National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Plans for Validation of Version 5

Eric Fetzer

Jet Propulsion Laboratory, California Institute of Technology

AIRS Science Team Meeting, Pasadena, CA

27 March 2007

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Thanks to all the authors of validation papers to date
(and apologies to those I've missed...)

Aumann, H.H., S. Broberg, D. Elliot, S. Gaiser, D. Gregorich (2006), Three years of Atmospheric Infrared Sounder radiometric calibration validation using sea surface temperatures, J. Geophys. Res., 111, D16S90, doi:10.1029/2005JD006822.

Bian, J., A. Gettelman, H. Chen, and L. L. Pan (2007), Validation of satellite ozone profile retrievals using Beijing ozonesonde data, *J. Geophys. Res., 112*, D06305, doi:10.1029/2006JD007502.

Cho, C., and D. H. Staelin (2006), Cloud clearing of Atmospheric Infrared Sounder hyperspectral infrared radiances using stochastic methods, J. Geophys. Res., 111, doi:10.1029/2005JD006013.

Divakarla, M., C. Barnet, M. D. Goldberg, L. McMillin, E. S. Maddy, W. W. Wolf, L. Zhou, and X. Liu (2006), Validation of Atmospheric Infrared Sounder temperature and water vapor retrievals with matched radiosonde measurements and forecasts, J. Geophys. Res., 111, doi:10.1029/2005JD006116.

Fetzer, E. J. (2006), Preface to special section: Validation of Atmospheric Infrared Sounder Observations, J. Geophys. Res., 111, D09S01, doi:10.1029/2005JD007020.

Fetzer, E. J., B. Lambrigtsen, A. Eldering, H. H. Aumann, and M. T. Chahine (2006), Biases in total precipitable water vapor climatologies from Atmospheric Infrared Sounder and Advanced Microwave Scanning Radiometer, J. Geophys. Res., 111, D09S16, doi:10.1029/2005JD006598.

Froidevaux, L., N. J. Livesey, W. G. Read, Y. B. Jiang, C. Jimenez, M. J. Filipiak, M. Schwartz, M. L. Santee, H. Pumphrey, J. H. Jiang, G. L. Manney, B. J. Drouin, J. W. Waters, E. J. Fetzer, P. F. Bernath, C. D. Boone, K. A. Walker, K. W. Jucks, G. C. Toon, J. J. Margitan, C. R. Webster, L. E. Christensen and J. W. Elkins (2006), Early validation analyses of the atmospheric profiles from EOS MLS on the Aura satellite, Accepted to *IEEE Trans. Geosci. and Remote Sensing*.

Gettelman, A., E. M. Weinstock, E. J. Fetzer, F. W. Irion, A. Eldering, E. C. Richard, K. H. Rosenlof, T. L. Thompson, J. V. Pittman, C. R. Webster and R. L. Herman, 2004: Validation of Aqua satellite data in the upper troposphere and lower stratosphere with in-situ aircraft instruments. *Geophys. Res. Lett.*, vol. 31, L22107, doi:10.1029/2004GL020730.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Thanks to all the authors of validation papers (continued)

Gettelman, A., V. P. Walden, L. M. Miloshevich, W. L. Roth, and B. Halter (2006), Relative humidity over Antarctica from radiosondes, satellites, and a general circulation model, J. Geophys. Res., 111, D09S13, doi:10.1029/2005JD006636.

Hagan, D. E., C. R. Webster, C. B. Farmer, R. D. May, R. L. Herman, E. M. Weinstock, L. E. Christensen, L. R. Lait and P. A. Newman (2004), Validating AIRS upper atmosphere water vapor retrievals using aircraft and balloon in situ measurements, *Geophys. Res. Lett.*, *31*, L21103, doi:10.1029/2004GL020302.

Kahn, B. H, A. Eldering, A. J. Braverman, E. J. Fetzer, J. H. Jiang, E. Fishbein and D. L. Wu, 2007: Towards the characterization of upper tropospheric clouds using AIRS and MLS observations, *J. Geophys. Res., 112*, D05202, doi:10.1029/2006JD007336.

Kahn, B. H., E. Fishbein, S. L. Nasiri, A. Eldering, E. J. Fetzer, M. J. Garay and S.-Y. Lee, 2007: The radiative consistency of AIRS and MODIS cloud retrievals, *J. Geophys. Res.*, in press.

McMillan, W. W., C. Barnet, L. Strow, M. T. Chahine, M. L. McCourt, J. X. Warner, P. C. Novelli, S. Korontzi, E. S. Maddy and S. Datta (2005), Daily global maps of carbon monoxide from NASA's Atmospheric Infrared Sounder, *Geophys. Res. Lett.*, *32*, L11801, doi:10.1029/2004GL021821.

Miloshevich, L. M., H. Voemel, D. Whiteman, B. Lesht, F. J. Schmidlin, and F. Russo (2006), Absolute accuracy of water vapor measurements from six operational radiosonde types launched during AWEX-G and implications for AIRS validation, J. Geophys. Res., 111, doi:10.1029/2005JD006083.

Nalli, Nicholas R., et al. (2006), Ship-based measurements for infrared sensor validation during Aerosol and Ocean Science Expedition 2004, J. Geophys. Res., 111, doi:10.1029/2005JD006385.

Rama Varma Raja, M. K., S. I. Gutman, J. G. Yoe, L. M. McMillin,and J. Zhao, (2007), The validation of AIR retrievals of integrated precipitable water vapour using measurements from a network of ground based gps receivers over the contiguous united states, J. Atmos. Oceanic. Tech, 2007, accepted.

Rosenkranz, P. W. (2006), Cloud liquid-water profile retrieval algorithm and validation, J. Geophys. Res., 111, D09S08, doi:10.1029/2005JD005832.

Rosenkranz, P. W., and C. D. Barnet (2006), Microwave radiative transfer model validation, J. Geophys. Res., 111, D09S07, doi:10.1029/2005JD006008.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Thanks to all the authors of validation papers (continued)

Strow, L. L., S. E. Hannon, S. De-Souza Machado, H. E. Motteler, and D. C. Tobin (2006), Validation of the Atmospheric Infrared Sounder radiative transfer algorithm, J. Geophys. Res., 111, D09S06, doi:10.1029/2005JD006146.

Susskind, J., C. Barnet, J. Blaisdell, L. Iredell, F. Keita, L. Kouvaris, G. Molnar, and M. Chahine (2006), Accuracy of geophysical parameters derived from Atmospheric Infrared Sounder/Advanced Microwave Sounding Unit as a function of fractional cloud cover, J. Geophys. Res., 111, D09S17, doi:10.1029/2005JD006272.

Tobin, D.C., H. E. Revercomb, R. O. Knuteson, B. Lesht, L. L. Strow, S. E. Hannon, W. F. Feltz, L. Moy, E. J. Fetzer, and T. Cress (2006), Atmospheric Radiation Measurement site atmospheric state best estimates for Atmospheric Infrared Sounder temperature and water vapor retrieval validation, J. Geophys. Res., 111, D09S14, doi:10.1029/2005JD006103.

Tobin, D.C., et al. (2006), Radiometric and spectral validation of Atmospheric Infrared Sounder observations with the aircraft-based Scanning High-Resolution Interferometer Sounder, J. Geophys. Res., 111, D09S02, doi:10.1029/2005JD006094.

Tobin, D.C., H. E. Revercomb, C. C. Moeller, and T. Pagano (2006), Use of Atmospheric Infrared Sounder high-spectral resolution spectra to assess the calibration of Moderate resolution Imaging Spectroradiometer on EOS Aqua, J. Geophys. Res., 111, D09S05, doi:10.1029/2005JD006095.

Walden, V., W. Roth, R. S. Stone, and B. Halter (2006), Radiometric validation of the Atmospheric Infrared Sounder (AIRS) over the Antarctic Plateau, J. Geophys. Res., 111, D09S03, doi:10.1029/2005JD006357.

Whiteman, D., et al. (2006), Analysis of Raman lidar and radiosonde measurements from the AWEX-G field campaign and its relation to Aqua validation, J. Geophys. Res., 111, D09S09, doi:10.1029/2005JD006429.

Ye, H., E. J. Fetzer, D. H. Bromwich, E. F. Fishbein, E. T. Olsen, S. Granger, S.-Y. Lee, L. Chen and Bjorn H. Lambrigtsen (2007), Atmospheric total precipitable water from AIRS and ECMWF during Antarctic summer, *Geophys. Res. Lett.*, in review.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Current validation status

- **Radiances are very well characterized.**
- **T and q over ocean meet 1 K / km, 15% / 2 km, even locally.**
- **Well characterized T and q over warm season land; 1 K/km and 15% / 2 km in the free troposphere.**
- **Minor gases in the free troposphere.**

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

*But...*We Need Better Insight into Some Quantities

- **Temperature and humidity**
  - ***vertical resolution, sensitivity and uncertainties.***
  - ***the boundary layer over land and poles.***
- **Cloud climatologies against ISCCP, MODIS and models.**
- **Long term *weather* variability compared to reanalyses.**
- **Minor gas information content.**
  - ***How we complement minor gases from other A-Train sensors.***
- **Sampling biases in *many* variables.**

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Our Validation Schedule as of September 2003

AIRS PRODUCT VALIDATION TIMELINE

Product	Version	3.0	4.0	5.0	6.0	7.0	8.0
	Activation Date	Aug 03	Sept 04	Jun 05	Mar 06	Dec 06	Sept 07
Level 1B Radiances							
	AIRS Radiance	Prov	Val2	Val4	Val5		
	VIS/NIR Radiance	Prov	Val2	Val4	Val5		
	AMSU Radiance	Beta	Prov	Val2	Val4	Val5	
	HSB Radiance	Beta	Prov	Val2	Val4	Val5	
Level 2 Standard Product							
	Cloud-Clear IR Radiance	Beta	Val2	Val3	Val4	Val5	
	Surface Temperature	Beta	Val2	Val3	Val4	Val5	
	Temperature Profile	Prov	Val2	Val3	Val4	Val5	
	Humidity Products	Beta	Val1	Val2	Val3	Val4	Val5
	Cloud Cover Products	N/A	Beta	Val1	Val2	Val2	Val3

Beta = Not suitable for scientific investigations. Consult with AIRS Project on regional status.
Prov = Provisionally validated. Useable for scientific investigations with caution. Validated for nonpolar night ocean only
Val1 = non-polar day/night ocean
Val2 = Val1 + non-polar night land
Val3 = Val2 + nonpolar day land
Val4 = Val3 + polar night
Val5= Val4 + polar day. Only Val5 data are useable for truly global scientific investigations.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Generally: We are data rich, analysis poor

We have:

- **Over 4 years of AIRS observations.**

- **Correlative data sources**
  - ***ECMWF and NCEP reanalyses.***
  - ***Thousands of operational and dedicated sondes***
    - Europeans, ARM, field campaigns including Aura validation.
  - ***Field campaigns for several minor gases.***
  - ***Similar observations from the A-Train***
    - H_2O, O_3, CH_4 and CO from TES and MLS.
    - Cloud properties from CloudSat, MODIS, MLS and AMSR.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Short-term goal: A Validation Plan

- **The next round of AIRS validation studies *must* be published, not just reported.**
  - ***We are not planning another Special Section; publish at will.***
  - ***Please keep me (at least) informed of what you're doing.***

- **Primarily science driven**
  - ***What do we need to know to answer the "twenty questions"?***
  - ***How do we improve the science analyses presented earlier?***

- **Finish the plan by the end of April**
  - ***It may just be a list of analyses / analysts.***

- **Comments on priorities are welcome.**

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Some topics for science analyses using validation data

More topics are welcome; volunteers are needed:

- **Land T and q in the boundary layer using dedicated sondes, (Tobin, Hearty).**
- **Polar water vapor and temperature (Tobin, Walden, Ye).**
- **Sampling biases (Hearty, Fishbein, Fetzer, Divakarla?, Tobin?).**
- **Ozone (Irion, Divakarla).**
- **Other minor gases (defer to Wallace and Bill here).**
- **CloudSat comparisons (Kahn).**
- **Land surface temperature (Knuteson).**

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Some Topics for science analyses using validation data (continued)

- **Surface exchange processes (Santanello & many others).**
- **Error estimates, averaging kernels, vertical resolution (Susskind, Irion).**
- **Profiles over stratocumulus (Teixeira, Fetzer)**
- **Upper trop humidity with dedicated sondes (Voemel, others?)**
- **Assess L3 against ECMWF (Granger).**
- **Minor gas comparisons again other A-Train sources (McMillan, Irion)**
- **Tropopause structure (Tian, Fetzer).**

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Finally...

- **All ideas and plans are welcome.**
- **Every contribution is valuable!**

Eric.J.Fetzer@jpl.nasa.gov