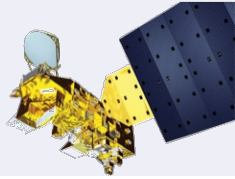

The Atmospheric Infrared Sounder Project Status

NASA Sounder Science Team Meeting

September 30, 2014

Thomas S. Pagano &
J. Teixeira, E. Fetzer, B. Lambrigtsen, S. Friedman, D. Elliott, H. Aumann, S. Ray, E. Olsen

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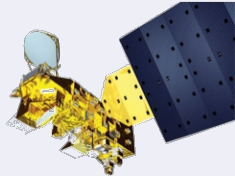
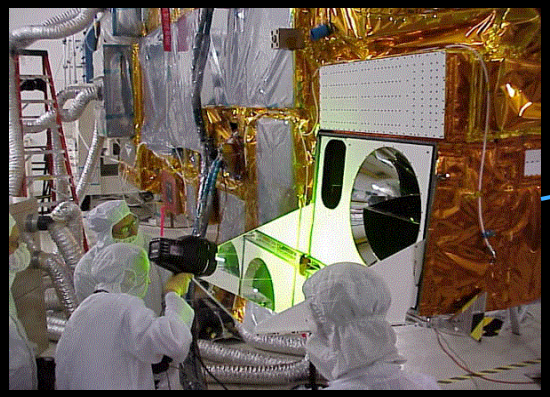
Agenda



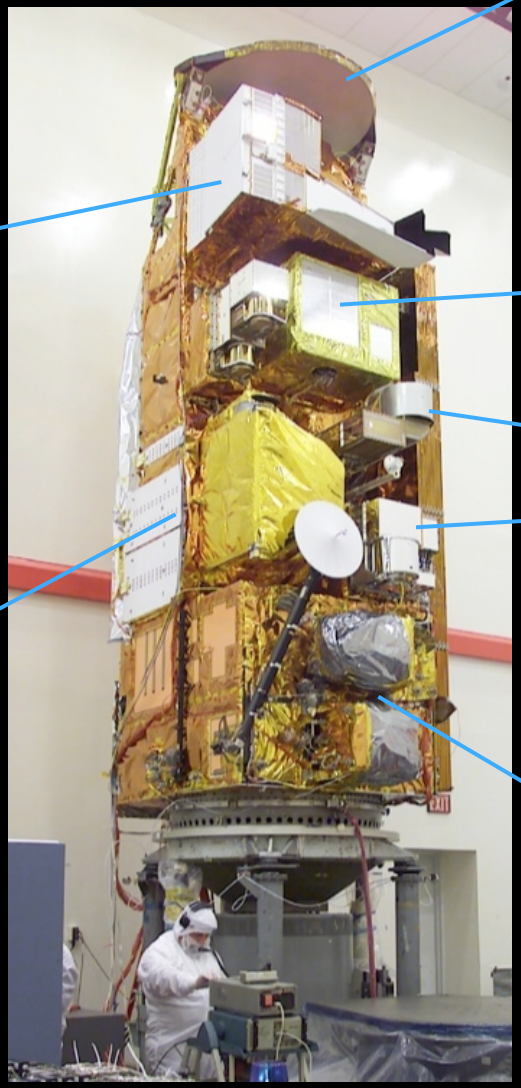
- AIRS Project Key Activities
  - Instrument Operations
  - Instrument Calibration
  - Standard Data Production at GSFC DAAC. V6 Reprocessing Complete
  - JPL Unique Processing Ongoing (for Validation and Research Products)
  - Science Integration (V6+ and V7) Starts Now
  - Data Product Validation
    - Focusing on Lower Tropospheric Temperature and Water Vapor
    - Trace Gases: Validation focus at JPL is CO2 and O3. Rely on Community
  - Applications Product Development
  - User Services
  - Education and Public Outreach

The Aqua Spacecraft
Launched May 4, 2002



Moderate Resolution Imaging Spectroradiometer (MODIS)
GSFC/Raytheon

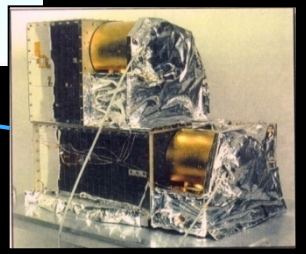
Atmospheric Infrared Sounder (AIRS)
JPL/BAE SYSTEMS



AQUA Spacecraft
GSFC/NGST

Advanced Microwave Scanning Radiometer (AMSR-E) MSFC/ JAXA

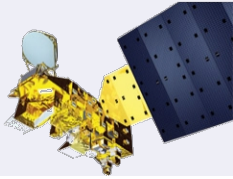
Advanced Microwave Sounding Units (AMSU-A/B)
JPL/Aerojet



Humidity Sounder from Brazil (HSB)
JPL/Aerojet

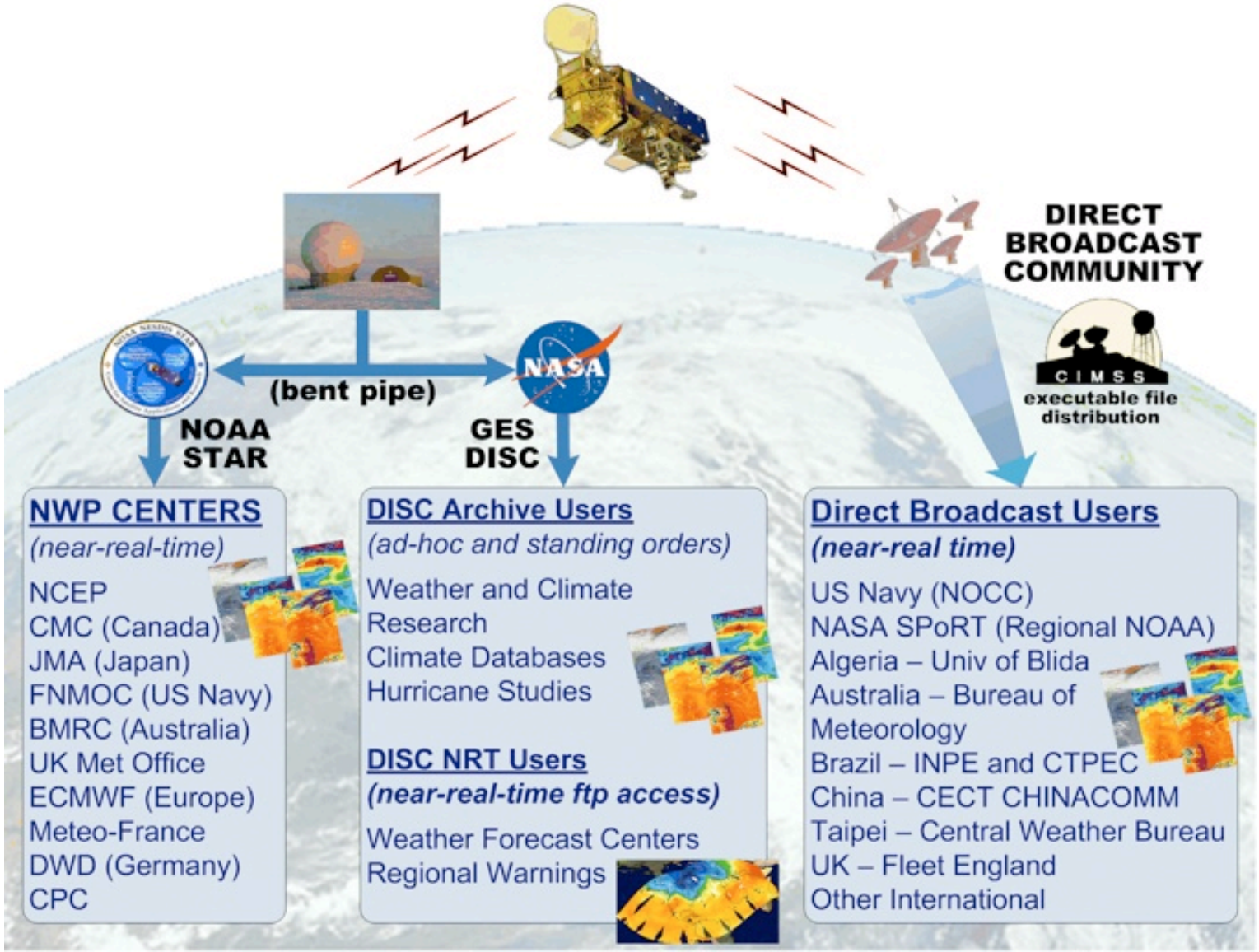
Clouds and Earth Radiant Energy System (CERES)
LaRC/NGST

AIRS Operations and Calibration Status

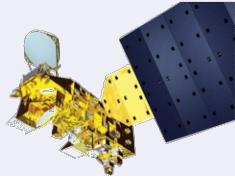


- Operations
  - Routine health monitoring—AIRS is in excellent condition and science data quality remains high
  - Routine commanding for
    - Drag make up maneuvers
    - Debris avoidance maneuvers
    - MODIS lunar calibration roll maneuvers
    - Photometric calibrations
  - Gain table update is in work
  - Cooler A telemetry/commanding anomaly
    - cannot communicate with cooler A but its compressor is working fine
    - more in Denis Elliott's talk on Thursday
- Calibration
  - Level 1C first delivery is nearly ready—more in Evan Manning's talk on Thursday
  - Polarization measurements of a scan mirror witness sample are in progress
  - On-going comparisons with other instruments—George Aumann has a CrIS/AIRS comparison talk on Thursday
  - For the long term
    - Improvements to Level 1B to make AIRS an even better climate instrument
    - Second delivery of Level 1C with expanded functionality
  - Session on instrument calibration on Thursday

NRT Data Essential for Applications. NRT built into AIRS Experiment



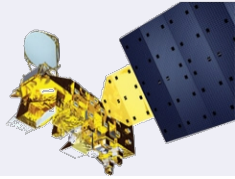
V6 Data Processing Progress



- Version 6 Reprocessing, which began in March 2013, was completed in June 2014 and includes:
  - AIRS+AMSU-A for entire mission
  - AIRS (IR-Only) for entire mission
  - AIRS+AMSU+HSB (late-August 2002 - early-February 2003), includes AMSU-A Channels 4 and 5

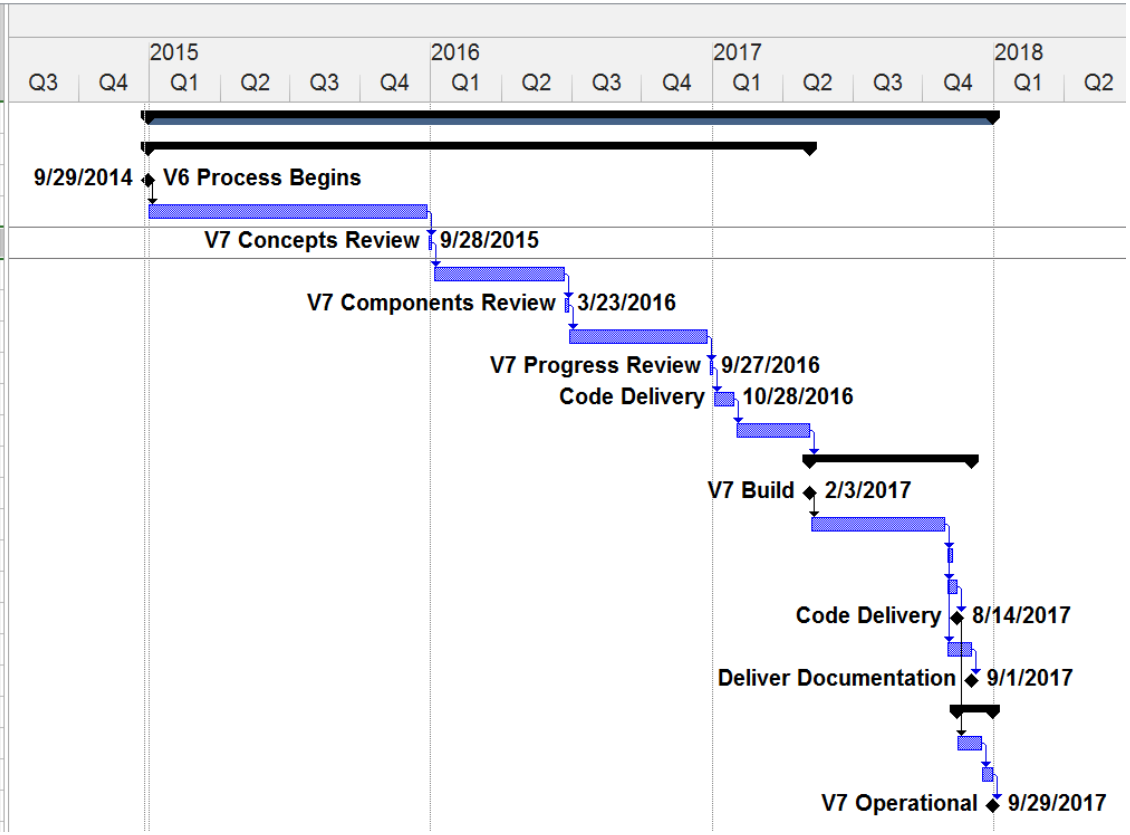
  - All standard products Level 1B, Level 2 and Level 3 are being produced routinely
- CO2 processing continues with Version 5 IR-Only
  - Products are produced monthly and archived at the GES DISC
- Level 1B and Calibration Subsets are produced using the Version 5 code base (not updated for V6)
- See Steve Friedman at JPL for more information on AIRS data processing and any special requirements

V7 Schedule Starts NOW!
Three years to release.

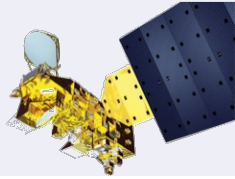


V7_Plan_at_SciTeam_2014-09.mpp

Task Name
V7 End-to-End
V7 Development
V7 Kickoff - Science Team Meting
V7 Concept Development and Prototyping
Science Team Meeting - V7 Concepts Review
V7 Code Development
Science Team Meeting - V7 Components Review
Continued V7 Development
Science Team Meeting - V7 Progress Review
Science Team Delivers Code
V7 Code Integration at JPL
Test and Deliver
V7 Candidate Build
V7 Integration and Test (JPL)
V7 Acceptance Tests
V7 Packaging
V7 Code Delivery
V7 User Documentation
V7 Deliver Documentation
GES DISC I&T
V7 Integration and Test (GES DISC)
V7 End-toEnd Flow Testing
V7 Data Processing Begins

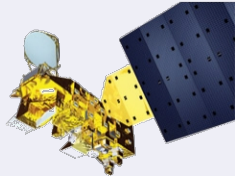


AIRS Project Science and Validation



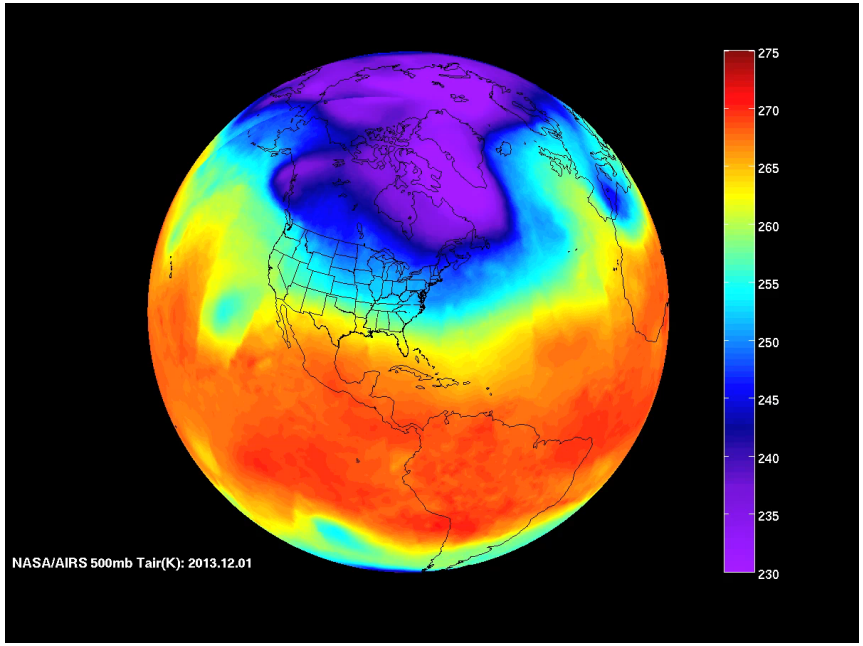
- AIRS Project Provides Science Data Product Integration and Test and Validation for AIRS data products
  - Project Science (Eric Fetzer)
  - Microwave Instrument Science (Bjorn Lambrigtsen, Team Lead and Group Supervisor)
  - Algorithm/product development, I&T (V7: Bill Irion; CO2: Edward Olsen; Clouds: Brian Kahn; RTM/Spectroscopy: Mathias Schreier, Evan Fishbein, Qing Yue, Luke Chen)
  - Climatology/L3 (Baijun Tian)
  - Validation (Eric Fetzer/Bjorn Lambrigtsen coordinators + Van Dang, Sun Wong)
  - Applications Research (Bjorn Lambrigtsen coordinator; Stephanie Granger/Ali Behrangi – drought…)
  - 5-10 papers published per year
- Recent activities (some reported through talks at this meeting)
  - V6 testing: V6 Test report
  - V6 validation: NSAT (Dang's talk); temperature (Wilson's talk); uncertainties (Wong's talk); misc. publishable research (Yue's, Kahn's, Schreier's talks)
  - Validation data sets: Collection & consolidation
  - Performance metrics: Under development
  - Climatology: Obs4Mips (Tian's talk); various climatologies under development

Product Validation Status



AIRS Product	Product	Accuracy (V5)	Val Status (V5)
Core: Radiances			
AIRS IR Radiance	L1B-AIRS	<0.2K	Stage 3
AIRS VIS/NIR Radiance	L1B-VIS	15-20%	Stage 2
AMSU Radiance	L1B-AMSU	1-3 K	Stage 3
HSB Radiance	L1B-HSB	1-3 K	Stage 3
Core: Thermodynamic			
Cloud Cleared IR Radiance	L2	1.0 K	Stage 2
Sea Surface Temperature	L2	1.0 K	Stage 3
Land Surface Temperature	L2	2-3 K	Stage 2
Land Surface Emissivity	L2	10%	Stage 2
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 3
Cloud Top Height	L2	1 km	Stage 3
Cloud Top Temperature	L2	2.0 K	Stage 3
Core: Composition			
Carbon Monoxide	L2	15%	Stage 2
Carbon Dioxide	Post-Proc	1-2 ppm	Stage 2
Total Ozone Column	L2	5%	Stage 3
Ozone Profile	L2	20%	Stage 2
Dust	L1B	0.5 K	Stage 1
Methane	L2	2%	Stage 2
OLR	L2	5 W/m2	Stage 3
Sulfur Dioxide	L1B & L2	1 DU	Stage 1
Research Products			
Dust	L2	TBD	TBD
HNO3	L1B-Post	TBD	TBD
NH3	L2	TBD	TBD
N2O	L2	TBD	TBD

AIRS Measures Key Greenhouse Gases with Global Daily Coverage



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.

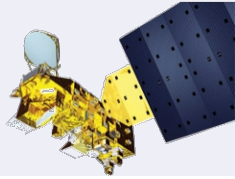
Stage 2: Validation Product accuracy has been assessed over a widely distributed set of locations and time periods via several ground-truth and validation efforts.

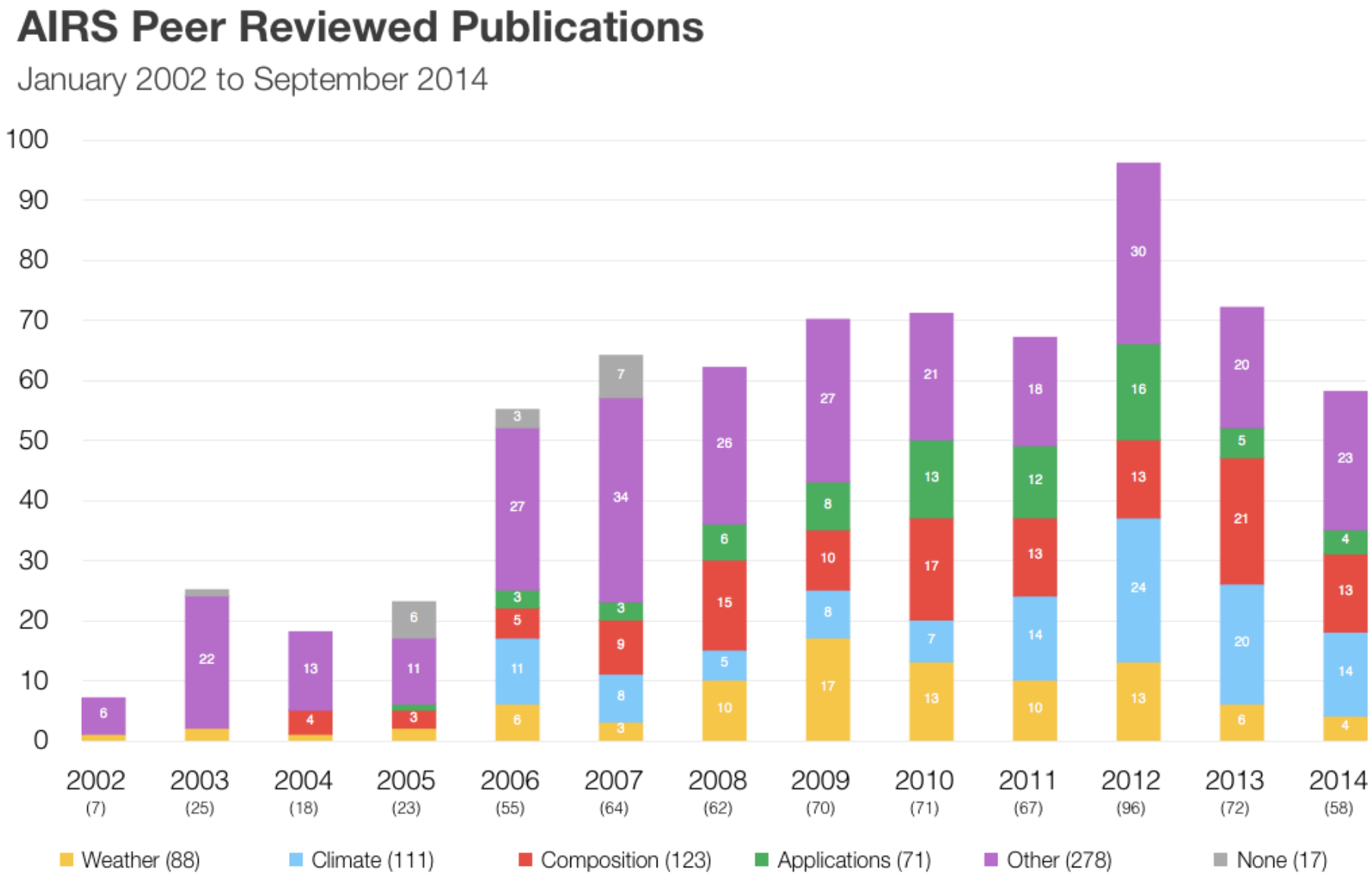
Stage 3: Validation Product accuracy has been assessed, and the uncertainties in the product well-established via independent measurements made in a systematic and statistically robust way that represents global conditions.

See Eric Fetzer's Talk for AIRS Validation Status

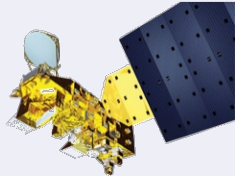
Jet Propulsion Laboratory
California Institute of Technology

Over 688 AIRS-Related Peer Reviewed Journal Publications to Date

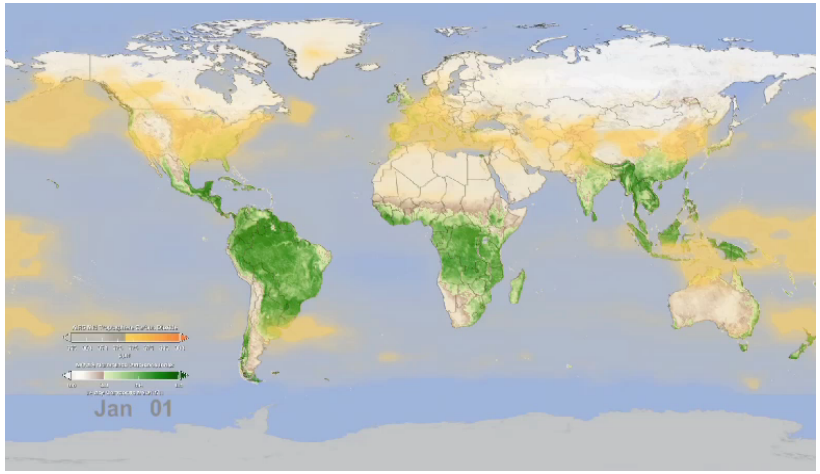


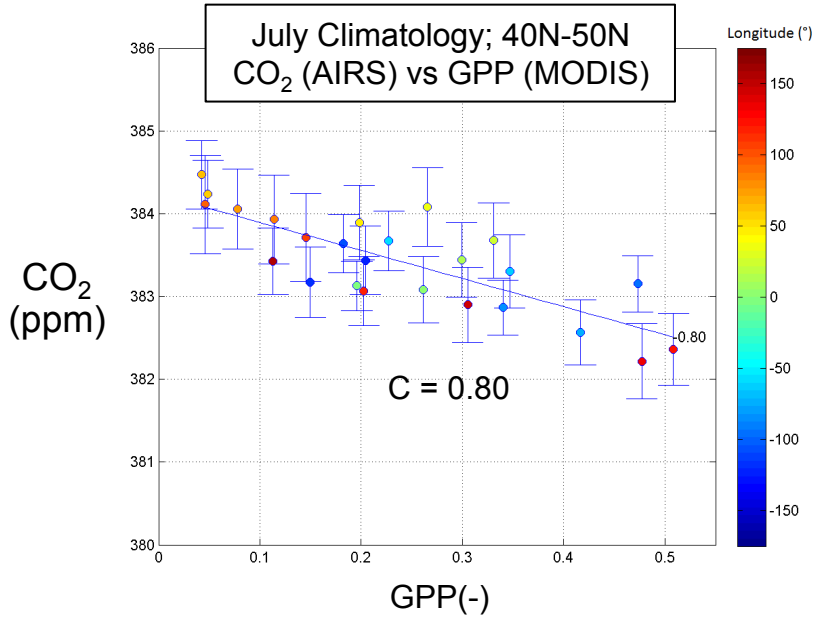


AIRS CO_2 Shows Influence of Surface and Inter-hemispheric Transport



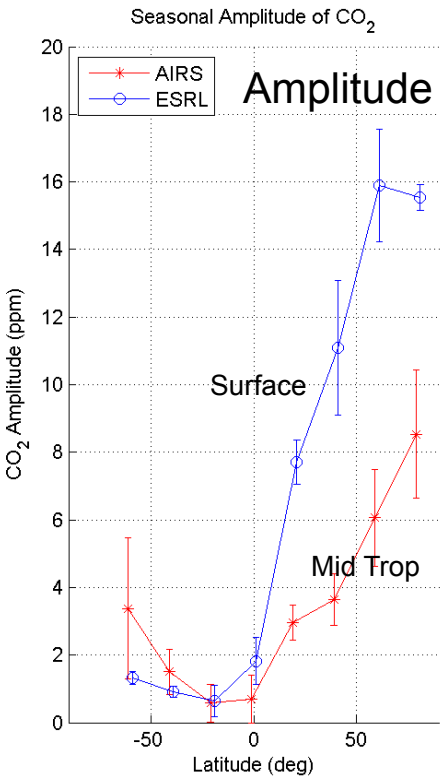
High Correlation of CO_2 and GPP for July in the NH Boreal Forests

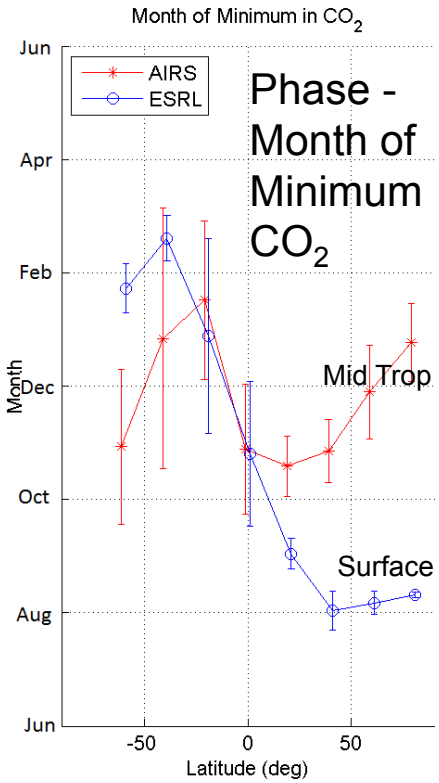




AIRS Shows Strong CO_2 Seasonal Cycle:

- Influence of surface on mid-troposphere
- NH damped and delayed => vertical transport
- SH has higher amplitude and precedes surface. => Inter-hemispherical transport?





T.S. Pagano, E.T. Olsen, H. Nguyen et al.; "Global variability of midtropospheric carbon dioxide as measured by the Atmospheric Infrared Sounder," J. Appl. Remote Sens., 8(1), 084984 (2014). doi:10.1117/1.JRS.8.084984.

AIRS Level-4 / Applications Products Support Weather, Air Quality and Human Health

Weather Processes
Climate Processes
Atmospheric Chemistry

Weather Prediction
Air Quality
Human Health
Transportation
Drought and Fire

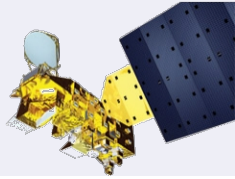
Initial Products Identified

Carbon Monoxide	*air quality*
Air Temperature	*air quality*
Surface Temperature	*weather*
Temperature Inversions	*health*
Water Vapor	*weather*
Relative Humidity	*weather*
Ozone Hole	*health*
Carbon Monoxide	*air quality*
Stratospheric Ozone Intrusion	*air quality*
Carbon Dioxide	*air quality*
Volcanic Ash	*transportation*
Dengue Fever Threat	*health*
West Nile Virus Threat	*health*
Vapor Pressure Deficit	*drought*
Fire Weather Conditions	*fire*

Bridging the Gap

- *Applications Development Pipeline in Place*
- *Customer works with the scientist early in the process*
- *Parallel effort with building the machinery: algorithm development and test, product development and validation, image generation and client server*
- *Product ideas solicited. Make IR sounders more useful to the public and government agencies*
- *See Sharon Ray's talk for more information*

AIRS Project Activity Summary



- AIRS Project Going Strong!
- Instrument Operations: Supporting spacecraft maneuvers and minor instrument anomalies. No issues. Operational for 12+ years!
- Calibration: Cross-comparisons look good. L1C, Spectral Cal Updates.
- Processing: Version 6 Processing up to date.
- Data Centers: GSFC and NOAA continue to provide AIRS data products to the scientific and operational communities.
- Science Integration: Version 7: New Start driven by New ROSES Science Team. 3 Years to complete?
- Validation: Version 5 validation papers identified. Several Version 6 validation papers complete and more underway.
- Applications: Development of image based products for a wide range of public and government applications is underway.
- Welcome to the NASA Sounder Science Team Meeting! Thank you for attending and participating.