MODIS Level 3 Atmosphere Products (MOD 08)

Product Description

There are three MODIS Level 3 Atmosphere Products, each covering a different temporal scale. The Earth Science Data Type names (and time spans) for each of the products are: MOD08_D3 (Daily), MOD08_E3 (8-Day), MOD08_M3 (Monthly).

Each of these Level 3 products contains statistics derived from over 50 science parameters from the Level 2 Atmosphere products: MOD04_L2, MOD05_L2, MOD06_L2, and MOD07_L2.

A range of statistical summaries is computed, depending on the Level 2 science parameter being considered. Statistics for a given Level 2 measurement might include:

- Simple (mean, minimum, maximum, standard deviation) statistics
- Parameters of normal and log-normal distributions
- Fraction of pixels that satisfy some condition (e.g., cloudy, clear)
- Histograms of the quantity within each grid box
- Histograms of the confidence placed in each measurement
- Histograms and/or regressions derived from comparing one science parameter to another; statistics may be computed for a subset that satisfies some condition
- Pixel counts

Statistics are sorted into 1° × 1° cells on an equal-angle grid and then summarized over the globe. The equal-angle grid has a fixed dimension of 360×180 pixels. It should be noted that three additional MOD 08 products, using the same temporal scales but summarized over an equal-area grid, will be available after launch.

The daily product contains nearly 400 statistical summary parameters. The 8-day and monthly products, which are identical in format, include over 600 statistical summary parameters.

Additional information on the MODIS Level 3 Atmosphere products can be obtained from the MODIS-Atmosphere web site at: http://modis-atmos.gsfc.nasa.gov.

Research and Applications

Users should refer to the research applications of Level 2 Atmosphere products from MOD 04, MOD 05, MOD 06, and MOD 07 listed in this handbook. Level 3 statistical products derived from Level 2 measurements lend themselves to longer-term time-series studies that help monitor variations in environmental conditions and aid research for assessing both natural and human-induced global change.

Data Set Evolution

Definition of Time Spans

For the daily product (MOD08_D3), Level 2 granules that overlap any part of the data day (0000 to 2400 UTC) are included in the computation of statistics. Therefore a particular Level 2 granule may be included in two consecutive MOD08_D3 products.

The 8-day product (MOD08_E3) is computed by manipulating and summarizing the daily product over eight consecutive days. The running 8-day interval begins with the first day of MODIS data on Terra (February 25, 2000). The 8-day intervals for MODIS on Aqua will be the same 8-day intervals as for MODIS on Terra for the period of data overlap. It should be noted that the starting day of the 8-day interval is not reset to the first, during the rollover of a calendar month or calendar year.

The monthly product (MOD08_M3) is computed by manipulating and summarizing the daily product over a calendar month.

Definition of Daily Statistics

For the daily product, assume that $x_1, x_2, \ldots, x_n$ represent the retrieved pixel values of a Level 2 parameter over a 1° × 1° grid box, Q_i is the quality flag for each retrieved pixel value, and w_i is the weighting factor (1 for the daily case), then the simple statistics are defined as:

$$\overline{X_d} = \frac{\Sigma_i^n w_i \cdot x_i}{\Sigma_i^n w_i} \qquad (1)$$

$$\overline{X_{dQ}} = \frac{\Sigma_i^n Q_i \cdot x_i}{\Sigma_i^n Q_i} \qquad (2)$$

$$X_{std} = \frac{\Sigma_1^n (w_i \cdot x_i - w_i \cdot \overline{X_d})^2}{\Sigma_i^n w_i^2} \qquad (3)$$

$$X_{stdQ} = \frac{\Sigma_1^n (Q_i \cdot x_i - Q_i \cdot \overline{X_{dQ}})^2}{\Sigma_i^n Q_i^2} \qquad (4)$$

$$X_{min} = min\ (x_1, x_2, \ldots, x_n) \qquad (5)$$

$$X_{max} = max\ (x_1, x_2, \ldots, x_n) \qquad (6)$$

In these equations, (1) will be referred to as the "regular" mean, (2) as the QA-weighted mean, (3) as the regular standard deviation, (4) as the QA-weighted

standard deviation, (5) as the minimum, and (6) as the maximum.

The simple statistics also include daily log regular mean, log standard deviation, log QA mean, and log QA standard deviation. These log quantities are calculated as shown in equations (1-4), except that x_1, x_2, …, x_n are replaced by their logarithms.

Regression statistics, based on the pixels within each 1° × 1° grid cell, include the slope, intercept, mean squared error (MSE), and the coefficient of determination (R^2).

The histograms and joint histograms report the counts of the pixels falling into predetermined numerical intervals.

The pixel counts are used to represent the number of pixels for the parameters that do not have QA flags, while the confidence-histograms-counts is used to represent the number of counts for each parameter that fall within each QA bin (e.g., good, very good, marginal, and total).

Definition of 8-day and Monthly Statistics

The 8-day and monthly statistics are based on the daily statistics with the assumption that the daily statistics from retrieved pixels can represent the statistics of the "populations" of each 1° × 1° grid cell. In other words, it is assumed that the samples composed of retrieved pixels can represent the "populations" composed of all the pixels within each grid cell.

The simple statistics for 8-day and monthly quantities include mean, standard deviation, and minimum and maximum values of the corresponding daily means (i.e., daily mean, daily QA mean, daily log mean, and daily log QA mean).

For example, if $X_{d1}, X_{d2}, \ldots, X_{dn}$ are the daily means for a Level 3 parameter, then their monthly simple statistics (i.e., mean, standard deviation, minimum, and maximum) are represented by equations (1, 3, 5, and 6) with X_i replaced by X_{di}. It should be noted that in the monthly case, the weights in equations (1) and (2) are taken either as unweighted (i.e., $w_i = 1$), pixel weighted (e.g., weighted by the number of pixels over the total pixels), or fraction weighted (e.g., weighted by the cloud fraction).

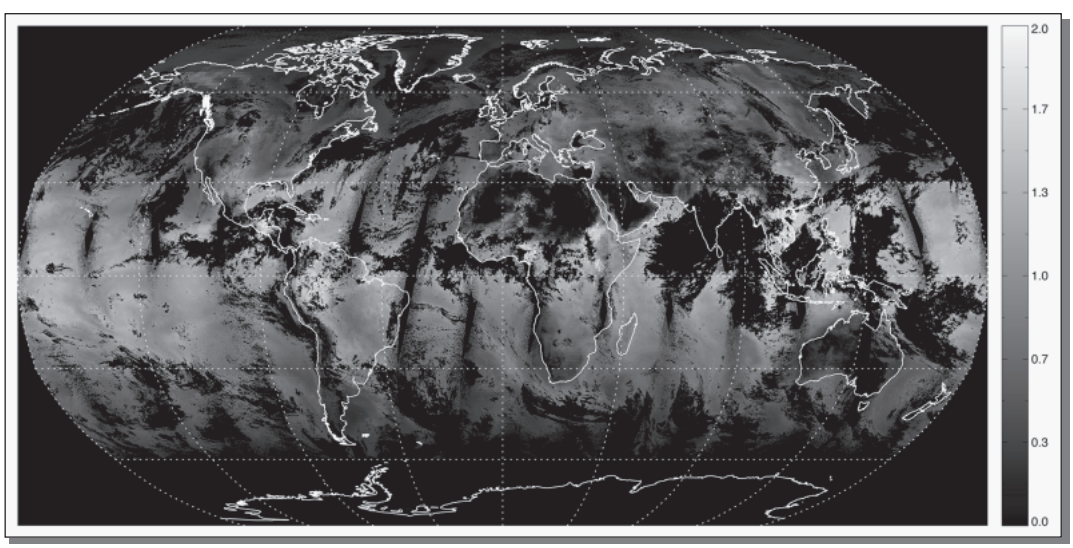
The fraction statistics represent the mean and standard deviation of the daily fraction values.

The regression statistics, which include four components (slope, intercept, mean-squared-error, and the coefficient of determination), are calculated by using the daily mean values of the first parameter versus the daily mean values of the second parameter. Therefore, two daily mean time series are used to calculate monthly regression attributes.

Histogram and joint-histogram statistics represent the number of times a parameter falls into each predefined interval.

The total counts are reported. This is simply the summation of all the counts from each interval for the parameter.

The 8-day and monthly product has an additional statistical parameter called "mean daily standard deviation." This parameter is used to represent the mean values of the daily standard deviations, such as the mean of daily standard deviation, mean of daily QA standard deviation, mean of log standard deviation, and mean of log QA standard deviation. The standard deviation of the mean is used to describe the variation of a parameter around its monthly mean, while the mean of the standard deviation is used to describe the average daily variation of a parameter.



Level 3 MODIS Global Atmospheric Mean Water Vapor below 850 mb (in cm) for June 6, 2000, derived from data from the MODIS instrument on Terra.

For example, a parameter may have a large daily standard deviation on each day, but those variations may be similar to each other. In this case, the mean daily standard deviation will be large, but its standard deviation will be small.

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

Suggested Reading

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MODIS Level 3 Atmosphere Products Summary

Coverage: Global

Spatial/Temporal Characteristics: 1.0° latitude-longitude equal-angle grid/daily, 8-day, and monthly

Key Science Applications: Climate and ecosystem monitoring and modeling, cloud radiative properties, atmospheric properties, and atmospheric corrections

Key Geophysical Parameters: Aerosol properties, cloud radiative properties, atmospheric water vapor and temperature

Processing Level: 3

Product Type: Standard, at-launch

Maximum File Size: 411 MB (Daily Level 3), 713 MB (8-day and Monthly Level 3)

File Frequency: 1/day (Daily Level 3), 1/8-day (8-Day Level 3), 1/month (Monthly Level 3)

Primary Data Format: HDF-EOS

Browse Available: http://modis-atmos.gsfc.nasa.gov/MOD08_E3/browse_main.html

Additional Product Information: http://modis-atmos.gsfc.nasa.gov/MOD08_E3/index.html

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