National Aeronautics and Space Administration Goddard Earth Science Data Information and Services Center (GES DISC)

README Document for Consistent Long-Term Aerosol Data Records over Land and Ocean from SeaWiFS

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Revision History

Revision Date	*Changes*	*Author*
05/31/2011	Original	
11/21/2011	Updated L2 and L3 production descriptions.	Corey Bettenhausen
12/19/2011	Updated sections 2.3.1, 2.3.2 and additional minor content in other sections per input from Science Team	Dana Ostrenga
06/14/2013	Updated for v004.	Corey Bettenhausen
08/12/2013	Updated with land algorithm reference and data citation example.	Corey Bettenhausen
03/01/2021	Updated data service in section 5.0	Suhung Shen

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1.0 Introduction

The impact of natural and anthropogenic sources of air pollution has gained increasing attention from scientific communities in recent years. Indeed, tropospheric aerosols not only perturb the radiative energy balance of the Earth by interacting with solar and terrestrial radiation, but also by changing cloud properties and lifetime. Due to the relatively short lifetime of aerosols (a few hours to about a week), the distributions of these airborne particles vary extensively in both space and time. Consequently, satellite observations are needed over both source and sink regions for continuous temporal and spatial sampling of aerosol properties.

This document provides basic information for using data records produced by the MEaSUREs project titled "Consistent Long-Term Aerosol Data Records over Land and Ocean from SeaWiFS." The major goal of this project is the creation of the aerosol data records suitable for climate studies by providing a significant piece of puzzle using well-calibrated radiances acquired by the Sea-Viewing Wide Field-of-view Sensor (SeaWiFS) over the full SeaWiFS mission, 1997-2010. The principal investigator responsible for this project is Dr. N. Christina Hsu.

1.1 Dataset/Mission Instrument Description

Long-term climate data records of aerosols are currently needed to form a consensus among the science community and policy makers regarding the impact of anthropogenic aerosols on the global radiative budget. We have created such a data set by combining the long-running, well-calibrated radiance data from the SeaWiFS mission (1997-2010) and a consistent algorithm to retrieve aerosol properties over both land and ocean. The primary data products include daily swath (level 2) and gridded (level 3) products of aerosol optical thickness, Ångström exponent and single scattering albedo.

1.1.1 SeaWiFS

The SeaWiFS instrument provided radiances over 8 wavelength bands ranging from 412nm to 865 nm with a spatial resolution of about 4.5 km at the center of the swath. SeaWiFS was launched on August 1, 1997 and started delivering data shortly thereafter in September. After a mechanical failure, the mission was declared over in December 2010. The primary mission of

SeaWiFS was to measure ocean color and thus, the instrument was calibrated meticulously over its lifetime. This fact makes it particularly suitable for long-term records and trend analyses.

1.1.2 Deep Blue Aerosol Data

There are currently four types of data produced by the project, daily level 2 products (L2), daily level 3 products (L3), monthly level 3 products (L3M), and monthly level 3 climatology products (L3MC). Level 2 products contain data corresponding to a single SeaWiFS swath. There are about 15 L2 data files produced per day. Each contains retrieved aerosol properties averaged to a resolution of 3x3 SeaWiFS pixels (13.5x13.5 km at the center of the swath given 4.5km SeaWiFS pixels). All daily and monthly level 3 products are global and gridded. We provide two resolutions, 0.5 degrees and 1.0 degree. There is a single L3 and L3M data file produced per resolution per day and per month respectively. There is a single L3MC file for each month of the year (12 files total). Further details on these files can be found in section 2.3.

All data files utilize the Hierarchical Data Format, v5 (HDF5) and include metadata compliant with the Climate and Forecast (CF) conventions. A more detailed description of the file format is in section 2. More information on HDF5 and how to read this format can be found in section 4.

1.2 Algorithm Background

Our aerosol retrieval algorithm is split into three major components – ocean, vegetated land, and barren land. Aerosol retrievals over oceans use the 510 nm, 670 nm, and 865 nm top-of-atmosphere (TOA) reflectance measurements simultaneously to retrieve the aerosol optical thickness and fine mode fractional volume at 550 nm as a function of viewing geometry, solar geometry, and wind speed. These values in conjunction with the model parameters are used to then derive the aerosol optical thickness at 510 nm, 670 nm, and 865 nm and Ångström exponent in a consistent manner. Over barren and vegetated land, the surface is characterized first with a seasonal surface reflectivity database and then adjusted for surface bidirectional reflectance and local vegetation effects. A look up table is then used to match the TOA reflectance and retrieve the aerosol optical thickness and size parameters.

For more information on the Deep Blue algorithm, please see the following two publications:

Sayer, A., N. Hsu, C. Bettenhausen, Z. Ahmad, B. Holben, A. Smirnov, G.E. Thomas, and J. Zhang (2012). SeaWiFS Ocean Aerosol Retrieval (SOAR): algorithm, validation, and comparison with other datasets. *J. Geophys. Res*, *117, D03206*. doi:10.1029/2011JD016599

Hsu, N. C. M.-Jeong, C. Bettenhausen, A. M. Sayer, R. Hansell, C. S. Seftor, J. Huang, and S.-C. Tsay (2013). Enhanced Deep Blue Aerosol Retrieval Algorithm: the 2nd Generation, J. Geophys. Res, doi: 10.1002/jgrd.50712 (accepted)

1.3 Data Disclaimer

When using our data in any analysis, the data must be filtered using the confidence flags for aerosol optical thickness and Ångström exponent. **For analyses over land, we recommend using only data with a confidence flag value of 3. For analyses over oceans, data with confidence flag values of 2 or 3 may be used.** Please see section 3.3.1 and the descriptions therein for the location and meaning of the confidence flags. As described in Section 2.3, the level 2 product includes a data field (aerosol_optical_thickness_550_land_ocean_-best_estimate) consisting of only those retrievals we recommend for general use. Data outside of these recommendations should only be used for qualitative purposes e.g. images or animations. Retrievals are assigned a low confidence flag if it is believed their quality might be adversely affected by e.g. cloud contamination. For more information on the production of L3 data, please see sections 2.3.3 and 2.3.4. If you have any questions regarding appropriate use of our data, please contact Dr. Andrew Sayer (andrew.sayer@nasa.gov).

1.3.1 Acknowledgement

If you use our data in a publication, we hope you will acknowledge the project appropriately. For instance, the following is sufficient:

We thank the Deep Blue science team for their efforts in producing the SeaWiFS Deep Blue aerosol data records.

The appropriate reference(s) for the algorithms should also be cited.

Sayer, A. M., N. C. Hsu, C. Bettenhausen, Z. Ahmad, B. N. Holben, A. Smirnov, G. E. Thomas, and J. Zhang (2012), SeaWiFS Ocean Aerosol Retrieval (SOAR): Algorithm, validation, and comparison with other data sets, J. Geophys. Res., 117, D03206, doi:10.1029/2011JD016599.

Hsu, N. C. M.-Jeong, C. Bettenhausen, A. M. Sayer, R. Hansell, C. S. Seftor, J. Huang, and S.-C. Tsay (2013). Enhanced Deep Blue Aerosol Retrieval Algorithm: the 2nd Generation, J. Geophys. Res, doi: 10.1002/jgrd.50712 (accepted)

As of v004, the digital object identifier (DOI) can also be used to precisely cite a specific dataset. The DOI for each product is listed in the identifier_product_doi global attribute. They are also listed below for reference.

- L2 – http://doi.org/10.5067/MEASURES/SWDB/DATA201
- L305 – http://doi.org/10.5067/MEASURES/SWDB/DATA301
- L310 - http://doi.org/10.5067/MEASURES/SWDB/DATA302
- L3M05 - http://doi.org/10.5067/MEASURES/SWDB/DATA303
- L3M10 - http://doi.org/10.5067/MEASURES/SWDB/DATA304
- L3MC05 - http://doi.org/10.5067/MEASURES/SWDB/DATA305
- L3MC10 - http://doi.org/10.5067/MEASURES/SWDB/DATA306

The doi registered to each data product can simply be pasted into a web browser and will resolve to a landing page that provides a recommended form for citing the data. For example, the recommended for when citing the L2 data products is as follows:

N. Christina Hsu, Andrew M. Sayer, M.-J. Jeong, Corey Bettenhausen (2013), SeaWiFS Deep Blue Aerosol Optical Depth and Angstrom Exponent Level 2 Data, version 004, Greenbelt, MD, USA: Goddard Space Flight Center Distributed Active Archive Center (GSFC DAAC), Accessed <Enter User Data Access Date> at doi:10.5067/MEASURES/SWDB/DATA201

If a significant portion of our data is used in your publication, offers of coauthorship are also appreciated. In this case, please contact Dr. N. Christina Hsu (christina.hsu@nasa.gov).

1.3.2 Contact Information

If you have general questions or comments regarding our data products, please email them to Corey Bettenhausen (corey.bettenhausen@nasa.gov). For specific questions about our retrieval algorithm, please contact Dr. Andrew Sayer (andrew.sayer@nasa.gov).

You may also find more information and documentation on our project website, http://disc.gsfc.nasa.gov/dust.

1.4 What's New?

1.4.1 Version 004

As with version 003, we recommend all users use the latest version, v004. This version incorporates the following changes:

- New monthly climatology product introduced.
- Improved turbid water filter.
- Improved aerosol models in regions with highly absorbing aerosols resulting is reduced bias.
- Updates to QA-filtering during L3 aggregation.
- Added DOI-related attributes to all products and spatial completeness attributes to L3 products.
- Fixed error in ocean LUT search.
- Fixed error where very high AOT's (>3.5) were incorrectly reported as 0.02.

1.4.2 Version 003

Version 003 of the SeaWiFS Deep Blue aerosol data is a significant improvement over version 002. We recommend version 003 to all users.

This version incorporates the following changes:

- Improved surface characterization of barren areas in Australia and South America.
- Improved cloud screening scheme for distinguishing thick haze from clouds.
- Improved coverage of northern Arabian peninsula.
- Improved detection and removal of turbid water and sea ice.

- Updated solar spectrum over ocean.
- Fixed error causing underestimation of surface reflectivity.
- Added or corrected global and data attributes.

1.4.3 Version 002

First public release of SeaWiFS Deep Blue aerosol products.

2.0 Data Organization

2.1 File Naming Convention

The file naming convention is as follows:

<product>_<level>_<begindate>_<version>.<suffix>

, where
< product > = < type = DeepBlue >-< source = SeaWiFS >
< level > = < level = L3, L3M, L3MC, L2 >
< begindate > = < yyyymm[dd[Thh[mm[ss]]Z]] >
for a daily file: yyyymmdd
for monthly file: yyyymm
for an orbit/swath file: yyyymmddThhmmssZ
< version > = < number = v004 >-< productiontime = yyyymmddTHHMMSSZ >
< suffix > = h5 = HDF5

<u>Sample L2 filename</u>:

DeepBlue-SeaWiFS_L2_19971030T003336Z_v004-20130515T233557Z.h5

<u>Sample L3 filenames</u>:

DeepBlue-SeaWiFS-0.5_L3_19970926_v004-20130603T205755Z.h5

DeepBlue-SeaWiFS-1.0_L3_19970928_v004-20130603T205812Z.h5

<u>Sample L3M filenames</u>:

DeepBlue-SeaWiFS-0.5_L3M_200908_v004-20130604T125506Z.h5

DeepBlue-SeaWiFS-1.0_L3M_201004_v004-20130604T140602Z.h5

<u>Sample L3MC filenames</u>:

DeepBlue-SeaWiFS-0.5_L3MC_199801-201001_v004-20130614T143911Z.h5

DeepBlue-SeaWiFS-1.0_L3MC_199801-201001_v004-20130614T144149Z.h5

2.2 File Format and Structure

Each data file for both L2 and L3 data consists of two groups, the root group, “/”, and a diagnostic group, “/diagnostic”. **Only data fields in the root group are suitable for scientific analysis.** Data fields stored in the diagnostic group are for the purposes of algorithm development and debugging only.

2.3 Key Science Data Fields

See the tables in section 3.3 below for lists of important data fields in both the L2 and L3 data files.

2.3.1 L2 Production and Filtering

As stated in section 1.1.2, each L2 file contains data corresponding to a single SeaWiFS swath. There are about 15 L2 data files produced per day. We produce L2 data at a resolution of 3x3 native SeaWiFS pixels (given 4.5km SeaWiFS pixels, each L2 cell is thus 13.5x13.5 km at the center of the swath). All scientific data is filtered for clouds, sea ice, and surface snow or ice.

In general, data fields represent the arithmetic mean of all defined values within each cell. Data fields storing geolocation and geometry information are taken from the center pixel of each cell. Only the aerosol_optical_thickness_550_land_ocean_best_estimate data field is filtered by a confidence flag. In this case, only cells having a confidence flag value of 3 over land or 2 or 3 over ocean will be defined i.e. cells not fitting the criteria are reset to the fill value. No confidence flag filtering is performed on any other data field. For the location and meaning of the confidence flags, please see section 3.3.1 and descriptions therein.

Data fields that contain both land and ocean data are provided to simplify the user experience. Each cell in the L2 data is designated as land if the majority of pixels in that cell are over land as determined by our land/sea mask. Water cells are determined in the same manner. The values of land cells are derived using only data from land pixels. Any data from water pixels in a land cell is discarded. And vice versa for water cells. Thus, data fields containing both land and ocean data are simply composites of the individual land and ocean data fields since there is no overlap between them.

2.3.2 Daily L3 Production and Filtering

Daily level 3 (gridded) files at two resolutions, 0.5 degrees and 1.0 degree, are produced from the L2 data. In most cases, each data field represents the arithmetic mean of all cells whose latitude and longitude places it within the bounds of each grid element. Furthermore, only cells measured on the day of interest are included in this calculation. The local date based on the longitude of the cell is calculated from the time of measurement. If the local date equals the day of interest, the cell is included in the L3 data processing.

The following data fields are further filtered by confidence flag values:

- aerosol_optical_thickness_550_land
- aerosol_optical_thickness_550_ocean
- aerosol_optical_thickness_550_land_ocean
- aerosol_optical_thickness_land
- aerosol_optical_thickness_ocean
- angstrom_exponent_land
- angstrom_exponent_ocean
- angstrom_exponent_land_ocean

Generally, when calculating the mean for the above data fields, only L2 data with a confidence flag value of 3 over land or 2 or 3 over ocean are considered. The subsequent count and standard deviation fields are calculated after filtering by confidence flag. For all of the above fields, the values from the dataset aerosol_optical_thickness_confidence_flag_land_and_ocean are used to filter the data during L3 aggregation. This confidence flag is used even for the angstrom exponent data so that both data sets are spatially consistent. However, if the angstrom exponent data is to used for anything quantitative, the user should use the L2 products after filtering by the angstrom_exponent_confidence_flag_land_ocean dataset (or the separate land and ocean versions). As stated above, only data with confidence flag values of 2 or 3 over ocean and 3 over land should be used.

There is currently no lower threshold for the number of L2 cells required for each L3 grid element. We have provided separate *_count data fields containing the number of L2 cells going into each L3 grid element which may be used to filter out grid elements with low counts.

2.3.3 Monthly L3 Production and Filtering

We also produce a monthly L3 gridded product (L3M) based on the daily L3 gridded data and at the same resolutions, 0.5 degrees and 1.0 degree. The monthly product is simply the arithmetic mean of the daily L3 gridded product. However, we do require at least 3 days of data in the month when calculating the mean. Otherwise, we do not believe that sampling is sufficient to provide a representative monthly average value.

2.3.4 Monthly L3 Climatology Production and Filtering

Along with the L3M products, we produce a monthly climatology product (L3MC) for each month of the year. These files are simply the arithmetic mean of the L3M products for each month. We require at least 4 months of data to calculate the mean to assure decent sampling. We have not included the angstrom exponent data in the L3MC products. These products were produced to facilitate anomaly studies, and, in this context, angstrom exponent anomalies aren't particularly meaningful nor are such anomalies reliable.

3.0 Data Contents

3.1 Dimensions

L2 data files contain 4 dimensions.

- nxtrack – number of cells across (x) the swath (track). Since the number of pixels per scan line is fixed, the length of this dimension should always be 82. The values stored in this data field should not be used.
- natrack – number of cells along (a) the swath (track). This dimension represents the number of cells in the along-swath direction (roughly north to south). The length of this dimension fluctuates depending on the number of scan lines in the swath. The values stored in this data field should not be used.
- land_bands – land wavelength bands. We report some products at multiple wavelength bands, e.g aerosol optical thickness. This dimension provides the wavelength information for these products.
- ocean_bands – ocean wavelength bands. We report some ocean products at multiple wavelength bands, eg. aerosol optical thickness. This dimension provides the wavelength information for these products.

Level 3 data files also have three dimensions defined.

- latitude – latitude of center of each row of data. For 0.5 degree products, this dimension has 360 elements. For 1.0 degree products, this dimension has 180 elements.
- longitude – longitude of center of each column of data. For 0.5 degree products, this dimension has 720 elements. For 1.0 degree products, this dimension has 360 elements.
- land_bands – wavelength bands used over land. See description in L2 section above.

- ocean_bands – wavelength bands used over ocean. See description in L2 section above.

3.2 Global Attributes

Attribute Name	Description	Data Type
Conventions	the metadata conventions followed in the file, e.g. CF-1.4	string
title	a title for the data set	string
history	a record of modifications to the data	string
institution	institution of the original data producers	string
references	published or web-based information on the data	string
description	short, informative descriptive statement	string
long_name	long, descriptive name for data set	string
short_name	short name for data set	string
local_granule_id	filename of the current data file	string
production_datetime	date and time the current file was produced	string
pge_version	version of executable used to create data	string
version_id	data version	string
north_bounding_coordinate	northernmost latitude contained in current file	float
south_bounding_coordinate	southernmost latitude contained in current file	float
east_bounding_coordinate	easternmost longitude contained in file	float
west_bounding_coordinate	westernmost longitude contained in file	float
equator_crossing_date	date on which the satellite crossed the equator	string
equator_crossing_longitude	longitude at which the satellite crossed the equator	real
equator_crossing_time	time at which the satellite crossed the equator	string
orbit_number	orbit number, passed directly from SeaWiFS L1B	integer
instrument_long_name	long, descriptive name of measuring instrument	string
instrument_short_name	abbreviated name for measuring instrument	string
platform_long_name	descriptive name for platform on which instrument was installed	string
platform_short_name	abbreviated name of platform containing instrument	string
range_beginning_date	earliest date of data in current file	string
range_beginning_time	earliest time of data in current file	string
range_ending_date	latest date of data in current file	string
range_ending_time	latest time of data in current file	string
input_data_products	input files used in data processing	string
contact_person_name	name of point of contact regarding the data	string
contact_person_role	role of contact person in project	string
contact_person_address	physical address of contact_person_name	string
contact_person_email	email address for contact_person_name	string
related_url	related website for more information on the data	string
keyword	descriptive words or phrases related to the data	string
format	file format of the data (HDF5)	string
identifier_product_doi	digital object identifier e.g. 10.5067/MEASURES/SWDB/DATA201	string

identifier_product_doi_authority	authority through which DOI can be resolved	string
The following attributes apply to L3 data only.		
northernmost_latitude	latitude of the northernmost data point	float
southernmost_latitude	latitude of the southernmost data point	float
easternmost_longitude	longitude of the easternmost data point	float
westernmost_longitude	longitude of the westernmost data point	float
latitude_resolution	resolution of data in the north-south direction	float
longitude_resolution	resolution of data in the east-west direction	float
spatial_completeness_definition	description of how the spatial completeness of the file was determined	string
spatial_completeness_ratio	ratio of the number of grid elements with data to the total number of grid elements.	float
spatial_completeness_comment	human-readable string describing the above ratio in terms of whether the ratio signifies an abnormal amount of missing data.	string

The spatial_completeness_ratio is intended to provide a warning to the user that the data may be unreliable due to poor sampling caused by missing L1B reflectance (instrument outages, tilt maneuvers, etc). Please note that this is not a reflection of the completeness of the SWDB aerosol retrieval products. The following two strings are the only two possible values of the spatial_completeness_comment attribute:

- "little or no data missing"
- "a significant amount of data may be missing"

The spatial_completeness_ratio contains the actual ratio of the number of grid elements with data to the total number of grid elements. A threshold is placed on this value to derive the spatial_completeness_comment string. The values of these thresholds are 0.57, and 0.60 for the L305 and L310 products respectively. All L3M products use 0.75 as the threshold.

3.2 Data Field Attributes

Attribute Name	Description	Data Type
standard_name	standard name for data field according to CF conventions. See also http://cf-pcmdi.llnl.gov/documents/cf-standard-names/.	string
long_name	long, descriptive name of data field	string
units	units of the data field	string
comment	miscellaneous information about the data or how it was produced	string
valid_range	range of valid values of data in data field	same type as data field
flag_meanings	space-delimited string specifying meanings of flags corresponding to elements of flag_values	string

flag_values	integer array of valid flag values of data field corresponding to each flag meaning in flag_meanings	integer

3.3 Products/Parameters

3.3.1 Level 2 Data Fields

Data Field Name	Description	Units
latitude	latitude of the center of the cell	degrees_north
longitude	longitude of the center of the cell	degrees_east
land_bands	wavelength bands over land	nm
ocean_bands	wavelength bands over ocean	nm
solar_zenith_angle	angle between the pixel zenith and the sun	degrees
viewing_zenith_angle	angle between the cell zenith and the instrument	degrees
relative_azimuth_angle	difference between the satellite and solar azimuth angles NOTE: Follows the Gordon convention and is measured relative to South.	degrees
scattering_angle	angle between the direction of incident radiation and the direction into which it is scattered	degrees
time_of_measurement	time of measurement for each line of data	seconds since 1993-01-01 00:00:00.0
aerosol_optical_thickness_550_land_ocean_best_estimate	aerosol optical thickness at 550 nm with confidence flag value of 3 over land or 2 and 3 over ocean	none
aerosol_optical_thickness_550_land_ocean	aerosol optical thickness at 550 nm over land and ocean including interior water bodies	none
aerosol_optical_thickness_550_land	aerosol optical thickness at 550nm over land only	none
aerosol_optical_thickness_550_ocean	aerosol optical thickness at 550 nm over ocean and interior water bodies (lakes, rivers, etc)	none
aerosol_optical_thickness_confidence_flag_land	confidence flags associated with all aerosol optical thickness over land data fields 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none
aerosol_optical_thickness_confidence_flag_ocean	confidence flags associated with all aerosol optical thickness over ocean data fields 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none

aerosol_optical_thickness_confidence_flag_land_ocean	confidence flags associated with all aerosol optical thickness over land and ocean data fields 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none
aerosol_optical_thickness_land	aerosol optical thickness at 412 nm, 490 nm, and 670 nm over land only	none
aerosol_optical_thickness_ocean	aerosol optical thickness at 510 nm, 670 nm, and 865 nm over ocean only	none
angstrom_exponent_land_ocean	Ångström exponent of aerosols over land and ocean.	none
angstrom_exponent_confidence_flag_land_ocean	confidence flag associated with angstrom_exponent_land_ocean data field 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none
angstrom_exponent_land	Ångström exponent of aerosols calculated using the aerosol optical thickness at 412 nm and 490 nm over land.	none
angstrom_exponent_confidence_flag_land	confidence flag associated with angstrom_exponent_land data field 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none
angstrom_exponent_ocean	Ångström exponent of aerosols calculated using the aerosol optical thickness at 440 nm and 870 nm over ocean. See note below.	none
angstrom_exponent_confidence_flag_ocean	confidence flag associated with angstrom_exponent_ocean data field 0 = No retrieval 1 = Marginal 2 = Good 3 = Very Good	none
number_pixels_used_land	number of pixels used per cell in average over land	count
number_pixels_used_ocean	number of pixels used per cell in average over ocean	count

Note: Ångström exponents over ocean are calculated using aerosol optical thickness at 440 nm and 870 nm to match the data from AERONET. These AOT values are derived in a physically consistent manner using the retrieved aerosol properties.

3.3.2 Level 3 Data Fields

Data Field Name	Description	Units
latitude	latitude of the center of the grid element	degrees_north
longitude	longitude of the center of the grid element	degrees_east
land_bands	wavelength bands over land	nm
ocean_bands	wavelength bands over ocean	nm
solar_zenith_angle	angle between the pixel zenith and the sun	degrees

viewing_zenith_angle	angle between the cell zenith and the instrument	degrees
relative_azimuth_angle	difference between the satellite and solar azimuth angles NOTE: Follows the Gordon convention and is measured relative to South.	degrees
scattering_angle	angle between the direction of incident radiation and the direction into which it is scattered	degrees
time_of_measurement	average time of measurement	seconds since 1993-01-01 00:00:00.0
aerosol_optical_thickness_550_land_ocean	aerosol optical thickness at 550nm over land and ocean	
aerosol_optical_thickness_550_land	aerosol optical thickness at 550nm over land only	none
aerosol_optical_thickness_550_ocean	aerosol optical thickness at 550 nm over ocean and interior water bodies (lakes, rivers, etc)	none
aerosol_optical_thickness_550_count_land_ocean	number of cells used per grid element in average	count
aerosol_optical_thickness_550_count_land	number of cells used per grid element in average over land	count
aerosol_optical_thickness_550_count_ocean	number of cells used per grid element in average over ocean	count
aerosol_optical_thickness_550_stddev_land_ocean	standard deviation of aerosol optical thickness at 550 nm per grid element over land and ocean	none
aerosol_optical_thickness_550_stddev_land	standard deviation of aerosol optical thickness at 550 nm per grid element over land	none
aerosol_optical_thickness_550_stddev_ocean	standard deviation of aerosol optical thickness at 550 nm per grid element over ocean	none
aerosol_optical_thickness_land	aerosol optical thickness at 412 nm, 490 nm, and 670 nm over land only	none
aerosol_optical_thickness_ocean	aerosol optical thickness at 510 nm, 670 nm, and 865 nm over ocean only	none
aerosol_optical_thickness_count_land	number of cells used per grid element in average over land	count
aerosol_optical_thickness_count_ocean	number of cells used per grid element in average over ocean	count
aerosol_optical_thickness_stddev_land	standard deviation of aerosol optical thickness per grid element over land	none
aerosol_optical_thickness_stddev_ocean	standard deviation of aerosol optical thickness per grid element over ocean	none
angstrom_exponent_land_ocean	Ångström exponent of over land and ocean.	none
angstrom_exponent_land	Ångström exponent of aerosols calculated using the aerosol optical thickness at 412 nm and 490 nm over land.	none
angstrom_exponent_ocean	Ångström exponent of aerosols calculated using the aerosol optical thickness at 440 nm and 870 nm over ocean. See note below.	none
angstrom_exponent_stddev_land_ocean	standard deviation of Ångström exponent per grid element over land and ocean	none
angstrom_exponent_stddev_land	standard deviation of Ångström exponent per grid element over land	none

angstrom_exponent_stddev_ocean	standard deviation of Ångström exponent per grid element over ocean	
angstrom_exponent_count_land_ocean	number of cells used per grid element in average over land and ocean	count
angstrom_exponent_count_land	number of cells used per grid element in average over land	count
angstrom_exponent_count_ocean	number of cells used per grid element in average over ocean	count

Note: Ångström exponents over ocean are calculated using aerosol optical thickness at 440 nm and 870 nm to match the data from AERONET. These AOT values are derived in a physically consistent manner using the retrieved aerosol properties.

3.3.3 Level 3 Climatology Data Fields

Please note that the Angstrom exponent data fields are not included in the climatology products.

Data Field Name	Description	Units
latitude	latitude of the center of the grid element	degrees_north
longitude	longitude of the center of the grid element	degrees_east
land_bands	wavelength bands over land	nm
ocean_bands	wavelength bands over ocean	nm
solar_zenith_angle	angle between the pixel zenith and the sun	degrees
viewing_zenith_angle	angle between the cell zenith and the instrument	degrees
relative_azimuth_angle	difference between the satellite and solar azimuth angles NOTE: Follows the Gordon convention and is measured relative to South.	degrees
scattering_angle	angle between the direction of incident radiation and the direction into which it is scattered	degrees
aerosol_optical_thickness_550_land_ocean	aerosol optical thickness at 550nm over land and ocean	
aerosol_optical_thickness_550_land	aerosol optical thickness at 550nm over land only	none
aerosol_optical_thickness_550_ocean	aerosol optical thickness at 550 nm over ocean and interior water bodies (lakes, rivers, etc)	none
aerosol_optical_thickness_550_count_land_ocean	number of cells used per grid element in average	count
aerosol_optical_thickness_550_count_land	number of cells used per grid element in average over land	count
aerosol_optical_thickness_550_count_ocean	number of cells used per grid element in average over ocean	count
aerosol_optical_thickness_550_stddev_land_ocean	standard deviation of aerosol optical thickness at 550 nm per grid element over land and ocean	none
aerosol_optical_thickness_550_stddev_land	standard deviation of aerosol optical thickness at 550 nm per grid element over land	none
aerosol_optical_thickness_550_stddev_ocean	standard deviation of aerosol optical thickness at 550 nm per grid element over ocean	none
aerosol_optical_thickness_land	aerosol optical thickness at 412 nm, 490 nm, and 670 nm over land only	none
aerosol_optical_thickness_ocean	aerosol optical thickness at 510 nm, 670 nm, and 865 nm over ocean only	none
aerosol_optical_thickness_count_land	number of cells used per grid element in average over land	count

aerosol_optical_thickness_count_ ocean	number of cells used per grid element in average over ocean	count
aerosol_optical_thickness_stddev_ land	standard deviation of aerosol optical thickness per grid element over land	none
aerosol_optical_thickness_stddev_ ocean	standard deviation of aerosol optical thickness per grid element over ocean	none

4.0 Options for Reading the Data

Data usability is very important to us. We have selected HDF5 to maximize the usability and accessibility of our data now and well into the future. Access to HDF5 files is available in a number of ways. There are several third party applications that can be used to read HDF5 files, create plots or maps, or simply list the contents. Application interfaces (API's) implemented in a wide range of computer languages are also available.

If you have trouble reading our data or have suggestions on how to make our data more usable or more accessible, please email your comments to corey.bettenhausen@nasa.gov.

4.1 Command Line Utilities

The HDF Group provides a number of utilities with the HDF5 library to examine and edit HDF5 files. A list of these utilities and descriptions can be found on their website at: http://www.hdfgroup.org/products/hdf5_tools/index.html#h5dist.

4.2 Tools/Programming

Any application that supports the HDF5 file format can be used to read our data. If you are new to HDF5 or to our data, the following tools might be useful starting points.

- HDFView (http://www.hdfgroup.org/hdf-java-html/hdfview/index.html)
- Panoply **(**http://www.giss.nasa.gov/tools/panoply/)
    - http://disc.sci.gsfc.nasa.gov/cookbook/How-to-View-Remote-Data-in-OPeNDAP-with-Panoply

For more advanced users or programmers:

- IDL (http://www.ittvis.com/language/en-us/productsservices/idl.aspx)
- Matlab (http://www.mathworks.com/products/matlab/)
- GrADS (http://www.iges.org/grads/)
- Python (http://h5py.alfven.org/)
- Java (http://www.hdfgroup.org/hdf-java-html/)
- C/C++ (http://www.hdfgroup.org/HDF5/)
- Fortran77/90 (http://www.hdfgroup.org/HDF5/)

5.0 Data Services

The data is currently available through several services which may be accessed through the GES DISC web page https://disc.gsfc.nasa.gov

Searching for keyword 'SWDB'
(https://disc.gsfc.nasa.gov/datasets?keywords=SWDB&page=1)
or searching for keyword 'seawifs+aerosol'
(https://disc.gsfc.nasa.gov/datasets?keywords=seawifs%2Baerosol&page=1)

Clicking on the title of an interested data collection, it will lead you to the data set landing page. Then, you may download or visualize the data with the listed data access methods.

If you need assistance or wish to report a problem:
Email: gsfc-dl-help-disc@mail.nasa.gov
Voice: 301-614-5224
Fax: 301-614-5268
Address:
Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

6.0 More Information

For more information on our project or data, please visit our website at:

1G

For more information on SeaWiFS, please visit the Ocean Color Web:

http://oceancolor.gsfc.nasa.gov/

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