Introduction to V6 and V7

and

Recent Science Highlights

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V6 Status

Improvements since V5 include:

- Reduced spurious cooling trend in the free troposphere.
- Smaller temperature biases.
- Higher yield
  - No trend in yield.
- Improved surface properties (see Glynn Hulley talk).
- Improved cloud properties (see Van Dang talk).
- Improved trace gases.
V6 Has Higher Yield and No Yield Trend

Higher Yield

Removed Trend in Yield

Courtesy J. Susskind, GSFC
Reduced Temperature Trends
Location of radiosondes coincident with AIRS (1 hr and 100 km)
SON 2006

Courtesy F. W. Irion, JPL
Temperature bias results for AIRS – RaObs
V5.0.14 and V5.9.12 30° N – 60° N SON 2006

init – sonde bias

final – sonde bias

RMS

No. of matched observations

Final – sonde kerned by AIRS averaging kernel

i.e. sonde profile is

\[ \hat{x} = x_0 + A(x_T - x_0) \]

1 hr miss time and 100 km miss distance from sonde launch. Data taken from 1st, 6th, 11th, 16th, 21st and 26th of each month. Data matched one-to-one between versions with both passing qualSurf =0 or 1.

Courtesy F. W. Irion, JPL
Temperature bias trend results for AIRS – RaObs V5.0.14 and V5.9.12 30° N – 60° N

3 hr miss time and 100 km miss distance from sonde launch. Data taken from 1st, 6th, 11th, 16th, 21st and 26th of each month through 2009.

Data matched one-to-one between versions with both passing qualSurf = 0 or 1.

Trends calculated by finding linear trends for each calendar month and then averaging.
Improvements in AIRS Cloud Top Properties Compared to V5

Verified by CloudSat/CALIPSO:

- AIRS V5.9.12 is able to detect more clouds.
- More realistic Cloud Top Height for AIRS V5.9.12 -- especially low level clouds.
- AIRS Top Layer Cloud Top Height distribution is not as wildly off in V5.9.12, especially for multilayered clouds.
- Defaulting to NN surface temperature for cloud retrieval gives better CTH comparisons
  - same cases in V5 did not compare as well.

Courtesy Van Dang, JPL
AIRS V6 water vapor is not simply replicating ECMWF

V6 AIRS at 850 hPa

01/02/2007, Coloring based on AIRS V5.12 Water Vapor (g/kg dry air) at 850 mb

ECMWF at 850 hPa

01/02/2007, Coloring based on ECMWF Water Vapor (g/kg dry air) at 850 mb

Differences of order ±100%

Courtesy Van Dang, JPL
Next Step: Assessing AIRS relative to other global data sets

We need to ask hard questions like:

• Has ECMWF become so good it is nearly indistinguishable from AIRS?
• Is the neural network replicating ECMWF?

Apparently “no” to both, but we need metrics to answer these and similar questions.

  – How different are they?
  – Where and why?
One Motivation: Boundary Layer Science

• How much additional information is in the boundary layer?
  – *We know V5 is informative, but V6 is better.*

• We should do better than models over land
  – *Assimilated microwave radiances provide limited information here, and near-surface IR is not fully assimilated because of clouds.*
Another Motivation: Climate Trends

- What are the trends in important climate variables like water vapor, clouds, trace gases (and yes, temperature).
  - The AIRS record is becoming long enough to reach some robust conclusions about climate processes.

Decadal trend in TPW

Santer et al. (2007), Identification of human-induced changes in atmospheric moisture content, *PNAS*.
What to expect in V7

• Better selection of water vapor channels from Antonia Gambacorta.

• Better information content analysis.
AIRS Key Products and Science Areas

Cloud and Water Vapor Processes

Greenhouse Gas Forcing

Ozone

Atmospheric Water Vapor

Ozone

Atmospheric Temperature

Cloud Properties

Dust

Methane

CO2

SO2

Emissivity
440 AIRS Peer Reviewed Publications to Date
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.

Temperature Inversions and Winter Sea Ice


AIRS inversions well validated with radiosondes.
Observations and models agree well in three areas where CloudSat detects frequent low clouds, but AIRS has infrequent retrievals. Poorer agreement in N. Atlantic suggests issues with representativeness of AIRS retrievals.

AIRS Humidity Used to Constrain Cirrus Cloud Trajectory Model

AIRS Radiances Validate Clouds in Forecast Model

AIRS and MODIS Clouds Are Radiatively Consistent

Models and Reanalyses Do Not Replicate AIRS Temperature and Water Vapor Variability

- No universal structure
- Agreement only at largest scales

Closing the Water Mass Balance with AIRS, MERRA and TRMM

Total atmospheric water mass flux converge from AIRS humidity and MERRA winds.

Surface mass balance from TRMM precipitation and MERRA evaporation.

Study of Tropical Anvil Clouds

Asymmetry in observed cloud top temperatures

Top: Likely viewing geometry.
Bottom: CloudSat liquid water

Seasonal frequency, spatial distribution, sampling rates and temperature-humidity inversion covariability (right) from eight years of data determine polar energy balance and are important constraints on model physics.

CO time series at 55 N, 37 E, from Yurganov et al.

CO time series at three locations over Russia, from Witte et al.
