## MODIS Total Precipitable Water (MOD 05)

### Product Description

The MODIS Precipitable Water product (MOD 05) consists of column water-vapor amounts. During the daytime, a near-infrared algorithm is applied over clear land areas of the globe and above clouds over both land and ocean. Over clear ocean areas, water-vapor estimates are provided over the extended glint area. An infrared algorithm for deriving atmospheric profiles is also applied both day and night for Level 2.

The Level 2 data are generated at the 1-km spatial resolution of the MODIS instrument using the near-infrared algorithm during the day, and at $5 \times 5$ 1-km pixel resolution both day and night using the infrared algorithm when at least nine FOVs are cloud free. The infrared-derived precipitable water vapor is generated as one component of product MOD 07, and simply added to product MOD 05 for convenience.

The solar retrieval algorithm relies on observations of water-vapor attenuation of reflected solar radiation in the near-infrared MODIS channels so that the product is produced only over areas where there is a reflective surface in the near IR.

### Research and Applications

The near-infrared total-column precipitable water is very sensitive to boundary-layer water vapor since it is derived from attenuation of reflected solar light from the surface. This data product is essential to understanding the hydrological cycle, aerosol properties, aerosol-cloud interactions, energy budget, and climate. Of particular interest is the collection of water-vapor data above cirrus cloudiness, which has important applications to climate studies. MODIS will also provide finer horizontal-scale atmospheric water-vapor gradient estimates than are currently available from the Polar-orbiting Operational Environmental Satellites (POES).

### Data Set Evolution

The solar-column water-vapor parameter is derived from the attenuation by water vapor of near-IR solar radiation. Techniques employing ratios of water-vapor-absorbing channels 17, 18, and 19 with the atmospheric window channels 2 and 5 are used. The ratios remove partially the effects of variation of surface reflectance with wavelength and result in the atmospheric water-vapor transmittances. The col-umn-water-vapor amounts are derived from the transmittances based on theoretical radiative-transfer calculations and using look-up-table procedures. MODIS is the first space instrument to use near-IR bands together with the traditional IR bands to retrieve total precipitable water. Experience in this retrieval is based on an AVIRIS instrument aboard an ER-2 aircraft. Atmospheric water vapor should be determined with an accuracy of 5-10%.

The thermal column water-vapor parameter is derived by integrating the moisture profile through the atmospheric column. Other, split-window, methods also exist. This class of techniques uses the difference in water-vapor absorption that exists between channel 31 (11 μm) and channel 32 (12 μm).

Data validation will be conducted by comparing these data with water-vapor measurements from the National Weather Service (NWS) radiosonde network, from ground-based upward-looking microwave radiometers, from a ground-based GPS network, and from a ground-based sunphotometer network. Quality control will be performed in two dimensions. The first will be comparisons of specific validation sites across as many different climatic and geographic regions as possible. The second will be a statistical analysis of the entire data set.

The related MODIS Cloud product ATBDs can be found in PDF format at http://eos.nasa.gov/atbd/modistables.html.

### Suggested Reading

Gao, B.C., and A.F.H. Goetz, 1990.

Gao, B.C. *et al.*, 1993a,b.

Green, R.O., and J.E. Conel, 1995.

Jedlovec, G.J., 1987.

Kaufman, Y.J., and B.C. Gao, 1992.

Product Summary Chart on Following Page

# MODIS Total Precipitable Water Summary

*Coverage:* Global

*Spatial/Temporal Characteristics:* Varies with retrieval technique; 1 km near-infrared daylight only, and 5 km infrared day and night

*Key Science Applications:* Hydrological cycle climatology, effect on aerosol and clouds, atmospheric correction, characterization of the atmosphere

*Key Geophysical Parameters:* Atmospheric total column water vapor

*Processing Level:* 2

*Product Type:* Standard, at-launch

*Maximum File Size:* 15 MB

*File Frequency:* 288/day

*Primary Data Format:* HDF-EOS

*Browse Available:*
http://modis-atmos.gsfc.nasa.gov/ MOD05_L2/sample.html

*Additional Product Information:*
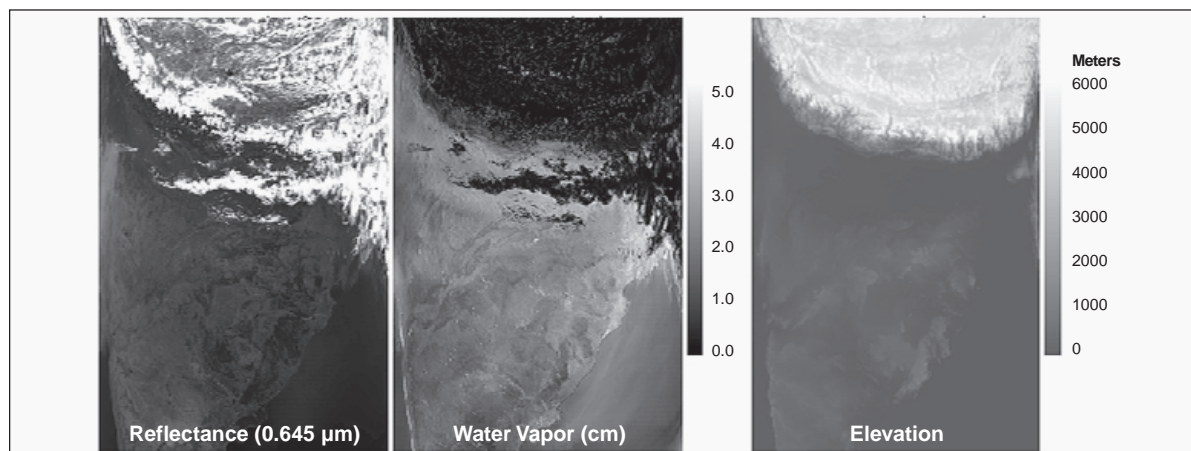http://modis-atmos.gsfc.nasa.gov/ MOD05_L2/index.html

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**Sample Columnar Atmospheric Water Vapor from Terra MODIS data from the vicinity of Tibet and India on March 2, 2000, at UTC 0525. These results are derived from data from channels located within and around the 0.94-µm water vapor band. The left panel shows an image processed from MODIS channels centered at 0.645 µm. The lower part of the scene covers portions of India and the nearby Indian Ocean. The upper part of the scene covers Nepal and part of the Tibetan Plateau. The middle panel shows the MODIS column water vapor. The right panel shows the corresponding image of surface elevations. It is seen from these images that column water vapor values vary significantly with surface elevation.**