



AIRS THE ATMOSPHERIC INFRARED SOUNDER ON NASA'S AQUA SATELLITE



Global carbon dioxide data of Earth's mid-troposphere

THE FIRST RELEASE OF A 7-YEAR GLOBAL CARBON DIOXIDE DATA SET BASED SOLELY ON OBSERVATIONS

ABOUT THE INSTRUMENT

The Atmospheric Infrared Sounder, AIRS, was launched aboard the Aqua Spacecraft in 2002 as part of NASA's Earth Observing System Afternoon Constellation of satellites known as the "A-Train." Key features of the AIRS instrument are:

- 2378 hyperspectral infrared channels
- High accuracy, sensitivity, and stability
- Global daily coverage
- Sensitive to carbon dioxide in 3 layers (only mid-troposphere data available at this time)

THE AIRS CARBON DIOXIDE PRODUCT

AIRS has provided the first satellite retrieval of mid-tropospheric CO₂ under cloudy conditions, without the use of a priori information from models. AIRS retrievals use cloud-cleared thermal IR radiance spectra in the 15 micron band with an accuracy better than 2 ppm.

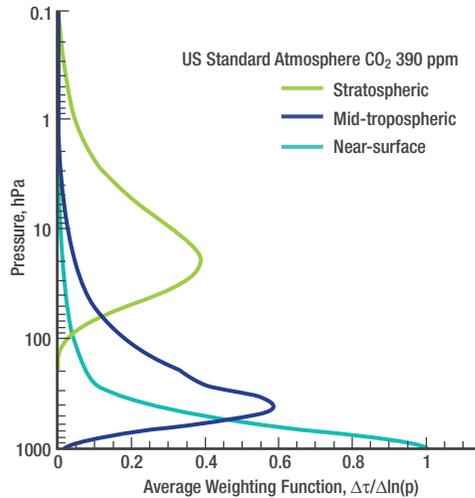
The hyperspectral data from AIRS have been used to produce global maps of carbon dioxide and other trace gases including ozone, methane, and carbon monoxide. These data are providing important constraints on modeling the global distribution and transport of these gases around the world. The AIRS carbon dioxide data set currently consists of:

- CO₂ in the mid-troposphere
- Level 2 data (individual soundings)
- 18,000 soundings per day
- Level 3 data in daily, multi-day, and calendar monthly at a spatial resolution of 2 deg latitude by 2.5 deg longitude
- Better than 2 ppm accuracy
- Global daily coverage, latitude range 60 S to 90 N

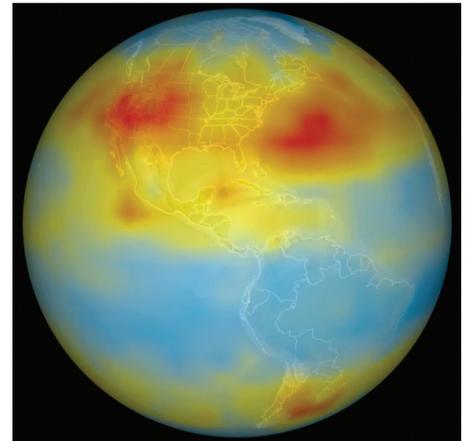
AIRS reports the daytime and nighttime global distribution of carbon dioxide in the mid-troposphere at a nadir resolution of 90 km x 90 km. The high spectral resolution and stability of AIRS allows a measurement accuracy between 1.5 ppm and 2 ppm, making it ideal for mapping the distribution and transport of carbon dioxide levels in the free troposphere.

AIRS CO₂ retrievals have been validated by comparison with:

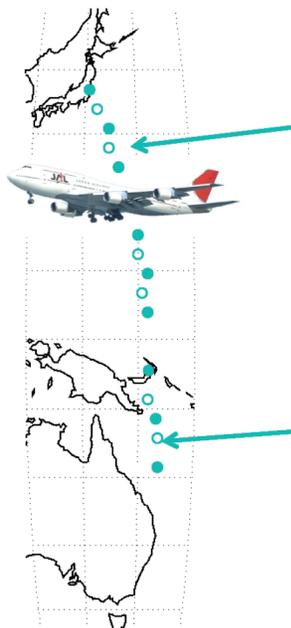
- Airborne flask measurements by CONTRAIL
- Vicarious airborne CO₂ profile measurements
- Upward-looking FTIR systems



AIRS Sensitivity to CO₂ with Altitude

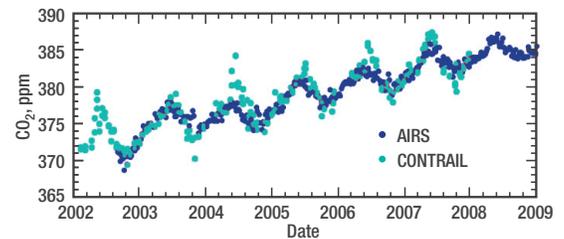


Monthly average of carbon dioxide in the middle troposphere, made with AIRS data retrieved in July 2003.



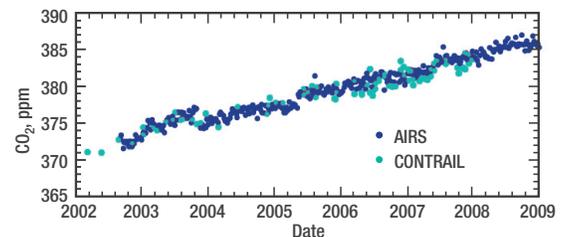
7-day averages of AIRS retrievals: Latitude = +25° ± 5°
Longitude = 143° ± 5°

CONTRAIL individual flask measurements: Latitude = +25° ± 5°



7-day averages of AIRS retrievals: Latitude = +25° ± 5°
Longitude = 150° ± 5°

CONTRAIL individual flask measurements: Latitude = -25° ± 5°

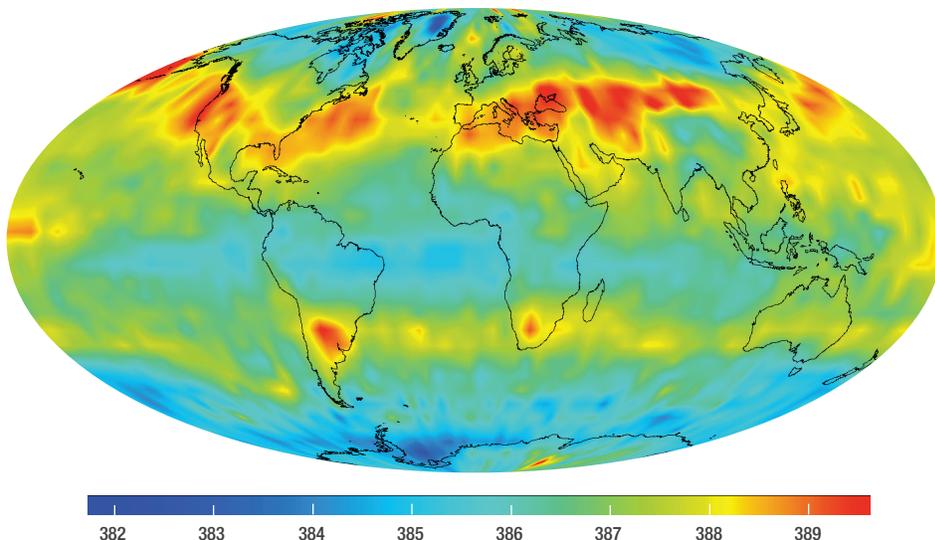


Rate of Growth: AIRS = 1.98 ± 0.05 ppm/year
(30°S to 30°N) CONTRAIL = 2.01 ± 0.04 ppm/year

Comparison of V2 AIRS CO₂ and CONTRAIL (Matsueda) Airborne Flask Measurements

SIGNIFICANT FINDINGS FROM AIRS DATA

- **CO₂ is not homogeneous in the mid-troposphere; previously it was thought to be well-mixed**
- **The distribution of CO₂ in the mid-troposphere is strongly influenced by large-scale circulations such as the mid-latitude jet streams and by synoptic weather systems, most notably in the summer hemisphere**
- **There are significant differences between simulated and observed CO₂ abundance outside of the tropics, raising questions about the transport pathways between the lower and upper troposphere in current models**
- **Zonal transport in the southern hemisphere shows the complexity of its carbon cycle and needs further study**



Monthly average atmospheric carbon dioxide concentration for July 2009 = 387 ppm. Measurement recorded at Mauna Loa Observatory (Scripps/NOAA/ESRL).

Carbon Dioxide in the Mid-Troposphere, 2009.

KEY PAPERS

Chahine, M.T. et al. (2008), "Satellite Remote Sounding of Mid-Tropospheric CO₂", *Geophys. Res. Lett.*, 35, September, doi:10.1029/2008GL035022.

Tiwari Y. K., M. Gloor, R. J. Engelen, F. Chevallier, C. Rödenbeck, S. Körner, P. Peylin, B. H. Braswell, M. Heimann (2006), "Comparing CO₂ Retrieved from Atmospheric Infrared Sounder with Model Predictions: Implications for Constraining Surface Fluxes and Lower-to-Upper Troposphere Transport," *J. Geophys. Res.*, 111, D17106, doi:10.1029/2005JD006681.

Chahine M., C. Barnet, E. T. Olsen, L. Chen, E. Maddy (2005), "On the Determination of Atmospheric Minor Gases by the Method of Vanishing Partial Derivatives with Application to CO₂," *Geophys. Res. Lett.*, 32, L22803, doi:10.1029/2005GL024165.

Engelen, R.J., S. Serrar, F. Chevallier (2009), "Four-dimensional Data Assimilation of Atmospheric CO₂ Using AIRS Observations," *J. Geophys. Res.*, 114, D03303, doi:10.1029/2008JD010739.

Strow, L. Larrabee and Scott E. Hannon (2008), "A 4-year Zonal Climatology of Lower Tropospheric CO₂ Derived from Ocean-Only Atmospheric Infrared Sounder Observations," *J. Geophys. Res.*, doi:10.1029/2007JD009713.

Maddy, E.S., C.D. Barnet, M. Goldberg, C. Sweeney, X. Liu (2008), "CO₂ Retrievals from the Atmospheric Infrared Sounder: Methodology and Validation," *J. Geophys. Res. - Atmospheres*, 113, D11, D11105.

AIRS data products are free and are available to the science community and general public

HOW TO GET AIRS CARBON DIOXIDE DATA

The Goddard Earth Sciences Data and Information Services Center (GES-DISC) at Goddard Space Flight Center serves as the central facility for the processing, archiving, and distribution of EOS Aqua data. Access to AIRS near-real-time-data, the AIRS data FTP server, the Giovanni browse tool, and other data access methods can be found here: <http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings>

RESOURCES AND HELP

The AIRS data support page at the GES-DISC includes documentation, data product descriptions and software tools: <http://disc.sci.gsfc.nasa.gov/AIRS/>

The AIRS public website contains information, images, and contact information: <http://airs.jpl.nasa.gov>

ASK AIRS is an online form for questions about AIRS data and products: <http://airs.jpl.nasa.gov/AskAirs/>

CONTACT INFORMATION

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The Jet Propulsion Laboratory, California Institute of Technology, manages the AIRS instrument suite for the National Aeronautics and Space Administration.

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