

# SAFARI 2000 MAPSS MOD05\_L2 Water Vapor Summary Data for Southern Africa

## Abstract

The MODIS (Moderate Resolution Imaging Spectroradiometer) Atmosphere Group develops remote sensing algorithms for deriving sets of atmospheric parameters from MODIS radiance data. These parameters can be integrated into conceptual and predictive global models. MODIS Atmosphere Products Subset Statistics (MAPSS) are generated over important locations around the world, as one of the ways to increase the scope of application of the MODIS atmospheric parameters. This MAPSS data set contains daily time series of the MODIS MOD05\_L2 water vapor product over several SAFARI 2000 ground sites for the period February 24, 2000 through March 4, 2002. Seventeen (17) AERONET sunphotometer measurement sites in Southern Africa were used as the focal points for these spatial statistics.

The process of generating the statistics involves identifying these locations on the MODIS MOD05\_L2 product, extracting the values of the pixel corresponding to each coordinate point as well as surrounding pixels falling within a 50 x 50 km box centered on the coordinate point.

The data product 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 data files are stored as ASCII tables in comma-separated-value (.csv) format. There is one file per site per year for each of the following two variables: total column precipitable water vapor (infrared retrieved) and total column precipitable water vapor (near-infrared retrieved).

The MAPSS database was established to provide a means of intercomparison and cross-validation of MODIS atmosphere products with those of other sensors and instruments (ground-based, airborne, or spaceborne) obtained at different locations around the globe. 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).

## Background Information

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**Project:** SAFARI 2000

**Data Set Title:** SAFARI 2000 MAPSS MOD05\_L2 Water Vapor Summary Data for Southern Africa

**Site:** Southern Africa

**Westernmost Longitude:** -14.415 W

**Easternmost Longitude:** 32.905 E

**Northernmost Latitude:** -7.976 S

**Southernmost Latitude:** -28.248 S

### Data Set Citation:

Ichoku, C., Y. J. Kaufman, and L. A. Remer. 2005. SAFARI 2000 MAPSS MOD05\_L2 Water Vapor Summary Data 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.

**Web Site:** <http://modis-atmos.gsfc.nasa.gov/mapss.html>

## Data File Information

This MAPSS data set contains daily statistics of spatial subsets of the MODIS MOD05\_L2 water vapor product over SAFARI 2000 ground sites for the period February 24, 2000 through March 4, 2002. Seventeen (17) AERONET sunphotometer measurement sites in Southern Africa were used as focal points for these spatial statistics (Table 1). The process of generating the statistics involves identifying these locations on the MODIS MOD05\_L2 product, extracting the values of the pixel corresponding to each coordinate point as well as surrounding pixels falling within a 50 x 50 km box centered on the coordinate point.

**Table 1. AERONET Sunphotometer Measurement Sites Used as Focal Points for the MAPSS MOD05\_L2 Water Vapor Spatial Statistics for SAFARI 2000.**

AERONET Sites	Longitude	Latitude
Ascension Island	-14.415	-7.976
Bethlehem, South Africa	28.333	-28.248
Etosha Pan, Namibia	15.914	-19.175
Inhaca, Mozambique	32.905	-26.041
Joberg, South Africa (Johannesburg)	28.029	-26.186
Kaloma, Zambia	24.827	-14.860
Kaoma, Zambia	24.795	-14.793
Maun Tower, Zambia	23.550	-19.900
Mongu, Zambia	23.151	-15.254
Mwinilunga, Zambia	24.431	-11.740
Ndola, Zambia	28.658	-12.995
Pietersburg, South Africa	29.450	-23.883
Senanga, Zambia	23.293	-16.109
Skukuza, South Africa	31.587	-24.992
Solwezi, Zambia	26.363	-12.171
Sua Pan, Zambia	26.067	-20.533
Zambezi, Zambia	23.107	-13.533

The data files are stored as ASCII tables in comma-separated-value (.csv) format. There is one file per site per year for each of the following two variables shown in Table 2.

**Table 2. MAPSS MOD05\_L2 Water Vapor Data Variables.**

MOD05 Water Vapor Data		
File Name	Data Column Abbrev.	Definition
wtr_vap_ir	wir	Total Column Precipitable Water Vapor - Infrared
wtr_vap_nir	wni	Total Column Precipitable Water Vapor - Near-infrared

The data files contain the following columns:

The first 14 columns in each data file describe the AERONET location and measurement characteristics and the next 7 are computed statistics for the subset array of pixels for the AERONET location.

In the data files, column names representing the statistics are prefixed by: pval\_, mean\_, sdev\_, slop\_, slaz\_, and mcoc\_, respectively. These prefixes are followed by a short acronym to identify the water vapor product.

These statistical parameters were calculated for the MODIS MOD05 L2 water vapor product for SAFARI 2000 for the period February 24, 2000 through March 4, 2002. There may be some data gaps, however, resulting from non-retrieval of the MODIS images due to some

unfavorable factors such as cloud cover in the reflective wavebands.

NOTE: It is possible for the data columns to change part way through a file as parameters were added or removed from the extraction process. Instead of reprocessing the entire file, such changes were marked by the insertion of a new list of column headings at the start of the new column arrangement.

Column Label	Description/format (example)
Date	2002-01-02
Time	11:15
Dayfrac	0.46875000
HDFfile	MOD05_L2.A2002002.1115.003.2002007010715.hdf
Location	Ascension_Island
Longitude	decimal degrees (-14.415)
Latitude	decimal degrees (-7.976)
SolarZenith	degrees (29.220)
SolarAzimuth	degrees (123.650)
SensorZenith	degrees (20.840)
SensorAzimuth	degrees (97.890)
ScatteringAngle	degrees (missing)
boxsize	Square km (11)
nchan	Number of channels (1)
pval_wir or _wni	Value of the central pixel in cm (3.583)
npix_wir or _wni	Number of pixels in subset (94)
mean_wir or _wni	Mean of the subset in cm (3.571)
sdev_wir or _wni	Standard deviation of the subset in cm (0.159)
slop_wir or _wni	Slope of a plane fitted to the subset (30.829)
slaz_wir or _wni	Azimuth (direction, degrees from true north) of the slope (68.474)
mcoc_wir or _wni	Multiple Correlation Coefficient (0.575)

**Example data files:**      [acsension\\_2002\\_wtr\\_vap\\_ir.csv](#)

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TITLE : MODIS Aerosol Products Subset Statistics (MAPSS)
PGE Type : MOD05_L2
SDS name : Water_Vapor_Infrared
SDS description : "Total Column Precipitable Water Vapor - IR Retrieval"
SDS no.of layers : 1
SDS units of measure : cm
Contact person : Charles Ichoku (ichoku@climate.gsfc.nasa.gov)
Pr. Investigator(s) : Yoram Kaufman (kaufman@climate.gsfc.nasa.gov)
                    Lorraine Remer (rem@climate.gsfc.nasa.gov)

Date,Time,Dayfrac,HDFfile,Location,Longitude,Latitude,SolarZenith,SolarAzimuth,SensorZenith,SensorAzimuth,ScatteringAngle,boxsize,nchan,
pval_wir,npix_wir,mean_wir,sdev_wir,slop_wir,slaz_wir,mcoc_wir
2002-01-02,11:15,0.46875000,MOD05_L2.A2002002.1115.003.2002007010715.hdf,Ascension_Island,-14.415,-
7.976,29.220,123.650,20.840,97.890,,11,1,3.583,94,3.571,0.159,30.829,68.474,0.575
2002-01-02,23:30,0.97916669,MOD05_L2.A2002002.2330.003.2002007074817.hdf,Ascension_Island,-14.415,-7.976,142.440,-
145.630,1.840,71.980,,11,1,0,,,,
2002-01-03,11:55,0.49652779,MOD05_L2.A2002003.1155.003.2002008224850.hdf,Ascension_Island,-14.415,-7.976,21.000,136.550,58.790,-
83.050,,11,1,,68,3.942,0.129,16.447,17.914,0.398
2002-01-04,00:15,0.01041667,MOD05_L2.A2002004.0015.003.2002009234448.hdf,Ascension_Island,-14.415,-7.976,147.250,-160.260,64.630,-
100.020,,11,1,0,,,,
2002-01-04,00:15,0.01041667,MOD05_L2.A2002004.0015.003.2002013202444.hdf,Ascension_Island,-14.415,-7.976,147.250,-160.260,64.630,-
100.020,,11,1,12.4036,0.190,26.654,4.396,0.386

```

## acsension\_2002\_wtr\_vap\_nir.csv

```
TITLE : MODIS Aerosol Products Subset Statistics (MAPSS)
PGE Type : MOD05_L2
SDS name : Water_Vapor_Near_Infrared
SDS description : "Total Column Precipitable Water Vapor - Near Infrared Retrieval"
SDS no.of layers : 1
SDS units of measure : cm
Contact person : Charles Ichoku (ichoku@climate.gsfc.nasa.gov)
Pr. Investigator(s) : Yoram Kaufman (kaufman@climate.gsfc.nasa.gov)
                    Lorraine Remer (rem@climate.gsfc.nasa.gov)

Date,Time,Dayfrac,HDFFile,Location,Longitude,Latitude,SolarZenith,SolarAzimuth,SensorZenith,SensorAzimuth,ScatteringAngle,boxsize,nchan,
pval_wni,npix_wni,mean_wni,sdev_wni,slop_wni,slaz_wni,mcoc_wni
2002-01-02,11:15,0.46875000,MOD05_L2.A2002002.1115.003.2002007010715.hdf,Ascension_Island,-14.415,-
7.976,29.220,123.650,20.840,97.890,,51.1,2.522,1628,2.316,0.384,59.775,248.849,0.635
2002-01-02,23:30,0.97916669,MOD05_L2.A2002002.2330.003.2002007074817.hdf,Ascension_Island,-14.415,-7.976,142.440,-
145.630,1.840,71.980,,51.1,0,,,,,
2002-01-03,11:55,0.49652779,MOD05_L2.A2002003.1155.003.2002008224850.hdf,Ascension_Island,-14.415,-7.976,21.000,136.550,58.790,-
83.050,,51.1,,1147,2.646,0.256,16.963,304.338,0.375
2002-01-04,00:15,0.01041667,MOD05_L2.A2002004.0015.003.2002009234448.hdf,Ascension_Island,-14.415,-7.976,147.250,-160.260,64.630,-
100.020,,51.1,0,,,,,
2002-01-04,00:15,0.01041667,MOD05_L2.A2002004.0015.003.2002013202444.hdf,Ascension_Island,-14.415,-7.976,147.250,-160.260,64.630,-
100.020,,51.1,0,,,,,
```

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## MOD05 Water Vapor Data

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. The MODIS MOD05\_L2 water vapor data product files contain data collected from the Terra and Aqua platforms.

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 MODIS MYD05\_L2 water vapor data product collected from the Aqua platform, and 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.

### 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 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%.

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  $\mu\text{m}$ ) and channel 32 (12  $\mu\text{m}$ ). Data validation are 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 is 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.

For more information, visit [http://modis-atmos.gsfc.nasa.gov/MOD05\\_L2/index.html](http://modis-atmos.gsfc.nasa.gov/MOD05_L2/index.html).

### Additional Sources of Information

For more information about MAPSS, please refer to: <http://modis-atmos.gsfc.nasa.gov/mapss.html>

For more information about MOD04 Level 2, please refer to:

[http://modis-atmos.gsfc.nasa.gov/MOD05\\_L2/index.html](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. [ [http://modis-atmos.gsfc.nasa.gov/\\_docs/atbd\\_mod03.pdf](http://modis-atmos.gsfc.nasa.gov/_docs/atbd_mod03.pdf) ]

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