V5 RTA
NON-LTE
Transmittances
Aerosols
Minor Gases
SO_2
HNO_3
CO_2
Spectral Calibration for AIRS Climate Studies

V5 RTA, Aerosols, Minor Gases

L.Larrabee Strow, Scott Hannon, Sergio DeSouza-Machado, and Howard Motteler

Atmospheric Spectroscopy Laboratory (ASL)
Physics Department
and the
Joint Center for Earth Systems Technology

University of Maryland Baltimore County (UMBC)

September 26, 2006

Overview

V5 RTA, Aerosols, Minor Gases

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V5 RTA
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Minor Gases
SO_2
HNO_3
CO_2

Spectral Calibration for AIRS Climate Studies

- RTA V5 validation and liens
- Dust aerosols: OLR longwave forcing and impact on retrievals (Sergio)
- Minor gases: CO_2 (Strow) and SO_2, HNO_3 (Hannon)
- Frequency calibration (Strow)

V5 RTA: Main Improvements

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Spectral Calibration for AIRS Climate Studies

- Non-LTE (with Lopez-Puertas, Funke, Edwards)
- Reflected thermal
- New transmittance adjustments (with Maddy and Barnet)
- More minor gases can be varied
- M12 (649-682 cm^{-1}) channel centers fixed
- Fringes unchanged (a lien)
- Frequencies fixed (a lien)

Improvements to Reflected Thermal

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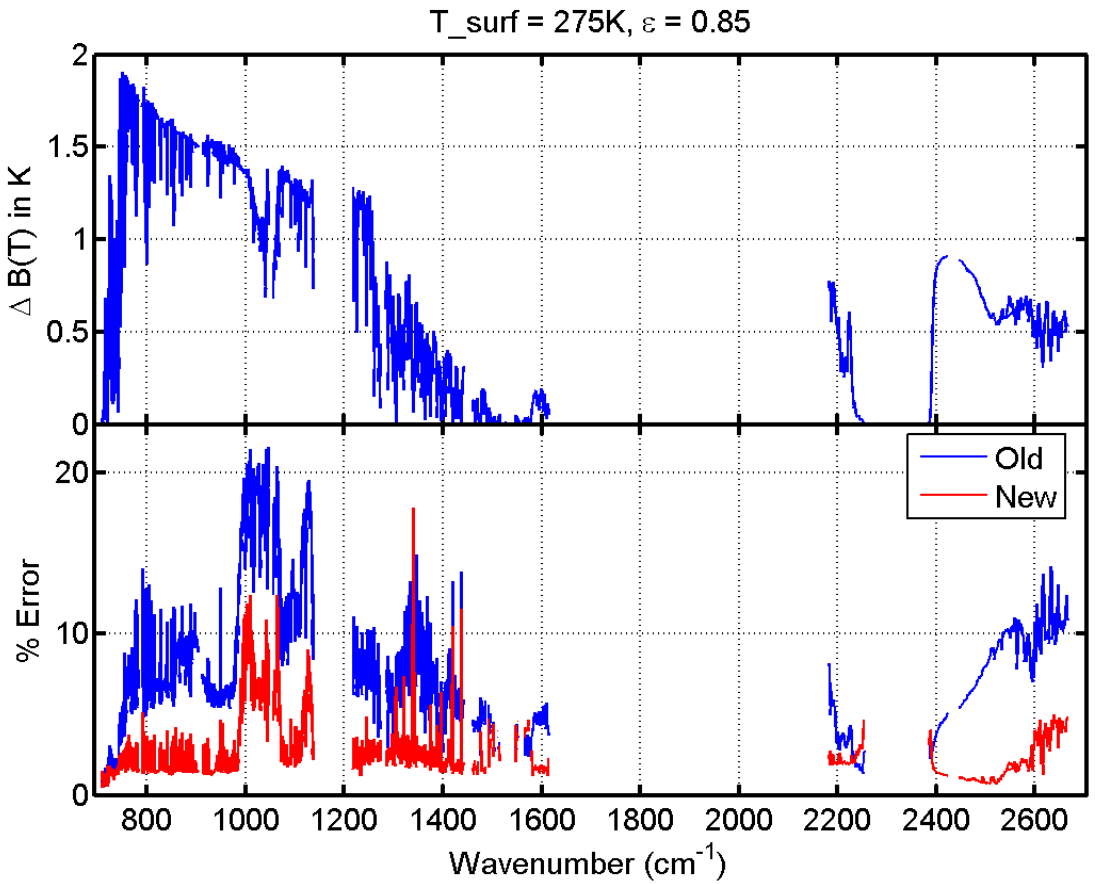
Spectral Calibration for AIRS Climate Studies

- Reflected thermal more realistic, downward radiation computed similarly to upward.



Channel Center Wavenumbers

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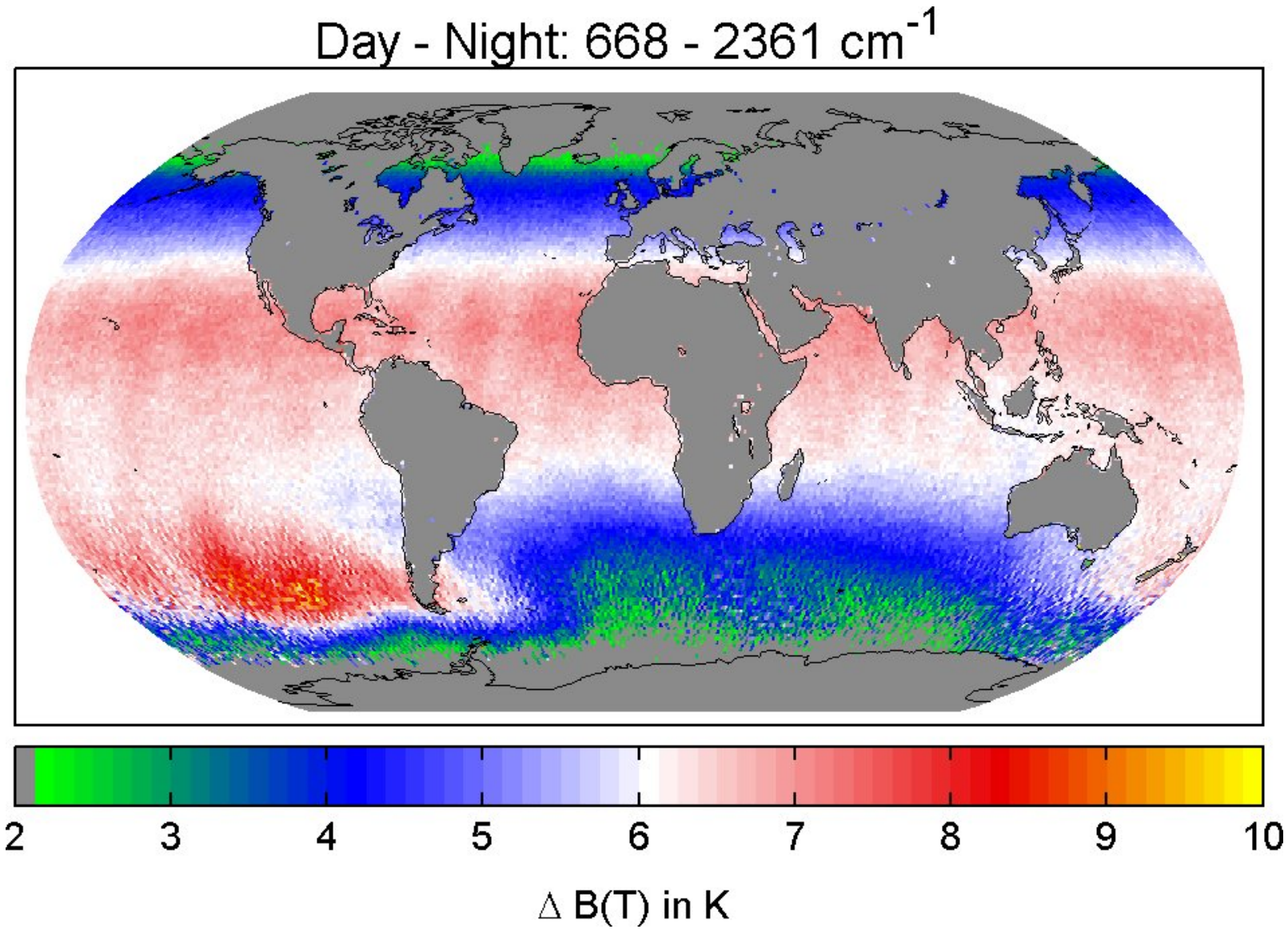
Spectral Calibration for AIRS Climate Studies

- Module-12 ((649-682 cm^{-1}) center wavenumbers shifted by ~1.5% of a SRF FWHM.
- Other wavenumber drifts, variations with orbit not addressed. OK for weather applications, NOT OK for climate applications. (These are more on the 0.5% of a FWHM level, see Friday's talk on calibration for climate applications).

Minor Gases

- CO_2 can now be adjusted on all 100 layers, previously limited to a single scale factor for the whole profile
- N_2O, SO_2, and HNO_3 profiles can now be varied.

Global Picture of Non-LTE Emission



Band Included in Non-LTE

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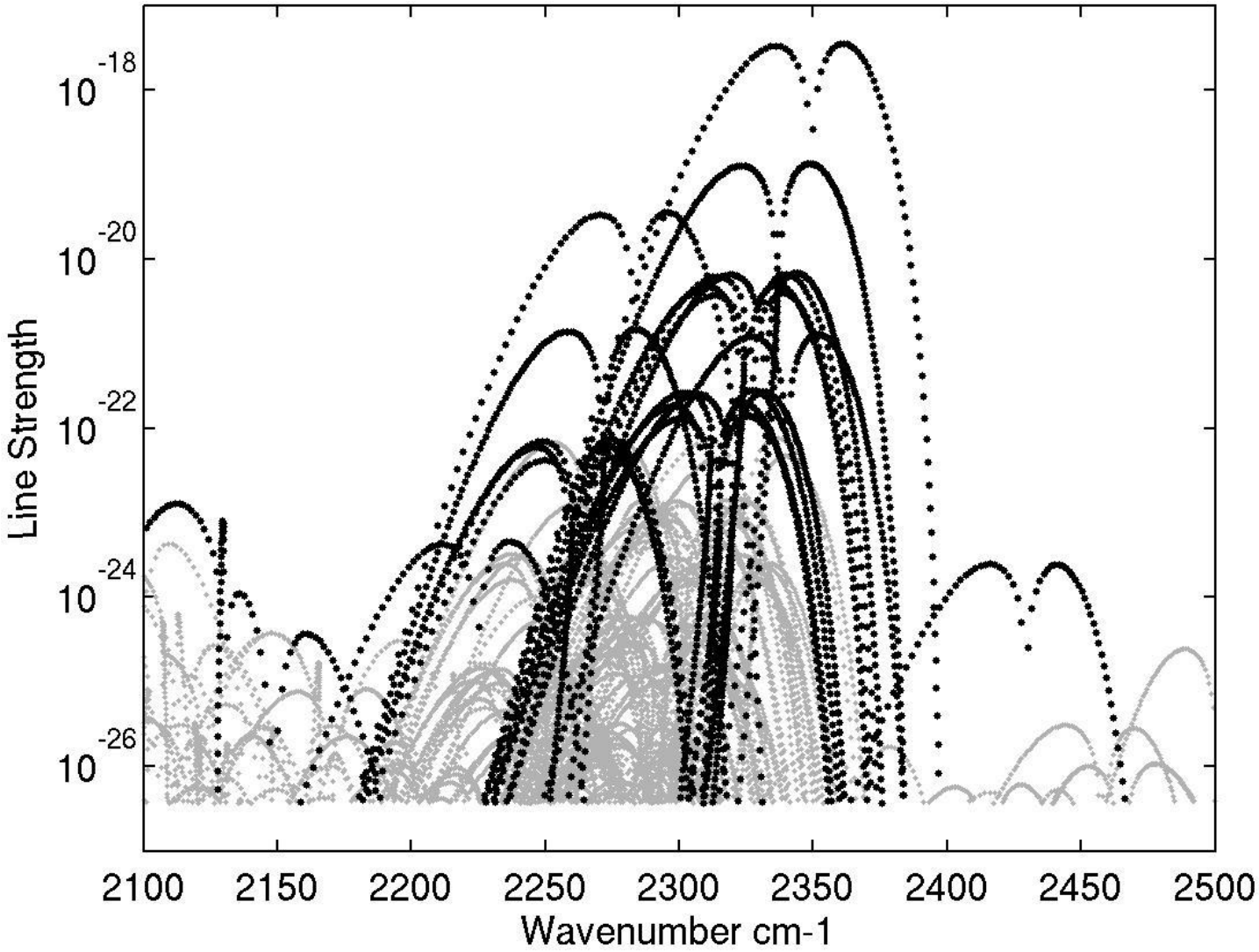
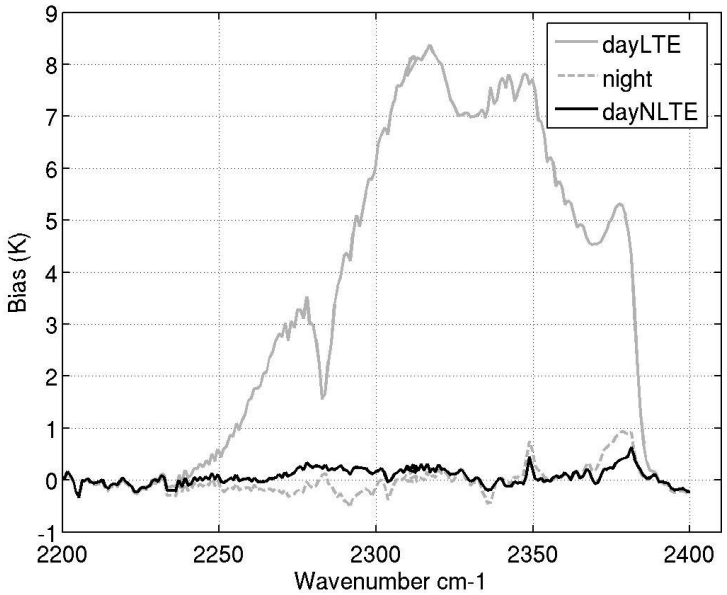
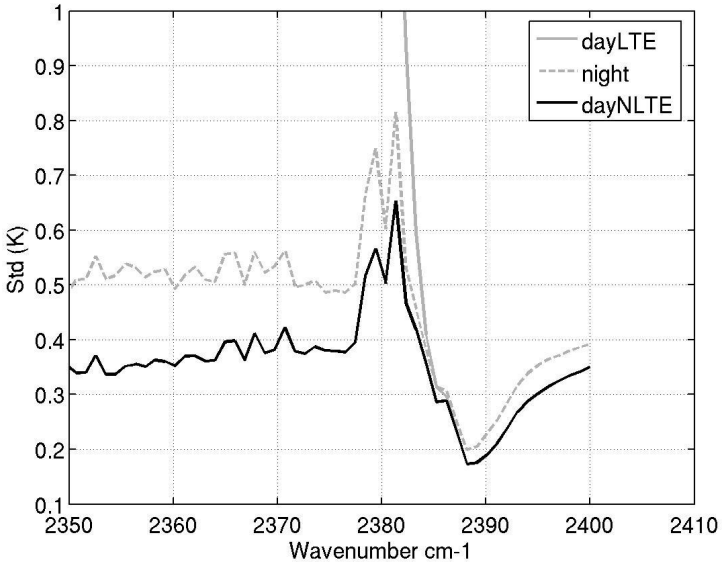
Spectral Calibration for AIRS Climate Studies

Bands used colored black.



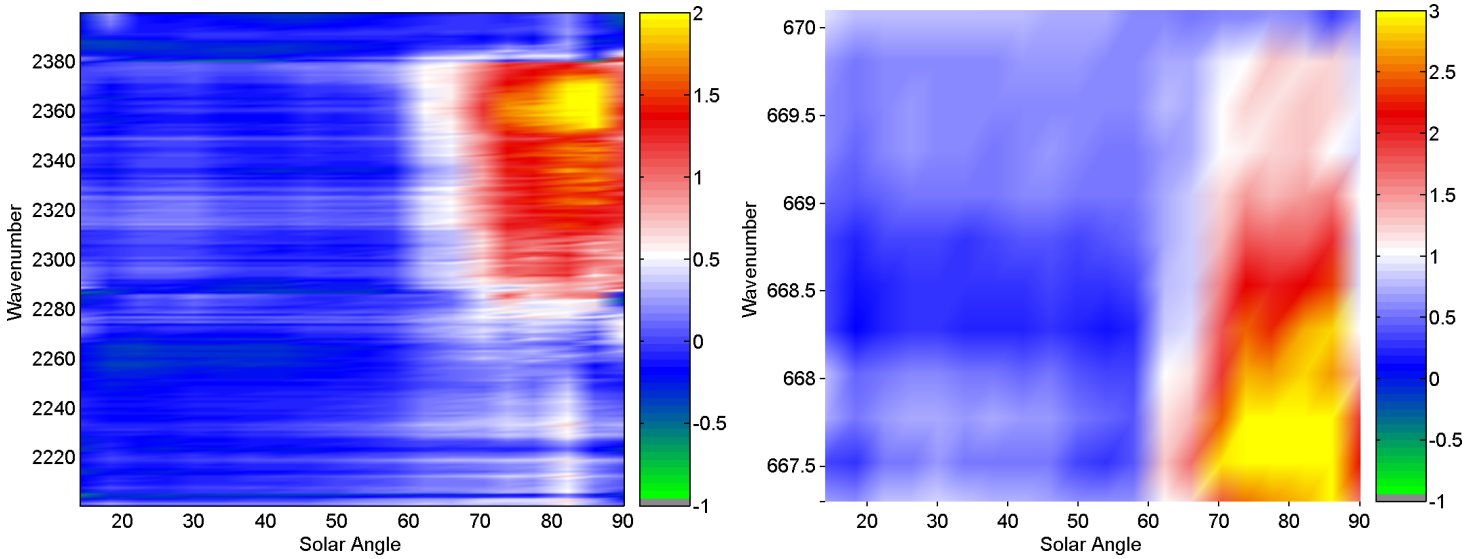
Global Bias in Non-LTE Channels





Non-LTE Bias Versus Solar Angle

Left: Shortwave Bias where Non-LTE is strong
Right: Longwave Bias with similar channel, but no NON-LTE



Revised Optical Depth Tuning

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Spectral Calibration for AIRS Climate Studies

- Lack of truth in the stratosphere (Use GPS in future?)
- Retrieve (w/ V4-RTA) strat profiles for RS-90 val data.
- Replace ECMWF with these retrievals above ~60 mbar.
- Re-derive transmittance tuning (with TWP-1) for channels that span the 60 mbar switchover.
- Channels above 60 mbar remain unvalidated, channels that span 60 mbar remain partially unvalidated/uncorrected.
- NOAA-CMDL MBL (Marine Boundary Layer) used for CO_2.
- Test RTA with TWP-2, TWP-3, Minnett, ABOVE, etc.
- Minor changes to H_2O and CH_4 lines in 1320 cm^{-1} region (due to HNO_3).
- Very minor change to window H_2O continuum (again, due to HNO_3)
- New O_3 transmittances from HITRAN2004 included via transmittance adjustments.

Transmittance Adjustments

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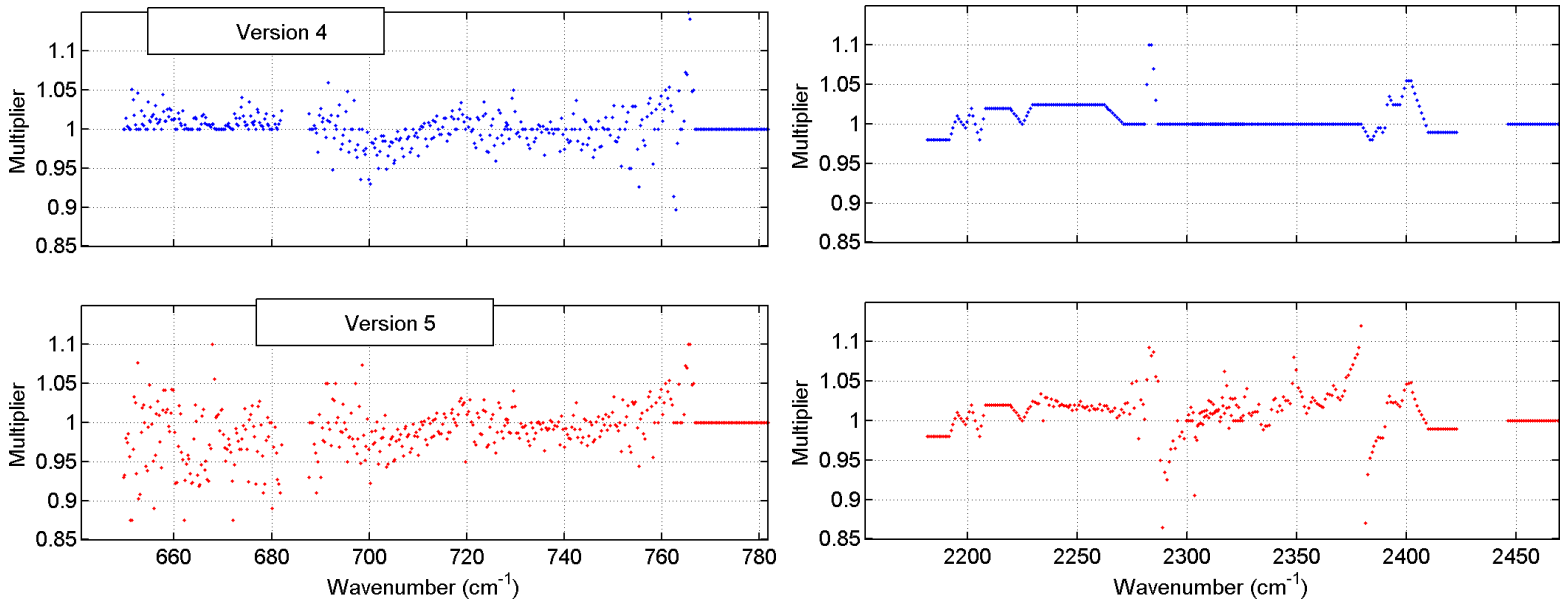
Water channel tuning unchanged from V4 to V5.



V5 versus V4 Bias, Ocean, Night RS-90's

V5 RTA, Aerosols, Minor Gases

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V5 RTA

NON-LTE

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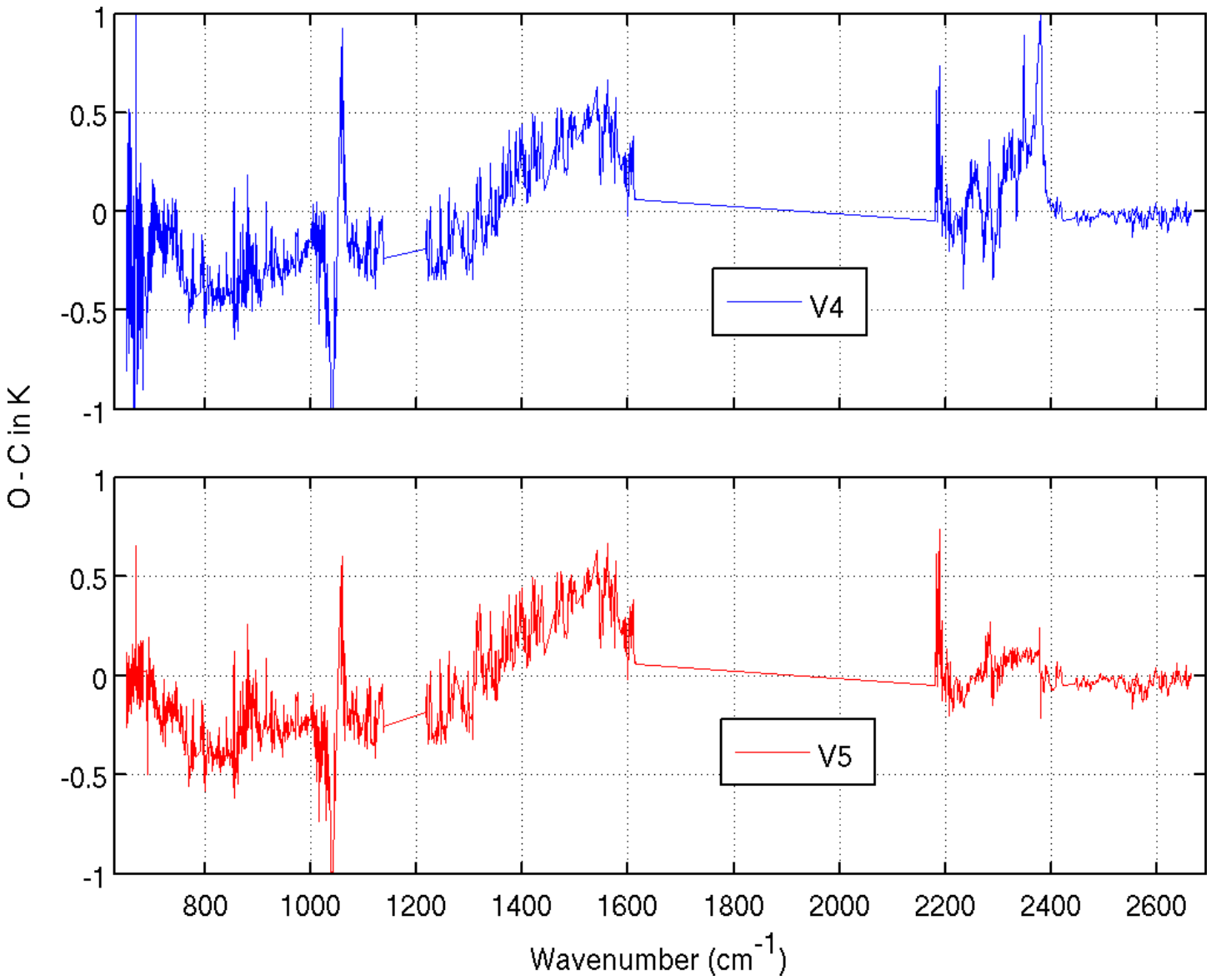
SO_2

HNO_3

CO_2

Spectral Calibration for AIRS Climate Studies



V5 versus V4 Bias, Ocean, Day RS-90's

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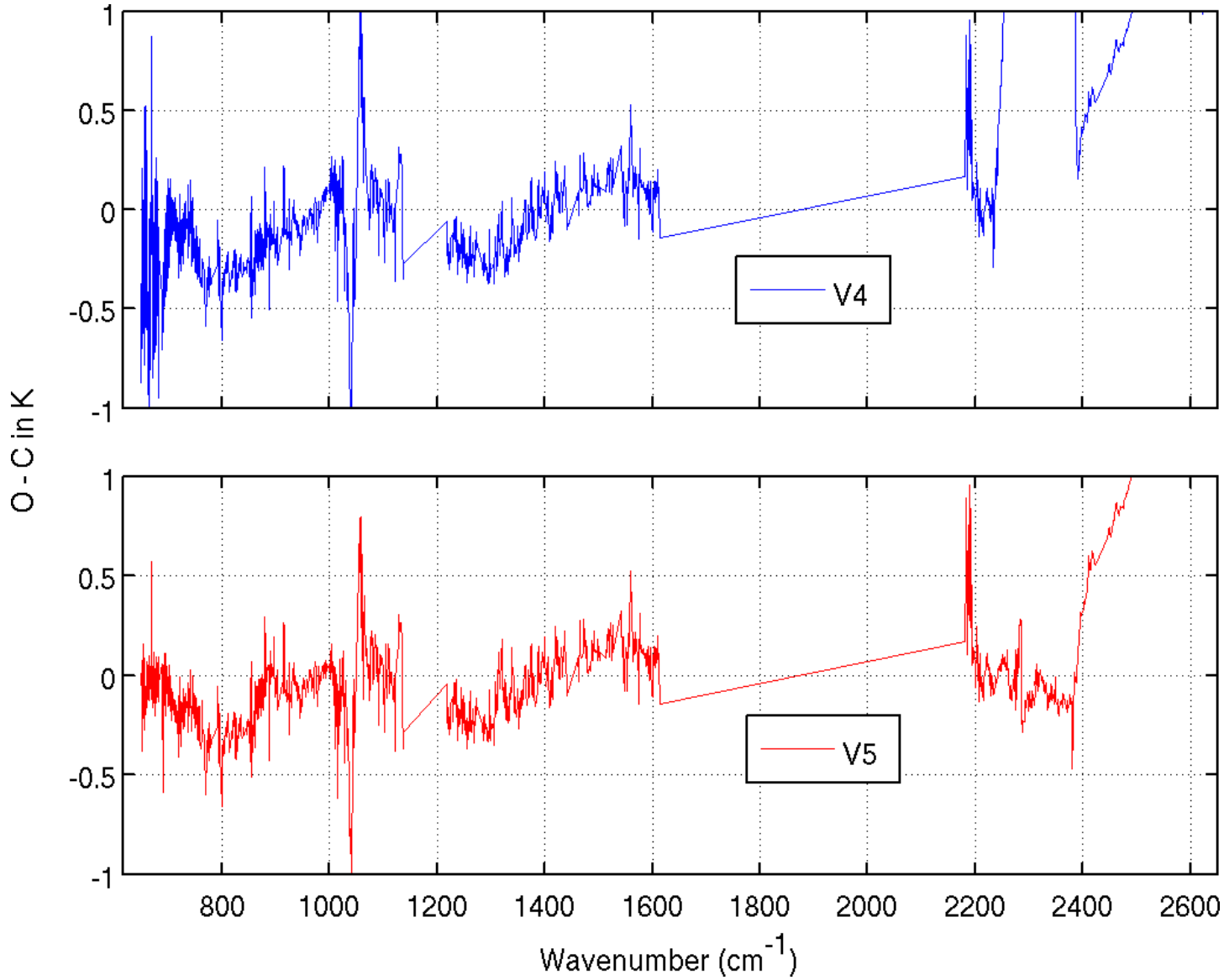
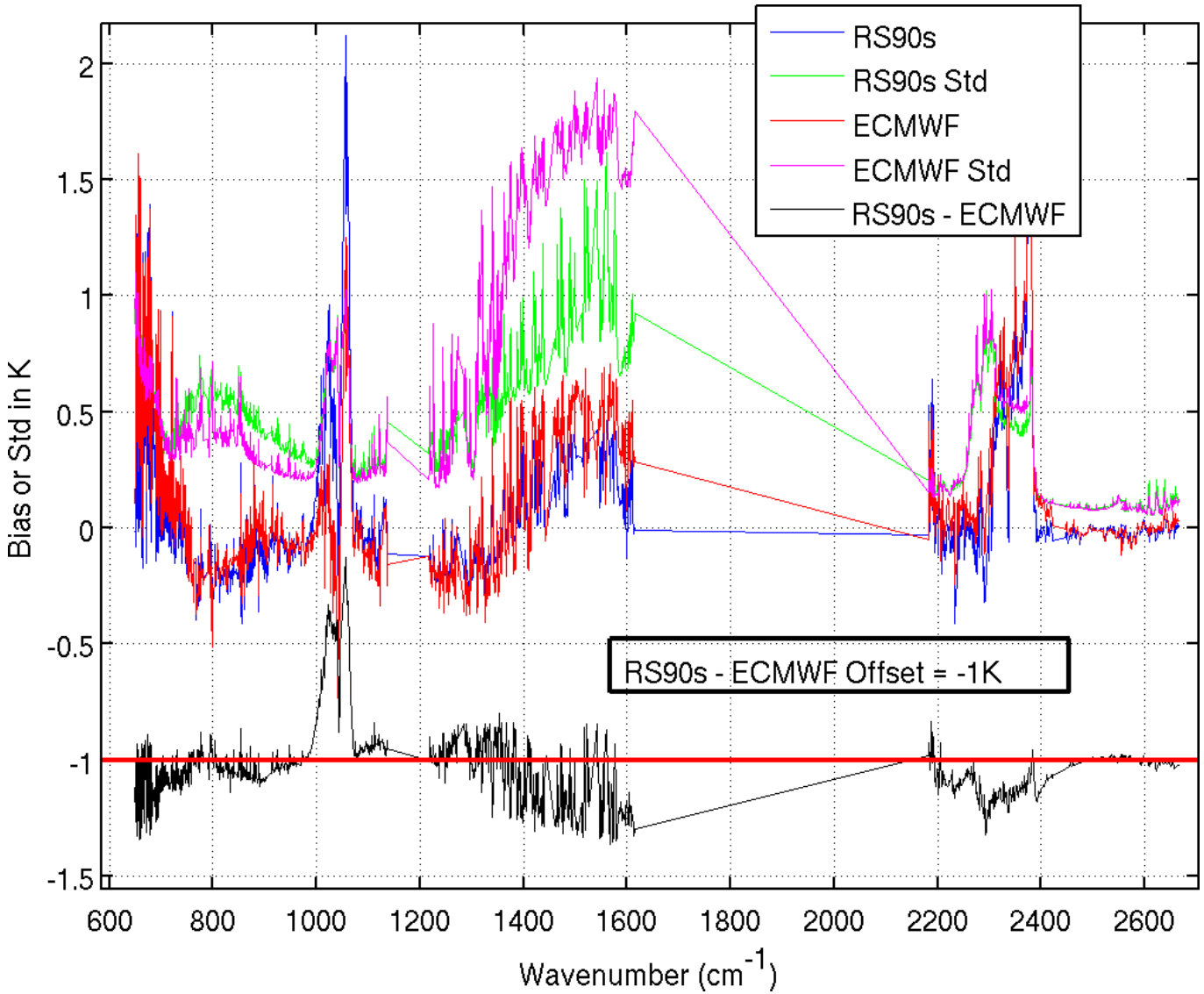
Spectral Calibration for AIRS Climate Studies



Validation: Coincident RS-90's vs ECMWF

Very different sampling characteristics.



Bias and Std. versus ECMWF

V5 RTA, Aerosols, Minor Gases

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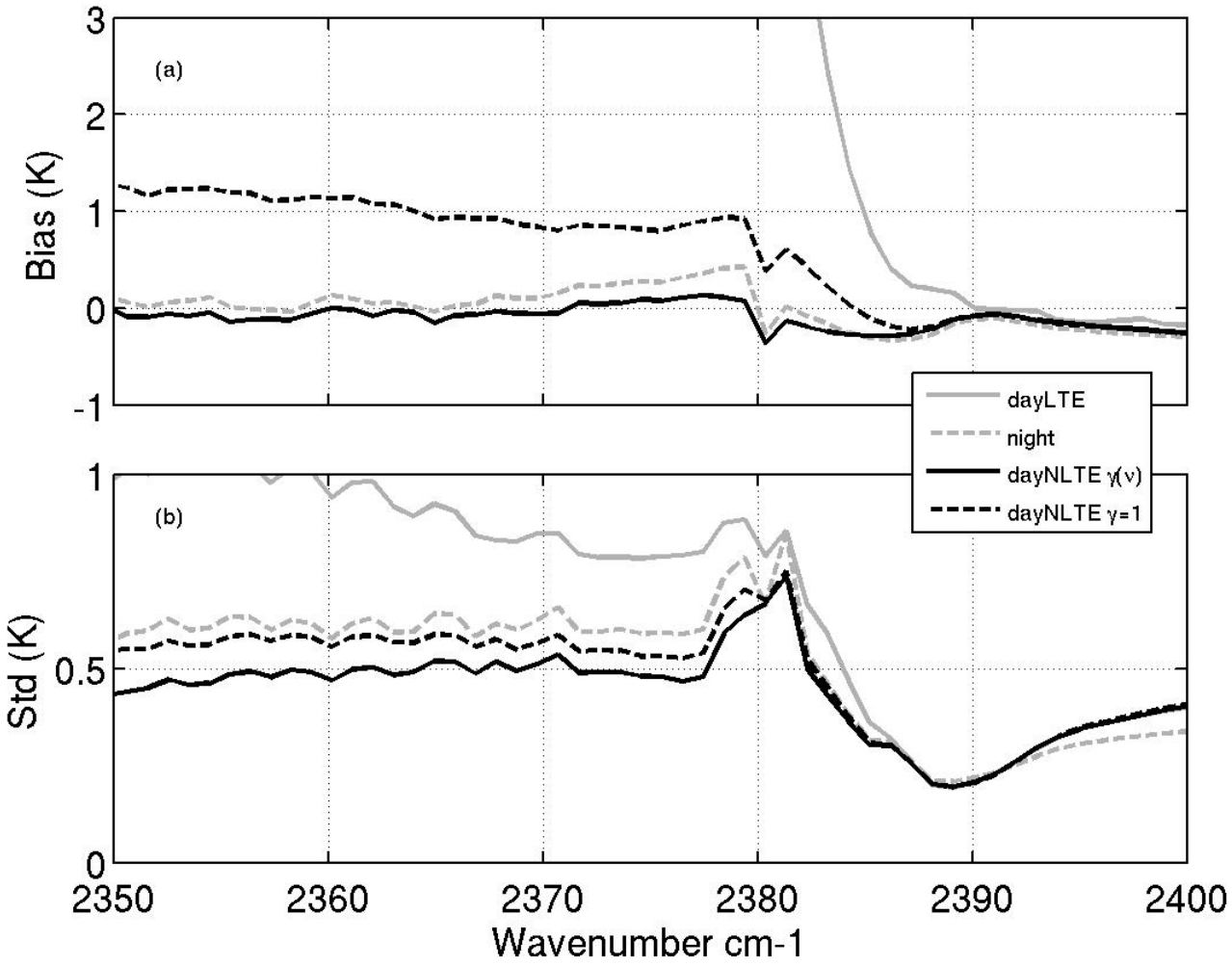

Long Range Transport of Sahara Dust AIRS data for July 2003

ASL

V5 RTA, Aerosols, Minor Gases

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V5 RTA

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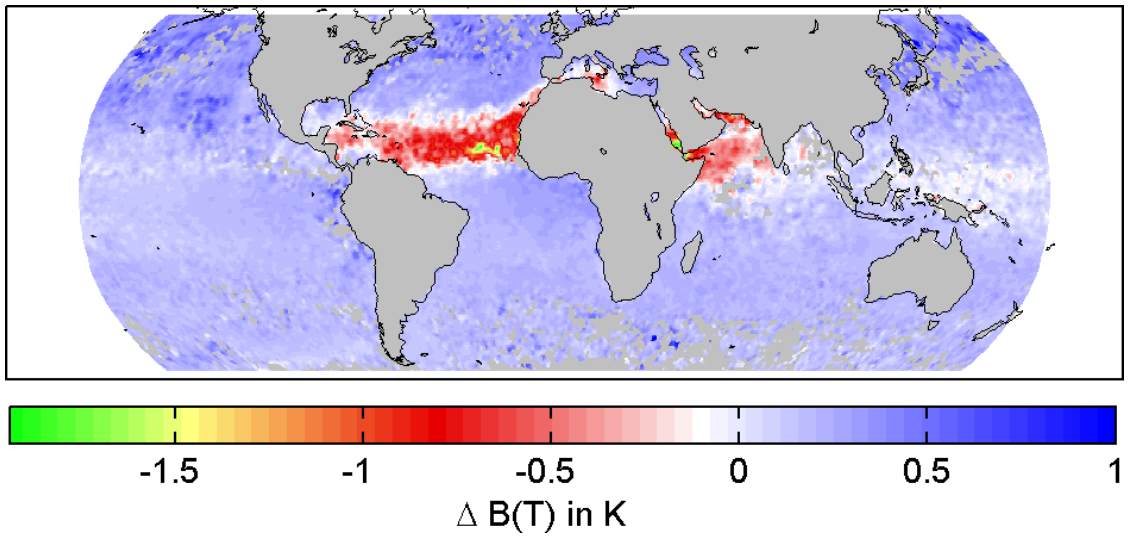
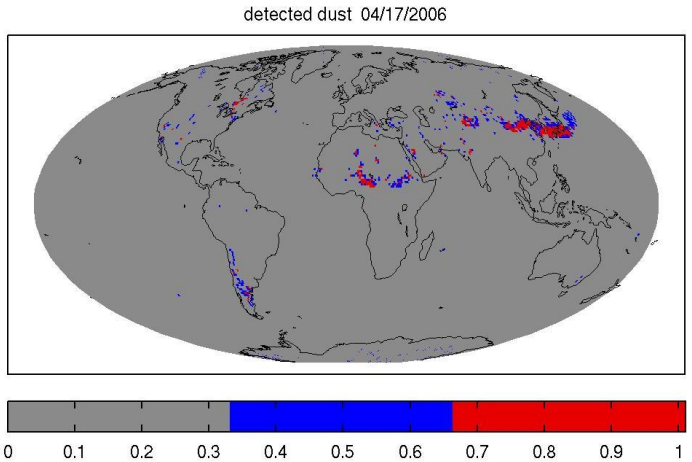
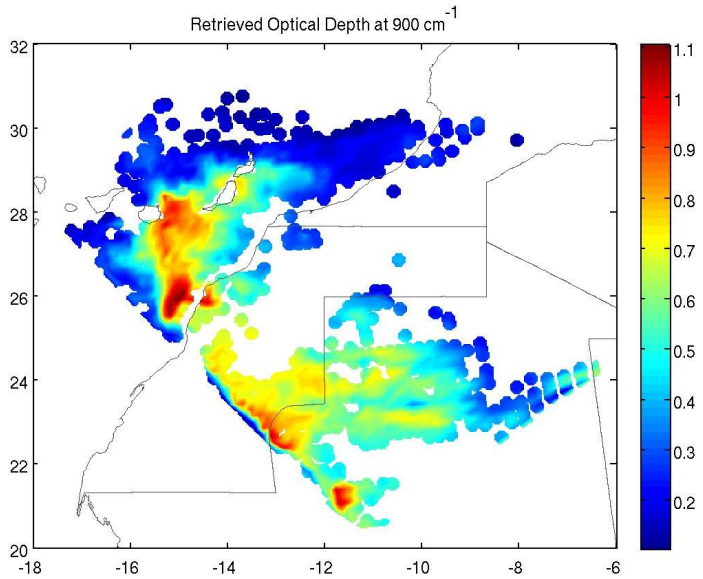
Spectral Calibration for AIRS Climate Studies







Infrared Retrievals from many global duststorms

V5 RTA, Aerosols, Minor Gases

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V5 RTA
NON-LTE
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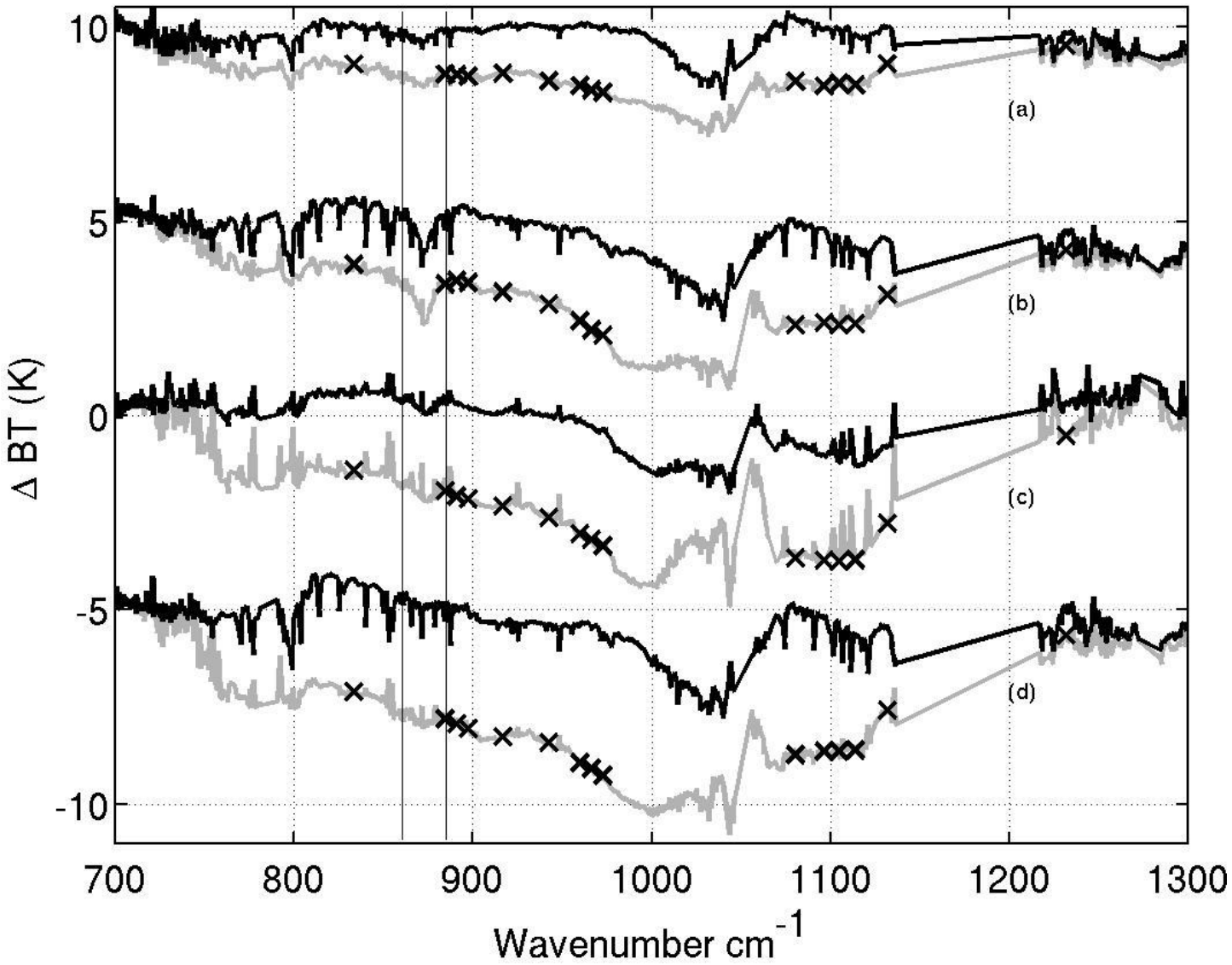
Spectral Calibration for AIRS Climate Studies



New Comparisons to MODIS

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V5 RTA
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SO_2
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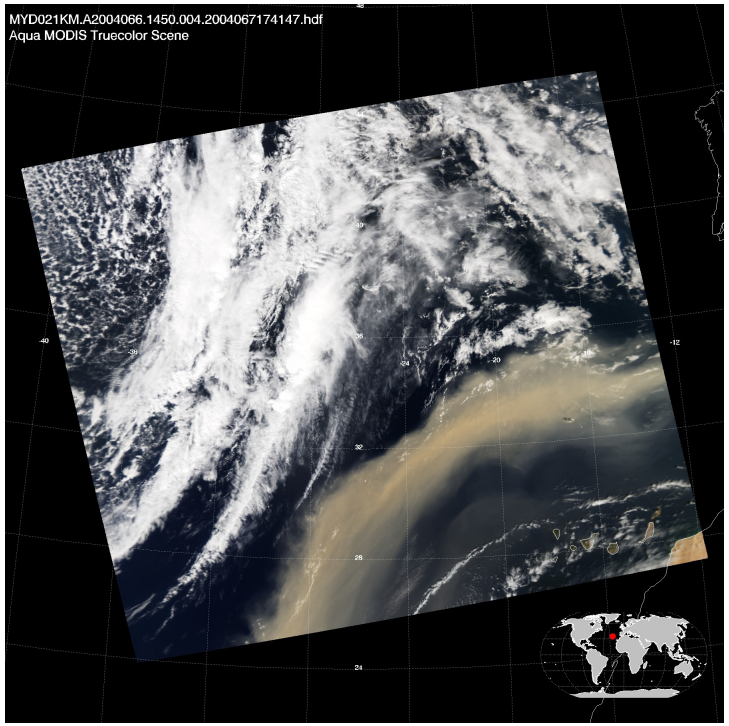
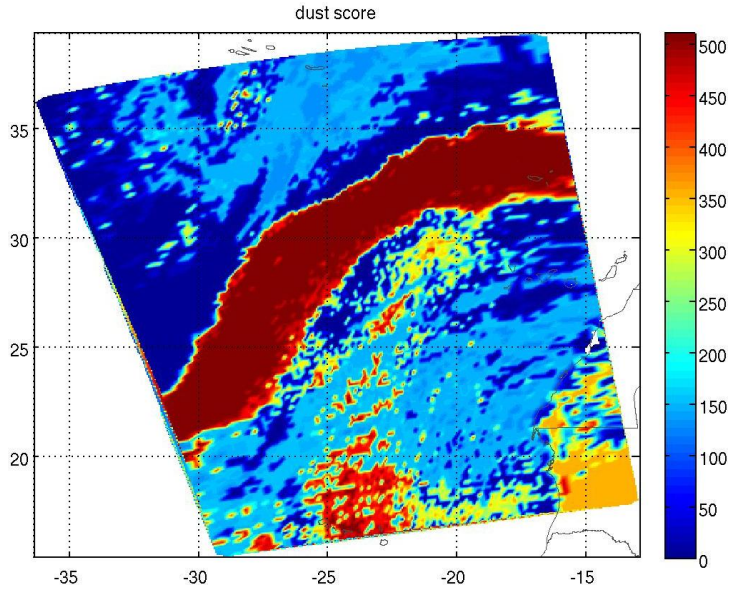
Spectral Calibration for AIRS Climate Studies





Pixels with a score above 380 are flagged as dust contaminated.

Optical Depth and Bias

V5 RTA, Aerosols, Minor Gases

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V5 RTA
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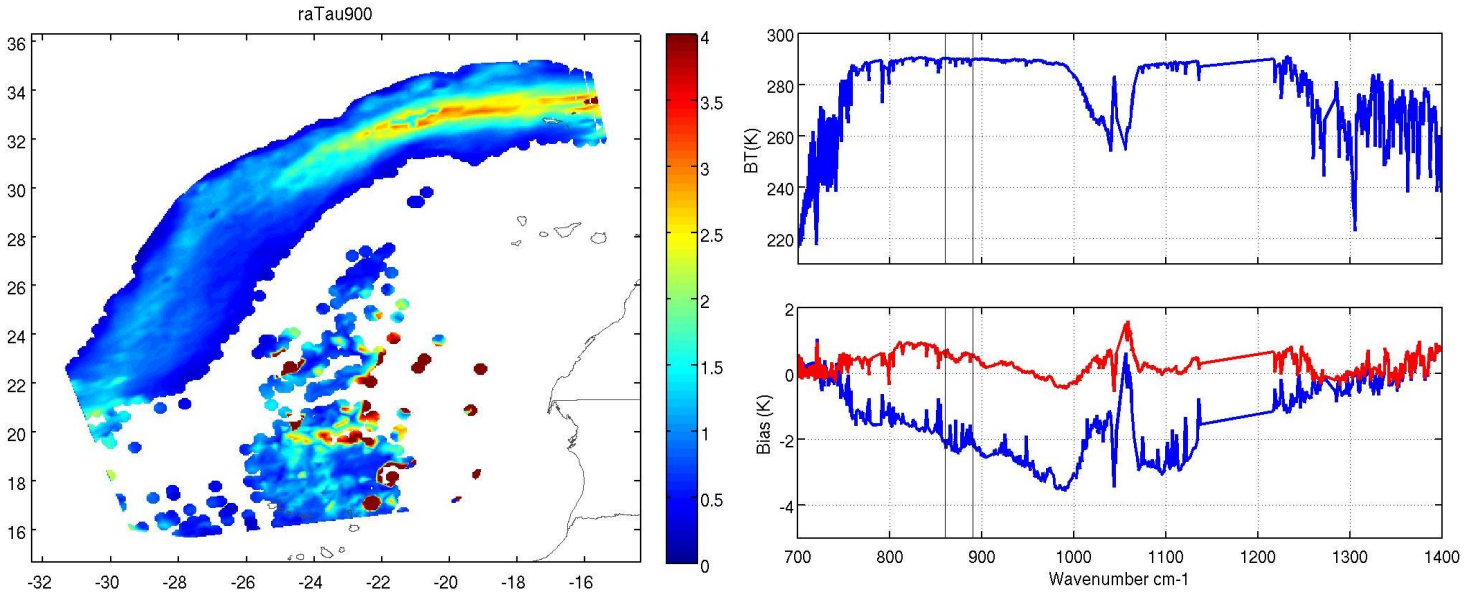

AIRS vs MODIS Aerosol τ's

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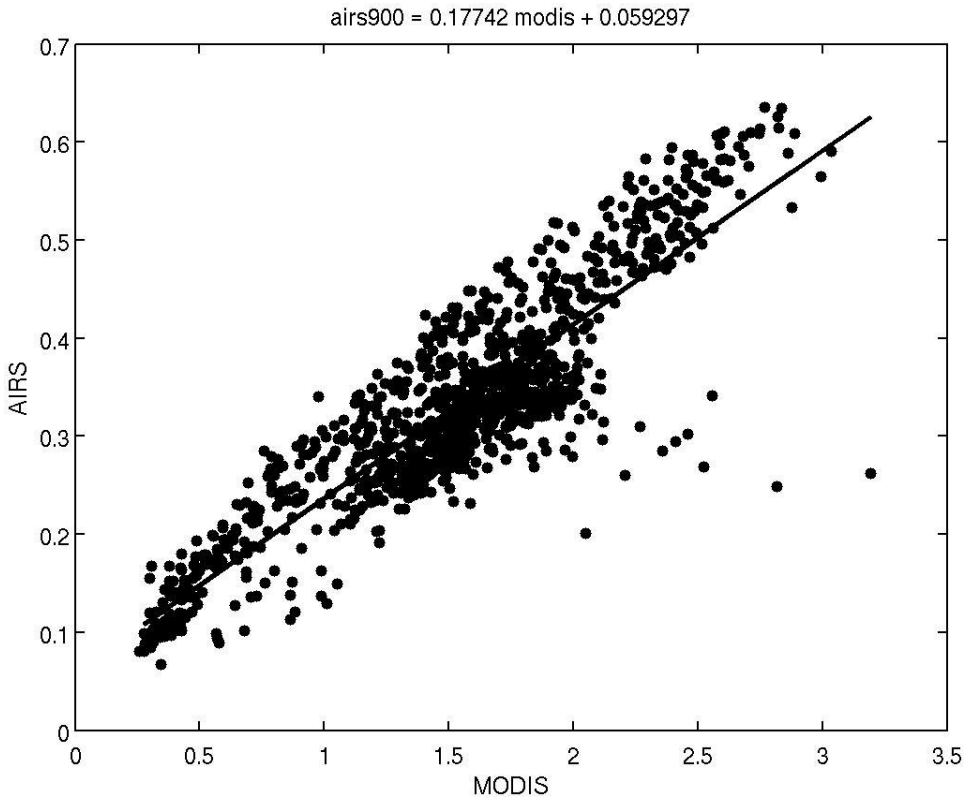
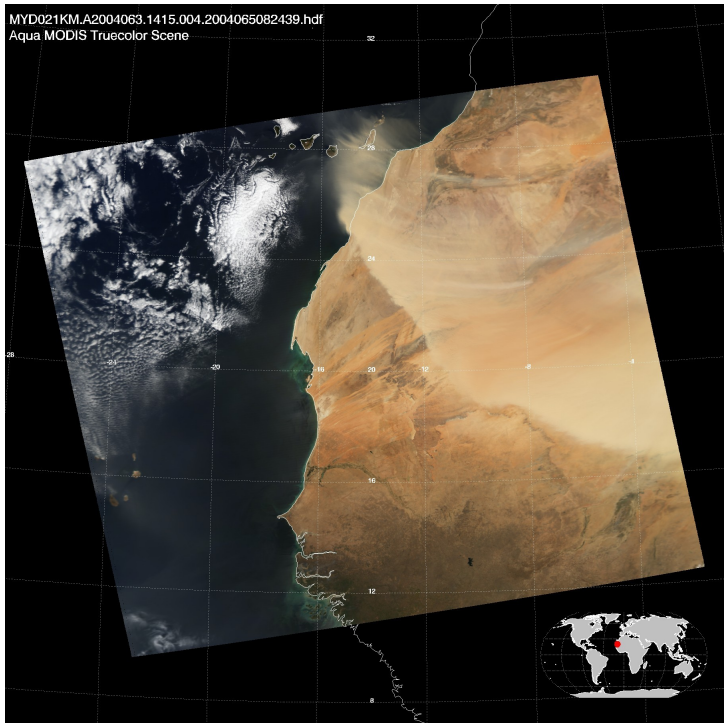
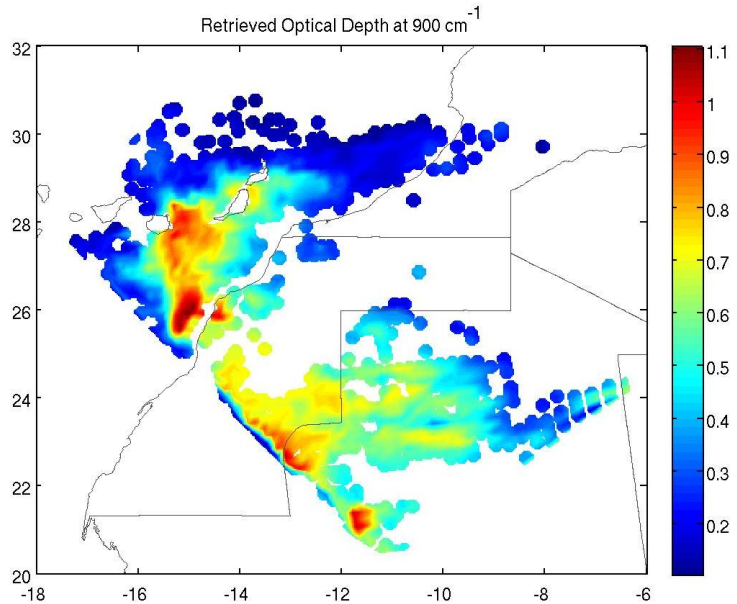


AIRS infrared optical depths plotted against MODIS visble infrared optical depths. The AIRS depths are reported for the 900 cm^{-1} window channel, while the MODIS depths are for Channel 2 (550 nm).

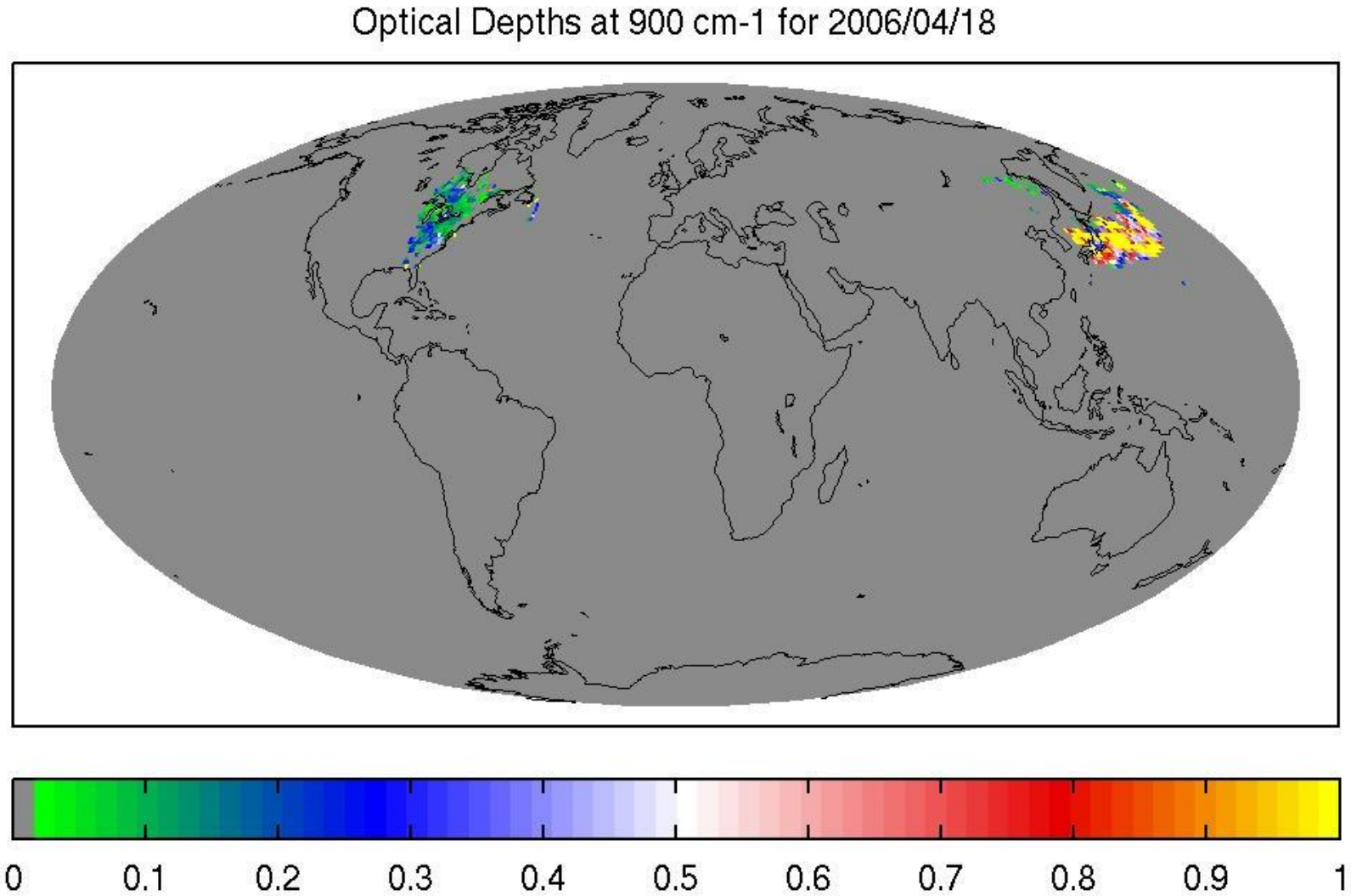
Starting Dust Retrievals Over Land





Able to track Gobi desert dust transport to US East Coast. Dust forcing from Gobi storm **still** ~**3K** in Maryland!

Gobi Dust over Maryland



SO_2 from Mt. Etna (GRL, 2005)

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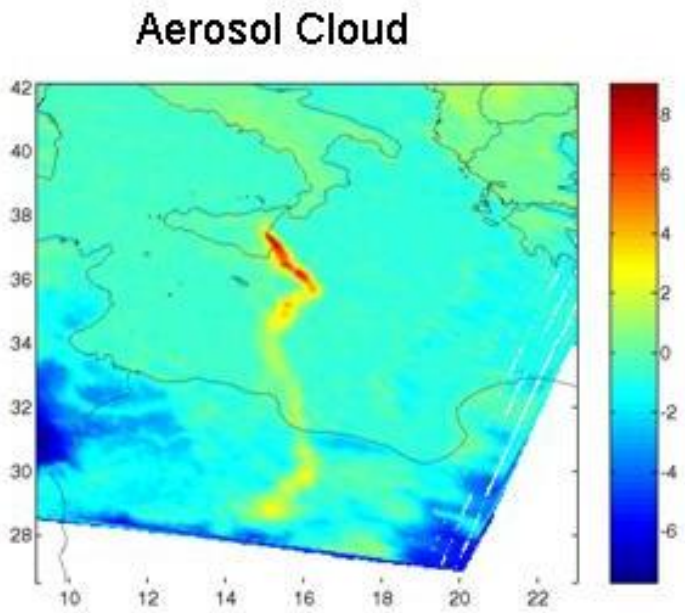
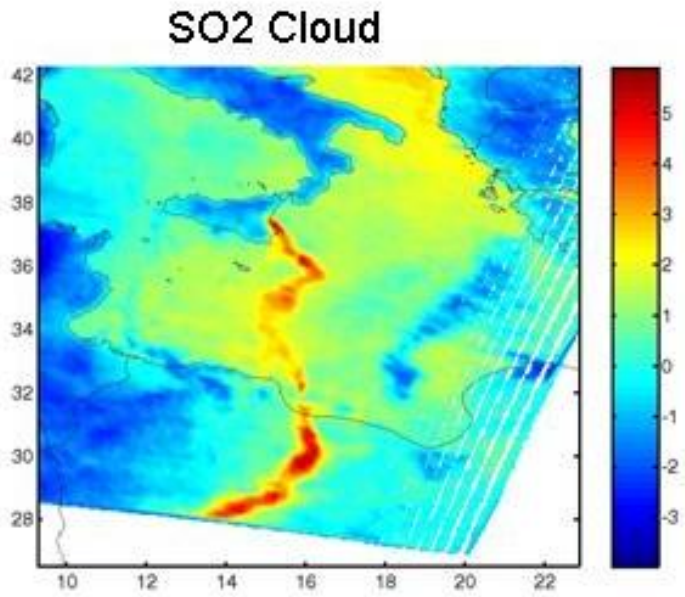
Spectral Calibration for AIRS Climate Studies





We have continued some work on volcanic SO_2. We have not continued to specifically pursue detection of volcanic aerosol clouds.

AIRS SO_2 Compared to OMI

See talk by S. Hannon

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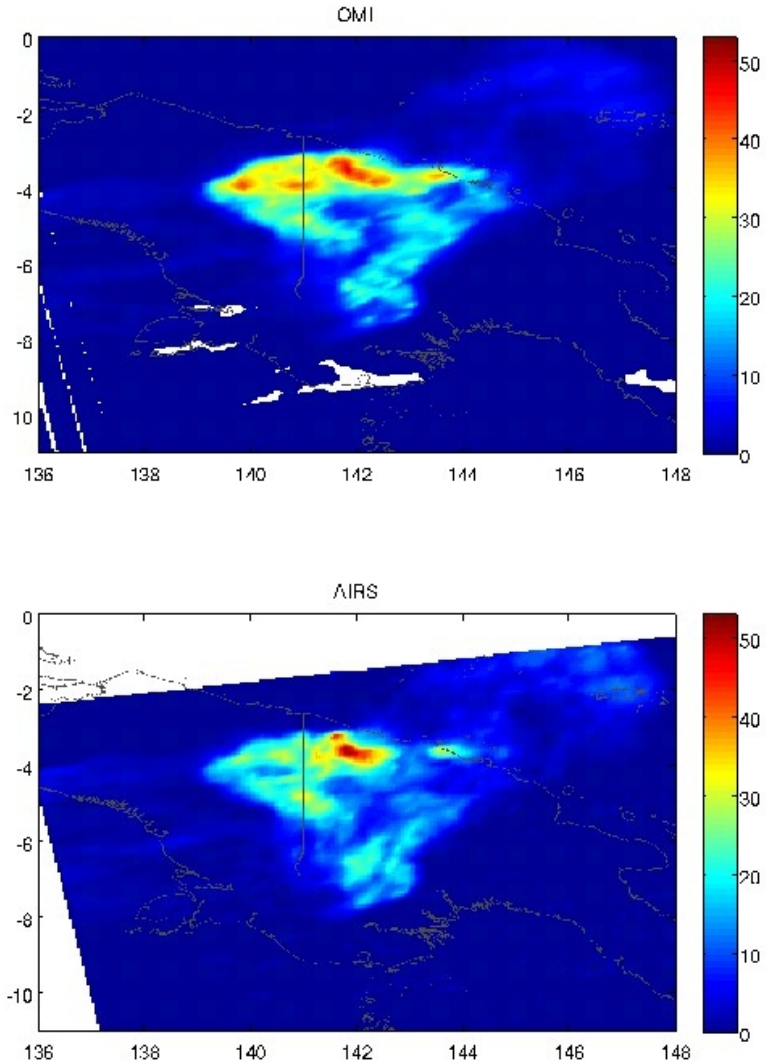

HNO_3 Seen in Polar Bias Spectra

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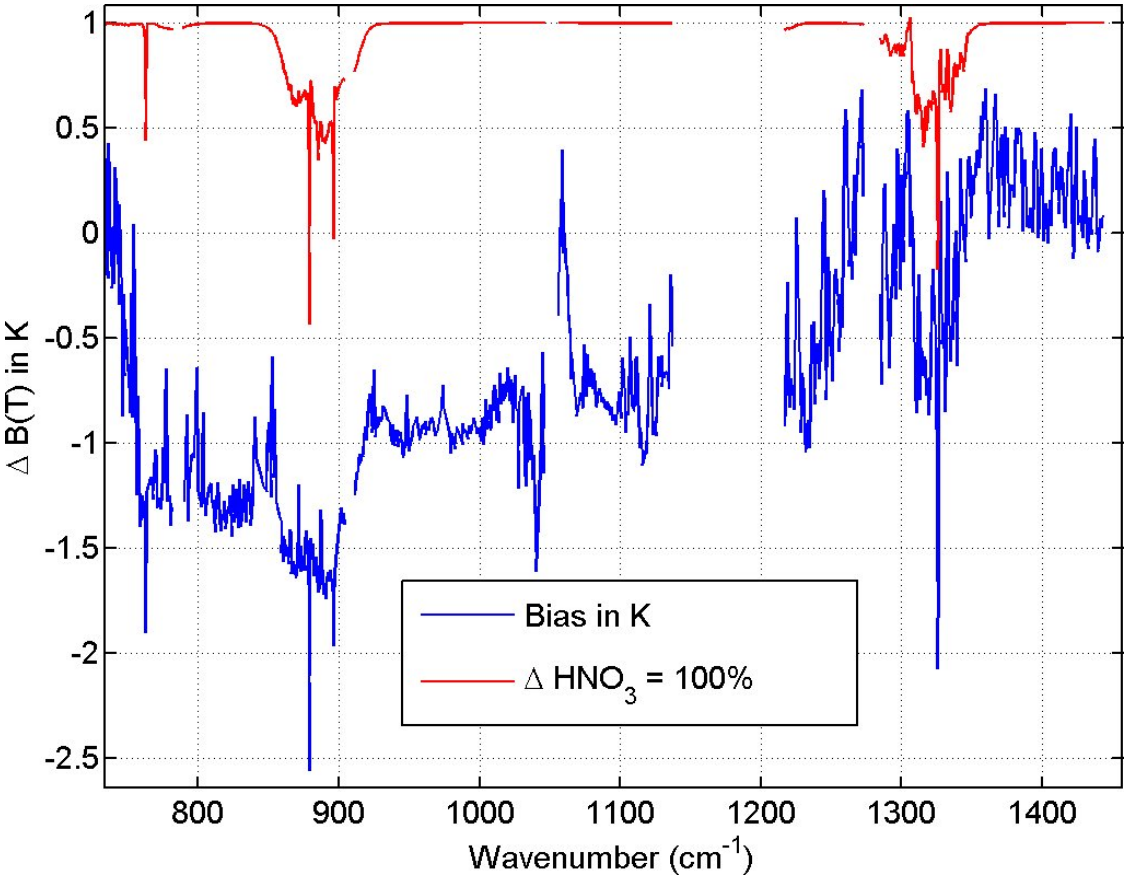

HNO_3 spectra present in enough channels to cause concern. Maybe effect my CO_2 retrievals at 791 cm^{-1}.

ASL

AIRS vs MLS HNO_3: See talk by S. Hannon

MLS: Top Panel, AIRS: Bottom Panel

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V5 RTA

NON-LTE

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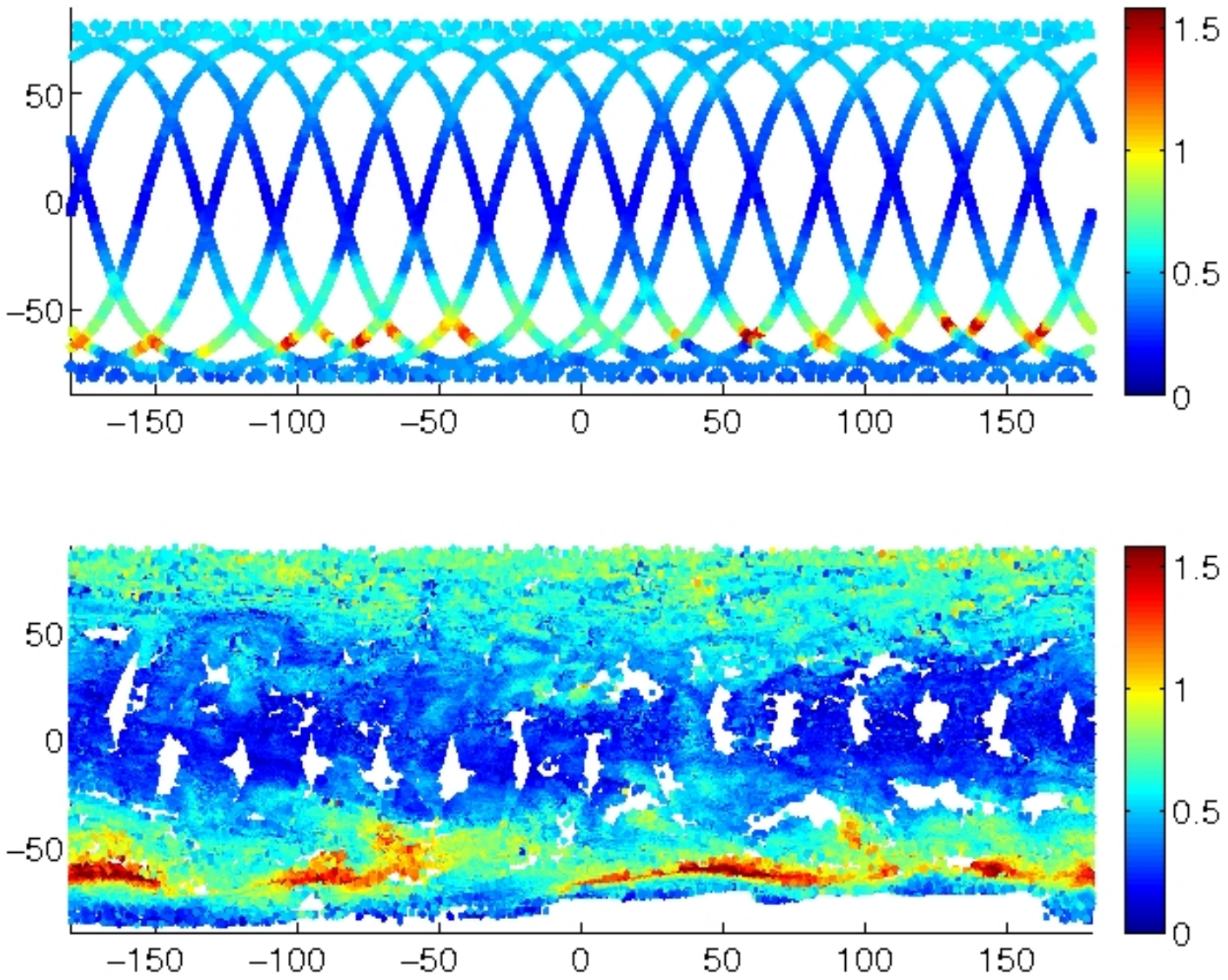
Spectral Calibration for AIRS Climate Studies



AIRS vs MIPAS HNO_3 *(very preliminary)*

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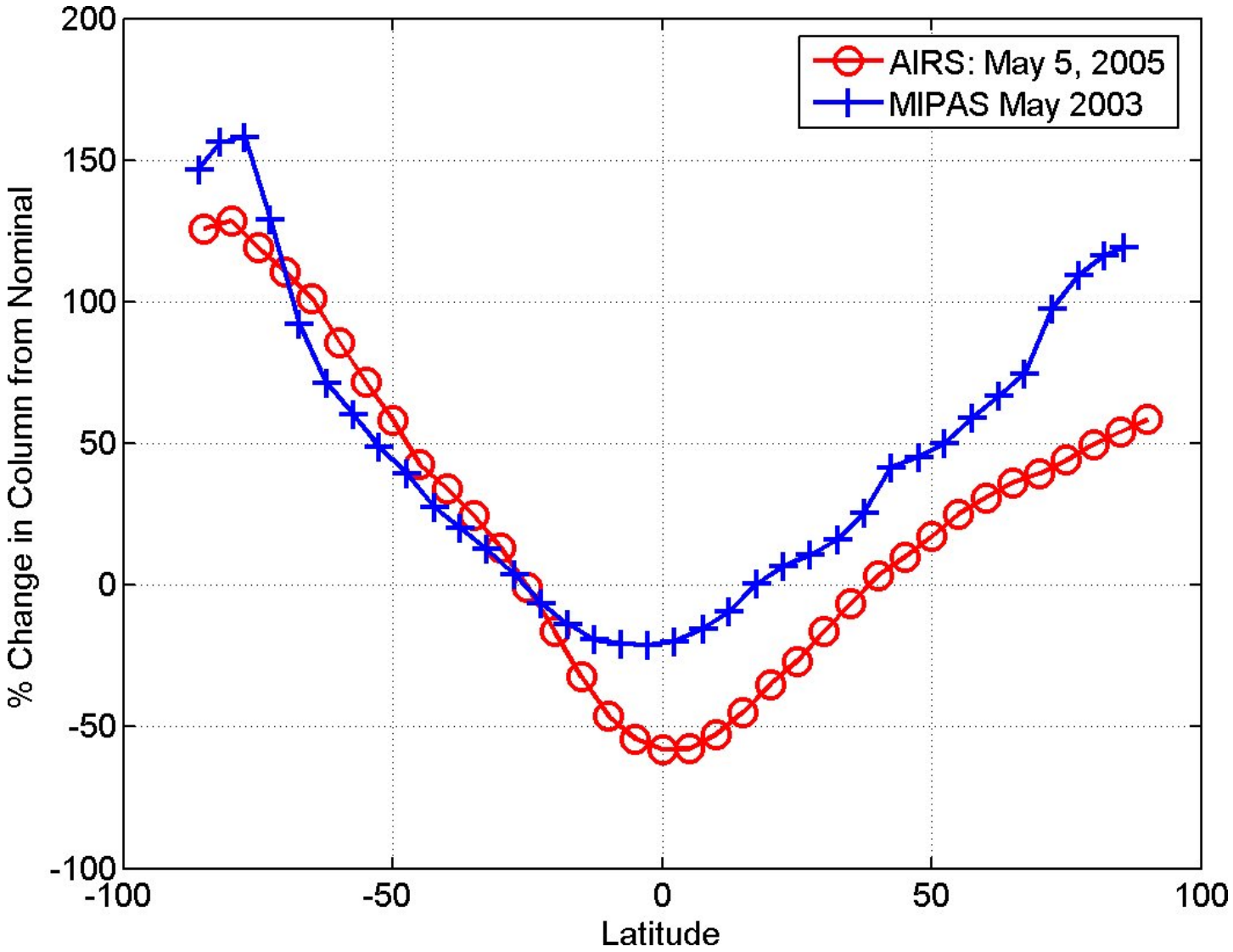

CO_2 from AIRS: See talk this afternoon

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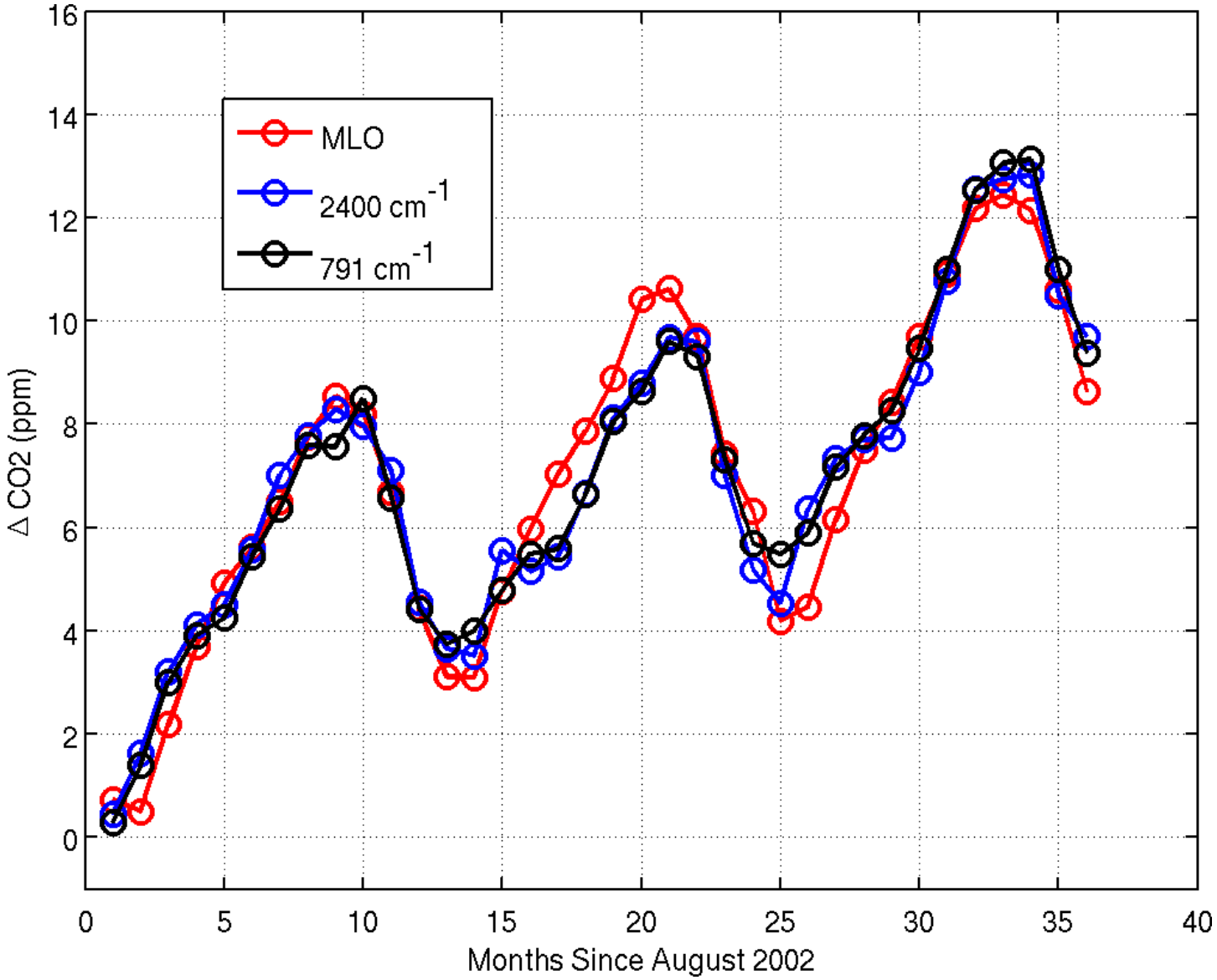
Spectral Calibration for AIRS Climate Studies



Spectral Calibration for AIRS Climate Studies

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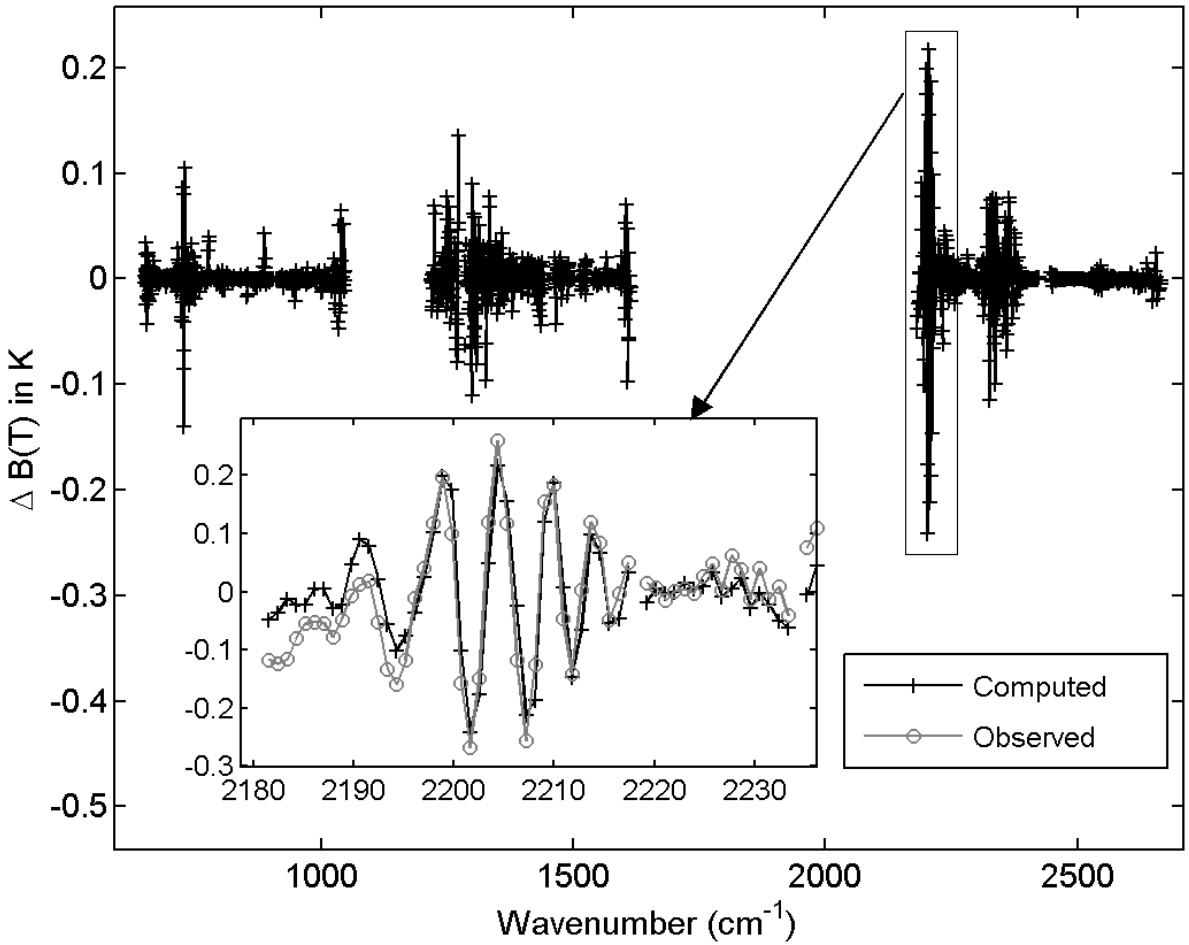
Spectral Calibration for AIRS Climate Studies

AIRS spectral calibration (and SRF shapes) have changed enough over time that we must re-calibrate AIRS for climate applications.



AIRS Freq. Cal. Result Summary

Daytime Frequency Shifts (Nov. 2003 Corrected)

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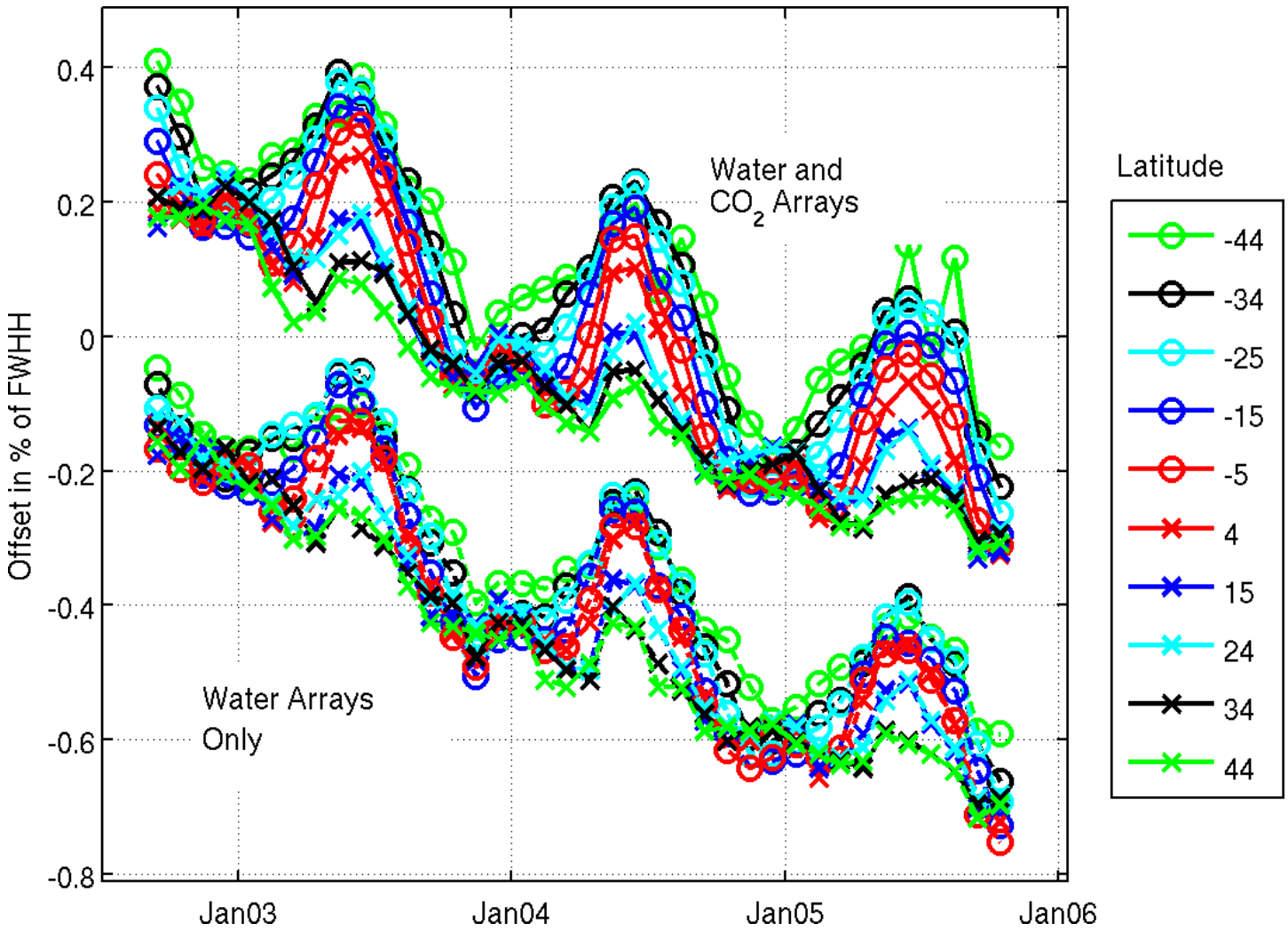
Spectral Calibration for AIRS Climate Studies