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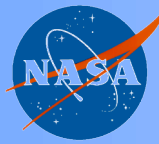
**Jet Propulsion Laboratory**  
California Institute of Technology  
Pasadena, California

# AIRS Version 4 Data

International TOVS Study Conference XIV  
Beijing, China  
May 2005

Sung-Yung Lee, H. H. Aumann, Bjorn Lambrigtsen,  
Evan Manning, Edward Olsen, Tom Pagano

California Institute of Technology  
Jet Propulsion Laboratory



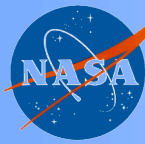
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## Summary

- **AIRS Version 4 software was delivered to GDAAC**
  - Current AIRS data has been processed since April 2005.
  - Old data since Sept 2002 will be reprocessed soon.
    - Collection 3 is without HSB data
    - Collection 4 utilizes HSB data for Sept 2002 through Jan 2003.
  - Documents describing the version are also released.
  - Level 3 data products were added.
  - Direct Broadcast version software will be released soon
- **AIRS and AMSU are operating in excellent health**
  - AIRS is extremely stable, radiometrically and spectrally
  - Temperature sensors on AMSU-A2 became noisy, but impact on radiance is minimal
  - All trends indicate healthy instruments for many more years
- **NWP forecast improving with AIRS/AMSU data**
- **Many interesting results on minor gases: CO, SO<sub>2</sub>, CO<sub>2</sub>, CH<sub>4</sub>**



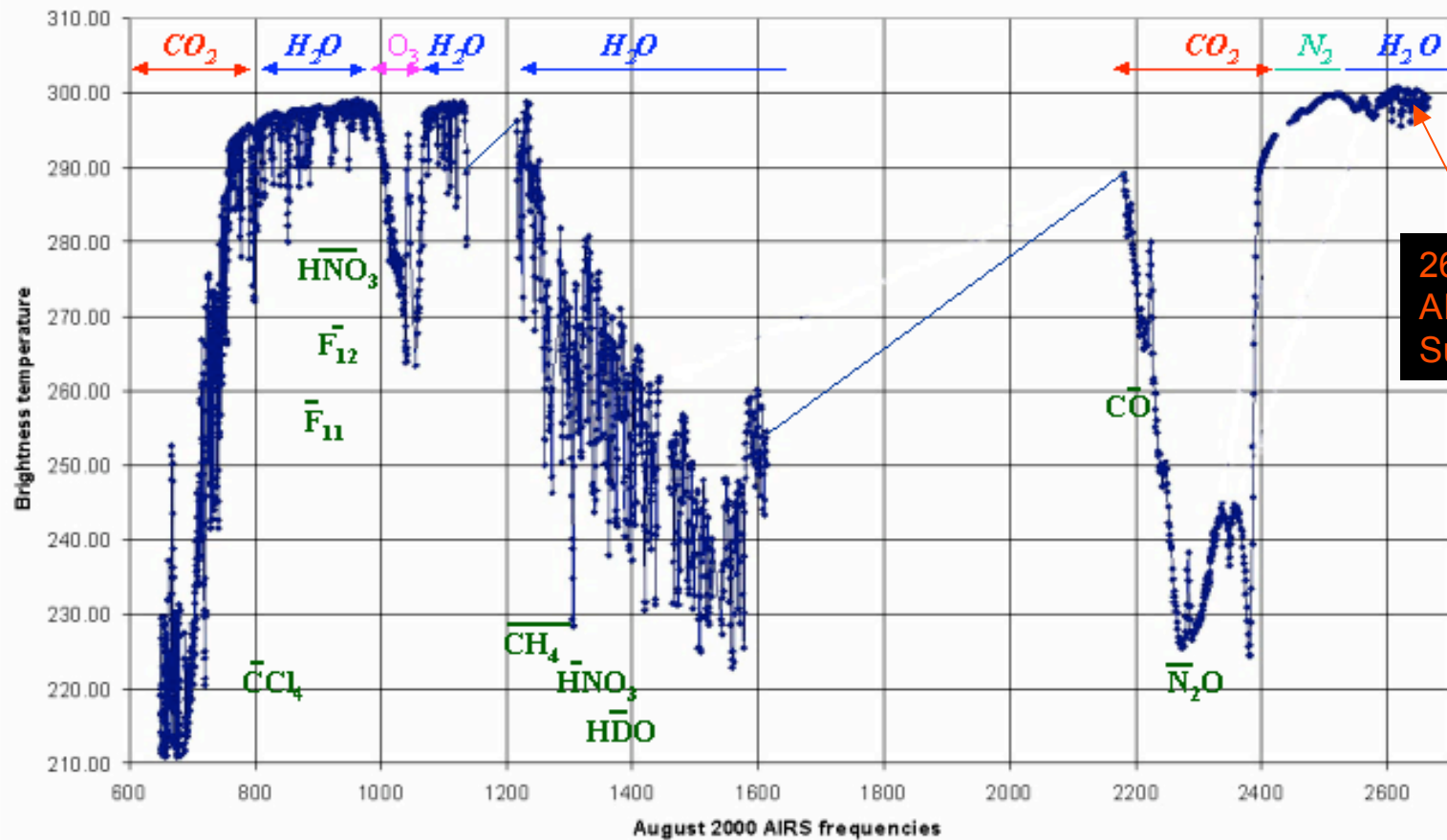
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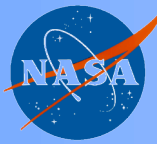
## AIRS Spectrum Reveals State and Composition of the Atmosphere

### AIRS Channels for Tropical Atmosphere with $T_{\text{surf}} = 301\text{K}$

Full Spectrum



2616 cm-1  
AIRS  
Superwindow



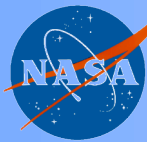
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## Major Changes in Version 4

- **This is the second release of level 2 and third release of level 1b.**
- **HDF internal compression is used to reduce file size**
- **Major Calibration updates**
  - Robust quality control on AIRS radiances
  - Smoothing of gain to reduce striping on some channels
  - Spatial coherency (Cij) indicator upgrade
  - Time dependent VIS/NIR calibration to account for slow degradation of sensitivity
  - Upgrade of lunar intrusion algorithms (AIRS and AMSU)
- **Major Level 2 updates**
  - New Rapid Transmittance Algorithm to improve forward algorithm accuracy
  - New retrieval quality control flags to output partial retrievals
  - Improved cloud retrieval
- **Level 3 data products were added**
  - One degree by One degree maps of selected parameters
  - Daily, 8 day and monthly fields



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## Standard Product Activation / Validation Timeline

Version	3.0	4.0	5.0	6.0
Activation Date	9/03	4/05	6/06	10/07
Radiance Products (L1)	Ocean	Land	Polar	Global
AIRS Radiance	Prov	Val2	Val3	Val4
VIS/NIR Radiance	Prov	Val2	Val3	Val4
AMSU Radiance	Beta	Prov	Val2	Val3
HSB Radiance	Beta	N/A	N/A	N/A
Standard Products (L2)				
Cloud-Cleared IR Radiance	Beta	Val2	Val3	Val4
Surface Temperature	Beta	Val1	Val2	Val4
Temperature Profile	Prov	Val2	Val3	Val4
Humidity Products	Beta	Val1	Val2	Val3
Cloud Cover Products	N/A	Val1	Val2	Val3

**Beta = Not suitable for scientific investigations.**

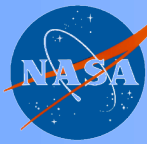
**Prov = Provisionally validated. Useable for scientific investigations with caution. Validated for non-polar, night, ocean only.**

**Val1 = non-polar, day/night, ocean.  
Val2 = Val1 + land.  
Val3 = Val2 + polar  
Val4 = Global All Cases**

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Due to T Pagano, JPL

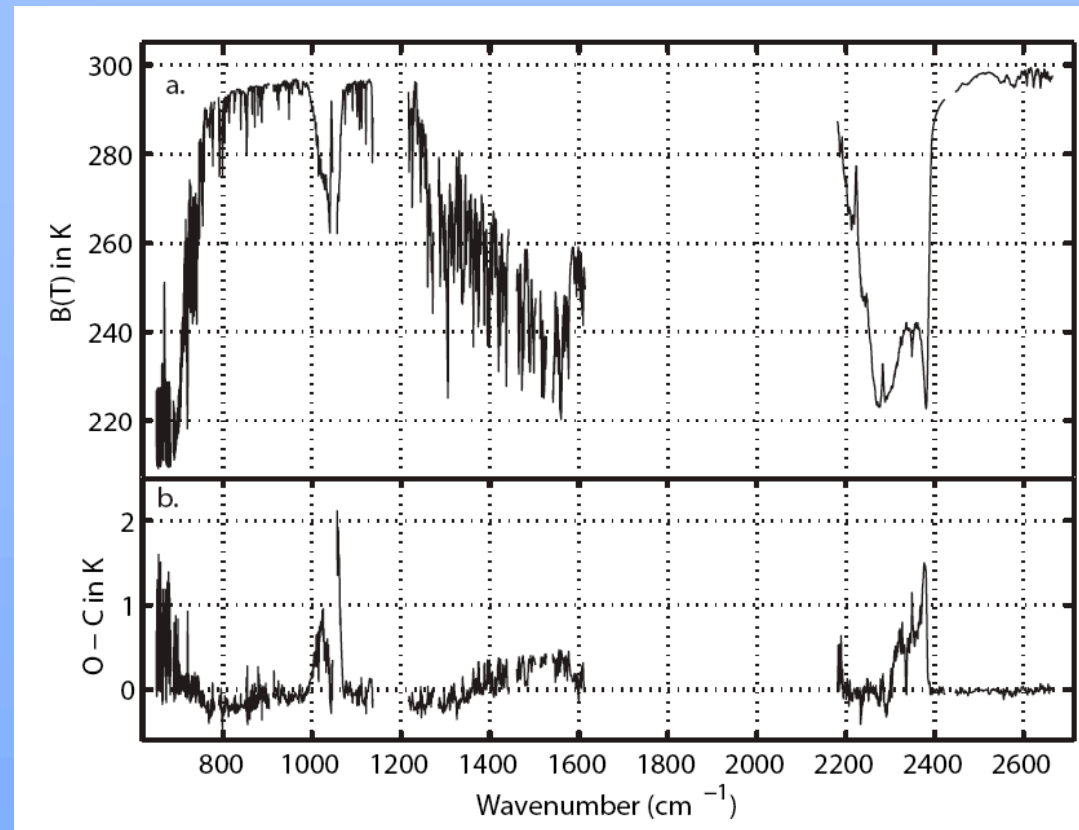
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## Radiance Residual

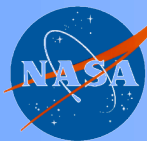


Due to L Strow  
of UMBC

- Comparison of observed radiances with computed radiances
  - Clear RS 90 Ra obs with ECMWF forecast above ra obs
- Differences in strong CO<sub>2</sub> absorption bands and in ozone band can be explained by biases in ECMWF forecast in the stratosphere and in ozone, respectively

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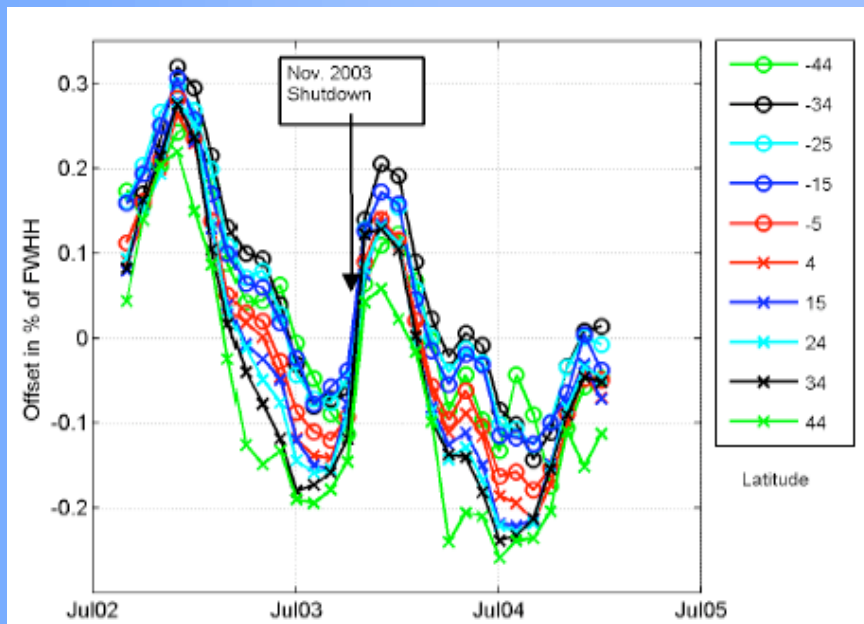


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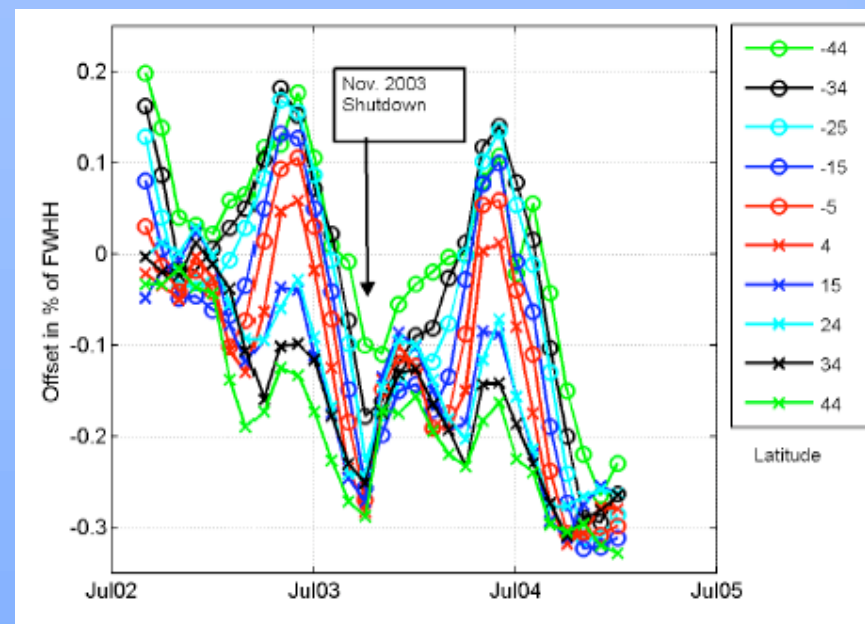


## Spectral Stability of AIRS

Nighttime



Daytime

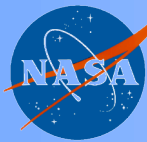


Due to L Strow of UMBC

- Plot of measured night and day spectral shift as a function of zenith angles
- AIRS Frequencies stables to  $< 5$  PPM, knowledge to  $< 1$  PPM

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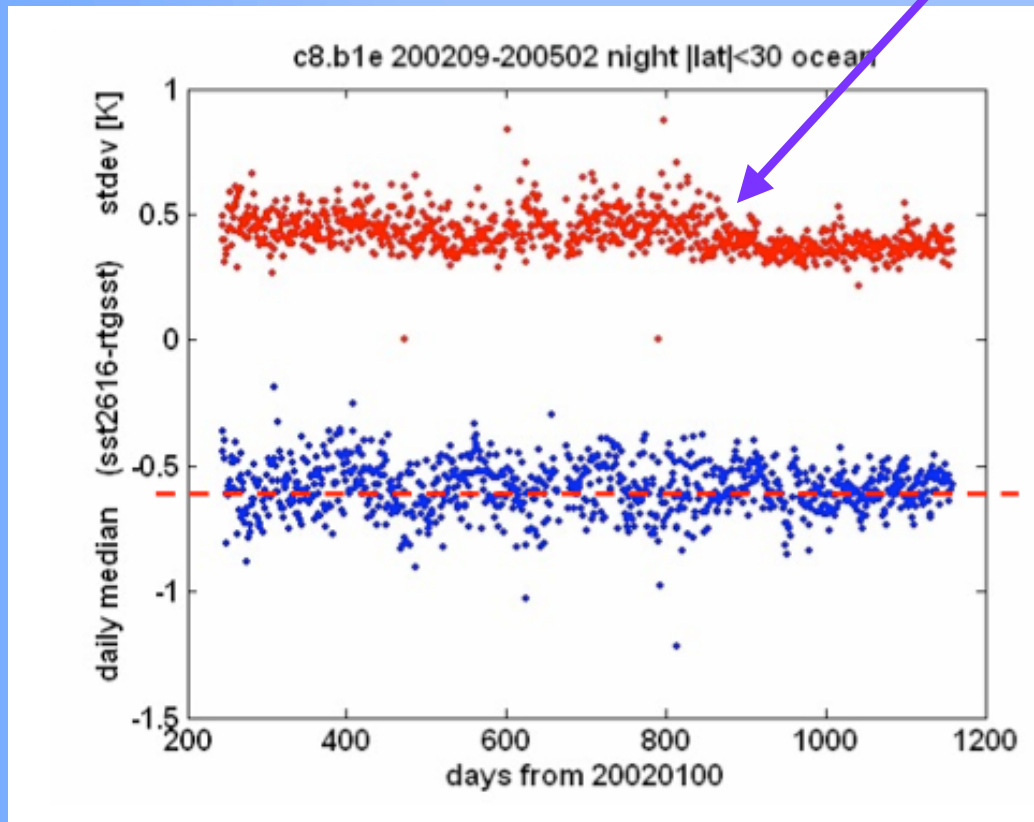
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## Radiometric Stability of AIRS



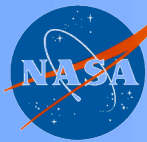
- 2.5 years of AIRS SST compared to RTGSST shows impressive measurement stability
- RTGSST at night is 0.4K warmer than the skin temperature measured by AIRS
- bias = -0.589 K
- (-4 +/-4) mK/year trend upper limit 8mK/year
- AIRS stable enough to sense RTG improvement in May 2004 (Blue arrow)

Due to H. H. Aumann, JPL

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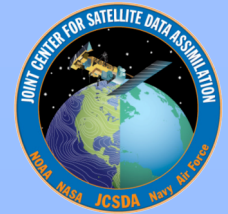


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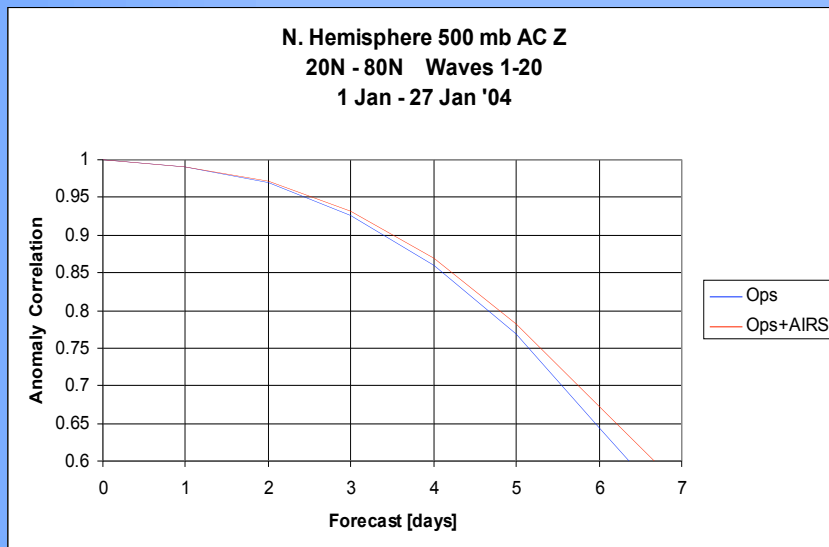
# Assimilation of AIRS Improves Forecast Accuracy

**Joint Center for Satellite Data Assimilation (JCSDA)  
NCEP Operational Model**



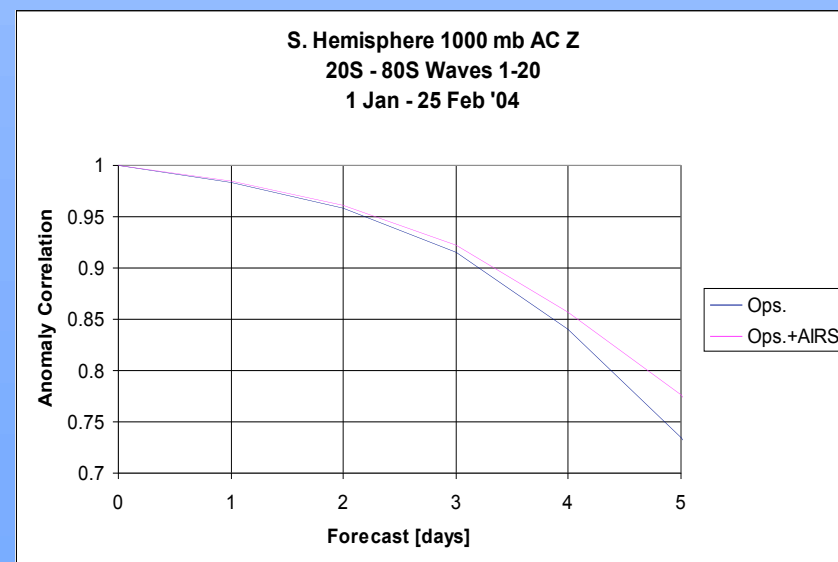
**“A several hour increase in forecast range at five or six days normally takes several years to achieve at operational weather centers” and “This magnitude of improvement is quite significant when compared with the rate of general forecast improvement over the last decade”. John Le Marshall in EOS, March 15 2005, Vol 86, No 11**

## Northern Hemisphere (6 hrs on 6 Day Forecast)

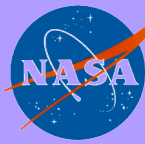


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## Southern Hemisphere (8 hrs on 5 Day Forecast)



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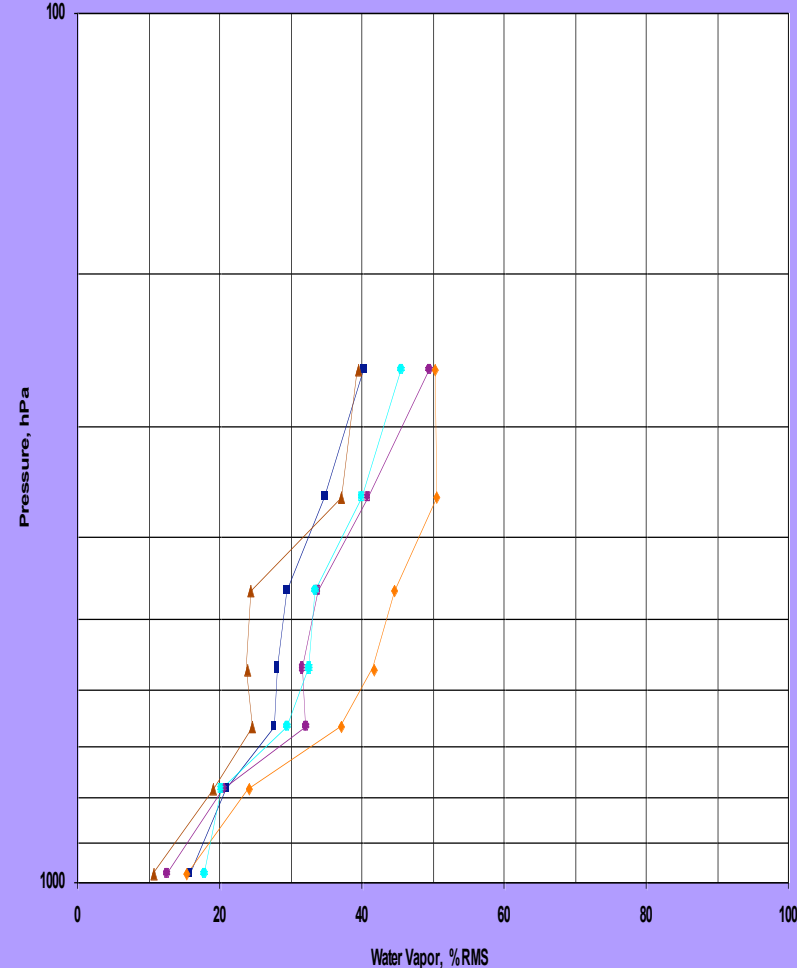
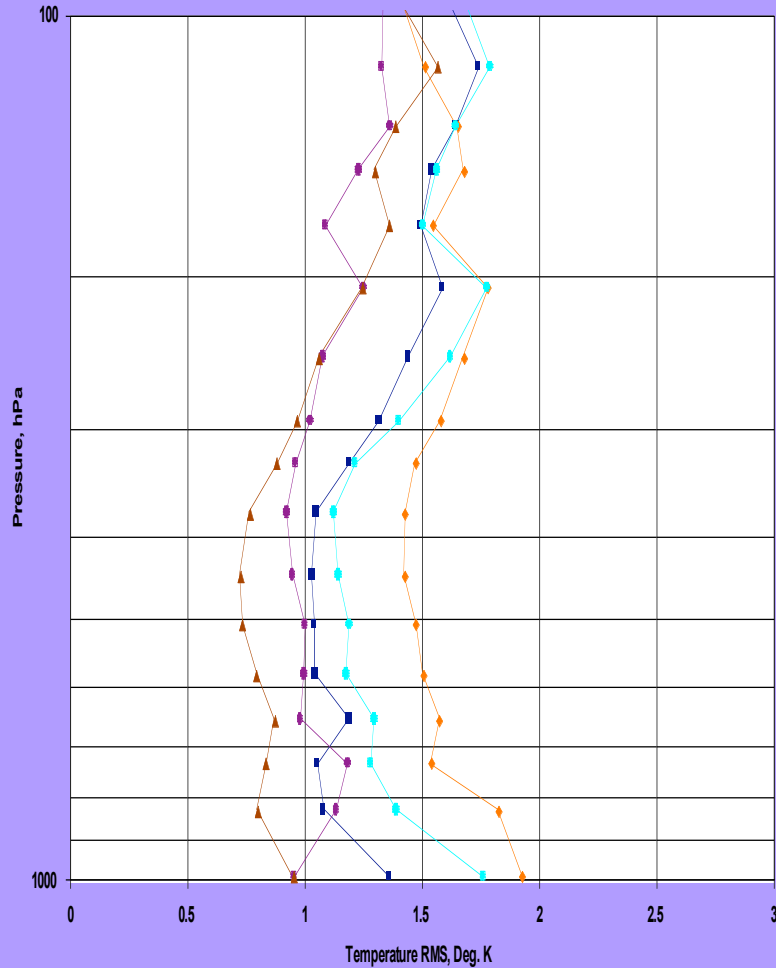
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# Temperature and WV RMS Difference: Sea only

**RAOB vs. AIRS** **AVN** **ATOVS** **FG** **ECMWF**

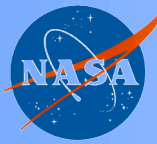
NSTAT= 5,330 N\_ECMWF = 1137



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Due to Murty Divakarla, NESDIS

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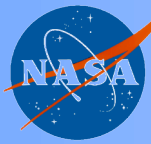
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## Level 3 Data

- **One degree by one degree spatial resolution**
- **Counts and standard deviations as well as mean**
  - Multi day products can be generated from daily products
- **MW only products in addition to combined IR/MW products**
  - Combined products tend to sample clearer fields of view
  - MW only products include MW only temperature and water vapor profiles, total cloud liquid water, MW surface emissivity at 50.3 GHz
- **Separate Ascending and Descending data**
- **Combined IR/MW data products include temperature/water vapor/ozone profiles, cloud parameters, surface parameters**
- **Level 3 products based on version 3 level 2 data are available for Sept 2002 - April 2005**
- **Version 4 level 3 files are available from GSFC DAAC**

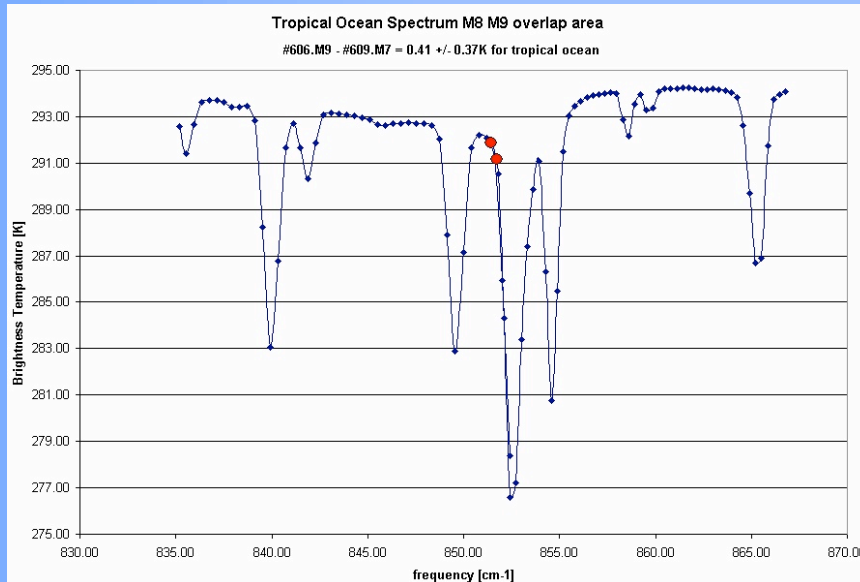


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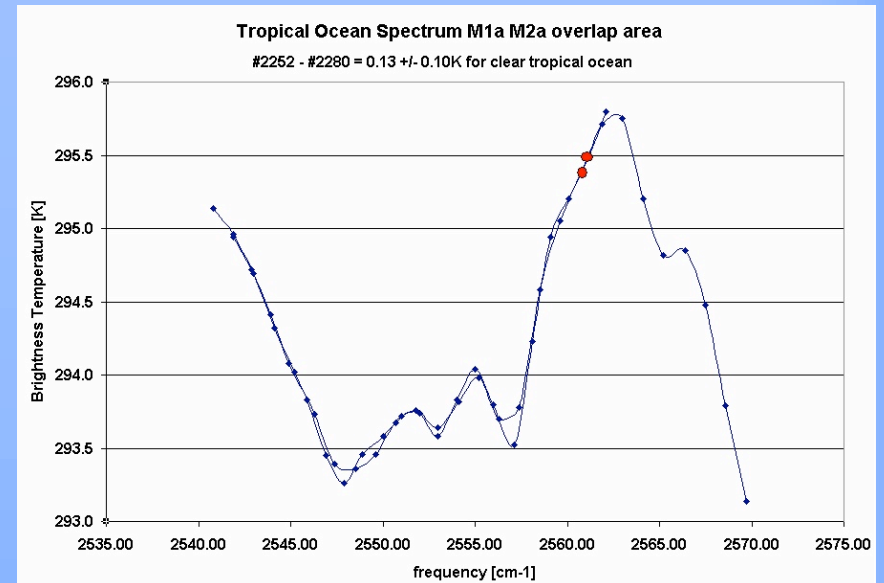


## Rdiff\_lwindow and Rdiff\_swindow

### Longwave Cij



### Shortwave Cij

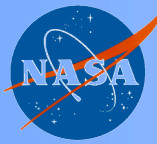


Graphics due to H. H. Aumann

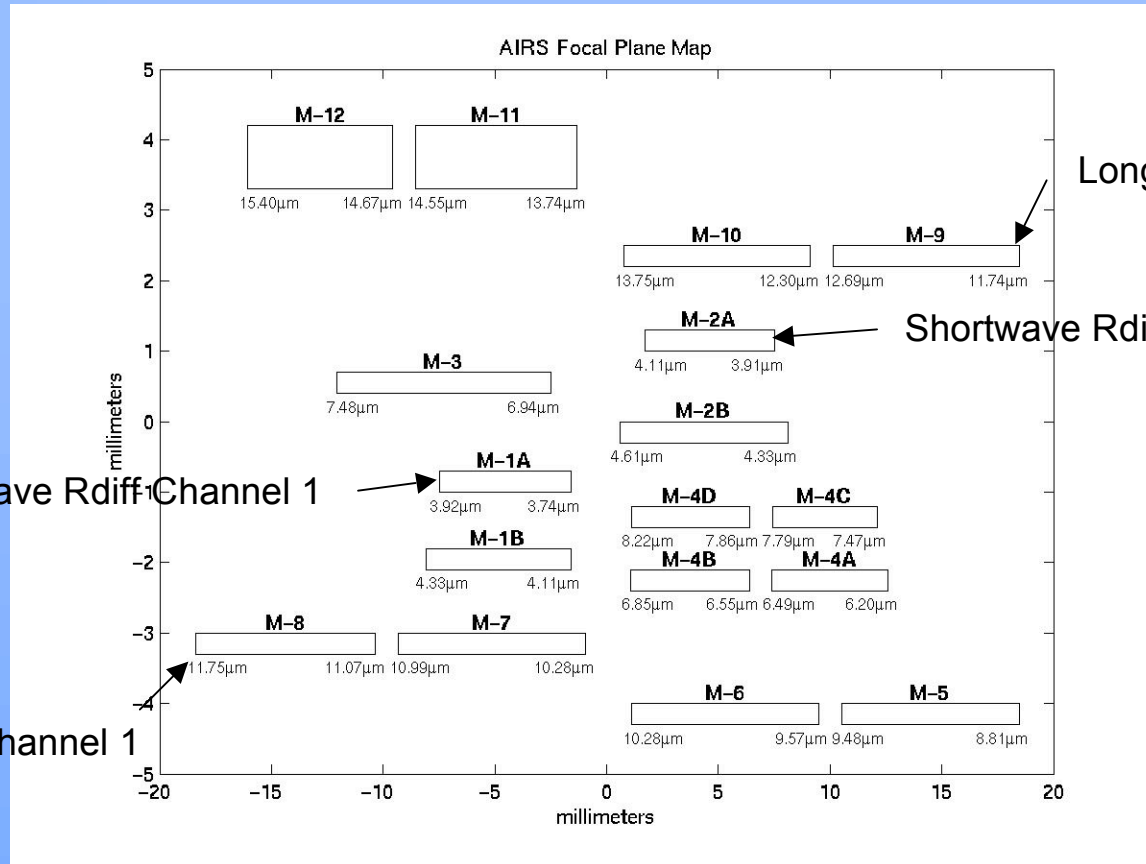
- **AIRS is uniquely able to measure channel inhomogeneity**
  - AIRS has sets of channels that measures same spectral radiances from two different parts of focal plane
- **AIRS has  $C_{ij} > 0.95$  for most channels**
- **No correlation was found between Rdiff and retrieval quality (C Barnett)**

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# AIRS Focal Plane



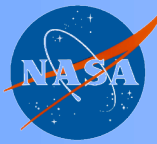
Longwave Rdiff Channel 2

Shortwave Rdiff Channel 2

Shortwave Rdiff Channel 1

Longwave Rdiff Channel 1

- Same spectral channel on different parts of focal plane
- Rdiff\_lwindow and Rdiff\_swindow are the radiance differences



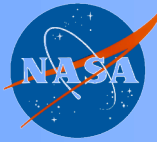
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## Validation Activities

- **Radiances with aircraft instruments.**
- **Microwave and infrared forward models using in situ observations.**
- **Extensive comparisons with ECMWF.**
- **Total ozone against TOMS and sondes.**
- **Temperature and humidity with dedicated sondes.**
- **Comparisons with 10,000+ operational sondes.**
- **Comparisons with other A-Train observations.**
- **Long-term trending of radiances against RTG.SST.**
- **AWEX reconciliation of in situ upper trop humidity observations.**



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## Other AIRS related Research Activities

- **Ozone**
  - Match TOMS to better than 5% except over ice.
  - Achieved Day or Night, Globally
- **CO**
  - Good horizontal resolution and coverage
- **CH<sub>4</sub>**
  - First retrievals show expected behavior
- **CO<sub>2</sub>**
  - Seasonal and annual trends match expectations
- **SO<sub>2</sub>**
  - AIRS distinguishes ash cloud from SO<sub>2</sub> gas
- **Aerosols**
  - Silicate signatures allow dust detection



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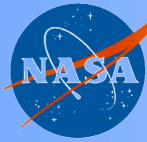
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## Data and Document Access from JPL and GDAAC

- **AIRS Version 4.0 Release User Documentation**
  - Significant Changes from V3 to V4
- **Subsetting Capabilities at GSFC DAAC : New**
- AIRS Public Web Page:  
**<http://airs.jpl.nasa.gov/>**
- AIRS Team Web Page:  
**<http://airsteam.jpl.nasa.gov/>**
- AIRS Data Support at DAAC:  
**<http://disc.gsfc.nasa.gov/AIRS/index.shtml>**
- AIRS DATA on DATA POOL:  
**<http://daac.gsfc.nasa.gov/data/datapool/AIRS/index.html>**
- Submit Questions about AIRS at URL:  
**[http://airs-inquiry.jpl.nasa.gov/feedback/feedback\\_form.cfm](http://airs-inquiry.jpl.nasa.gov/feedback/feedback_form.cfm)**
- Register for Announcements and Newsletter at URL:  
**<http://airs-inquiry.jpl.nasa.gov/DataRegistration/data/index.cfm>**





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## Plan for Version 5

- **Mid to late 2006 time frame**
- **No major changes are expected for calibration software**
- **Level 2**
  - Emissivity retrieval upgrade
  - No AMSU option
  - Error estimation upgrade
  - Remove or improve bias tuning
  - Minor gases (CO<sub>2</sub>, CH<sub>4</sub>, CO, SO<sub>2</sub>) retrieval
  - Dust/cirrus retrieval
- **Level 3**
  - Quantization products