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IASI and AIRS Validation and Intercomparisons with SARTA

L. Larrabee Strow[1], Scott Hannon[1], and David Tobin[2]

Physics Department and Joint Center for Earth Systems Technology
University of Maryland Baltimore County (UMBC)[1]
University of Wisconsin, SSEC[2]

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Overview

- AIRS/IASI/CrIS promise to give us a 20+ year hyperspectral time-series of climate
- How well can we tie together the AIRS and IASI records? (AIRS won't be around for CLARREO.)
- A new method for deriving spectroscopy from radiances??

Spectroscopy is not Climate-Quality

- AIRS stability is $<$0.01K/year, probably sufficient for climate trends. IASI appears to have very good stability as well.
- Spectroscopy is only good to, at the very best, 0.1-0.2K
- Climate studies using retrievals require consistent RTA's, making intercomparisons among groups very difficult
- Retrievals sensitive to prior (assimilation), and cloud clearing performance (limited in troposphere in mid-, higher-latitudes)
- At present, I do not have a statistical set of high-quality coincident sondes measurements for IASI. Do they exist?
- IASI and AIRS agree far better than the spectroscopy

Approach: IASI/AIRS Radiance Intercomparisons

Use two independent techniques to intercompare IASI and AIRS radiance.

1. Simultaneous nadir overpasses (SNOs).
   - IASI and AIRS in different orbits, so tight time/space overlaps limits SNOs to $\pm$73.8 degrees
   - SNOs are relatively cold spectra, esp. in window regions.
2. Double-differences of sensor biases versus model (ECMWF)
   - RTA calculations using ECMWF model data can reproduce radiances for clear ocean-only FOVs to within $\sim$0.2 - 1.0K in many channels.
   - Double differences; $(\text{obs} - \text{cal(ECMWF)})_{IASI} - (\text{obs} - \text{cal(ECMWF)})_{AIRS}$ removes most inaccuracies in the RTA and ECMWF
   - Essentially ECMWF used to interpolate over the 4 hour time difference in the orbits

SNO Details (from Dave Tobin)

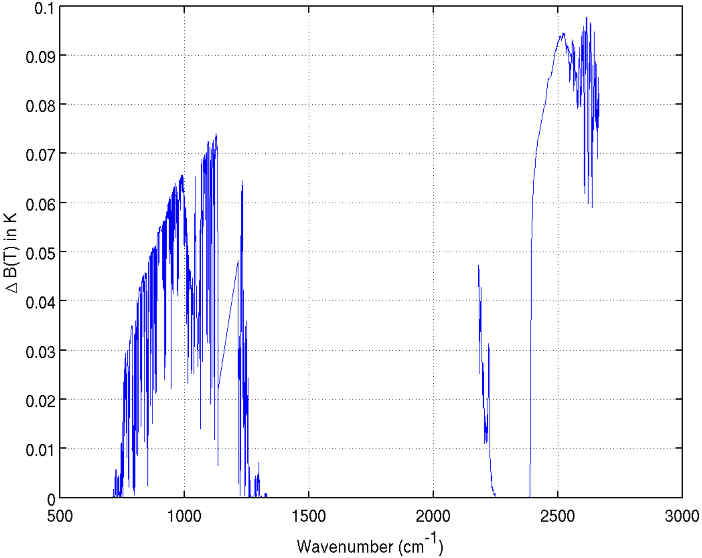
May not be current!

- Data from May 2007 to Feb. 2008
- Matchup thresholds are Δt = 2 minutes, Δd= 30 km, from nadir orbit crossing point
- This resulted in 284 SNO's each containing 3-4 IASI FOVs and 6-8 AIRS FOVs. Standard deviations of these individual measurements are made and propagated into means over the 284 SNO's.
- Except for shortwave, statistical errors in AIRS-IASI BT differences are roughly equivalent to the mean differences. SW statistics are not as good.
- Cross-convolve each radiance with other instrument's SRF

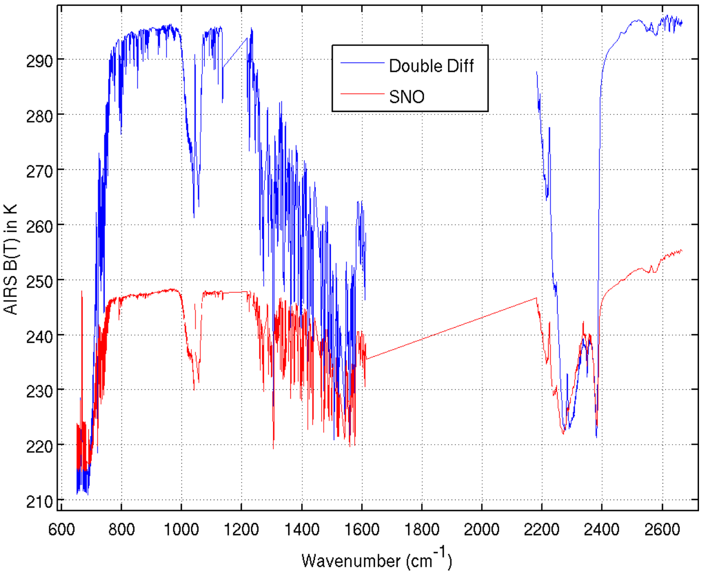
Double-Difference Details

- Observations are clear ocean FOVs for month of July 2007 for latitude range of $\pm$25 degrees, where ECMWF is very good, diurnal variations smallest
- Essential that the RTA for both instruments has identical spectroscopy.
- Avoid channels with high sensitivity above 70 mbar
- Added correction for diurnal change in SST (not done in ECMWF)
- Cross-convolve each radiance with other instrument's SRF

Diurnal Correction

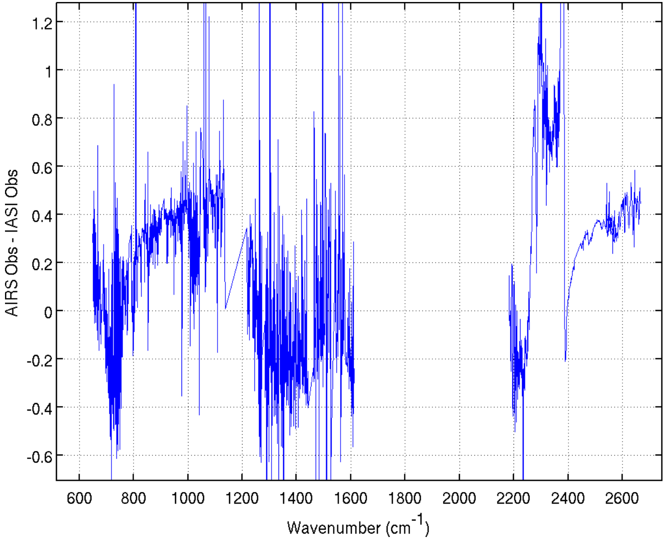


Average Spectra for SNOs and Double-Diffs



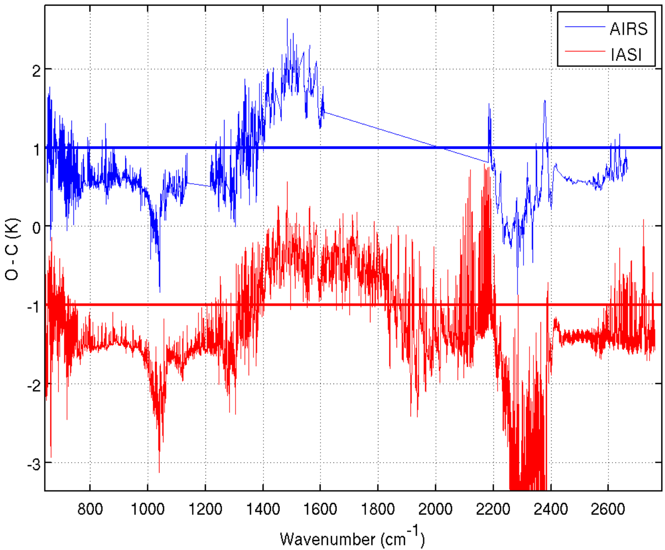
Double-Differences: Obs AIRS-IASI B(T)s

Therefore NO ECMWF calculations in this result



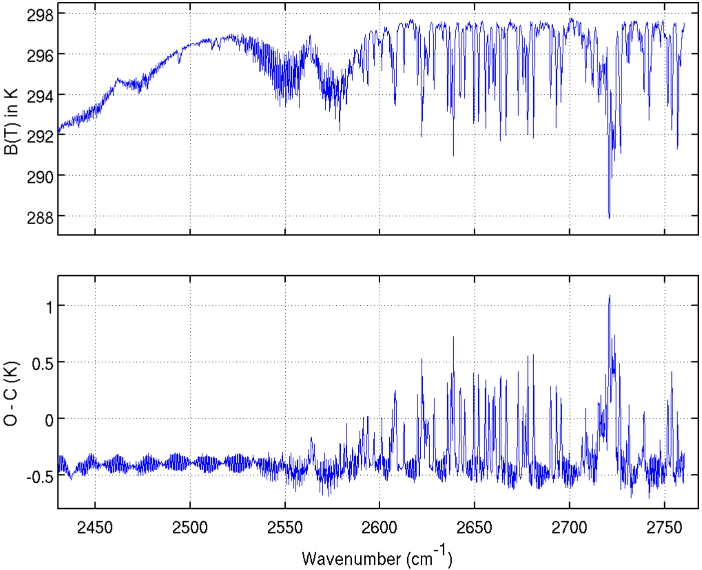
AIRS and IASI Biases vs ECMWF

No Cross Convolutions Done Yet



IASI Contains "Fringing" in the ShortWave

The cross-convolution with AIRS SRF averages out "fringing"



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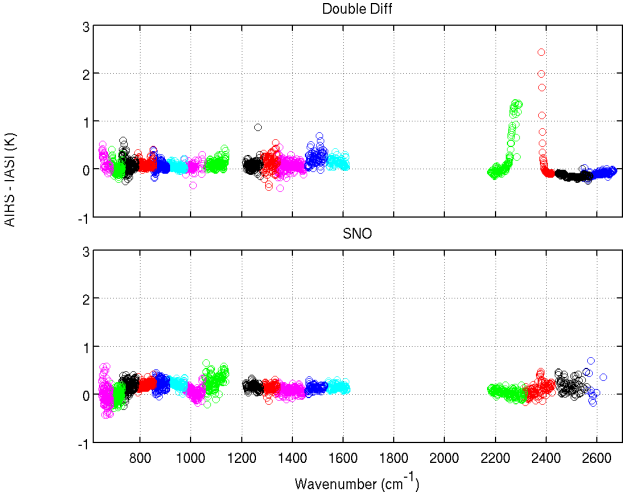
AIRS-IASI B(T) Comparisons: Summary



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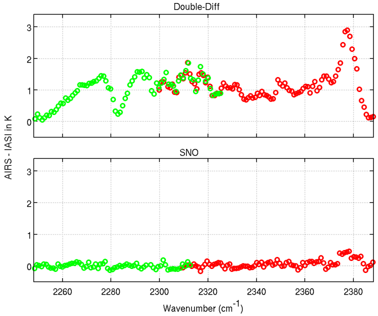
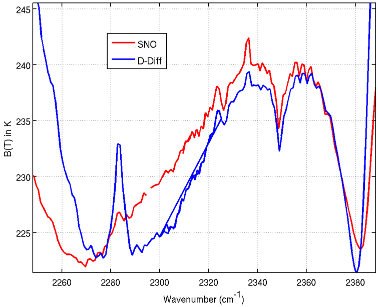
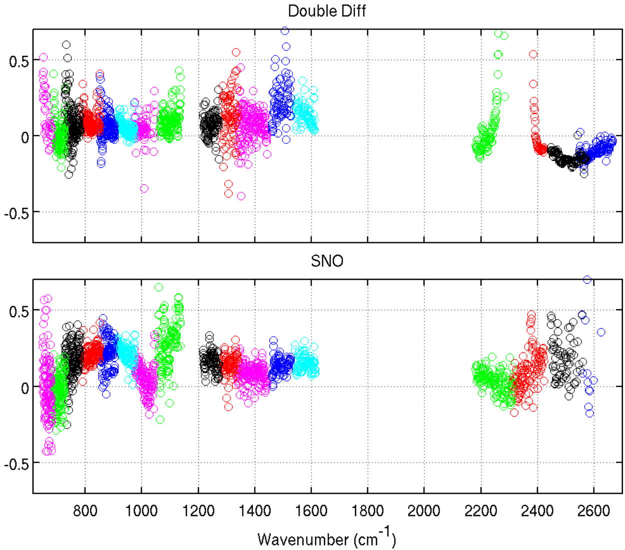
ShortWave Shows Large Differences for Double-Diff

Double-Diff B(T)'s are generally colder in this region.





Double-Differences and SNO's: Zoom



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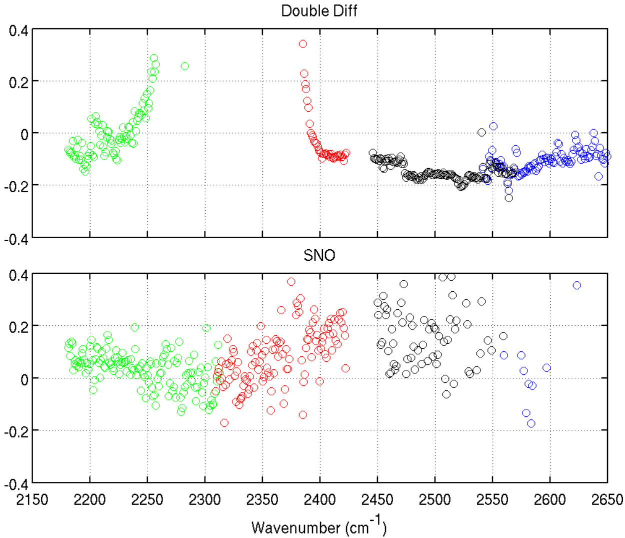

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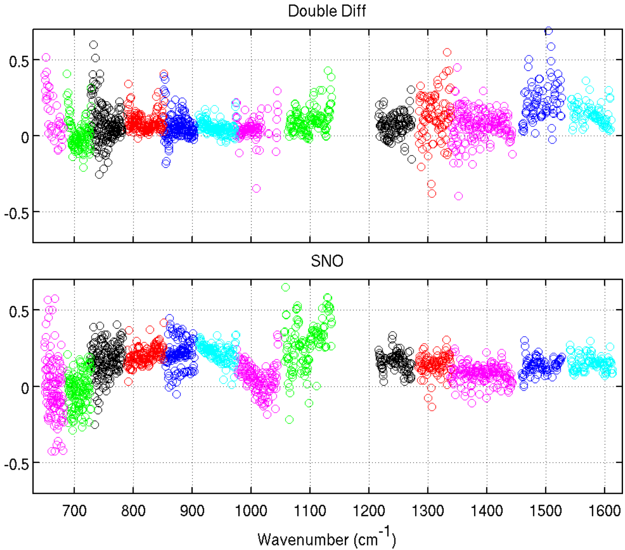

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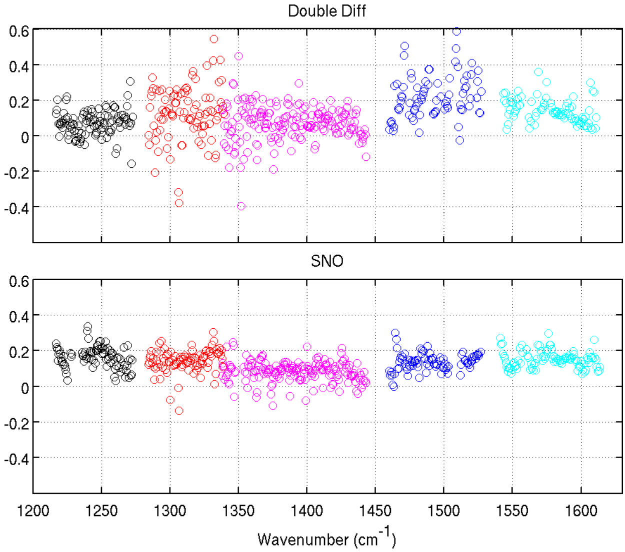
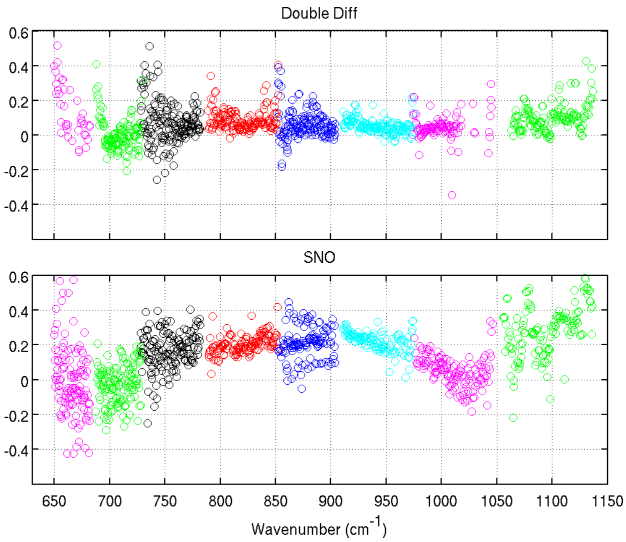
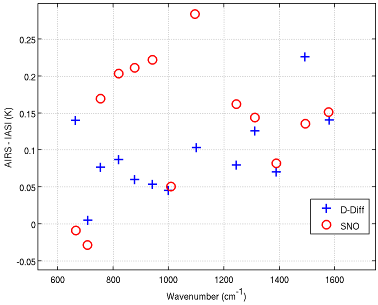
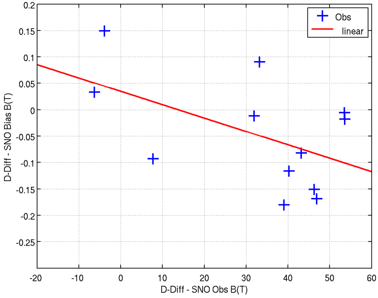


Double-Differences and SNO's: Zoom



Summary by AIRS Module





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IASI/AIRS RTA

L. Strow
UMBC

Module Statistics

For Ddiff < 1650 cm^{-1}, all channels for P < 70 mbar: 0.09 +- 0.06 K

f_mod	DDiff	SNO	DDiff-SNO	
664.40	0.14	-0.01	0.15	
708.73	0.01	-0.03	0.03	0.03 +- 0.12
754.35	0.08	0.17	-0.09	
820.08	0.09	0.20	-0.12	
876.99	0.06	0.21	-0.15	
942.05	0.05	0.22	-0.17	-0.12 +- 0.07
999.12	0.05	0.05	-0.01	
1099.68	0.10	0.28	-0.18	
1244.18	0.08	0.16	-0.08	
1311.25	0.13	0.14	-0.02	
1388.39	0.07	0.08	-0.01	-0.01 +- 0.06
1492.05	0.23	0.14	0.09	
1580.09	0.14	0.15	-0.01	
2233.05	0.27	0.03	0.23	
2401.00	0.16	0.10	0.07	
2506.63	-0.15	0.18	-0.33	
2602.59	-0.10	0.15	-0.25	

Summary: AIRS vs IASI

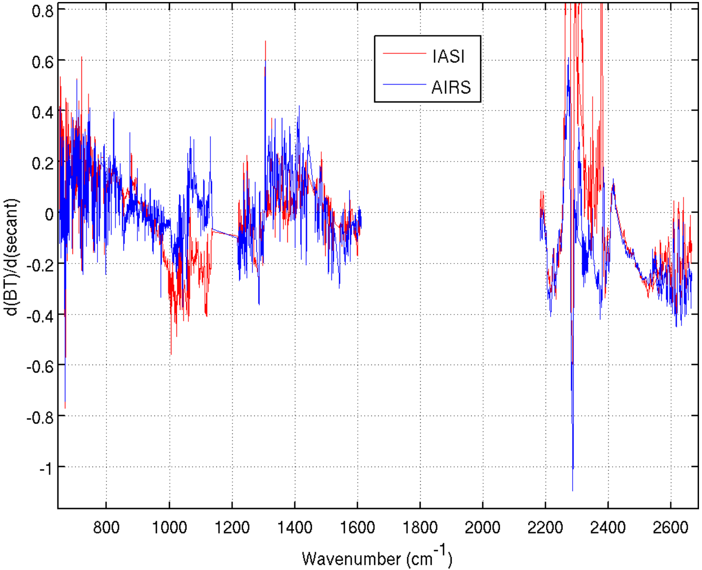
- Two approaches to IASI, AIRS inter-calibration show similar results. LW agreement is -0.04 $\pm$ 0.10 K (D-Diff - SNO's).
- Frequency calibration of AIRS not done here, will be at the 0.05K level or lower, will be ready soon for implementation
- Approach has some unknown sensitivity to SRF shapes and clear FOV detection differences between AIRS and IASI.
- Results suggest we are hitting the 0.1K level. Agreement between two approaches is getting below 0.1K
- Variability with AIRS arrays seen, suggesting adjustments may be warranted.
- More statistics needed and trending. Will do July 2008 soon.

Biases vs ECMWF Vary with Secant of Viewing Angle

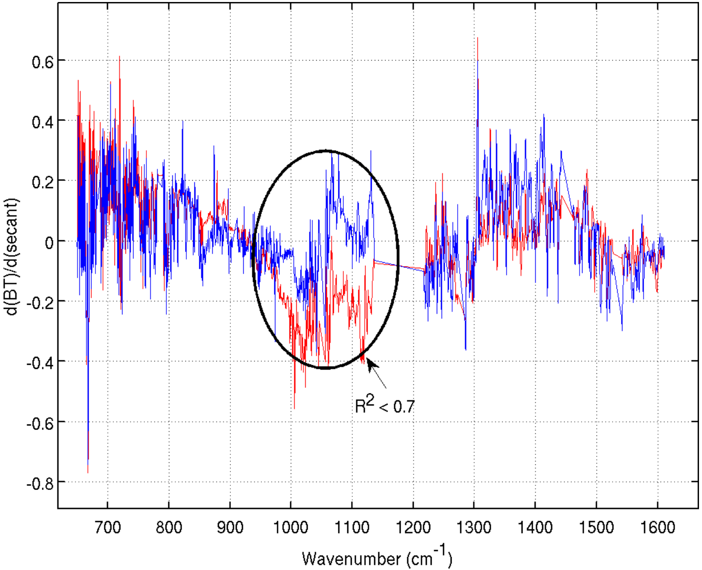
- Empirical corrections used average biases
- Spectroscopy, constituent abundance errors will vary with viewing angle/secant
- Assume ECMWF errors do not depend on secant angle
- Fit $dbias = offset + slope \times \Delta secant$; $offset$ very small
- If assume $bias = (inst\_bias, model\_bias) + slope \times secant$ can use above fit to determine slope, and then solve for (inst_bias,model_bias)
- Still need atmospheric constituent amount/profile to get spectroscopy

Fit Results: Slope of dbias/dsec

Secant varies from 1 to 1.37



Fit Results: Slope of dbias/dsec, zoom



Fit Results: Slope of dbias/dsec, zoom