

## AIRS Project Status

NASA Sounder Science Team Meeting

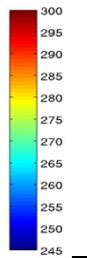
May 5, 2009, Pasadena, Ca

Thomas Pagano, AIRS Project Manager

California Institute of Technology, NASA JPL

AIRS 278 K Isotherms of Surface Temperature. DCF 2002-2008

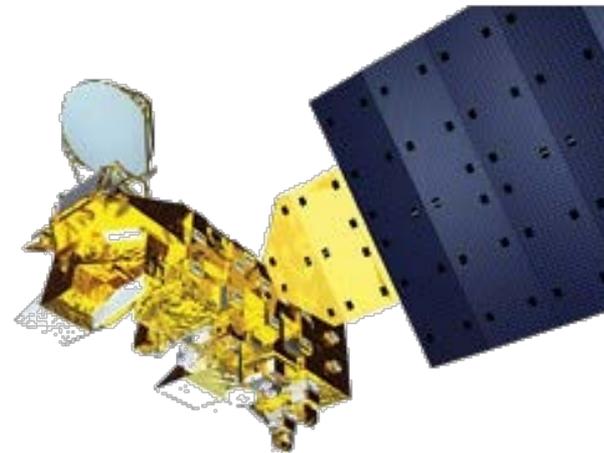
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008





# Instrument and Spacecraft Status

- AIRS
  - High Calibration Accuracy,
  - Climate Quality Stability Demonstrated compared to in-situ observations.
  - Performance Continues to be Excellent
  - Telemetry shows minimal wear or degradation
- AMSU
  - Channel 5, while still useful, is steadily degrading and will probably become too noisy to use by this coming January or so
  - 12 of the 15 channels show no signs of any degradation
  - An AIRS/AMSU-A anomaly resolution guide complete
- Aqua is in very good condition
  - Some minor anomalies (mostly involving the power system) have occurred over the years
    - None ever interfered with operations
    - No new anomalies during the past year
  - A software problem with the solid state recorder (caused partly by operator error), which developed on December 2, 2007, was fixed this past January
    - Due to ground software workarounds, only a few hours of data were lost due to this incident
  - Present estimates say fuel will last until 2020



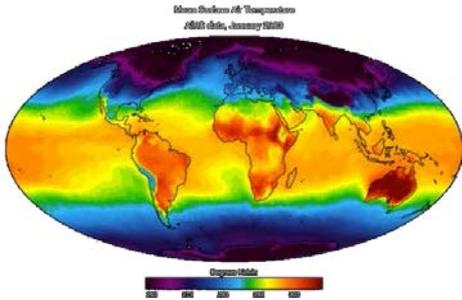


National Aeronautics and Space Administration

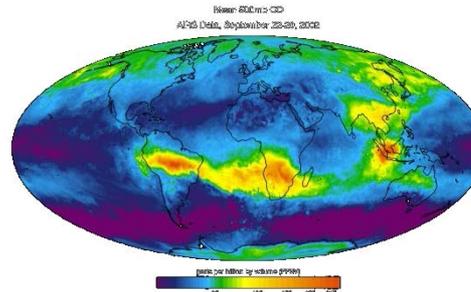
Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

# AIRS Science Products

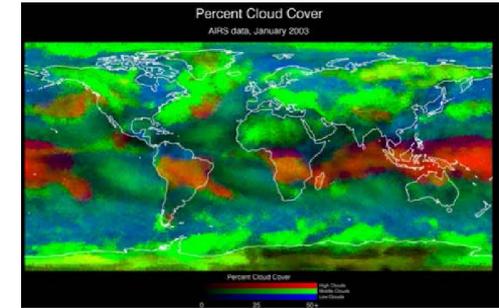
## Atmospheric Temperature



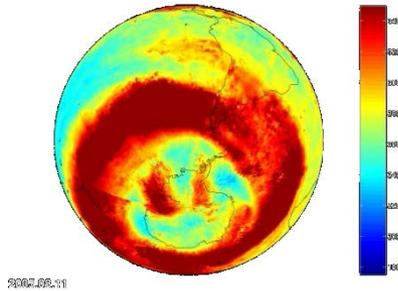
## CO



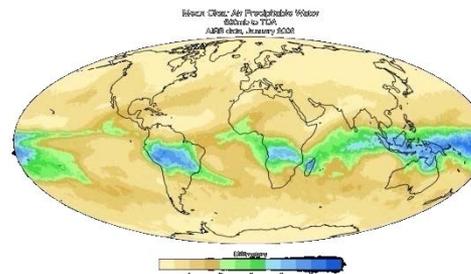
## Cloud Properties



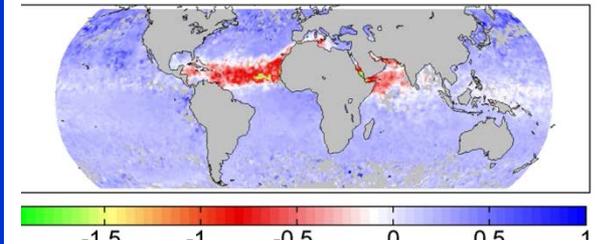
## Ozone



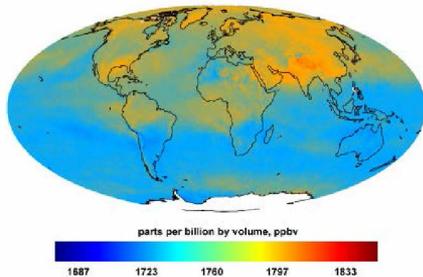
## Atmospheric Water Vapor



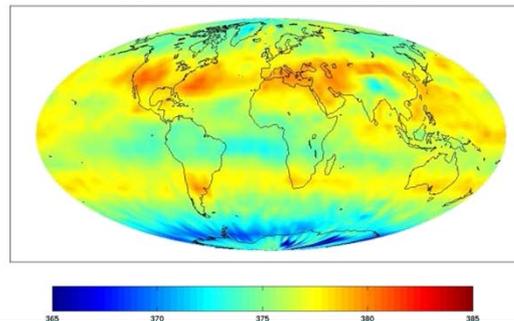
## Dust



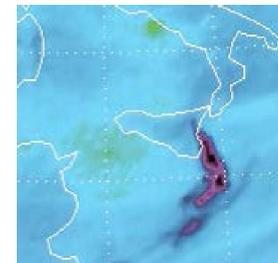
## Methane



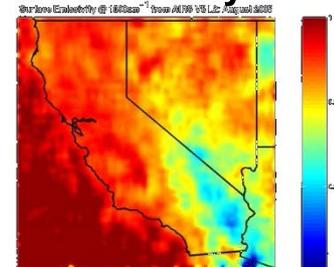
## CO2

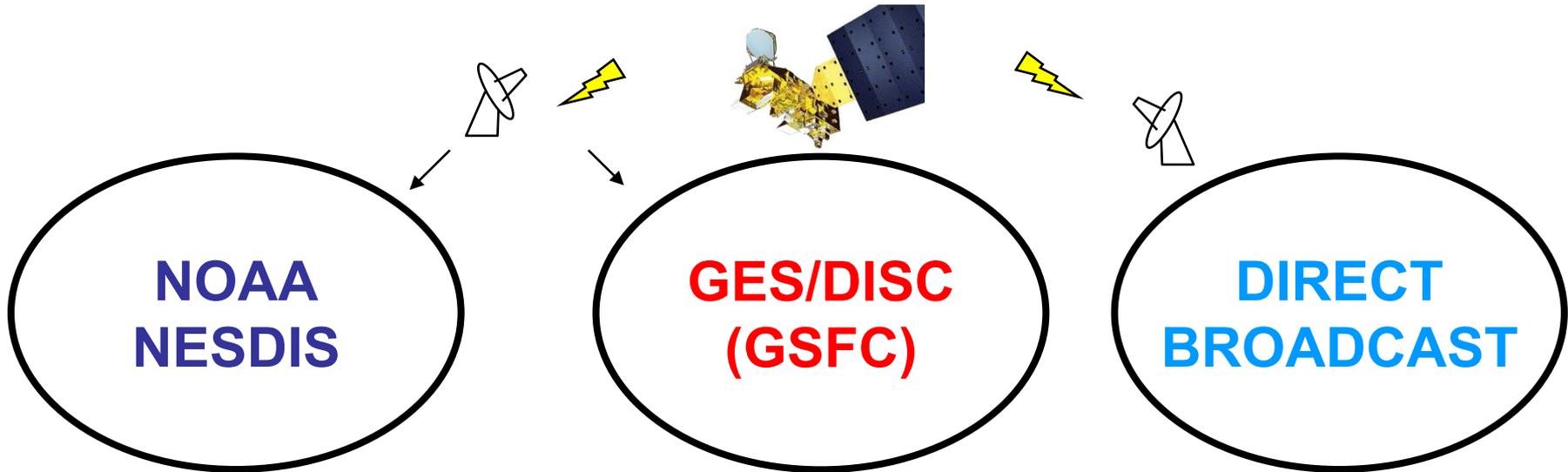


## SO2



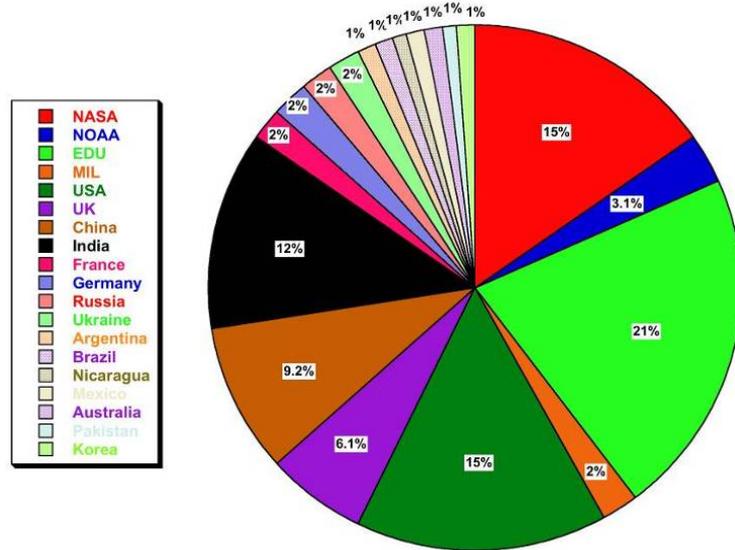
## Emissivity





**537 Registered Data Users (05/03/09)**

AIRS Registered Users by Country



NWP Centers

- NCEP
- CMC (Canada)
- JMA (Japan)
- FNMOG (US Navy)
- BMRC (Australia)
- UK Met Office
- ECMWF (Europe)
- Meteo-France
- DWD (Germany)
- CPC

[star.nesdis.noaa.gov](http://star.nesdis.noaa.gov)

- Universities
- SPoRT (Regional)
- Brazil (INPE)
- China
- Korea
- DoD
- Other International

[daac.gsfc.nasa.gov](http://daac.gsfc.nasa.gov)

[cimss.ssec.wisc.edu/imapp](http://cimss.ssec.wisc.edu/imapp)



# CO<sub>2</sub> and CO Elevated to Core Products in 2009 Aqua Senior Review Proposal

AIRS Product	Product	Accuracy (V5)	Val Status (V5)
<b>Core: Radiances</b>			
AIRS IR Radiance	L1B-AIRS	<0.2K	Stage 3
AIRS VIS/NIR Radiance	L1B-VIS	15-20%	Stage 1
AMSU Radiance	L1B-AMSU	1-3 K	Stage 3
HSB Radiance	L1B-HSB	1-3 K	Stage 3
<b>Core: Geophysical</b>			
Cloud Cleared IR Radiance	L2	1.0 K	Stage 2
Sea Surface Temperature	L2	1.0 K	Stage 2
Land Surface Temperature	L2	2-3 K	Stage 1
Temperature Profile	L2	1 K / km	Stage 3
Water Vapor Profile	L2	15% / 2km	Stage 3
Total Precipitable Water	L2	5%	Stage 3
Fractional Cloud Cover	L2	20%	Stage 2
Cloud Top Height	L2	1 km	Stage 2
Cloud Top Temperature	L2	2.0 K	Stage 2
Carbon Monoxide	L2	15%	Stage 2
Carbon Dioxide	Post-Proc	1-2 ppm	Stage 1
<b>Core: Necessary*</b>			
Total Ozone Column	L2	5%	Stage 2
Ozone Profile	L2	20%	Stage 2
Land Surface Emissivity	L2	10%	Stage 1
IR Dust	L1B-Flag	0.5 K	Stage 1
<b>Research Products</b>			
Methane	L2	2%	Stage 1
OLR	L2-Support	5 W/m <sup>2</sup>	Stage 1
HNO <sub>3</sub>	L1B-Post	0.2 DU	Stage 1
Sulfur Dioxide	L1B-Flag	1 DU	Stage 1

*CO<sub>2</sub> and CO  
Have High Priority for*

- Product Development*
- Validation*

*(along with other core products)*

\*Necessary Products are required to retrieve accurate temperature profiles (1K/km) in all conditions

#### Validation Status Definitions (Common to all Aqua Instruments)

Stage 1: Validation Product accuracy has been estimated using a small number of independent measurements obtained from selected locations and time periods and ground-truth/field program effort.

Stage 2: Validation Product accuracy has been assessed over a widely distributed set of locations and time periods via several ground-truth and validation efforts.

Stage 3: Validation Product accuracy has been assessed, and the uncertainties in the product well-established via independent measurements made in a systematic and statistically robust way that represents global conditions.

*Project Requires Science  
Community Support for  
Validation*



National Aeronautics and  
Space Administration

Jet Propulsion Laboratory  
California Institute of Technology  
Pasadena, California

# AIRS Releases Mid-Trop CO<sub>2</sub> Data

AIRS Releases 6 Years Mid-Trop CO<sub>2</sub> Data to Public, and 3 new papers...

- **NASA/JPL**

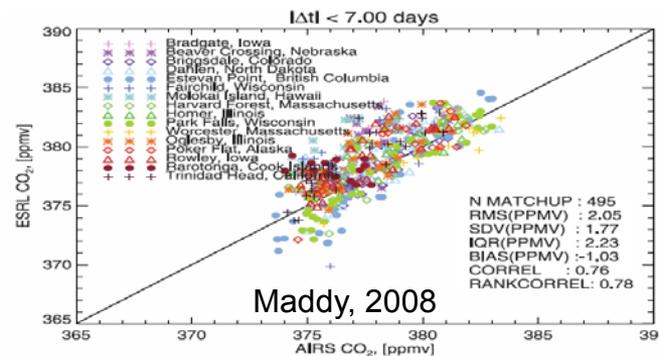
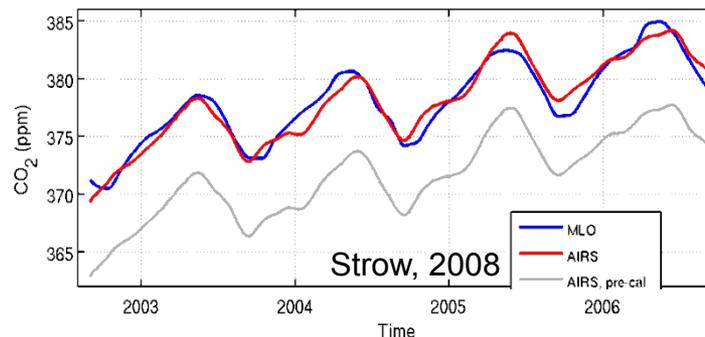
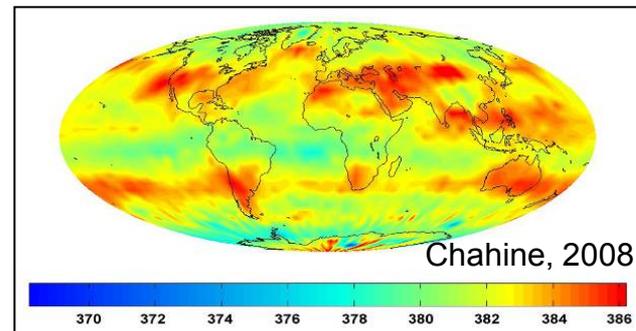
- Satellite Remote Sounding of Mid-Tropospheric CO<sub>2</sub>, Chahine, M.T., Chen, L., Dimotakis, P., Jiang, X., Li, Q., Olsen, E.T., Pagano, T., Randerson, J., Yung Y.L., Geophys.Res.Lett., 2008, 35, L17807, doi:10.1029/2008GL035022

- **UMBC**

- L. Larrabee Strow and Scott E. Hannon, A 4-year zonal climatology of lower tropospheric CO<sub>2</sub> derived from ocean-only Atmospheric Infrared Sounder observations Journal of Geophysical Research, accepted 29 May 2008; doi:10.1029/2007JD009713, 2008

- **NOAA**

- CO<sub>2</sub> retrievals from the Atmospheric Infrared Sounder: Methodology and Validation, Maddy, E.S., Barnet, C.D., Goldberg, M., Sweeney, C., Liu, X, Journal of Geophysical Research - Atmospheres, 2008, 113, D11, D11105





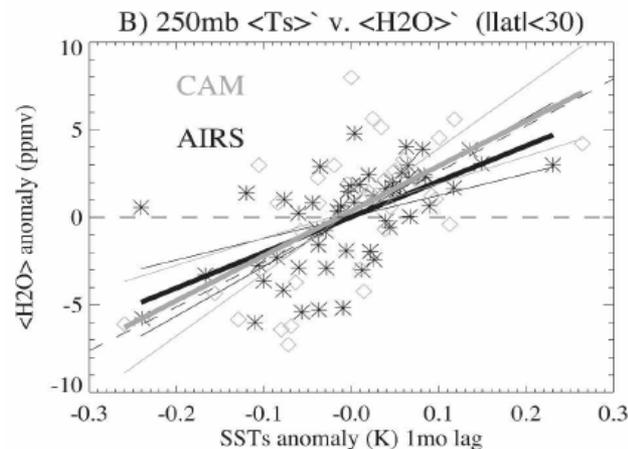
# AIRS Observes Water Vapor Feedback

- “These results provide enhanced confidence in the range of climate sensitivity in climate simulations, which are based on a positive upper tropospheric water vapor feedback... Furthermore, the results hint at a vertical structure to the variations, which may help reveal the processes responsible.” (Gettelman, 2008)
- “Positive  $\Delta q$  values indicate that  $q$  was higher during the warmer period (DJF07), consistent with an intuitive expectation of increasing atmospheric moisture with a warming planet. There are also regions where  $\Delta q$  is negative—meaning that  $q$  was lower during the warmer period—most notably in the subtropical mid-troposphere between 10N–20N.” (Dessler, 2008)
- “The existence of a strong and positive water-vapor feedback means that projected business-as-usual greenhouse gas emissions over the next century are virtually guaranteed to produce warming of several degrees Celsius.” (Dessler, 2008)

- Gettelman, A., Fu, Q., “Observed and simulated upper-tropospheric water vapor feedback”, *Journal of Climate*, 2008, 21, 13, 3282-3289
- A.E. Dessler, P. Yang, J. Lee, J. Solbrig, Z. Zhang, K. Minschwaner, “An Analysis of the dependence of clear sky top of atmospheric outgoing longwave radiation on atmospheric temperature and water vapor”, *Journal of Geophysical Research*, 2008, Vol, 113, D17102, doi: 10.1029/2008JDo10137, 2008

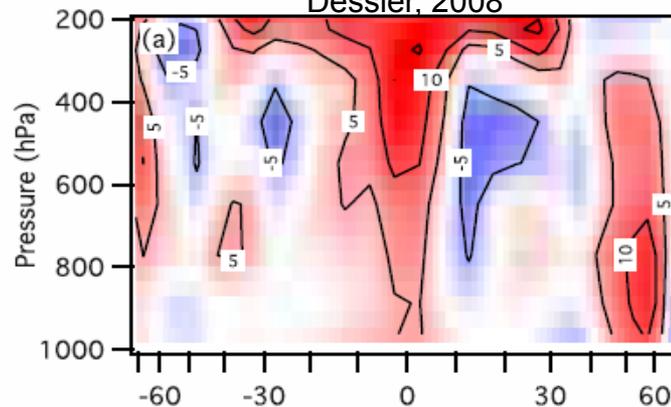
## Upper Trop Water Vapor Feedback

Gettelman, 2008

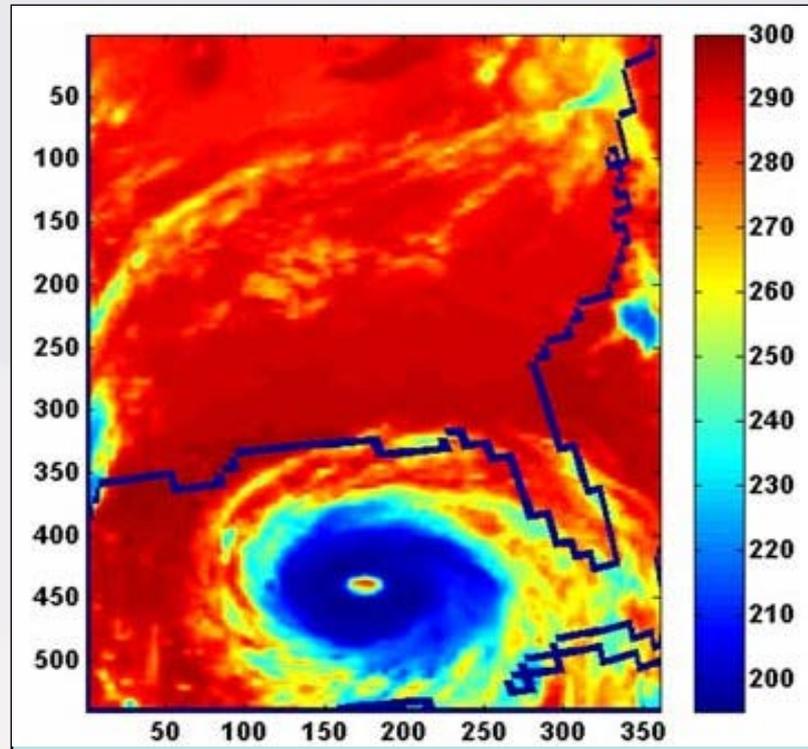


## Water Vapor % Difference 2007(Warmer)-2008(Cooler)

Dessler, 2008



# Frequency of Severe Storm and Global Warming



**Nasa Study Links Severe Storm Increase and Global Warming**

**Name, Journal, Date:**

**Aumann et al. GLR 2008**

**December 19, 2008 NASA Press Release**

**Problem:** In a global warming scenario, does the frequency and the strength of hurricanes and typhoons increase?

**Result:** The study using AIRS data shows that the frequency of severe storm increases 48%/ °C of warming of the tropical oceans. This corresponds to an increase of 5%/decade assuming warming continues at 0.1°C/decade.

**Significance:** Severe storms decrease in the current (AR4) climate models. The hyperspectral information from AIRS can be used to improve climate models.





National Aeronautics and  
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- ✓ = Algorithm Demonstrated
- ✓ = In process
- ✓ = Recently Completed

# Version 6 Algorithm Development Goals

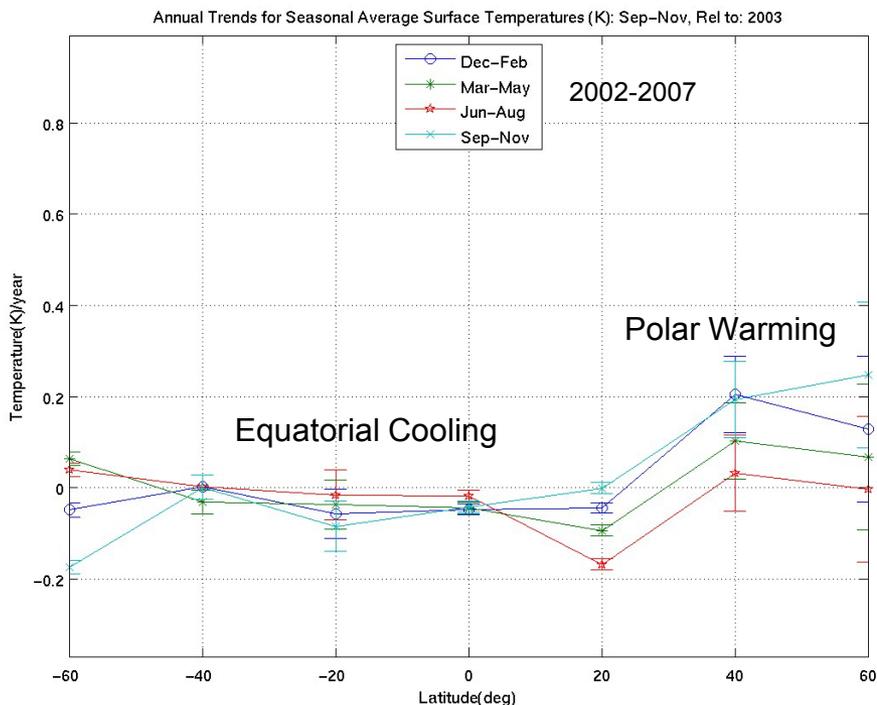
From 10/07 SciTeam Meeting

- **Susskind (GSFC)**
  - ✓ – Surface Parameters (T, e)
  - ✓ – Boundary Layer T, q
  - ✓ – Trend Evaluations/Recommendations
  - Improved Error Estimates and QC
  - ✓ – Cloud/Dust Product Improvement
  - ✓ – 1 x 3 Retrievals
- **Strow (UMBC)**
  - ✓ – L1C Algorithm
  - RTA Scattering Algorithm
  - ✓ – Additional RTA Tasks
    - ✓ • Dust
    - Cirrus
  - ✓ – OLR
- **Blackwell (MIT)**
  - SCC/NN Investigation
- **Barnet (NOAA)**
  - ✓ – Bias Trends Removal
  - Cloud Clearing vs Warmest FOV
  - ✓ – CO<sub>2</sub>
  - SO<sub>2</sub>, CH<sub>4</sub>, HNO<sub>3</sub>, N<sub>2</sub>O, O<sub>3</sub>
  - ✓ – CAPE, LI + Convective Products
  - ✓ – 1x3 (NOAA Interest, SPORT, Forecasters, etc.)
- **Goldberg (NOAA)**
  - ✓ – Initialization State (Regression Coefficients)
  - ✓ – Maintain RT System
- **Rosenkranz (MIT)**
  - ✓ – Updated MW RTA
- **JPL Science Team Algorithms**
  - ✓ – CO<sub>2</sub> (Chahine)
  - ✓ – Clouds (B. Kahn)
  - ✓ – L1C (H. Aumann)

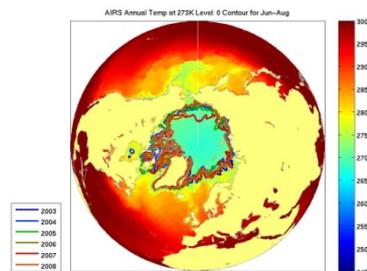
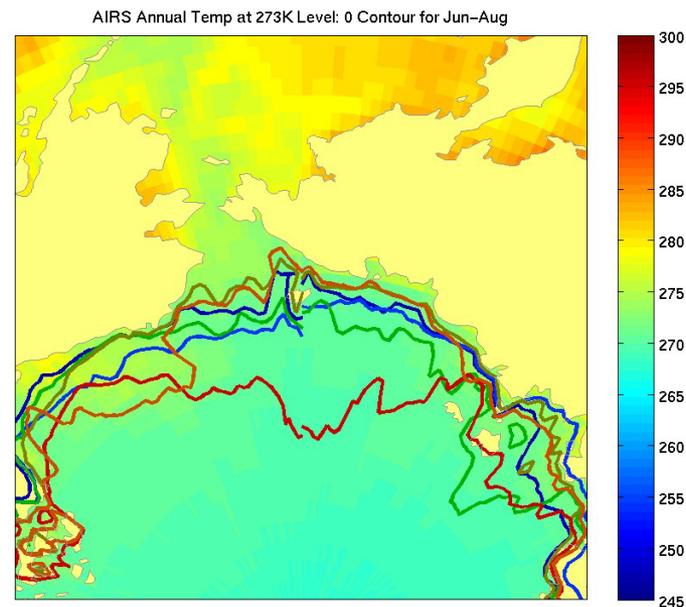


# Can we use AIRS Level 2 data for climate trending?

## Annual trends in $T_{surf}$ in Level 3



## Polar Isotherms



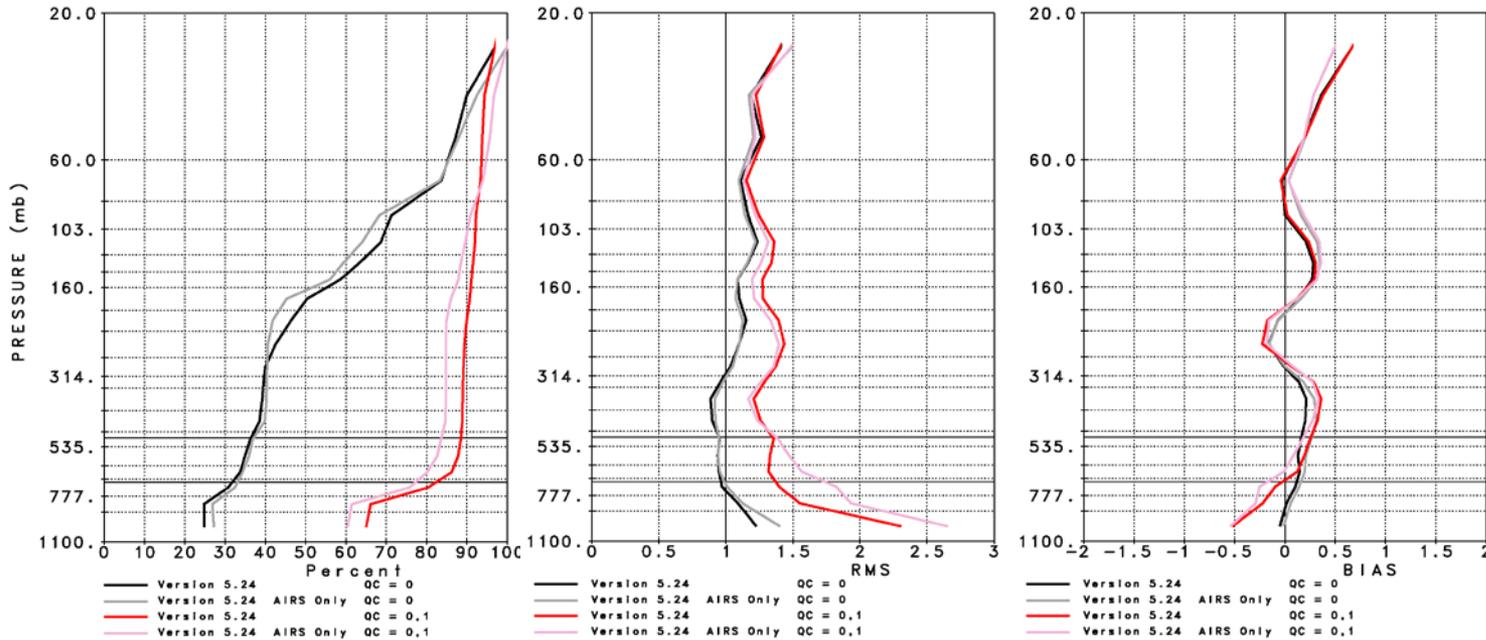
How do we validate < 50 mK/year?  
Major Priority for Version 6!



# AIRS-Only Retrievals have Comparable Performance to AIRS/AMSU

Global  
September 6, 2002 January 25, 2003 September 29, 2004

Percent of All Cases Included Layer Mean RMS Temperature (°C) Layer Mean BIAS





# User Services Request and Registered Users Growing

- **User Services**

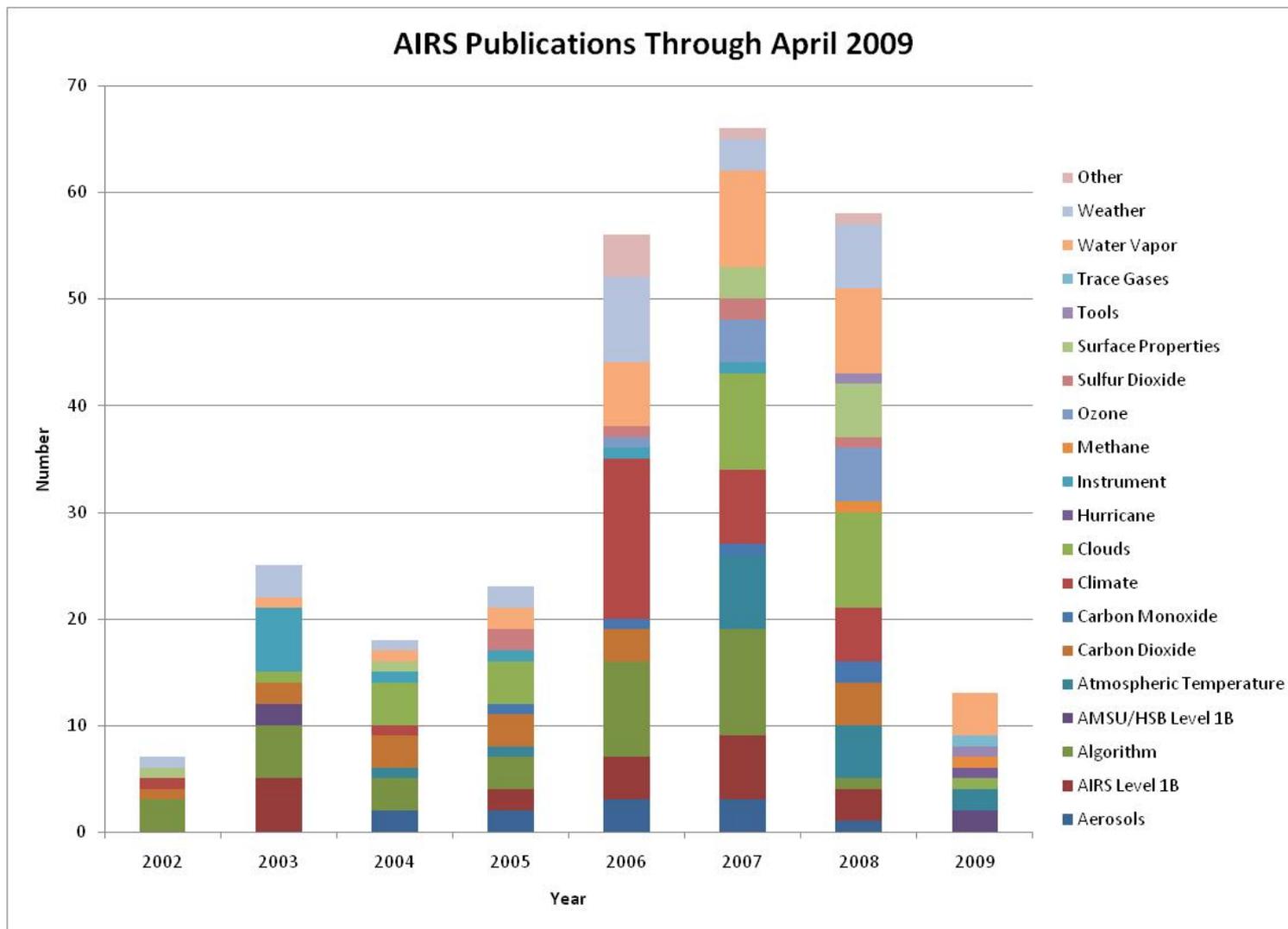
- **As of May 3, 2009, 322 questions have been asked and answered at AskAIRS**
- **27 have been submitted so far in 2009**
- **72 were submitted in 2008**
- **68 were submitted in 2007**
- **43 were submitted in 2006**

- **Registered Users**

- **As of May 3, 2009 there are 537 Registered AIRS Data Users**
- **55 registered so far in 2009**
- **213 registered in 2008**
- **150 registered in 2007**
- **88 registered in 2006**



# AIRS Peer-Reviewed Science Publications Through April 2009; 267 Total





# Summary

- Instrument and spacecraft operations going smoothly
- AIRS CO and CO<sub>2</sub> are core products.
- Validation status needs updating for all products. Need community support
- Major recent science accomplishments
  - Water vapor feedback
  - Deep Convective Clouds
  - Mid and Lower Tropospheric CO<sub>2</sub> Distribution
- Major Improvements Made to V6
  - Level 1B Calibration
  - Boundary Layer
  - Initialization State and Regression
- Expect V6 available to public in 1 year from now.
- Small Community doing a **Fantastic Job**



# Atmospheric Sounding Community

