AIRS Level 1b

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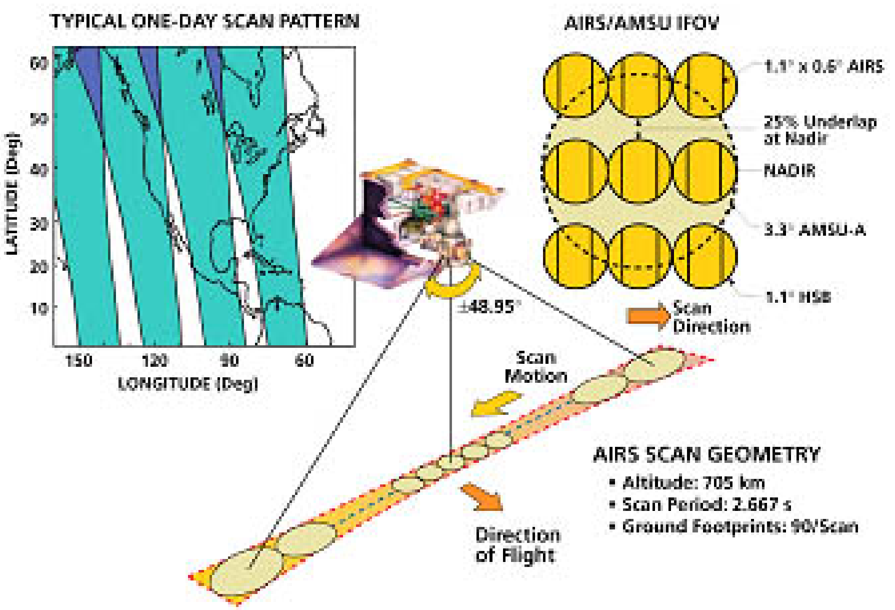
EOS Aqua was launch on 4 May 2002 into a 705km altitude sun-synchronous orbit.
AIRS IR calibration started on 13 June 2002
Routine operations started 1 September 2002
Expected end of life 2009



David Wark, Bill Smith   Phil Rosenkranz   Larrabee Strow   Catherine Gautier   Larry McMillin   Alain Chedin
Hank Revercomb   Roberto Calheiros   Joel Susskind   Moustafa Chahine   Mitch Goldberg   George Aumann

AIRS Design Highlights

L1b (radiances) Products

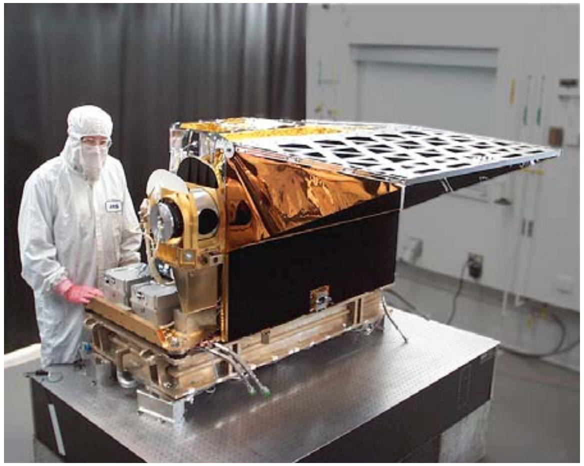
Example of new capability

AIRS SCIENCE DATA PRODUCTS
"Infrared Remote sensing through clouds"

<u>Core Products:</u> ***Global, Day- Night, Lands-Oceans***

Infrared cloud-cleared Spectrum (Radiances)

Atmospheric temperature profiles - 1C/1km
Sea surface temperature: 0.5C
Land surface temperature: 1C
infrared emissivity ratio
Relative humidity profiles: 20%/1 km
total perceptible water vapor: 5%
Fractional cloud cover 0.05
cloud-top pressure and temperature
cloud spectral infrared emissivity ratio
Total ozone burden of the atmosphere



<u>Research Products:</u>

Total CO2 burden of the atmosphere
CO, CH4, others
Precipitation rates
Etc.

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There are three key technical elements which combine to make the AIRS performance what is is:

A spectrometer with no moving optical components

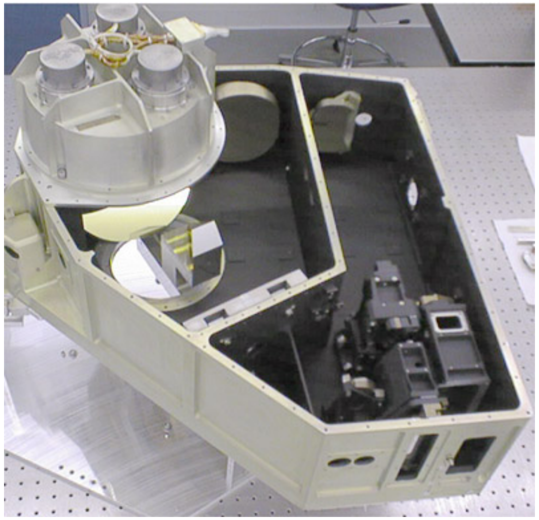
Temperature egulated spectrometer optics at 150K

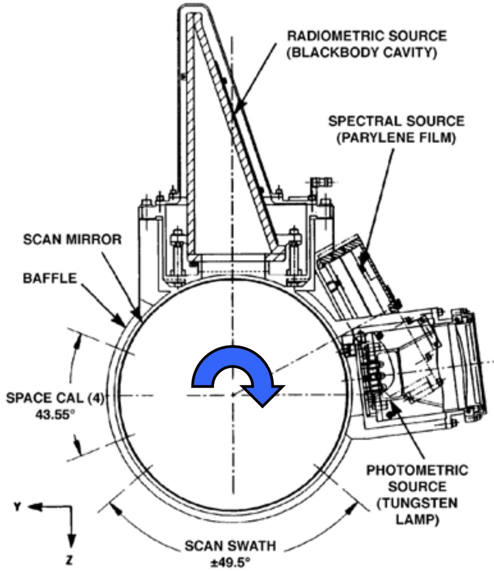
Very simple level 1b calibration algorithm

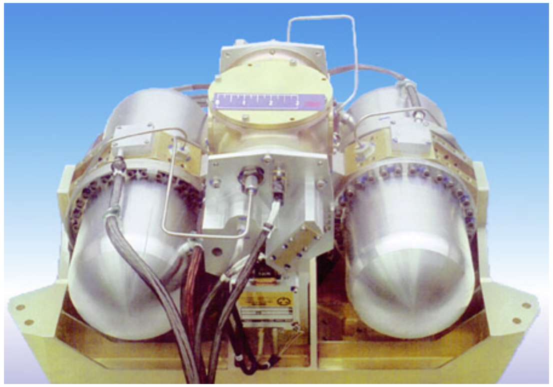
The result is incredible radiometric accuracy and stability

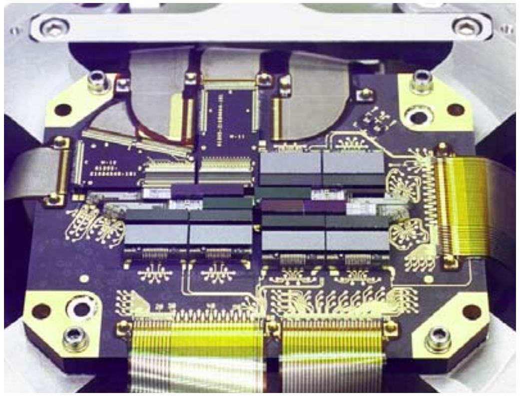
AIRS TECHNOLOGY

- IR Spectrometer: Multi-Aperture Array Grating Spectrometer
- Spectrometer Cooling to 155K with Two-Stage Passive Radiator
- Focal Plane Cooling using Single Stage Stirling Pulse Tube, Redundant
- FPAs: PV HgCdTe to 13.7 μm, PC HgCdTe to 15.4 μm
- On-Board Calibration Views: Space, Blackbody, Parylene (Spectral), 3 VIS/NIR Lamps
- Electronics Architecture:
  - Dual Redundant/μ-processor controlled
  - On-board radiation circumvention signal processing









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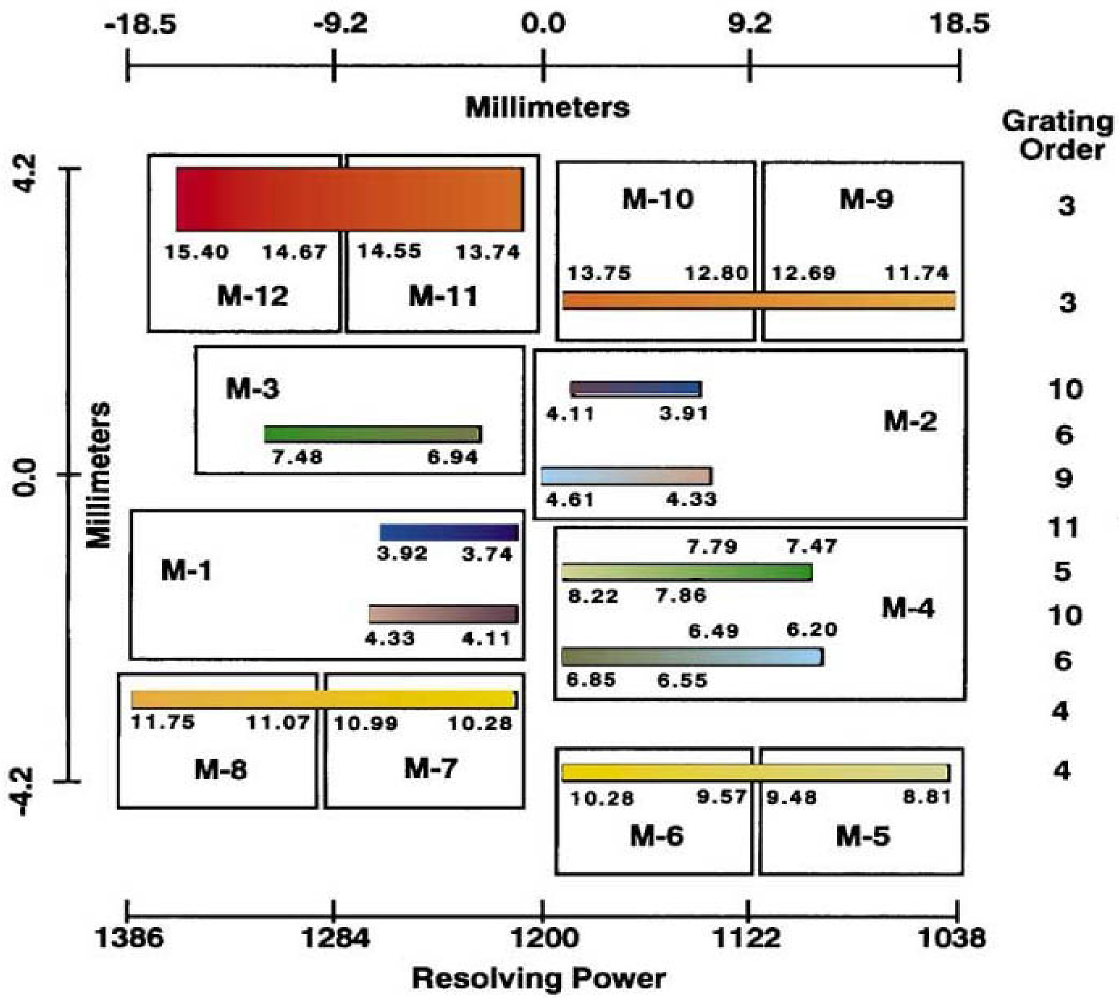
AIRS is a grating array radiometer, which covers the 3.7 to 15.4 micron spectrum with spectral resolution μ/Δμ=1200 using 2378 detectors (independent spectral channels) in 15 detector arrays..



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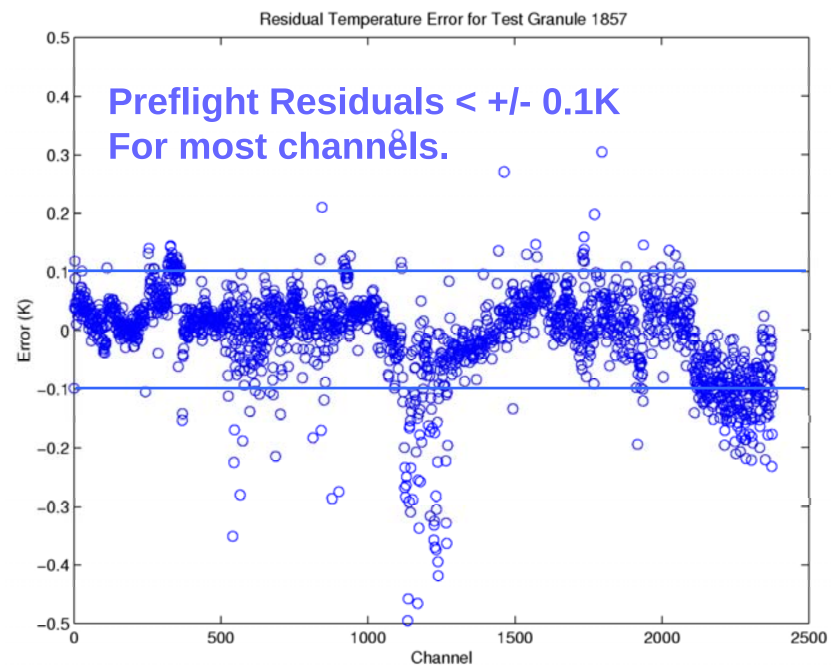
SIMPLE L1B ALGORITHM LEADS TO HIGH ACCURACY

$$N_{sc,i,j} = \frac{a_o(\theta_j) + a_{1,i}(dn_{i,j} - dn_{sv,i}) + a_2(dn_{i,j} - dn_{sv,i})^2}{1 + p_r p_t \cos 2(\theta_j - \delta)}$$

$$a_o(\theta_j) = P_{sm}\, p_r\, p_t\, [\cos 2(\theta_j - \delta) + \cos 2\delta]$$

$$a_{1,i} = \frac{N_{OBC,i}(1 + p_r p_t \cos 2\delta) - a_o(\theta_{OBC}) - a_2(dn_{obc,i} - dn_{sv,i})^2}{(dn_{obc,i} - dn_{sv,i})}$$

$N_{sc,i,j}$ = Scene Radiance (mW/m^2-sr-cm^{-1})
Psm = Plank radiation function
$N_{OBC,i}$ = Radiance of the On-Board Calibrator
i = Scan Index, j = Footprint Index
q = Scan Angle. q = 0 is nadir.
$dn_{i,j}$ = Raw Digital Number in the Earth View
$dn_{sv,i}$ = Space view counts offset.
a_o = Radiometric offset. $a_{1,i}$ = Radiometric gain.
a_2 = Nonlinearity
$p_r p_t$ = Polarization Factor Product
d = Phase of the polarization



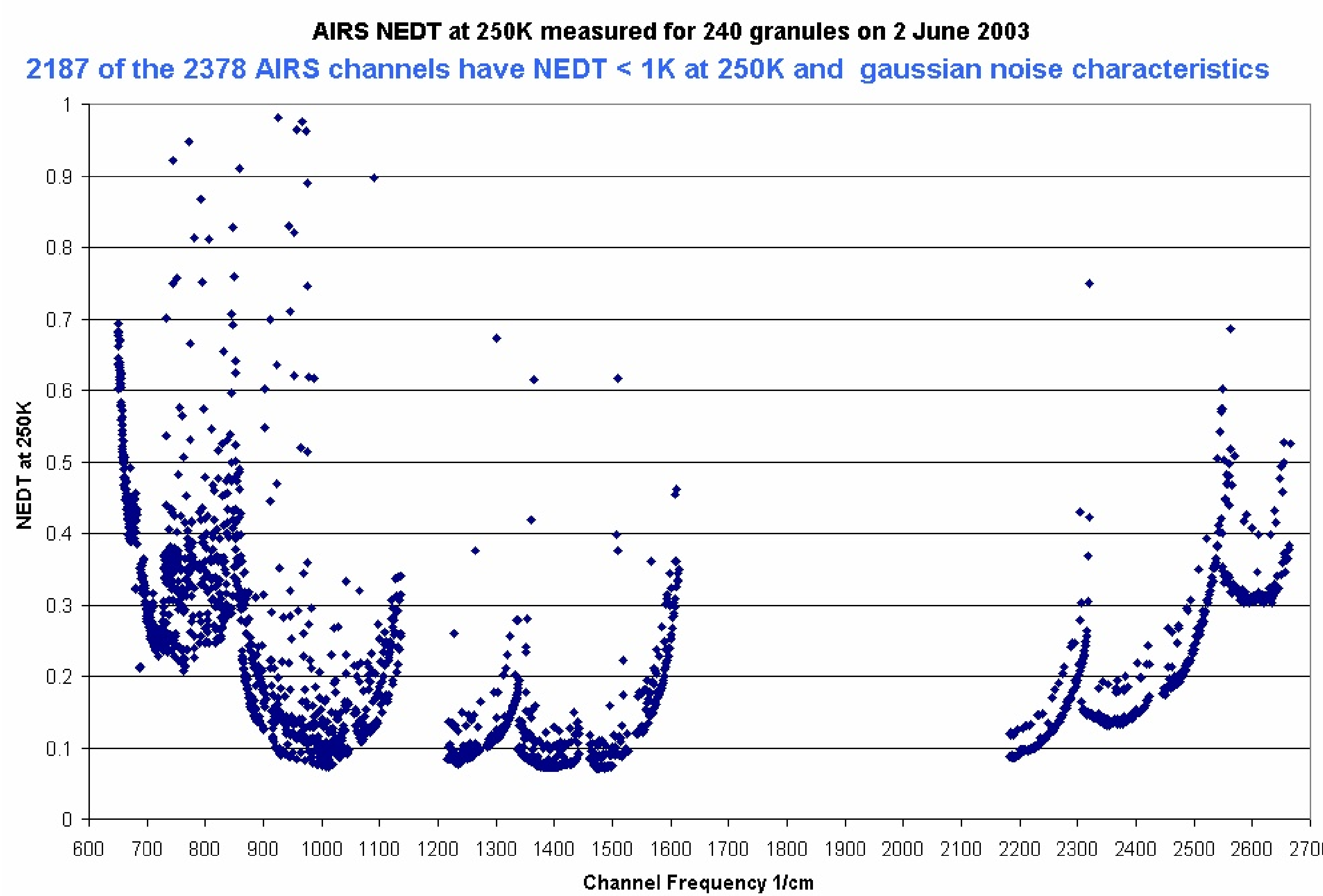
On orbit results

noise

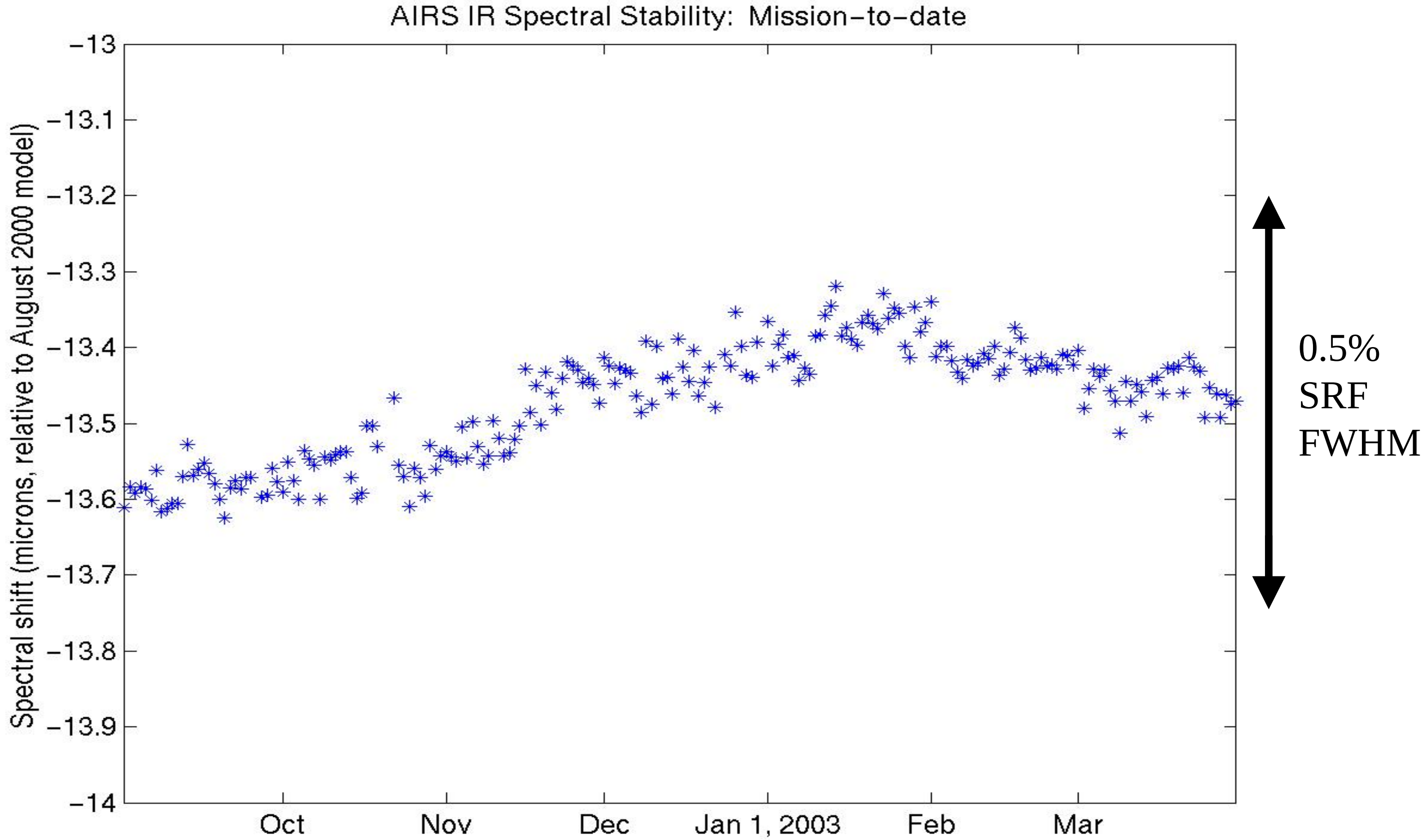
spectral calibration

radiometric calibration

Measurement NEDT is excellent and stable



Spectral Response Function (SRF) centroids are stable at better than 0.5% of SRF FWHM



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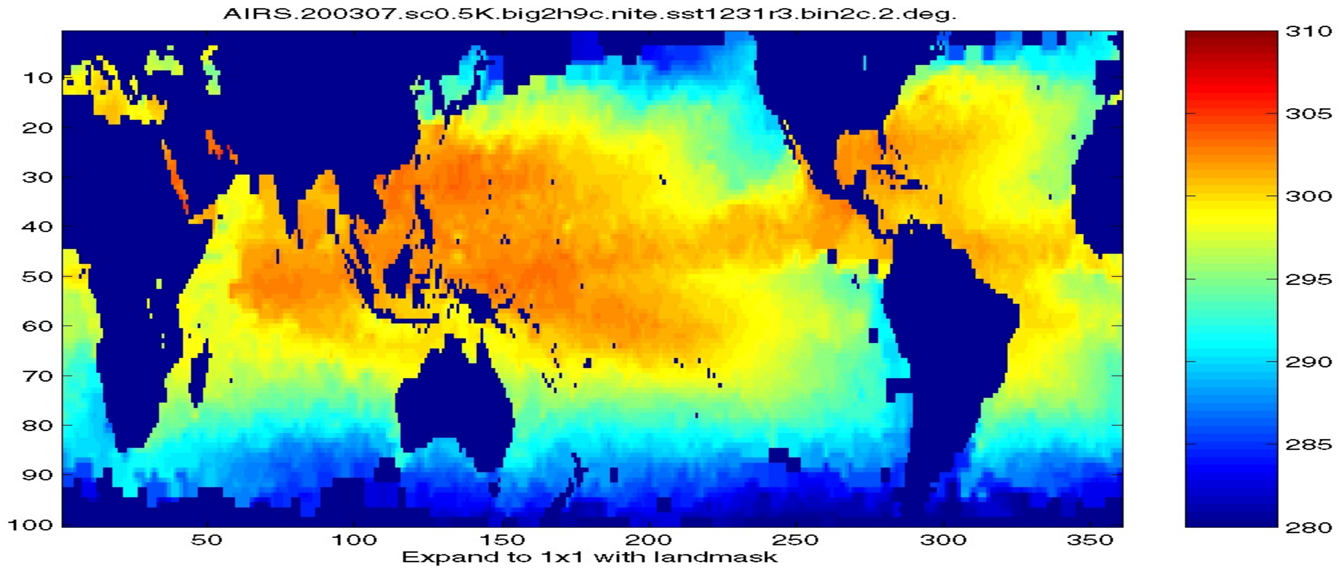
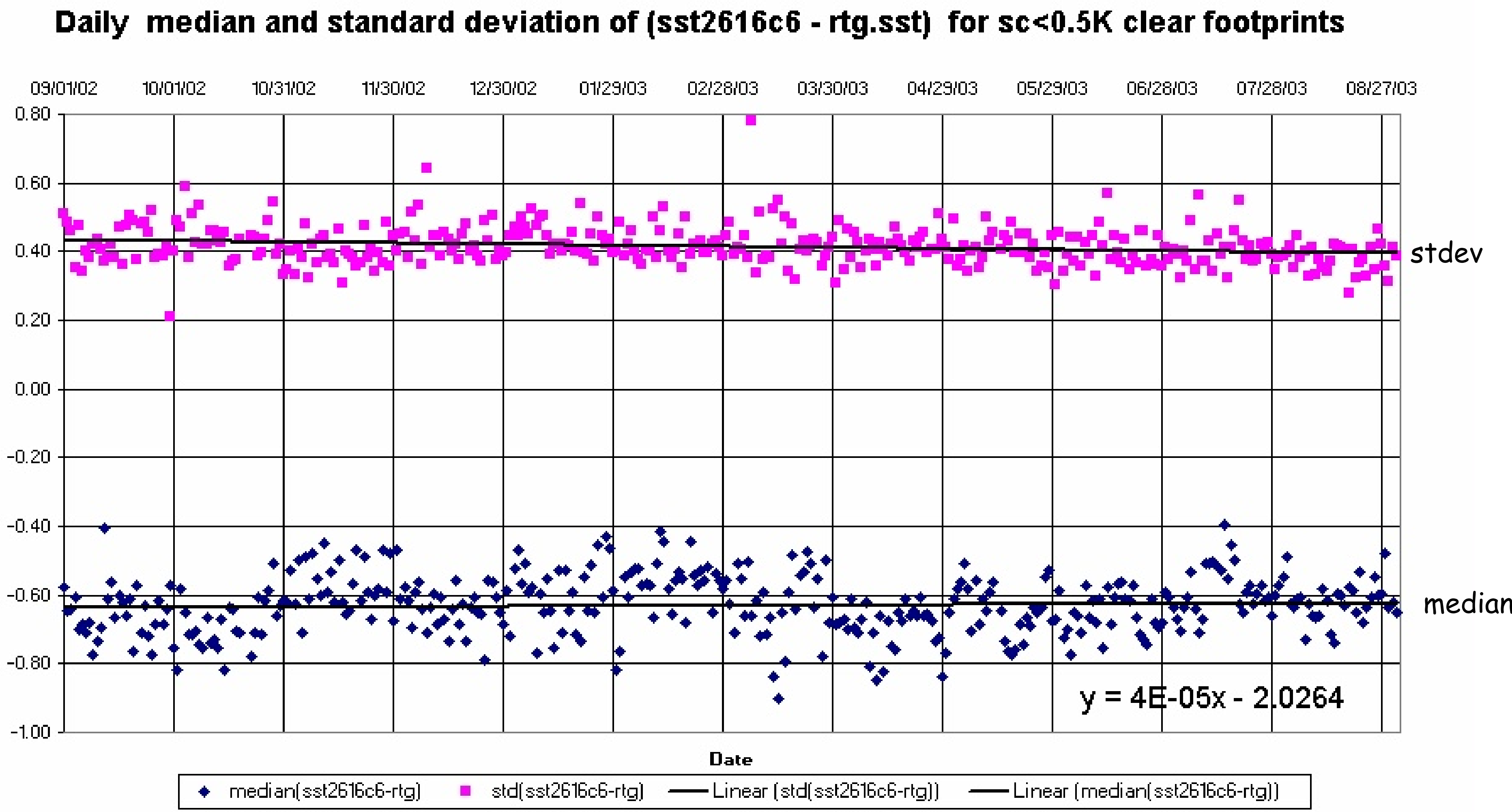
Radiometric Stability is monitored daily using clear matchups with the NCEP RTG.SST



Average sst1231r3 of the clear night AIRS footprints for July 2003

Comparison of the AIRS derived sst2616 with the NCEP RG.SST for the first 12 months of AIRS data shows excellent radiometric calibration stability.



What have we learned from the first 12 months of data

Clouds more abundant and more complex than expected

The key role of the 2616cm-1 super window channel

There are marine aerosols, cirrus and silicate dust in the atmosphere which vary on a monthly time scale

At the 0.5K level monthly variability of aerosol and dust

daily variability in cirrus near clouds

Radiative transfer models disagree for given T(p), q(p)

Validation "Truth" disagreements

Instrument spectral and radiometric stability are critical to

collect enough validation data under fixed conditions

Cloud-clearing using the AMSU works, but low clouds, and cirrus are challenges

The learning curve is steep

Unexpected capabilities are emerging

Example of one of the unexpected AIRS capabilities:

AIR – Sea Surface Temperature Difference Measurement

This requires

High vertical resolution weighting functions in the troposphere
Weighting function independent of water vapor
0.1K NEDT at 250K

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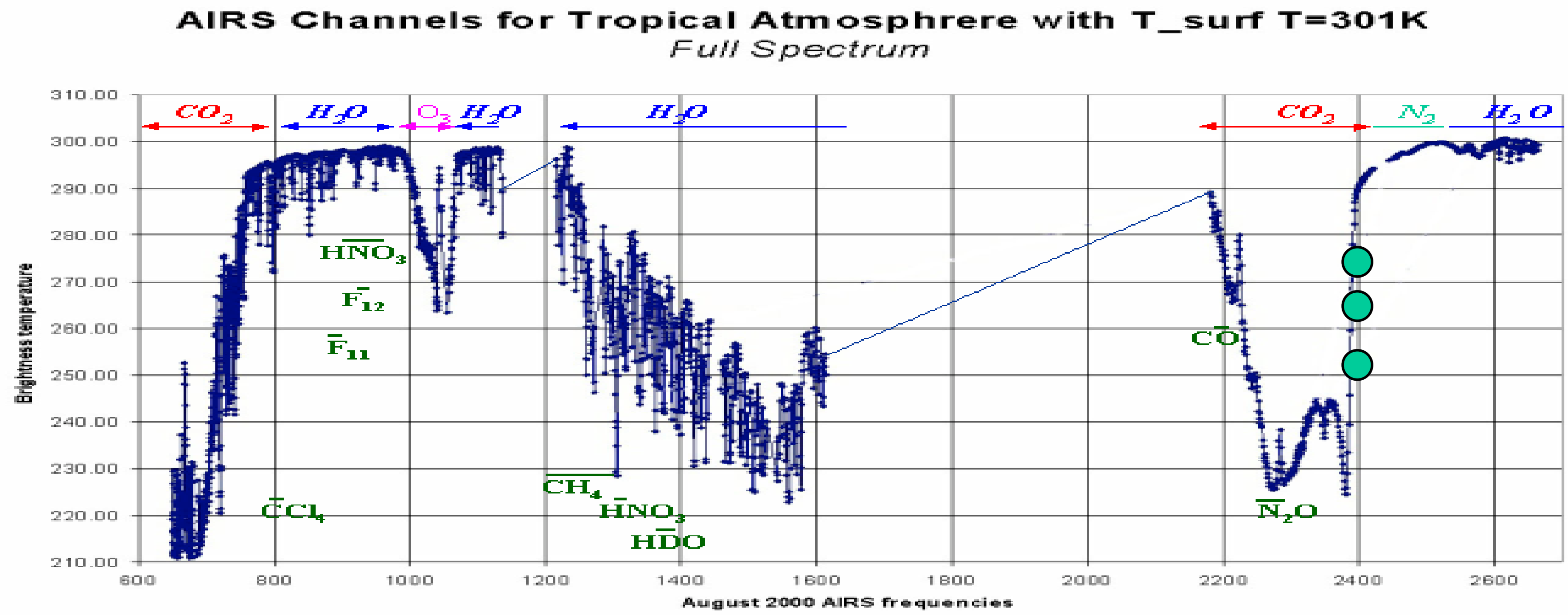
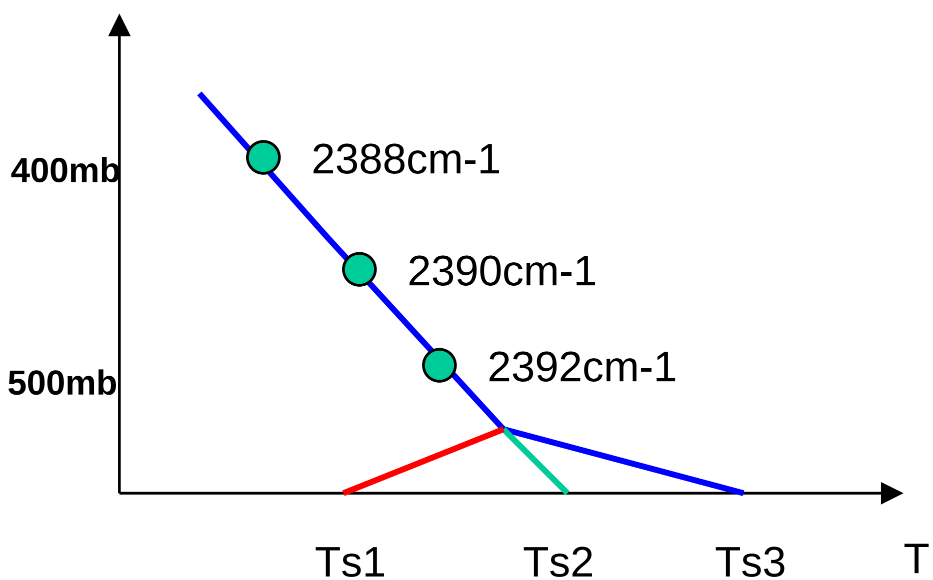
AIRS 4.3um co2 R-Branch channels





measured with sst2616 and rtg.sst

Ts2390=predicted Tsurf based on
4.3um RBranch lapse rate

Ts2390 == Ts2 normal case

Ts2390 == Ts3 surface warmer
than expected

Ts2390 == Ts1 inversion
if sst2616==rtg

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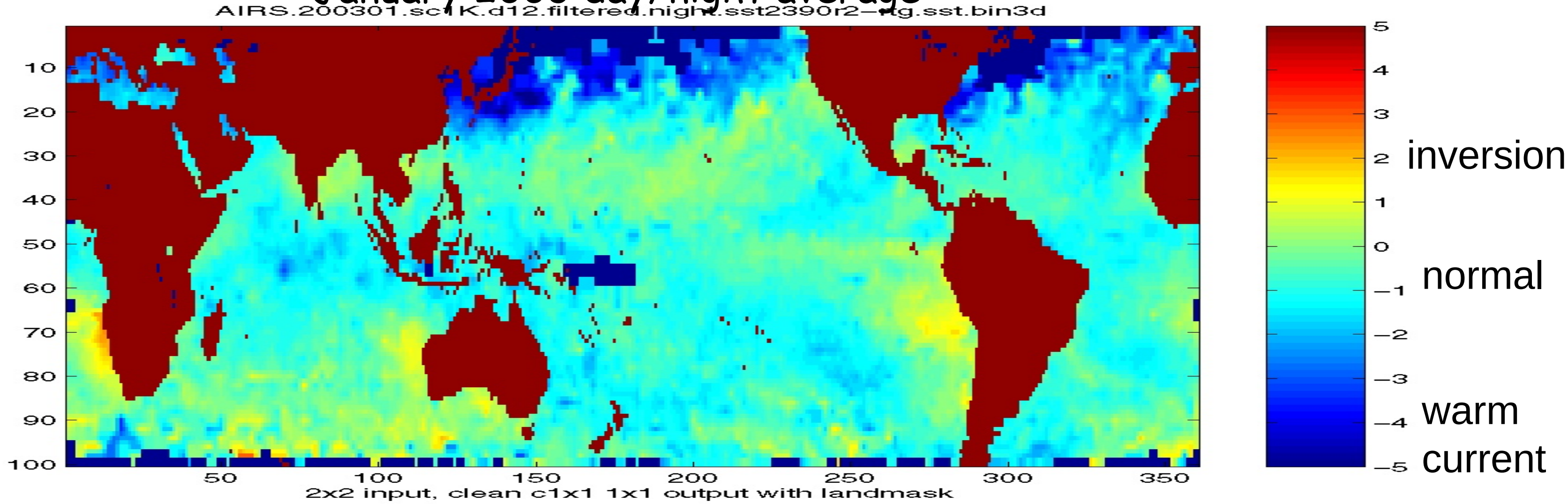
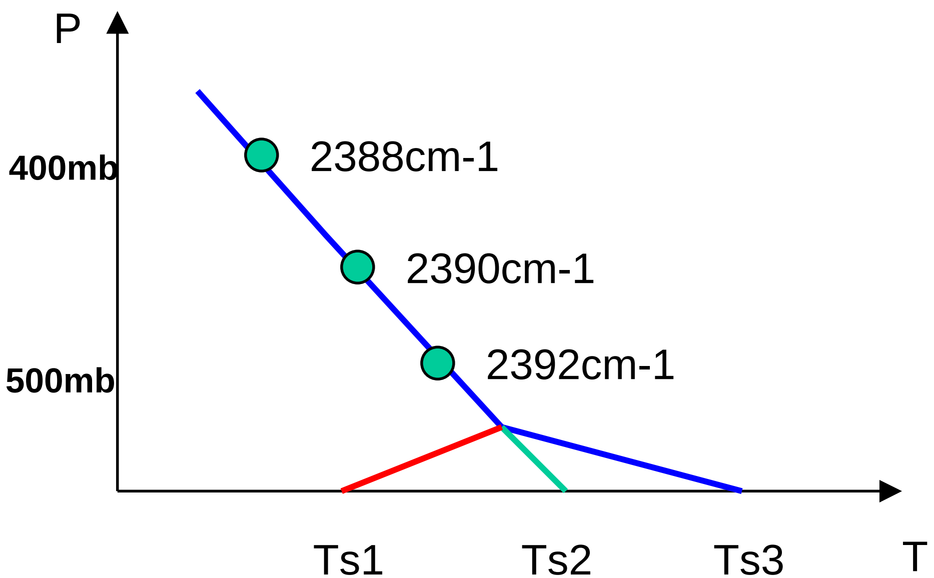
January 2003 day/night average





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Ts2390=predicted Tsurf based on 4.3um RBranch lapse rate

Ts2390 == Ts2 normal case

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Ts2390 == Ts1 inversion if sst2616==rtg

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Summary

good news

- The AIRS spectrometer level 1b data quality is excellent.
- The 2616cm-1 super window is key for bootstrapping the calibration, calibration monitoring and cloud screening
- Optimal use of a hyperspectral sounder has a steep learning curve
- Interesting research products are emerging

AIRS/AMSU/HSB* Data Release

Level 1b and level 2 products have been available to the general public since July 2003 from the GSFC DAAC at

http://daac.gsfc.nasa.gov/atmodyn/airs/

Level 1b (radiance product) is provisionally validated.

All L2 V3.0.8 standard products are beta validated.

Results of the validation effort using routine RAOB launches, dedicated RAOBs etc from ARM/CART and equivalent sites is available on

http://www.jpl.nasa.gov/airs/

*HSB data available through February 2003

This presentation serves an introduction

to the following presentations related to AIRS data