Ocean Level-3 Standard Mapped Image Products
June 4, 2010

1.0   Introduction

This document describes the specifications of Ocean Level-3 standard mapped archive products that are produced and distributed by the NASA Goddard Space Flight Center's Ocean Data Processing System (ODPS). The products are implemented in the Hierarchical Data Format (HDF), and HDF terminology is used in this document.

These specifications are given in terms of the logical implementation of the products in HDF and are not a physical description of file contents. HDF software must be used to create or read these products. Depending on the specific instrument, either HDF4 or HDF5 may be used.

The Level-3 standard mapped image (SMI) products are representations of binned data products generated from SeaWiFS, MODIS (Terra and Aqua), OCTS, CZCS, OCM2, VIIRS and Aquarius data. The data object, **l3m_data**, in each SMI product represents a mean at each grid point of the parameter specified by the global attribute **Parameter**. This object is a two-dimensional array of an Equidistant Cylindrical (also known as Plate Carrée) projection of the globe. The values can be stored as bytes, 2-byte integers, or 4-byte floats. The first two are scaled real values and may be converted to geophysical values using the global attributes **Scaling**, **Scaling Equation**, **Base**, **Slope**, and **Intercept**.

The standard SMI products are generated from binned data products, one for each geophysical parameter stored in the binned products. Thus, each SMI product represents data binned over the period covered by the parent product. The mean is used in each case to obtain the values for the SMI grid points from the binned data products. Each SMI product contains one image of a geophysical parameter and is stored in one physical HDF file.

2.0   Naming Convention

The root file names of SMI products correspond to those of their parent binned data products, indicating the binning periods as part of the names. The first character is the instrument identifier (S for SeaWiFS, A for Aqua MODIS, T for Terra MODIS, O for OCTS, C for CZCS, O2_ for OCM2, V for VIIRS, Q for Aquarius). The file name extensions are of the form L3m_ttt_pppp_r, where ttt represents the binning period length, pppp is a code for the geophysical parameter of the product, and r is the resolution. From each binned data product, SMI products are generated with the parameter codes as listed in Table 1. For the parameters that are wavelength specific, the relevant wavelengths for each sensor are shown in Table 2.

For a SeawiFS ocean color standard daily product set, the following SMI products would be generated:

```
day:            S1998001.L3m_DAY_CHL_chlor_a_9km
                S1998001.L3m_DAY_RRS_angstrom_9km
                S1998001.L3m_DAY_RRS_Rrs_412_9km
                S1998001.L3m_DAY_RRS_Rrs_443_9km
                S1998001.L3m_DAY_RRS_Rrs_490_9km
                S1998001.L3m_DAY_RRS_Rrs_510_9km
                S1998001.L3m_DAY_RRS_Rrs_555_9km
                S1998001.L3m_DAY_RRS_Rrs_670_9km
                S1998001.L3m_DAY_RRS_aot_865_9km
                S1998001.L3m_DAY_K490_Kd_490_9km
                S1998001.L3m_DAY_CDOM_cdom_index_9km
                S1998001.L3m_DAY_PIC_pic_9km
                S1998001.L3m_DAY_POC_poc_9km
                S1998001.L3m_DAY_PAR_par_9km
```

and similarly for the 8-day, monthly, seasonal, yearly and mission files.

3.0   Global Attributes

For global attributes that have constant values specific to this product type, the value is given.

3.1   Mission and Documentation

This section lists common attributes for all sensors, followed by sensor-specific attributes.

3.1.1   Common Attributes

Product Name (character): the name of the product file (without path).

Title (character): "sssss Level-3 Standard Mapped Image", where sssss is "SeaWiFS", "HMODISA", "HMODIST", "OCTS", "CZCS", "OCM2", "VIIRS" or "Aquarius".

Sensor Name (character): "SeaWiFS", "MODISA", "MODIST", "OCTS", "CZCS", "OCM2", "VIIRS" or "Aquarius".

Product Type (character): "D", "8D", "MO", "SNSU" or "YR"; represents product time period.

Software Name (character): "smigen"; name of the software used to create this product.

Software Version (character): version of the software used to create this product.

Processing Time (character): local time of generation of this product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Processing Version (character): the processing version of the product. This represents a specific combination of processing software, algorithms and parameters.

Processing Control (character): path and name of the file containing the control parameters. This information is stored in the product as part of its processing history.

Input Parameters (character): all input and processing control parameters used by the calling program to generate the product. Vertical bars or carriage return characters serve as parameter information delimiters. This information is stored in the product as part of its processing history.

Input Files (character): the name of the Level-3 binned data product (file name without path) from which the current product was created. This information is stored in the product as part of its processing history.

L2 Flag Names (character): Level-2 product flags that were used to mask data samples; same as for parent Level-3 binned product.

3.1.2   SeaWiFS-Specific Attributes

Data Center (character): "NASA/GSFC SeaWiFS Data Processing Center".

Station Name (character): data collection site.

Station Latitude (4-byte real): 37.9272.

Station Longitude (4-byte real): -75.4753.

Mission (character): "SeaStar SeaWiFS".

Mission Characteristics (character): "Nominal orbit: inclination = 98.2 (Sun-synchronous); node = 12 noon local (descending); eccentricity = <0.002; altitude = 705 km; ground speed = 6.75 km/sec".

Sensor (character): "Sea-viewing Wide Field-of-view Sensor (SeaWiFS)".

Sensor Characteristics (character): "Number of bands = 8; number of active bands = 8; wavelengths per band (nm) = 412, 443, 490, 510, 555, 670, 765, 865; bits per pixel = 10; instantaneous field-of-view = 1.5835 mrad; pixels per scan = 1285; scan rate = 6/sec; sample rate = 7710/sec". Note: Pixels per scan, scan rate, and sample rate are given for the sensor; effective rates for GAC data are lower due to subsampling.

3.2   Data Time

Note that for the Ocean Color and SST products, the actual data time range (as represented by the **Start** and **End** attributes) will be different from the **Period** time range because of the Data Day logic used to select data for the binned data products.

Period Start Year (2-byte integer): binning period start year (cf. **Start Year**) of parent product.

Period Start Day (2-byte integer): UTC day-of-year of start of binning period (cf. **Start Day**) of the parent product.

Period End Year (2-byte integer): binning period end year (cf. **End Year**) of the parent product.

Period End Day (2-byte integer): UTC day-of-year of end of binning period (cf. **End Day**) of the parent product.

Start Time (character): data start UTC as read from the parent product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

End Time (character): data end UTC as read from parent product; concatenated digits for year, day-of-year, hours, minutes, seconds, and fraction of seconds in the format of YYYYDDDHHMMSSFFF.

Start Year (2-byte integer): UTC year of data start from parent product.

Start Day (2-byte integer): UTC day-of-year of data start from parent product.

Start Millisec (4-byte integer): UTC milliseconds-of-day of data start from parent product.

End Year (2-byte integer): UTC year of data end from parent product.

End Day (2-byte integer): UTC day-of-year of data end from parent product.

End Millisec (4-byte integer): UTC milliseconds-of-day of data end from parent product.

Orbit (4-byte integer): number of the orbit crossing 180° longitude closest to equator at the start, from parent product.

Start Orbit (4-byte integer): first orbit that may have contributed data, from parent product.

End Orbit (4-byte integer): last orbit that may have contributed data, from parent product.

3.3   Scene Coordinates

Map Projection (character): "Equidistant Cylindrical".

Latitude Units (character): "degrees North"; units used for all latitude values in this product.

Longitude Units (character): "degrees East"; units used for all longitude values in this product.

Northernmost Latitude (4-byte real): 90.0 for standard products.

Southernmost Latitude (4-byte real): -90.0 for standard products.

Westernmost Longitude (4-byte real): -180.0 for standard products.

Easternmost Longitude (4-byte real): 180.0 for standard products.

Latitude Step (4-byte real): latitudinal distance between lines (180./**Number of Lines**).

Longitude Step (4-byte real): longitudinal distance between columns (360./**Number of Columns**).

SW Point Latitude (4-byte real): latitude of data point for southwesternmost grid cell to indicate location of data center within each grid cell; equals **Southernmost Latitude** + (**Latitude Step**/2.0).

SW Point Longitude (4-byte real): longitude of data point for southwesternmost grid cell to indicate location of data center within each grid cell; equals **Westernmost Longitude** + (**Longitude Step**/2.0).

3.4   Data Description

Data Bins (4-byte integer): number of bins containing data in the parent binned product.

Number of Lines (4-byte integer): number of points in the vertical (longitudinal) direction.

Number of Columns (4-byte integer): number of points in the horizontal (latitudinal) direction.

Parameter (character): geophysical parameter stored in this product; see Tables 1 and 2 for standard product values.

Measure (character): "Mean"; statistical method used to compute values for grid points.

Units (character): "mg m^-3", blank, "mW cm^-2 um^-1 sr^-1", blank, or "m^-1", corresponding, respectively, to the **Parameter** value; see Table 1.

3.5   Scaling Information

These parameters are used for data stored in scaled form (1-byte or 2-byte) to convert the values back to physical units, and also to suggest the range for displaying the data. For 4-byte floats, the scaling will show as linear with slope of 1 and offset of 0, since no scaling is applied. The Suggested Image Scaling parameters can be used by other applications to scale the floating-point maps to displayable images.

Scaling (character): "logarithmic" or "linear"; functional representation of data used for scaling.

Scaling Equation (character): "Base**((Slope*l3m_data) + Intercept) = Parameter value", if **Scaling** = "logarithmic"; else, "(Slope*l3m_data) + Intercept = Parameter value".

Base (4-byte real): 10.0, if **Scaling** = "logarithmic"; else, **Base** is not included as a global attribute; used to convert the values of **l3m_data** into geophysical parameters by **Base****((**Slope*l3m_data**) + **Intercept**).

Slope (4-byte real): used to convert the values of **l3m_data** into geophysical values by **Base****((**Slope*l3m_data**) + **Intercept**), if **Scaling** = "logarithmic", or (**Slope*l3m_data**) + **Intercept**, if **Scaling** = "linear".

Intercept (4-byte real): used to convert the values of **l3m_data** into geophysical values by **Base****((**Slope*l3m_data**) + **Intercept**), if **Scaling** = "logarithmic", or (**Slope*l3m_data**) + **Intercept**, if **Scaling** = "linear".

Data Minimum (4-byte real): minimum value of the input data used to generate **l3m_data**.

Data Maximum (4-byte real): maximum value of the input data used to generate **l3m_data**.

Suggested Image Scaling Minimum (4-byte real): suggested minimum value of **l3m_data** to

be used for display as an image.

Suggested Image Scaling Maximum (4-byte real): suggested maximum value of **l3m_data** to be used for display as an image.

Suggested Image Scaling Type (4-byte real): "LINEAR" or "LOG"; suggested function to be used to scale **l3m_data** for display as an image.

Suggested Image Scaling Applied (4-byte real): "Yes" or "No"; indicates whether suggested scaling has already been applied to **l3m_data**; for 1-byte or 2-byte data types.

4.0   Data Arrays

l3m_data (byte, 2-byte integer or 4-byte float, array size **Number of Lines** x **Number of Columns**): array of **Parameter** data; may be converted into real values using attributes **Base**, **Slope**, and **Intercept** as described by attributes **Scaling** and **Scaling Equation**. The value indicated by the attribute **Fill** is reserved to indicate "no data"; i.e., a bin for this geographic location does not exist in the parent Level-3 binned product.

l3m_qual (byte, array size **Number of Lines** x **Number of Columns**): array of quality levels associated with **Parameter** data (MODIS SST only); values of 0 represent best quality, and quality decreases with increasing values

Table 1. Summary of Level-3 standard mapped parameters.

Parameter	Description	Units
CHL	Chlorophyll a concentration	mg m^{-3}
RRS	Remote sensing reflectance at specified band (see Table 2)	sr^{-1}
Angstrom	Angstrom coefficient	None
aot	Aerosol optical thickness at specified band (see Table 2)	None
K490	Diffuse attenuation coefficient at 490 nm	m^{-1}
CDOM	CDOM Index	None
PIC	Calcite Concentration	mol m^{-3}
POC	Particulate Organic Carbon	mg m^{-3}
PAR	Photosynthetically Available Radiation	Einsteins m^{-2} day^{-1}
NFLH	Normalized Fluorescence Line Height (MODIS)	mW cm^{-2} um^{-1} sr^{-1}
SST	Sea Surface Temperature (MODIS)	degrees C
SSS	Sea Surface Salinity (Aquarius)	PSU

Scat_wind _speed	Scatterometer wind speed (Aquarius)	PSU

Table 2. Band-center wavelengths by sensor (nm). These are used in the geophysical parameter names that are based on wavelength.

SeaWiFS	MODIS	OCTS	CZCS	OCM2
412 (1)	412 (1)	412 (1)		415 (1)
443 (1)	443 (1)	443 (1)	443 (1)	442 (1)
	469 (1),(3)			
490 (1)	488 (1)	490 (1)		491 (1)
510 (1)	531 (1)	520 (1)	520 (1)	512 (1)
555 (1)	547 (1)	565 (1)	550 (1)	557 (1)
	555 (1),(3)			
	645 (1),(3)			620 (1)
670 (1)	667 (1)	670 (1)	670 (1),(2)	665 (1)
	678 (1)			681 (1)
765	748	765	750	754
865 (2)	869 (2)	865 (2)		866 (2)

(1) Used for **Rrs_WWW**
(2) Used for **aot_WWW**
(3) Generated from MODIS 250m or 500m data aggregated to 1 km