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NACP: MODIS Daily Land Incident 4-km PAR Images for North America, 2003-2005
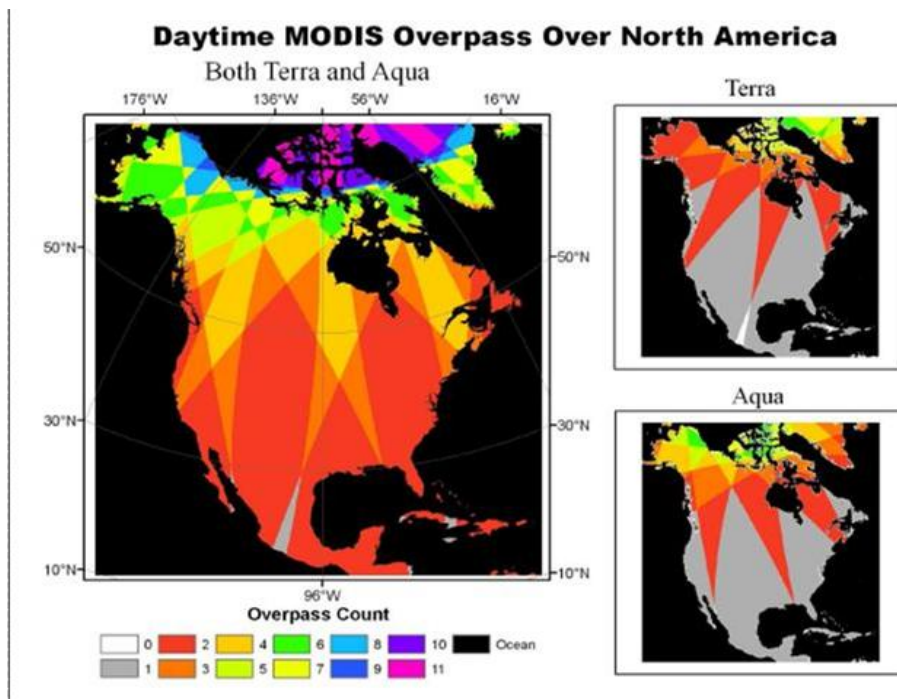
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Revision date: December 12, 2012

Summary:

This data set contains daily Moderate Resolution Imaging Spectroradiometer (MODIS) land incident photosynthetically active radiation (PAR) images over North America for the years 2003 - 2005 and was created to fill the need for daily PAR estimates. Incident PAR is the solar radiation in the range of 400 to 700 nm reaching the earth's surface and plays an important role in modeling terrestrial ecosystem productivity.

The daily images were derived by integrating MODIS/Terra and MODIS/Aqua instantaneous PAR data where the instantaneous PAR data is estimated directly from Terra or Aqua MODIS 5-min L1b swath data (Liang et al., 2006 and Wang et al., 2010).

The spatial distribution of this data set includes the MODIS tile subsets covering North America, Central America, portions of South America, and Greenland, available for the years 2003 - 2005. There are 45,376 *.hdf files with a spatial resolution of 4 km x 4 km in sinusoidal projection distributed by year in three compressed data files: 2003.zip, 2004.zip, and 2005.zip. Contained within each daily file are 4 separate image files: DirectPar, DiffusePAR, TotalPAR, and Observation Count. There are 46 MODIS tiles that cover the study area extent.

MODIS overpass of North America based on the Terra and Aqua orbital simulation from GMT 12:00 to 24:00, June 16, 2006. From Wang et al. (2010).

Data Citation:

Cite this data set as follows:

Liang, S. and D. Wang. 2012. NACP: MODIS Daily Land Incident 4-km PAR Images for North America, 2003-2005. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.
http://dx.doi.org/10.3334/ORNLDAAC/1140

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1. Data Set Overview:

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2. Data Characteristics:

File Organization

There are 45,376 *.hdf files with a spatial resolution of 4 km x 4 km distributed by year in three compressed data files:

 2003.zip: contains 15,027 *.hdf files

2004.zip: contains 14,634 *.hdf files

2005.zip: contains 15,715 *.hdf files

Contained within each daily file are 4 separate image files: DirectPar, DiffusePAR, TotalPAR, and Observation Count. There are 46 MODIS tiles that cover the study area extent.

Within these yearly .zip files, the MODIS_PAR files are arranged by MODIS TileID. Each .hdf file contains 4 bands as described below.

File Format

MODIS land incident PAR images are stored in the HDF-4 file format, which can be opened by most commercial Remote Sensing software packages (such as: ENVI, ERDAS, PCI).

File Naming Conventions

The daily MODIS Land Incident PAR Images files are named as follows:

 DailyPAR.AYYYYDDD.HMMVNN.hdf

Where, YYYY is the year and DDD is the day of the year; MM is the H number of MODIS tile system and NN is the V number.

For example, DailyPAR.A2003001.H070V6.hdf means this is the daily-integrated PAR of the first day of 2003, covering MODIS tile H07V06.

Bands

Each daily-integrated PAR image has four bands:

 DirectPAR, 16 bit signed integer, the direct part of the daily-integrated PAR value

 DiffusePAR, 16 bit signed integer, the diffuse part of the daily-integrated PAR value

 TotalPAR, 16 bit signed integer, the total daily-integrated PAR value

 ObservationCount, 8 bit signed integer, referring to how many instantaneous PAR values are used to estimate the daily-integrated value.

The units for the first three bands are kJ/m2/day, and the fill value is 32767.

Projection

The MODIS PAR products are projected into the MODIS sinusoidal projection.

The parameters of the sinusoidal projection are:

 Radius of reference sphere: 6371007.181 m

 Longitude of the central meridian: 0.0

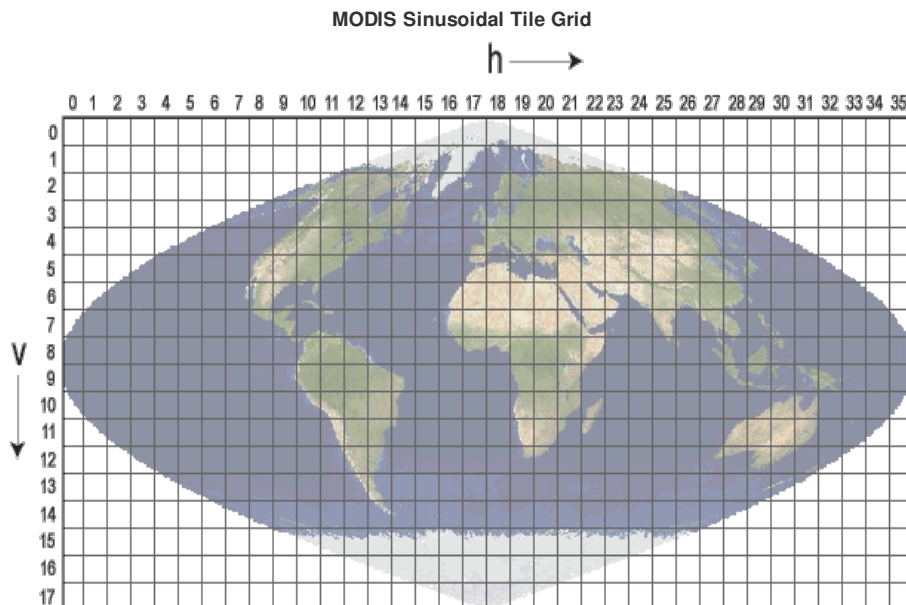 False easting: 0.0

 False northing: 0.0

 Pixel size: 3706.50173222 m (~ 4-km)

The MODIS_PAR files are distributed as tiles according to the MODIS tiling system. Each tile has 300*300 pixels.

The following tiles cover North American land areas (also depicted in the image below):

 H7V6, H8V4, H8V5, H8V6, H8V7, H9V2, H9V3, H9V4,
 H9V5, H9V6, H9V7, H9V8, H10V2, H10V3, H10V4, H10V5,
 H10V6, H10V7, H10V8, H11V2, H11V3, H11V4, H11V5, H11V7,

H12V1, H12V2, H12V3, H12V4, H12V5, H13V1, H13V2, H13V3,
H13V4, H14V1, H14V2, H14V3, H14V4, H15V0, H15V1, H15V2,
H16V0, H16V1, H16V2, H17V0, H17V1, H17V2

MODIS Sinusoidal Tile Grid

Tiles are 10 degrees by 10 degrees at the equator. The tile coordinate system starts at (0,0) (horizontal tile number, vertical tile number) in the upper left corner and proceeds right (horizontal) and downward (vertical). The tile in the bottom right corner is (35,17).

Companion Metadata Files

There is one companion file, spatial_metadata_txt.zip, which contains 46 text files (.txt), which provides spatial information for each of the 46 MODIS tiles.

Sample metadata file: spatial.meta.h10v2.txt

```
Projection=sinusoidal
Reference_sphere_radius=6371007.181000m
Central_meridian_longitude=0.0
False_easting=0.0
False_northing=0.0
Pixel_size=3706.501732m
Upperleft_point_coordinate(meter)=(-8895604.166673,7783663.637665)
Lowerright_point_coordinate(meter)=(-7783653.647007,6671713.117999)
```

Assessing HDF-4 Files

The C language library and other software to operate on HDF-4 files can be found at http://www.hdfgroup.org/products/hdf4/.

Visualization

HDF Explorer (http://www.space-research.org/index.html) is a data visualization program that reads the HDF-4, HDF-5 and netCDF data file formats. HDF Explorer runs in the Microsoft Windows operating systems.

Site boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
MODIS_PAR North America	-180.0	0.024	90.00	0.0

Tile boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
MODIS Tile H7 V6	-127.0171	-106.4089	20.000	30.000
MODIS Tile H8 V4	-155.5724	-117.4758	40.0000	50.0000
MODIS Tile H8 V5	-130.5407	-103.9134	30.0000	40.0000
MODIS Tile H8 V6	-115.4701	-95.7671	20.0000	30.0000
MODIS Tile H8 V7	-106.4178	-91.3799	10.0000	20.0000
MODIS Tile H9 V2	-180.0000	-159.9833	60.0000	63.6167

MODIS Tile H9 V3	-180.0000	-124.4449	50.0000	60.0000
MODIS Tile H9 V4	-140.0151	-104.4217	40.0000	50.0000
MODIS Tile H9 V5	-117.4867	-92.3664	30.0000	40.0000
MODIS Tile H9 V6	-103.9230	-85.1254	20.0000	30.0000
MODIS Tile H9 V7	-95.7760	-81.2257	10.0000	20.0000
MODIS Tile H9 V8	-91.3884	-79.9917	-0.0000	10.0000
MODIS Tile H10 V2	-180.0000	-139.9833	60.0000	67.1167
MODIS Tile H10 V3	-160.0000	-108.8877	50.0000	60.0000
MODIS Tile H10 V4	-124.4579	-91.3676	40.0000	50.0000
MODIS Tile H10 V5	-104.4326	-80.8194	30.0000	40.0000
MODIS Tile H10 V6	-92.3760	-74.4836	20.0000	30.0000
MODIS Tile H10 V7	-85.1342	-71.0714	10.0000	20.0000
MODIS Tile H10 V8	-81.2341	-69.9917	-0.0000	10.0000
MODIS Tile H11 V2	-180.0000	-119.9833	60.0000	70.0000
MODIS Tile H11 V3	-140.0000	-93.3305	50.0000	60.0000
MODIS Tile H11 V4	-108.9007	-78.3136	40.0000	50.0000
MODIS Tile H11 V5	-91.3785	-69.2724	30.0000	40.0000
MODIS Tile H11 V7	-74.4924	-60.9171	10.0000	20.0000
MODIS Tile H12 V1	-180.000	-146.1659	70.0000	73.8750
MODIS Tile H12 V2	-175.4283	-99.9833	60.0000	70.0000
MODIS Tile H12 V3	-120.0000	-77.7732	50.0000	60.0000
MODIS Tile H12 V4	-93.3434	-65.2595	40.0000	50.0000
MODIS Tile H12 V5	-78.3244	-57.7254	30.0000	40.0000
MODIS Tile H13 V1	-180.0000	-116.9278	70.0000	77.1667
MODIS Tile H13 V2	-146.1902	-79.9833	60.0000	70.0000
MODIS Tile H13 V3	-100.0000	-62.2160	50.0000	60.0000
MODIS Tile H13 V4	-77.7862	-52.2054	40.0000	50.0000
MODIS Tile H14 V1	-180.0000	-87.6898	70.0000	80.0000
MODIS Tile H14 V2	-116.9522	-59.9833	60.0000	70.0000
MODIS Tile H14 V3	-80.0000	-46.6588	50.0000	60.0000
MODIS Tile H14 V4	-62.2290	-39.1513	40.0000	50.0000
MODIS Tile H15 V0	-180.0000	-115.1274	80.0000	83.6250
MODIS Tile H15 V1	-172.7631	-58.4517	70.0000	80.0000
MODIS Tile H15 V2	-87.7141	-39.9833	60.0000	70.0000
MODIS Tile H16 V0	-180.0000	-57.5397	80.0000	86.8167
MODIS Tile H16 V1	-115.1754	-29.2137	70.0000	80.0000
MODIS Tile H16 V2	-58.4761	-19.9833	60.0000	70.0000
MODIS Tile H17 V0	-180.0000	57.2957	80.0000	90.0000
MODIS Tile H17 V1	-57.5877	0.0480	70.0000	80.0000
MODIS Tile H17 V2	-29.2380	0.0244	60.0000	70.0000

Time period:

- The data set covers the period 2003/01/01 to 2005/12/31.

3. Data Application and Derivation:

Incident PAR is a key variable needed by almost all terrestrial ecosystem models. Current incident PAR products estimated from remotely sensed data at spatial and temporal resolutions are not sufficient for carbon cycle modeling and various applications. In this study, the authors developed a new method based on the look-up table approach for estimating instantaneous incident PAR from MODIS data (Liang et al. 2006).

4. Quality Assessment:

Ground measurements from seven FLUXNET sites were used for validating the algorithm. The results indicated that this approach can produce reasonable PAR product at 1 km resolution and is suitable for global applications, although more quantitative validation activities are still needed (Liang et al. 2006).

The released version is version 1.5 and last modified on May 20, 2008. The integration method is the adjusted sinusoidal model, which may produce slight biases in some cases.

5. Data Acquisition Materials and Methods:

Instantaneous PAR can be used to simulate photosynthesis in many ecosystem models. However, many models require a daily time step and thus the daily PAR product is more desirable.

The daily PAR is calculated from two instantaneous PAR products (MODIS/Terra (AM) and MODIS/Aqua (PM)) (Liang et al. 2006 and Wang et al., 2010). Experiments show that the diurnal cycle can be approximated by cosine function of the local solar zenith angle (e.g., Tarpley, 1979). Following the same logic, the morning and afternoon diurnal cycles are expressed by two different functions. Specifically, MODIS/Terra instantaneous PAR values are used for determining the coefficient of the morning function, and MODIS/Aqua instantaneous PAR values are used for determining the afternoon function. The daily PAR is simply the integration of these two functions.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive Center:

Contact for Data Center Access Information:
E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Liang, S., Zheng, T., et al. (2006). Estimation of incident photosynthetically active radiation from Moderate Resolution Imaging Spectrometer data. Journal of Geophysical Research-Atmospheres 111(D15).

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Wang, D., S. Liang, R. Liu, and T. Zheng. (2010). Estimation of daily-integrated PAR from sparse satellite observations: Comparison of temporal scaling methods, International Journal of Remote Sensing. 31:6, 1661-1677.

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