Recent Science Highlights

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Summary Report from the November Sounder Science Workshop

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AIRS Science Team Meeting, Caltech

April 26-29, 2011
In Memory of Dr. Mous Chahine
AIRS Science Team Leader and Friend
AIRS Key Products and Science Areas

- Atmospheric Water Vapor
- Cloud Properties
- Cloud and Water Vapor Processes
- Atmospheric Temperature
- Greenhouse Gas Forcing
- Ozone
- Atmospheric Water Vapor
- Methane
- CO2
- Dust
- SO2
- Emissivity
AIRS Improves Weather Operations and Research

NCEP Operational Improvement

![Graph showing 6 hrs on 6 day forecast for N. Hemisphere 500 mb AC Z 20N - 80N Waves 1-20 1 Jan - 27 Jan '04.](image)

J. LeMarshall, JCSDA

AIRS Research Validates Models

![Images showing mixing ratio and pressure](image)

J. Fu, U of Hawaii

Regional Forecast Improvement

Pressure

Rainfall

![Maps showing pressure and rainfall](image)

B. Zavodsky, NASA SPoRT

NOAA Hurricane Center

Saharan Air Layer Hurricane Suppression

![Maps and images showing hurricane tracking](image)

J. Dunion, NOAA
Information from AIRS *Retrievals* in Cloudy Regions Improves Tropical Cyclone Forecasts

Major Impact to Tropical Cyclone Nargis Hindcast


http://www.agu.org/journals/gl/gl0906/2008GL037122/
AIRS Finds Biases in Climate Model Moisture & Temperature

- AIRS finds major climate models are too dry below 800 mb in the tropics, and too moist between 300 mb and 600 mb especially in the extra-tropics. (Pierce, John, Gettleman); too cold above.
- Radiance biases of opposite signs in different spectral regions suggests that the apparent good agreement of a climate model’s broadband longwave flux and total water with observations may be due to a fortuitous cancellation of spectral errors (Huang).


Water Vapor Vertical Climatology (Pierce, Scripps)

Outgoing Longwave Radiation (Huang, Univ. of Michigan)
AIRS H$_2$O Data used as “Truth” to Improve Parameterizations in Climate Models

- **Tim Barnett**: Scripps, UCSD
  - Coupled Climate Models show >50% bias errors in H$_2$O vapor. Models worst at mid altitude and mid latitude.

- **Andrew Gettleman**: NCAR
  - AIRS can provide insight on climate forcings
  - Variability not well reproduced in GCM/CAMS
  - Greenhouse effect appears to increase with SST
  - Water vapor feedback positive: but not as positive as constant RH would assume

- **Andrew Dessler**: Texas A&M
  - Simple trajectory model with fixed RH limit does a good job of reproducing AIRS annual average water vapor
  - Model shows that dehydration of mid-troposphere air occurs in three latitude bands
Atmospheric Composition: Influence of Madden-Julian Oscillation on AIRS CO₂

AIRS CO₂ data are modulated by the Madden-Julian Oscillation. The peak-to-peak amplitude of the MJO signal is ~ 1 ppm. 

Li et al. [PNAS, 2010]
Monthly-mean AIRS (black) and a posteriori model (red GEOS-4 and blue GEOS-5) CO2 concentrations (ppm) averaged over 30 degree latitude bins during 2003–2006: (a) 60 S–90 S, (b) 30 S–60 S, (c) 0–30 S, (d) 0–30 N, (e) 30 N–60 N, and (f) 60 N–90 N. The GEOS-Chem model, described at a horizontal resolution of 2° 2.5, has been sampled at the time and location of each AIRS level-3 CO2 scene, weighted by the observation numbers, and convolved using the vertical weighting functions from Chahine et al. (2008).

AIRS and MLS give complete picture of atmospheric water vapor

Equatorial mean (08°S–08°N, 180°E–180°W) time evolution of (b) water vapor (%), and (c) RH (%) with the time record mean removed at each pressure level.

AIRS Validates Upper Tropospheric Water Vapor and Temperature in Models

Weather and climate model upper tropospheric water vapor and temperature.

Observations of Deep Convective Clouds

Observations of air-sea interactions over ocean fronts

Sierra Snowfall Correlates with AIRS Surface Air Temperature but not weather models

• Held November November 1st and 2nd, 2010 in Greenbelt, MD.
  – *The two days prior to the last AIRS science team meeting.*

• Over 70 participants from the U.S., Europe, and Japan
  – NASA
  – NOAA
  – EUMETSAT
  – CNRS
  – Universities

• Four sessions:
  – *Plenary*
  – *Weather breakout*
  – *Climate breakout*
  – *Composition breakout*
A Draft Report with Recommendations is available

- **Authors:** Tom Pagano, Joel Susskind, Kevin Bowman, Chris Barnet, Eric Fetzer

- **Contents:** Objectives, Executive Summary, Overview of Sessions, Summary of Recommendations.

- Critics love it. “I’m impressed!” – B. Kahn
Primary Recommendations

Recommendation I: The formation of a US based Sounding Science Team is required to identify the current and future needs of the weather, climate and atmospheric composition communities using data from the IR and MW sounders.

Recommendation II: The JPSS enable the full spectral resolution possible with the FM-1 CrIS on NPP as soon as possible.

Recommendation III: NASA should begin development of an advanced IR sounder with high spatial resolution and improved spectral resolution to be ready to follow the current planned sounders expected to retire in the 2020 timeframe.

Detailed Session Recommendations

SESSION 1: Climate

Recommendation 1.1.1: The value of monitoring long-term variability and extreme climate events should be emphasized in all sounding systems.

Recommendation 1.1.2: Further research to generate new and improved products from AIRS and IASI is needed, especially with regard to cloud and dust microphysical and radiative properties. Improved theoretical techniques are needed for multiple scattering at finer spatial resolution.

Recommendation 1.1.3: Fully characterize IASI performance with increasing cloud cover, using AIRS as baseline. Evaluate 3+ years of IASI products generated by NOAA using an AIRS science team-like algorithm. Compare interannual differences and trends obtained from AIRS and IASI products. Repeat this experiment using a NOAA IASI retrieval algorithm when it becomes available.

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Conclusions

• Enormous breadth to AIRS research
  – *Reflected in ~400 publications mainly in*
    • Weather.
    • Climate.
    • Atmospheric Composition.

• Sounder Science Workshop held in November
  – *Expect a final workshop report very soon.*