

SAFARI 2000 MODIS MOD05_L2 Water Vapor Data, Binary Format, for Southern Africa

Abstract

The MODIS precipitable water product consists of vertical column water-vapor amounts in centimeters (cm) at 1 km spatial resolution. The SAFARI 2000 product, provided in flat binary data files, is a subset of the official MODIS Level 2 MOD05 product in EOS Hierarchical Data Format (HDF) format. Specifically, the SAFARI product contains data from daytime-only MODIS granules over southern Africa for the period August 21, 2000 through September 20, 2000. A granule is the data collected over the full MODIS swath in a five minute period. Further, the SAFARI product contains values generated by the MODIS near-infrared algorithm applied over clear land areas only (determined via the QA bit field). All values were derived from MODIS on the morning-pass Terra satellite. The product 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.

Background Information

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Project: SAFARI 2000

Data Set Title: SAFARI 2000 MODIS MOD05_L2 Water Vapor Data, Binary Format, for Southern Africa

Site: Southern Africa

Westernmost Longitude: -20° 38' 29.80" W

Easternmost Longitude: 50° 31' 12.55" E

Northernmost Latitude: 10° 05' 58.52" N

Southernmost Latitude: -42° 16' 57.42" S

Data Set Citation:

Gao, B. -C., Y. J. Kaufman, and D. Tanré. 2005. SAFARI 2000 MODIS MOD05_L2 Water Vapor Data, Binary Format, for Southern Africa. Data set. Available on-line [<http://daac.ornl.gov/>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Original Data Set Link: http://modis-atmos.gsfc.nasa.gov/MOD05_L2/index.html

Data File Information

The MOD05 water vapor data files were converted from their original HDF format to flat binary files for this SAFARI 2000 data set. This conversion was performed by J. Privette using code developed in the Interactive Data Language (IDL) Version 5.5 (Research Systems, Inc.).

The following Scientific Data Sets (SDS) are provided in this data set:

- Latitude (bilinearly interpolated to 1 km from the original 5 km resolution)
- Longitude (bilinearly interpolated to 1 km from the original 5 km resolution)
- Sensor_Zenith (bilinearly interpolated to 1 km from the original 5 km resolution)
- Water_Vapor_Near_Infrared (1 km original)

Several other MOD05 L2 SDS fields, including Solar_Zenith, Solar_Azimuth, and Sensor_Azimuth, are not included in this data set. These MODIS data products can be directly ordered through NASA/DAAC at no charges. The web sites are <http://daac.gsfc.nasa.gov/MODIS/> or <http://daac.gsfc.nasa.gov/data/datapool/>. You may need to order MOD021KM data in order to get the information on Solar_Zenith, Solar_Azimuth, and Sensor_Azimuth. All data can be ftp from DAAC after ordering. Note that the solar zenith and azimuth angles can be independently determined given the latitude, longitude and MODIS scan time (provided in the .txt file associated with each data file).

File Naming Convention

The image file names were derived from the standardized EOS Data Gateway (EDG) HDF file name. The names have been shortened to accommodate the 31-character file name limits of the Macintosh computer. The files names have had the HDF processing date and time removed, and the extension .xxx replacing .hdf. In this format, xxx is replaced with .dat for Water Vapor, .lat for Latitude, .lon for Longitude, or .senz for Sensor Zenith Angle.

Example: MOD05_L2.AYYYYYDDD.HHMM.VVV.dat

Where: **MOD05_L2** = Earth science data type name
 A = Platform code (A= Terra)
 YYYYYDDD = Year and Julian day of data acquisition
 HHMM = Time of data acquisition in UTC
 VVV = 3 Digit Version Number
 .dat = Water Vapor data

The flat binary format consists of unique files corresponding to individual SDSs extracted from the HDF format file of the MODIS product.

MOD05 Short Name	Abbreviation
Longitude	lon
Latitude	lat
Sensor_Zenith	senz
Water_Vapor_Near_Infrared	dat
IDL Conversion Metadata	txt

The parameters for the SAFARI MODIS precipitable water product are defined as:

Geolocation, Viewing Geometry, and Science Parameters	
MOD05 Parameter	Description
Latitude	Description: Geodetic Latitude Dimensions: (Cell_Along_Swath_1km, Cell_Across_Swath_1km) Valid Range: -90 to +90 degrees north
Longitude	Description: Geodetic Longitude Dimensions: (Cell_Along_Swath_1km, Cell_Across_Swath_1km) Valid Range: -180 to +180 degrees east
Viewing Geometry Parameters	
Sensor_Zenith	Description: Sensor Zenith Angle, Cell to Sensor Dimensions: (Cell_Along_Swath_1km, Cell_Across_Swath_1km) Valid Range: 0 to 180 degrees
Science Parameters	
Water_Vapor_Near_Infrared	Description: Total Column Precipitable Water Vapor - Near Infrared Retrieval Dimensions: (Cell_Along_Swath_1km, Cell_Across_Swath_1km) Valid Range: 0 to 20 cm

Data scaling factors: All data are stored in binary files as 2 or 4 byte signed integers:

2 byte integers: file .dat; Scaling factor=1000

4 byte integers: all other files

Scaling factors: 10000 for files .lat and .lon

Scaling factors: 1000 for file .senz

To retrieve the true value, the stored value must be divided by the scaling factor.

Data Flags

Water vapor values are only provided for cases where MODIS had a non-clouded view of the land surface. Values for all other cases were set to 9999. Values in all other files (.lat, .lon, .senz) for the corresponding non-clear-view pixels were assigned a value of 0. Note these flags refer to the stored integer values.

The 1 km latitude, longitude, and sensor geometry values were determined via bilinear interpolation (function BILINEAR in IDL 5.5) from the 5 km georeference information that accompanies the official MOD05 L2 product. These reference values were corresponded with the middle cell (position 3,3) of a 5 x 5 1 km kernel. Extrapolation was not performed; thus, the first/last two rows/columns of the interpolated data fields have the same values as the third row/column in from the edge. This artifact only affects the image borders. Also, the interpolation likely lead to discontinuities in the sensor azimuth angle for cells corresponding to nadir views, although this effect is probably minor.

The IDL Conversion Metadata files (.txt) contain:

```
line 1 TITLE                MODIS Water Vapor L2 Granule Binary Image Layers
line 2 HDF Name             Name of the original L2 hdf file
line 3 SDS names           Scientific Data Set names
line 6 Geolocation #rows   2030 (Typical size, check .txt file)
line 7 Geolocation #cols   1354 (Typical size, check .txt file)
line 8 Pixel size (Km)     spatial resolution, 1 km
line 9 Time of First       Seconds since 1 January 1993 00:00:00
   Scan in Granule         (International Atomic Clock)
line 10 Time of Last       Seconds since 1 January 1993 00:00:00
   Scan in Granule         (International Atomic Clock)
lines 11-14 Notes          concerning conversion from HDF to flat binary
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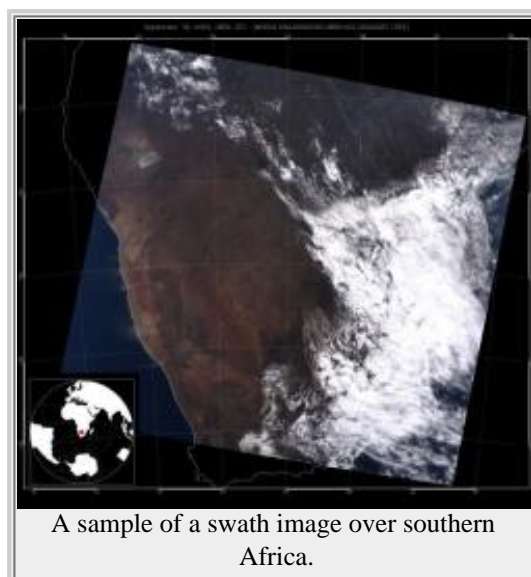
Algorithm Description

The solar-column water-vapor parameter is derived from the attenuation of near-IR solar radiation by water vapor. Techniques employing ratios of water-vapor-absorbing channels 17, 18, and 19 with the atmospheric window channels 2 and 5 are used. The ratios partially remove the effects of variation of surface reflectance with wavelength and result in the atmospheric water-vapor transmittances. The column-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%.

MOD05 Water Vapor Data Overview

The MODIS precipitable water product consists of column water-vapor amounts in centimeters (cm). 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. There are two MODIS water vapor data product files: MOD05_L2, containing data collected from the Terra platform; and MYD05_L2, containing data collected from the Aqua platform. The data in this data set are daytime-only MODIS granules from the TERRA platform.

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 x 5 1-km pixel resolution both day and night using the infra-red algorithm when at least nine FOVs are cloud free. The infrared-derived precipitable water vapor is generated as one component of product MOD07, and simply added to product MOD05 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.



A sample of a swath image over southern Africa.

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 is 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 is performed in two dimensions. The first are comparisons of specific validation sites across as many different climatic and geographic regions as possible. The second is a statistical analysis of the entire data set.

Additional Sources of Information

For more information, please refer to: http://modis-atmos.gsfc.nasa.gov/MOD05_L2/index.html.

References

Gao B. -C. and Y. J. Kaufman. 1998. The MODIS Near-IR Water Vapor Algorithm. Products: MOD05_L2, MOD08_D3, MOD08_E3, MOD08_M3. ATBD Reference Number: ATBD-MOD-03.

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Revision Date: Thursday, August 18, 2005