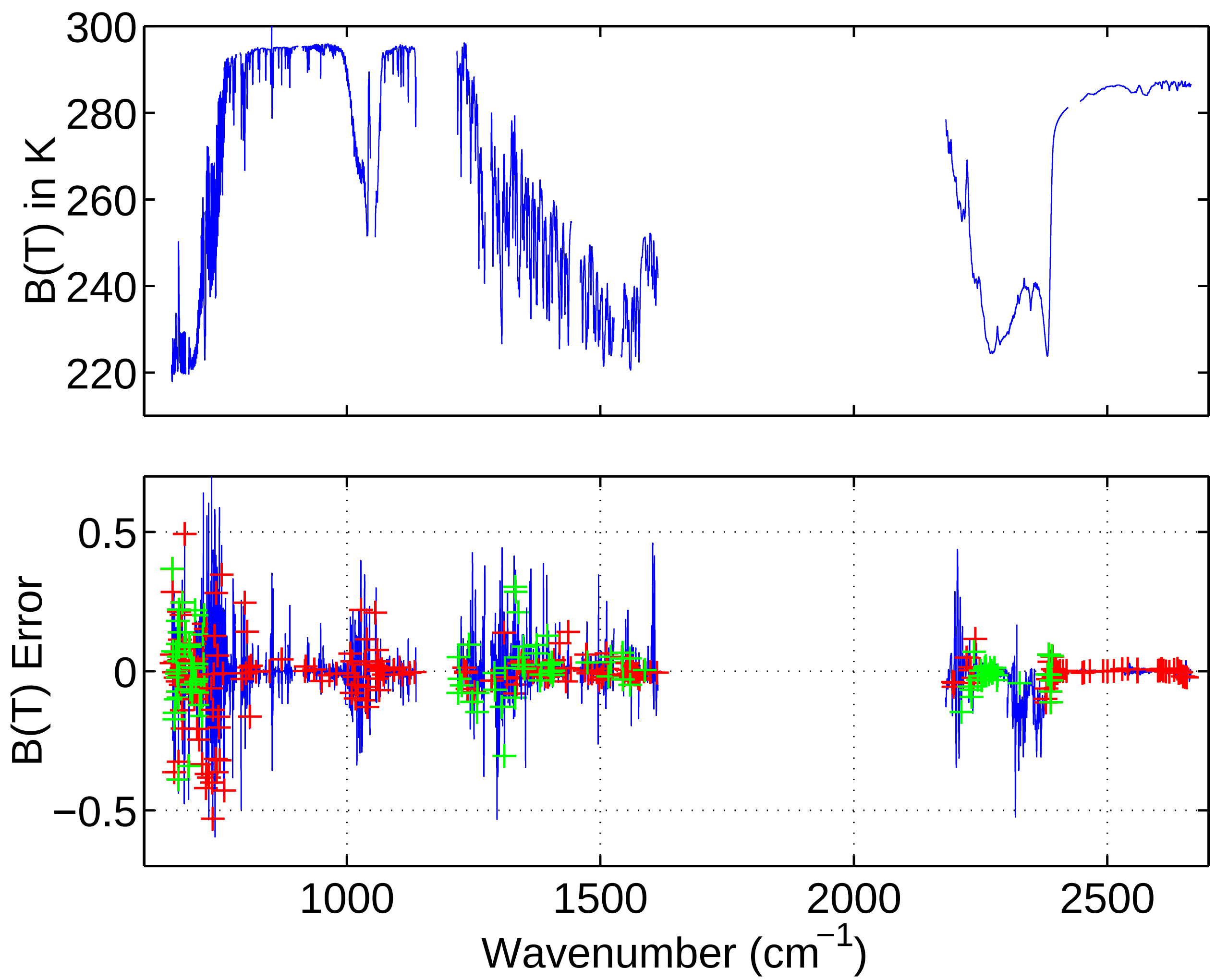
Possible Spectroscopic Errors, Short Wave



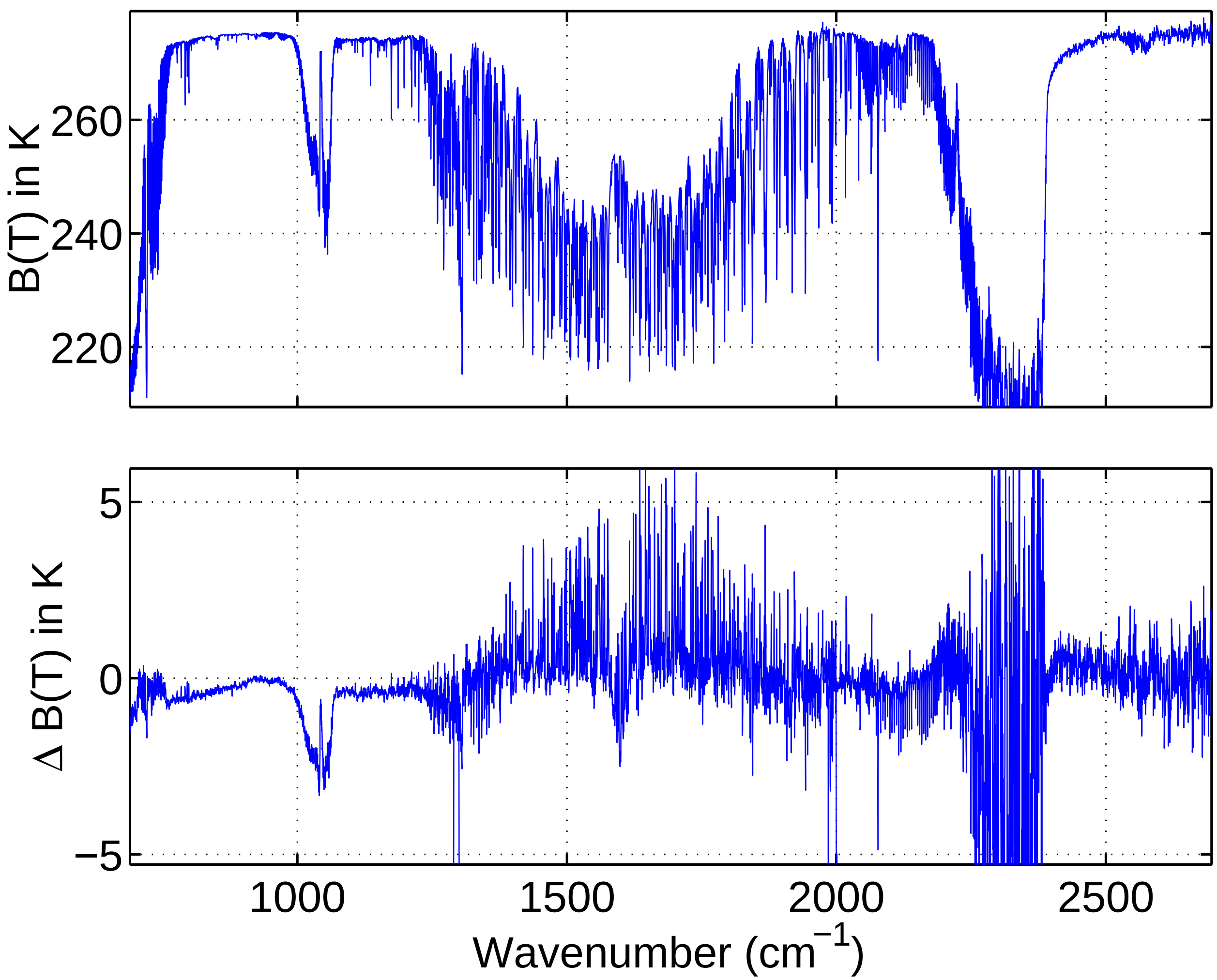
Effect of 10% Error in Water Continuum



Errors due to SRF Uncertainties

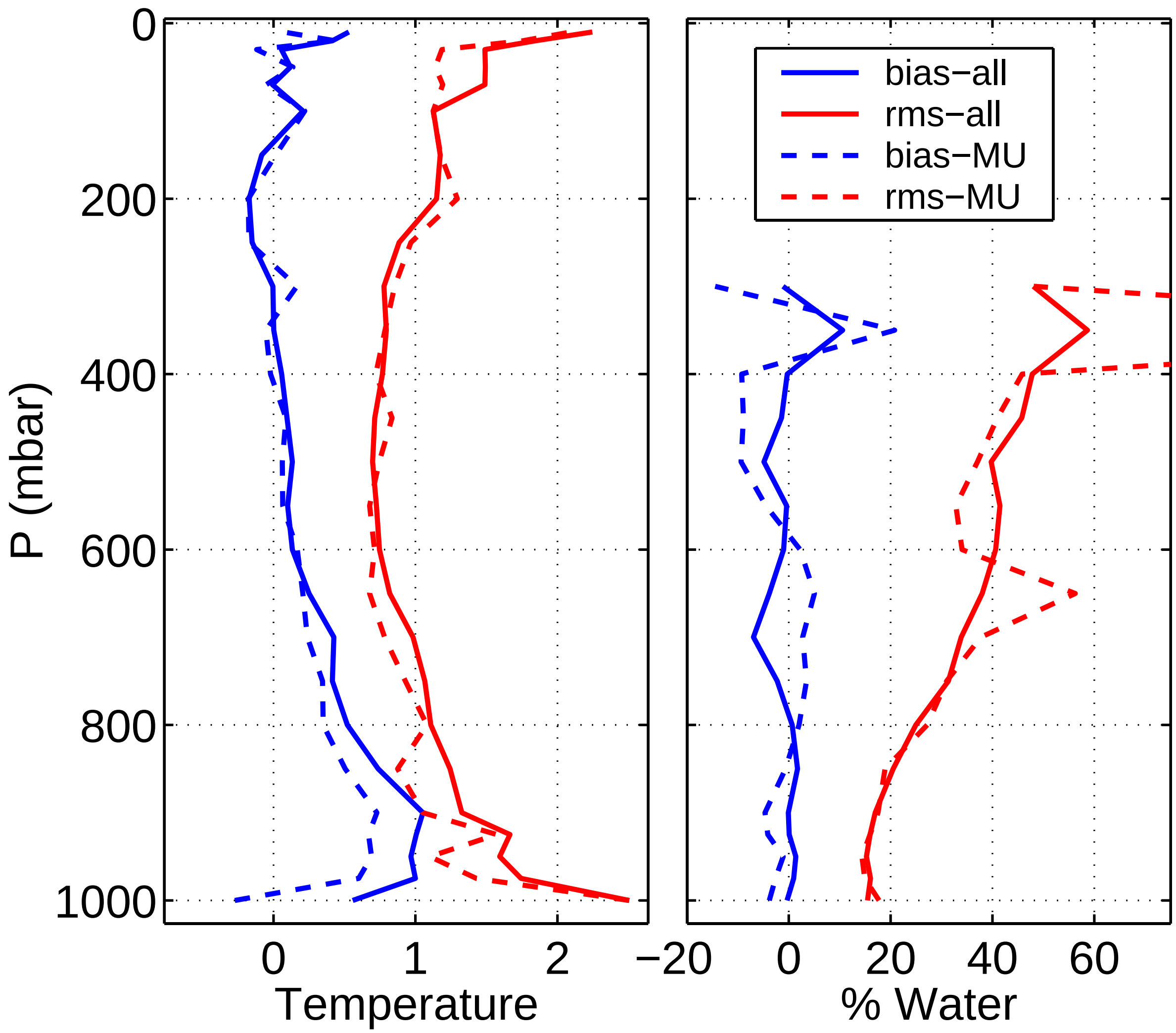


Obs-Calcs for NAST (WINTEX)



Model Fit to to All Sondes, MatchUp Sondes

Use NCEP/ECMWF model instead of sondes for bias evaluation?



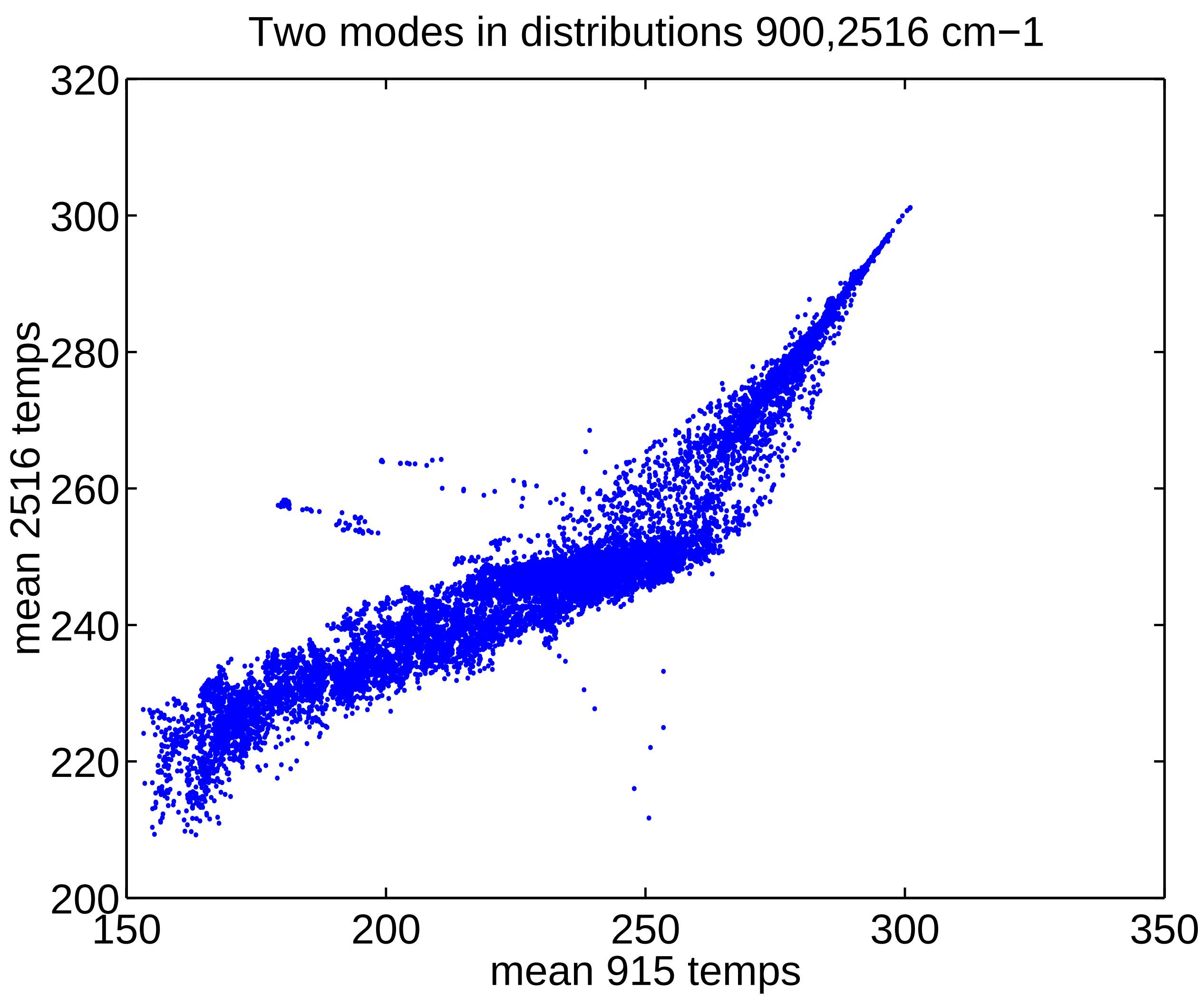
Exercise Summary/Lessons

- We are developing lots of software and we really need to use the TDS and associated filenames soon. We may want to do some processing at JPL, need to test loading of system when we are all working.
- RTP format worked out quite well for bias evaluation and our clear flag.
- We will probably want to run a number of different clear flag codes and evaluate relative to each other. We should all document "final" flag codes and distribute. Don't want to put everything into L2 files.
- Not many sonde matches, especially over water (and those were on islands or along coastlines).
  - No ship sondes in PREPQC? Where are they, we need them??
  - Use NCEP/ECMWF model fields for clear flag, bias evaluation in stable, well characterized regions?
- Applied biases too small in windows, didn't mimic spectroscopy or the instrument errors.
- Next exercise: (1) TDS, (2) **Multiple days with missing granules.** We would like to see multiple PREPQC files, etc.

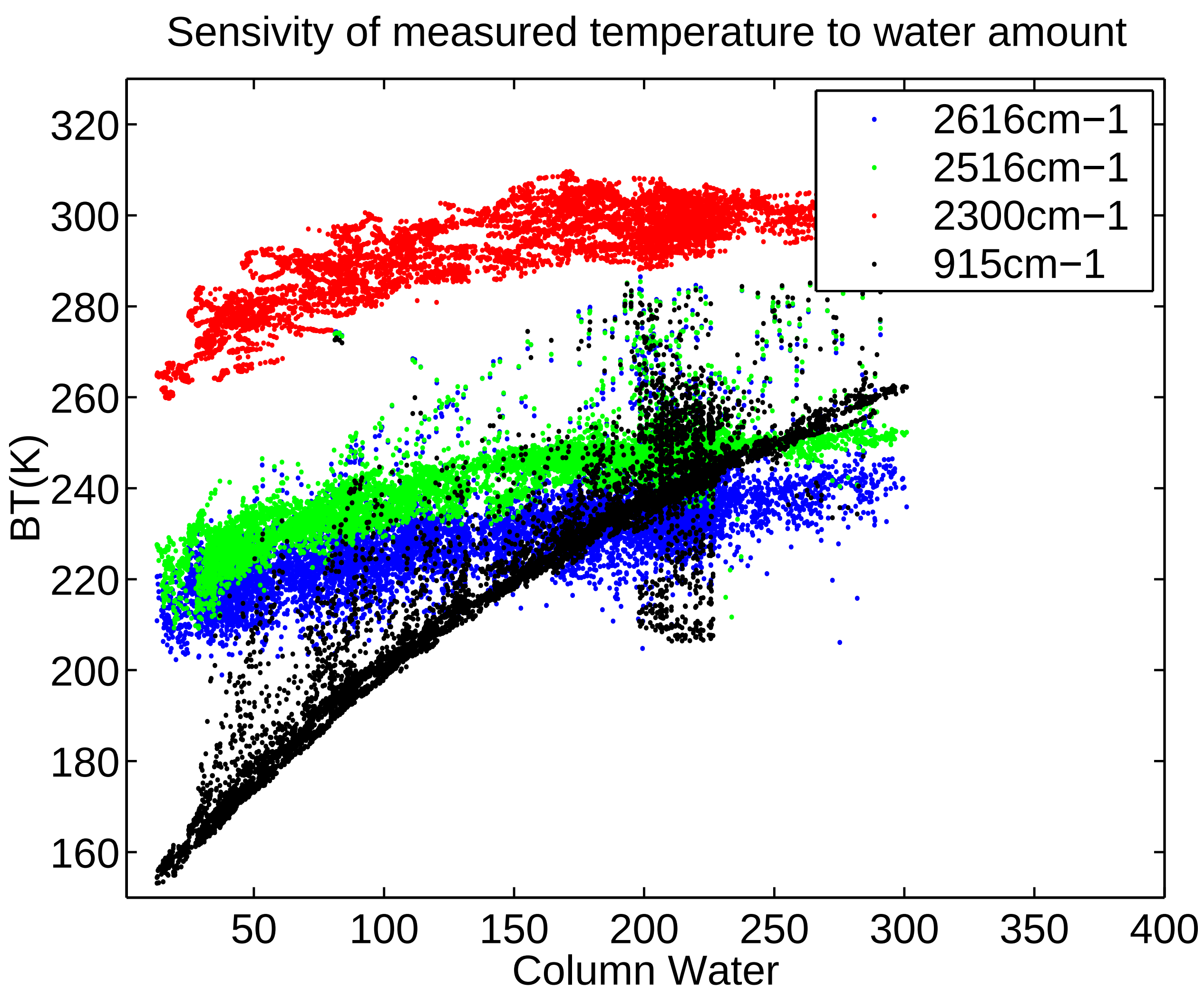
AERI Data for Window Regions

- Stimulating on how to handle clouds
- Easier, clouds always increase B(T)
- Probably where much of continuum in window regions originates
- Long AERI record now available to do statistics
- *May* use AERI to evaluate continuum in important clear-flag channels.

AERI Channel Comparisons



AERI B(T) vs Total Water (use microwave in future)



Cirrus Cloud Model

- Cirrus has highly wavelength dependent absorption/scattering in window region, and may be present in a large fraction of FOVs.
- AIRS is probably the best instrument to detect thin cirrus.
- We have incorporated DISORT, F. Evan's scattering codes, and our own very fast hybrid 2-stream/adding-doubling scattering code into kCARTA.
- A simple approximation (2-stream) is being integrated into the fast model, makes it about 2X slower. Solar scattering not very accurate.
- Could add cirrus effects into simulations at the end, simple.
- We plan to develop a simple cirrus detection algorithm using these tools, especially with regard to clear flags.

Effect of Cirrus on Window Radiances