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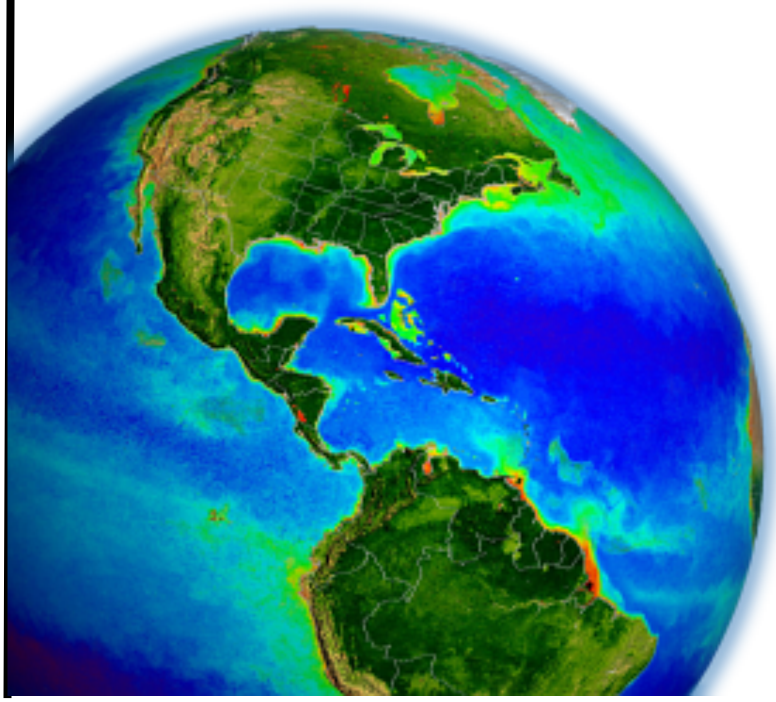
Ocean Biology Processing Group (OBPG), Code 616

NASA Goddard Space Flight Center Ocean Biology Processing Group Data Management Plan

September 2021



Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

Revision Log

Revision Date	Description of Change(s)	Pages Affected
Sep 2010	Initial Release	All
Aug 2012	Added MERIS Sensor	2, 5, 11, 16, 17, 22, 23, 25, 28
May 2016	Added new sensors: HICO and GOCI	2, 7, 8, 12, 23, 24, 26, 29, 31
Mar 2017	Updated NASA URLs to 'https', added OLCI sensor to document	5, 12, 15, 16, 29-30, 32, 36, 38
Sep 2017	Added JPSS-1 satellite and Hawkeye sensor	4, 10, 11, 13, 14, 31, 37
May 2018	Updated to reflect discontinuation of FTP distribution	17
Dec 2018	Added PACE mission and updated SeaHawk/Hawkeye for launch	13-15,32,39
Feb 2019	Updated title page and authority	1, 4
Aug 2021	Added S3B OLCI sensor, corrections to website links, included details for PACE instruments, updated text for Aquarius in section 3.2.6, expanded acronyms for PACE instruments	5, 12-15, 17, 19, 22-23, 26-30, 32-35, 43-45
Sep 2021	Added GLIMR information, updated TOC	3, 6, 17, 36, 38, 43

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1.0 INTRODUCTION

This document describes the Data Management Plan (DMP) for the Ocean Biology Processing Group (OBPG) at the NASA Goddard Space Flight Center (GSFC). The OBPG operates the Ocean Data Processing System, which functions as both the Ocean Science Investigator-led Processing System (SIPS) and the Ocean Biology Distributed Active Archive Center (OB.DAAC) for several past and current ocean remote sensing satellite sensors, and will also be supporting future sensors as well. The Ocean SIPS performs scientific data acquisition and processing, while the OB.DAAC performs archiving and distribution. Each supported mission and sensor is summarized in Section 2 below.

1.1 Purpose and Scope

This data management plan describes the acquisition, generation, management, archive and distribution of science data products generated by the OBPG. Covered in this plan are:

- Brief description of the programs and sensors
- Generic operations concept and mission-unique features and responsibilities.
- Description of the data flows
- Description of the science data products
- Data availability, archive and distribution policies

1.2 PDMP Development, Maintenance, and Management Responsibility

The OBPG, within the GSFC Ocean Ecology Laboratory (Code 616), is responsible for the development, maintenance, and management of this DMP. The Ocean SIPS Manager, Bryan A. Franz, and the OB.DAAC manager, Sean W. Bailey have joint responsibility for the plan, and have approval authority for any changes to the plan.

2.0 MISSION AND SENSOR OVERVIEW

The ODPS supports the following past, present and future missions and sensors, listed in chronological order by data acquisition start date.

- Nimbus-7 Coastal Zone Color Scanner (CZCS)
- Advanced Earth Observing Satellite (ADEOS) Ocean Color and Temperature Scanner (OCTS)
- OrbView-2 (OV-2) Sea-viewing Wide Field-of-view Sensor (SeaWiFS)
- Terra Moderate Resolution Imaging Spectroradiometer (MODIS) and Aqua MODIS
- Envisat Medium Resolution Imaging Spectrometer (MERIS)
- Satelite de Aplicaciones Científicas D (SAC-D) Aquarius
- Suomi National Polar-orbiting Partnership (SNPP) and Joint Polar Satellite System (JPSS) Visible and Infrared Imager Radiometer Suite (VIIRS)
- International Space Station (ISS) Hyperspectral Imager for the Coastal Ocean (HICO)
- Communication, Ocean and Meteorological Satellite (COMS) Geostationary Ocean Color Imager (GOCI)
- Sentinel-3A (S3A) and Sentinel-3B (S3B) Ocean and Land Color Instrument (OLCI)
- Seahawk Hawkeye
- Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) Ocean Color Instrument (OCI), Hyper Angular Rainbow Polarimeter 2 (HARP-2) and Spectro-Polarimeter for Planetary Exploration (SPEXone)
- Geostationary Littoral Imaging and Monitoring Radiometer (GLIMR)

Each mission and sensor is summarized in the following sections.

2.1 Nimbus-7 CZCS

The Nimbus-7 satellite was the last in a series of Earth remote sensing mission launched by NASA in the 1960's and 1970's. The mission is summarized in Table 1.

Table 2-1 – Nimbus-7 Mission Summary

Launch Date	October 25, 1978
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	955 km
Equator crossing time/direction	12 noon ascending
Orbit Period	~104 minutes

CZCS was the first satellite-based ocean color sensor, and was flown on Nimbus-7 as a proof-of-concept experiment. The onboard data storage was limited, and data collection was scheduled over designated locations. Data collection spanned nearly eight years, from October 30, 1978 to June 22, 1986. The instrument was officially declared dead on December 18, 1986.

Table 2-2 – CZCS Summary

Instrument Type	Cross-track scanning spectrometer
Data Record	October 30, 1978 to June 22, 1986
Resolution	825 m
Bands/channels	6 bands, 443 nm to 11.5 microns
Swath width	1556 km
Sensor Output	8 bits, single gain
Tilt	-20 to +20 degrees

2.2 ADEOS OCTS

ADEOS was launched and operated by the Japanese space agency (then NASDA, now JAXA). It was designed for a multi-year mission but suffered a fatal spacecraft control failure after nine months of operations.

Table 2-3 – ADEOS Mission Summary

Launch Date	August 17, 1996
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	800 km
Equator crossing time/direction	10:30 AM descending
Orbit Period	101 minutes

OCTS included bands for both ocean color (visible/NIR) and thermal IR measurements. It collected global ocean data from November 1, 1996 to the spacecraft failure on. June 30, 1997.

Table 2-4 – OCTS Summary

Instrument Type	Cross-track scanning radiometer
Data Record	November 1, 1996 to June 29, 1997
Resolution	700 m
Bands/channels	12 bands, 412 nm to 12.5 microns
Swath width	1400 km
Sensor Output	10 bits, single gain
Tilt	0, +/- 20 degrees

2.3 OV-2 SeaWiFS

OrbView-2 was launched and initially operated by Orbital Sciences Corporation (OSC). The ownership and operations were transferred to ORBIMAGE, a subsidiary of OSC, in 1998, and ORBIMAGE became GeoEye in 2006. OV-2 stopped responding to commands on December 11, 2010, and was declared dead by GeoEye.

Table 2-5 – OV-2 Mission Summary

Launch Date	August 1, 1997
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	705 km (at launch)*
Equator crossing time/direction	12 noon descending (at launch)*
Orbit Period	~99 minutes

*The orbit was not maintained. The altitude decayed to ~690 km and the crossing time drifted to ~02:22 PM. In July 2010 the orbit was raised to 781.5 km to reverse the crossing time drift. By the end of the mission the crossing time had drifted back to ~02:08 PM.

SeaWiFS was the first sensor designed to support global ocean color data collection, although it was preceded into orbit by OCTS. Routine data collection was started on September 18, 1997. Global Area Coverage (GAC) data, which were recorded globally, were subsampled at 4x4 from the full-resolution sensor data, and also truncated at the start and end of the scan. Local Area Coverage (LAC) data were collected at full resolution, and recorded in limited quantities over selected targets; full-resolution were also direct-broadcast to ground stations in High Resolution Picture Transmission (HRPT) format. The sensor continued to operate normally with no apparent problem until the end of the mission.

Table 2-6 – SeaWiFS Summary

Instrument Type	Cross-track scanning radiometer
Data Record	September 18, 1997 to December 11, 2010
Resolution	1.1 km
Bands/channels	8 bands, 412 to 865 nm
Swath width	1500 km (GAC), 2800 km (LAC)
Sensor Output	10 bits, bilinear gain
Tilt	0, +/- 20 degrees

2.4 Terra and Aqua MODIS

Terra and Aqua were the first two (of three, the third being Aura) large Earth Observing System (EOS) satellites launched and operated by NASA. Both EOS missions are multi-sensor and multi-disciplinary, and continue to operate without significant problems.

Table 2-7 – Terra Mission Summary

Launch Date	December 18, 1999
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	700 km
Equator crossing time/direction	10:30 AM descending
Orbit Period	98.9 minutes*

Table 2-8 – Aqua Mission Summary

Launch Date	May 4, 2002
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	700 km
Equator crossing time/direction	1:30 PM ascending
Orbit Period	98.9 minutes*

* Maintains 16-day repeat cycle

The MODIS instruments flown on Terra and Aqua were of identical designs. Terra MODIS was designated the proto-flight model (PFM) and started data collection on February 24, 2000; Aqua MODIS was designed Flight Unit 1 and started data collection on July 3, 2002. MODIS supports multidisciplinary (ocean, land and atmosphere) data product generation. Each instrument was designed for a five year mission; both are in mission extension and continue to operate nominally.

Table 2-9 – MODIS Summary

Instrument Type	Cross-track scanning radiometer
Terra Data Record Aqua Data Record	February 24, 2000 to present July 4, 2002 to present
Resolution	1 km, 500 m and 250 m
Bands/channels	36 bands, 412 nm to 14 micron
Swath width	2300 km
Sensor Output	12 bits, single gain
Tilt	None

2.5 Envisat MERIS

Envisat was developed and launched by the European Space Agency (ESA). The payload consisted of 10 science instruments, including MERIS. Envisat stopped responding to commands on April 8, 2012, and was subsequently declared dead by ESA.

Table 2-10 – Envisat Mission Summary

Launch Date	March, 2002
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	800 km
Equator crossing time/direction	10:00 AM descending
Orbit Period	101 minutes

The MERIS instrument was a programmable, medium-spectral resolution, imaging spectrometer operating in the solar reflective spectral range. Fifteen spectral bands can be selected by ground command, although the selected band suite remained fixed for the duration of the mission. The instrument scans the Earth's surface by the "push-broom" method. Linear charge-coupled device (CCD) arrays provide spatial sampling in the across-track direction, while the satellite's motion provides scanning in the along-track direction. MERIS data collection started on May 1, 2002. The instrument generates data at both full 300-meter resolution (FRS) and 1.2-km reduced resolution (RR) format. The FRS is only downlinked through direct broadcast or limited regional acquisitions, while the RR data is recorded and downlinked over the full daylit portion of every orbit.

Table 2-11 – MERIS Summary

Instrument Type	Multi-camera pushbroom radiometer
Data Record	April 29, 2002 to April 8, 2012
Resolution	300 m (FRS) and 1.2 km (RR)
Bands/channels	15 programmable bands, 390 to 1040 nm
Swath width	1150 km
Sensor Output	bits, single gain
Tilt	None

2.6 SAC-D Aquarius

SAC-D was the fourth scientific satellite built by Comision Nacional de Actividades Espaciales (CONAE) in Argentina. CONAE is headquartered in Buenos Aires, and the Mission Operations Center is located in Cordoba. SAC-D was launched by NASA, and operated by CONAE. The payload also included seven science instruments developed by CONAE and other agencies. SAC-D suffered a mission-ending power system failure on June 7, 2015.

Table 2-12 – SAC-D Mission Summary

Launch Date	June 10, 2011
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	657 km
Equator crossing time/direction	6:00 PM ascending
Orbit Period	98 minutes*

* Maintained 7-day repeat cycle

The Aquarius instrument was the first satellite-based ocean salinity sensor. It was built by NASA and flown on SAC-D. Aquarius combined a passive radiometer with an active pulsed radar scatterometer, which share the same optics (feed horns and antenna). The radiometer was built at GSFC, and the scatterometer and overall integration were the responsibility of the NASA Jet Propulsion Laboratory (JPL). The Aquarius commissioning was completed on August 25, 2011 and the sensor operated continuously from that date to the end of the mission.

Table 2-13 – Aquarius Radiometer Summary

Instrument Type	Passive microwave polarimeter
Data Record	August 25, 2011 to June 7, 2015
Resolution	~100 km
Bands/channels	1.413 GHz, three feed horns with four polarization states each
Swath width	~400 km
Sensor Output	16 bits
View	Boresights 25.8 to 40.3 degrees off nadir (fixed), ~6.5 degree beam size

Table 2-14 – Aquarius Scatterometer Summary

Instrument Type	Active radar scatterometer
Data Record	August 25, 2011 to June 7, 2015
Resolution	~100 km
Bands/channels	1.26 GHz, three feed horns with four polarization states each
Swath width	~400 km
Sensor Output	16 bits
View	Boresights 25.8 to 40.3 degrees off nadir (fixed), ~6.5 degree beam size

2.7 SNPP and JPSS VIIRS

The SNPP satellite was built and launched by NASA as a risk reduction mission for JPSS. Oversight for JPSS is shared by the National Oceanic and Atmospheric Administration (NOAA) and NASA. SNPP carries four other sensors besides VIIRS. The first JPSS satellite, JPSS-1, has an identical sensor suite. Following launch, spacecraft and instrument commissioning, the mission operations were handed off from NASA to NOAA.

Table 2-15 – SNPP Mission Summary

Launch Date	October 28, 2011
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	830 km
Equator crossing time/direction	1:30 PM ascending
Orbit Period	101.5 minutes*

Table 2-16 – JPSS-1 Mission Summary

Launch Date	November 10, 2017
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	830 km
Equator crossing time/direction	1:30 PM ascending
Orbit Period	101.5 minutes*

* Maintains 16-day repeat cycle

VIIRS will be flown on every JPSS satellite as well as on SNPP. It is conceptually similar to MODIS, with comparable resolution, spectral coverage and support for multidisciplinary data product generation. SNPP VIIRS started data collection on 21 November 2011; however, extended instrument testing caused interruptions in data collection for the remainder of the year. The ODPS VIIRS data set starts on January 2, 2012.

Table 2-17 – VIIRS Summary

Instrument Type	Cross-track scanning radiometer
Data Record	January 2, 2012 to present
Resolution	750 m and 375 m
Bands/channels	22 bands, 412 nm to 12 micron
Swath width	3040 km
Sensor output	12 bits, dual/single gain
Tilt	None

2.8 ISS HICO

The ISS is a habitable artificial satellite in low Earth orbit. It is a modular structure whose first component was launched in 1998. Since the arrival of Expedition 1 on November 2, 2000, the station has been continuously occupied.

Table 2-18 – ISS Mission Summary

Launch Date	November 20, 1998
Orbit Type	51.65-degree inclination
Altitude (nominal)	415 km
Equator crossing time/direction	variable
Orbit Period	92.9 minutes

HICO was developed by the Naval Research Laboratory (NRL) for the Office of Naval Research (ONR). Data collection started on October 15, 2009. The ONR support ended in December 2012, and the NASA ISS Program continued the operation of HICO. The instrument stopped data collection on September 13, 2014 during a solar storm, and was not recovered.

HICO collected one 30-second scene per orbit on most days. The targets were selected based on observing requests from investigators.

Table 2-19 – HICO Summary

Instrument Type	Imaging Spectrometer
Data Record	September 25, 2009 to September 13, 2014
Resolution	90 m
Bands/channels	~100 bands, 380 to 960 nm sampled at 5.7 nm
Swath width	50 km
Sensor output	14 bits
Tilt	None

2.9 COMS GOCI

Korea's first geostationary multi-purpose satellite, COMS, performs meteorological and ocean observations and communications services.

Table 2-20 – COMS Mission Summary

Launch Date	June 26, 2010
Orbit Type	Geostationary, 128.2º longitude
Altitude (nominal)	35,786
Orbit Period	1 day

GOCI is one of the three payloads onboard COMS. It is the first (and only) ocean color sensor in geostationary orbit. It acquires hourly observations during the daytime over the seas adjacent to the Korean peninsula, thus providing a unique capability to view the diurnal variation in ocean color products.

Table 2-21 – GOCI Summary

Instrument Type	Imaging radiometer
Data Record	April 1, 2011 to present
Resolution	500 m
Bands/channels	8 bands, 412 to 865 nm
Swath width	2500 km
Sensor output	Bits
Tilt	None

2.10 Sentinel-3A and Sentinel-3B OLCI

The main objective of the SENTINEL-3 mission is to measure sea surface topography, sea and land surface temperature, and ocean and land surface color with high accuracy and reliability to support ocean forecasting systems, environmental monitoring and climate monitoring. The first Sentinel-3 satellite, Sentinel-3a, launched in 2016 and works in conjunction with the second spacecraft, Sentinel-3b, which launched in 2018 and flies +/-140° out of phase with Sentinel-3a. Together they provide maximum coverage.

Table 2-22 – Sentinel-3A Mission Summary

Launch Date	February 16, 2016
Orbit Type	Near-polar, sun synchronous
Altitude (nominal)	814.5 km
Equator crossing time/direction	10:00 A.M. descending
Orbit Period	102 min

Table 2-23 – Sentinel-3B Mission Summary

Launch Date	April 25, 2018
Orbit Type	Near-polar, Sun-synchronous
Altitude (nominal)	814.5 km
Equator crossing time/direction	10:00 A.M. descending
Orbit Period	100.99 min

OLCI is an optical instrument used to provide data continuity for ENVISAT's MERIS. The primary objective of OLCI products is to screen the ocean and land surface to harvest information related to biology. OLCI also provides information on the atmosphere and contributes to climate study.

Table 2-24 – OLCI Instrument Summary

Instrument Type	Push-broom imaging spectrometer
Data Record	December 14, 2016 to present
Resolution	300 m
Bands/channels	21 bands, 0.4 to 1.02 nm
Swath width	1270 km
Sensor output	Bits
Tilt	None

2.11 Seahawk Hawkeye

Seahawk/Hawkeye is the first cubesat ocean color mission. The mission is funded by a grant from the Moore Foundation and managed by the University of North Carolina at Wilmington. The satellites, which are 3U cubesats, have been built and integrated by Clyde Space of Glasgow, Scotland. There are two identical Seahawk satellites; the first was launched in December 2018, as part of the SpaceX SmallSat Express mission by Spaceflight Industries of Seattle, WA. There are no plans to launch the second satatellite.

Table 2-25 – Seahawk 1 Mission Summary

Launch Date	December 3, 2018
Orbit Type	Polar Sun-synchronous
Altitude (nominal)	575 km (at launch)*
Equator crossing time/direction	10:30 AM descending (at launch)*
Orbit Period	~96.3 minutes (at launch)*

*The orbit will not be maintained.

Hawkeye is the first cubesat ocean color sensor. It was designed and built by Cloudland Instruments of Santa Barbara, CA, with spectral characteristics similar to SeaWiFS. The sensor data collection is scheduled by the OBPG, with at least one image of ~100 seconds per orbit.

Table 2-26 – Hawkeye Summary

Instrument Type	Cross-track pushbroom radiometer
Data Record	January 2019 to present
Resolution	129 m
Bands/channels	8 bands, 412 to 865 nm
Swath width	200 km
Sensor Output	12 bits, bilinear gain
Tilt	+/- 20 degrees (spacecraft pitch)

2.12 PACE OCI, HARP-2 and SPEXone

PACE is a strategic climate continuity mission that was defined as part of NASA's Climate Initiative, in response to the NRC 2007 Earth Science Decadal Survey. PACE will extend the high quality ocean ecological, ocean biogeochemical, cloud, and aerosol particle data records begun by NASA in the 1990s, building on the heritage of SeaWiFS, MODIS, the Multi-angle Imaging SpectroRadiometer (MISR), and VIIRS. The mission collects radiometric and polarimetric measurements of the ocean and atmosphere, from which these biological, biogeochemical, and physical properties will be determined. PACE data products not only add to existing critical climate and Earth system records, but also answer new and emerging advanced science questions related to Earth's changing climate. PACE is managed and developed at GSFC.

Table 2-27 – PACE Mission Summary

Launch Date	January 2024
Orbit Type	Near-polar, sun synchronous
Altitude (nominal)	675.5 km*
Equator crossing time/direction	1:00 P.M. ascending*
Orbit Period	98.4 minutes

*Altitude maintained within +/-1.5 km, crossing time within +/-10 minutes

The OCI is the primary instrument on the observatory and is developed at GSFC. The OCI is a hyper-spectral scanning HSS radiometer designed to measure spectral radiances from the ultraviolet to shortwave infrared (SWIR) to enable advanced ocean color and heritage cloud and aerosol particle science.

Table 2-28 – OCI Instrument Summary

Instrument Type	Cross-track scanning radiometer
Data Record	February 2024 to March 2027

Resolution	1050 m
Bands/channels	350 to 885 nm at 2.5 nm; and 7 SWIR bands 940 to 2260 nm
Swath width	2740 km
Sensor output	UV/Vis/NIR: 16 bits, single gain SWIR: 20 bits, single/dual gain
Tilt	+/-20 degrees

HARP-2 is a multi-spectral, wide swath, hyper-angular polarimeter. It is contributed by the University of Maryland, Baltimore County (UMBC). It has heritage in the airborne and ISS HARP instruments.

Table 2-29 – HARP-2 Instrument Summary

Instrument Type	Hyper-angular polarimeter
Data Record	February 2024 to March 2027
Resolution	4 km
Bands/channels	440, 550, 670 and 870 nm Three polarizations
Swath width	1570 km (nadir view)
Sensor output	16 bits
Along-track views	+/-56.5 degrees

SPEXone is a hyperspectral, multi-angle, narrow-swath polarimeter. It is a contributed instrument developed by a consortium consisting of the Netherlands Institute for Space Research (SRON) and Airbus. It has heritage in the airborne SPEX instrument.

Table 2-30 – SPEXone Instrument Summary

Instrument Type	Hyperspectral polarimeter
Data Record	February 2024 to March 2027
Resolution	2.5 km
Bands/channels	200 bands, 385 to 770 nm Two polarizations
Swath width	100 km
Sensor output	16 bits
Along-track views	-50, -20, nadir, +20, +50

2.13 GLIMR

GLIMR is a hyperspectral ocean color sensor launching after 2026 targets the Gulf of Mexico and other coastal and ocean waters of North and South America. With its vantage point from geostationary orbit, GLIMR will be the first hyperspectral ocean color sensor in the Western Hemisphere to study ocean processes at the diurnal timescales required to observe the dynamic ecological, biogeochemical and physical processes typical of coastal and ocean waters.

Table 2-31 – GLIMR Instrument Summary

Instrument Type	Push-broom imaging spectrometer
Data Record	Launch planned for 2026
Resolution	300 m
Bands/channels	141 bands / 340-1040 nm

3.0 ODPS DATA PROCESSING

3.1.1 Project-wide Processing

This section describes the ODPS activities that are common to all missions and sensors. An overview of the Data Processing is provided, followed by descriptions of Data Archive and Management, Data Distribution, and Software Configuration Management.

3.1.2 Data Processing Overview

The data processing for all sensor data within the ODPS is similar in nature. All data processing and management is controlled by non-mission-specific process scheduling and data management components. These comprise a fully automated, distributed data system for acquiring, processing, archiving, and distributing scientific data. The system is highly scalable and easily adaptable to support multiple concurrent missions. The following subsections describe the ODPS scheduling and archiving system and the science data processing software.

Scheduling and Archiving System
The components of the ODPS are: the Scheduler/Visual Database Cookbook (VDC); the Archive Device Manager (ADM); Data Acquisition and Ingest; File Migration and Management; and Data Distribution. The last two will be described in other sections.
The Scheduler/VDC runs in a daemon-like state and monitors task records in the to-do list table. It runs tasks according to defined task attributes. A standard job-shell interface allows new programs to be quickly adapted for Scheduler control. VDC uses recipes to encapsulate data-specific processing schemes and parameters. It defines Virtual Processing Units (VPUs) as distributed processing resources. VPUs are dynamically allocated based on available time and the current OS load. VDC also supports prioritization of processes and resources.

ADM supports logical pools of storage devices. When processes request a device in a specific pool, ADM returns information for a storage device in the requested pool. A disk-monitor process polls all devices periodically to record usage statistics and invoke threshold handlers.

Data acquisition and ingest is performed using active, passive, and periodic notification methods. The active method scans remote systems for new files and populates the ingest queue. The passive method waits for arrival of E-mail messages describing type and location of new file and populates the ingest queue. The periodic method schedules ingests of files at user-specified intervals.

Scientific Data Processing Software

The data from the various sensors are processed to standard levels as defined by EOS. The products and levels are described more fully in Section 4. The processing steps for all sensors include: Level-0 to 1A (unpacking), Level-1A to 1B (calibration), Level-1B to 2 (geophysical parameter retrieval), and Level-2 to 3 (spatial and temporal compositing). At each level, the products are stored and cataloged for subsequent retrieval or distribution.

The initial processing steps, unpacking and calibration, are sensor-specific, and are determined by the raw (Level 0) data format and the calibration approach for each sensor. The retrieval and compositing steps for most sensors and products, i.e., Ocean Color and Sea Surface Temperature (SST), are performed using multi-sensor software:

- The Multi-sensor Level-1 to Level-2 (l2gen) software performs the geophysical parameter retrieval. This includes atmospheric correction, determination of surface parameters (either remote sensing reflectance (Rrs) or brightness temperature), and determination of geophysical values (chlorophyll and optical properties for Ocean Color, or temperature for SST). For CZCS, SeaWiFS and Hawkeye, the inputs to l2gen are the Level-1A (uncalibrated) data, so the processing for these sensors requires the calibrations and sensor corrections to be applied by l2gen before the other steps. For VIIRS, the temporal response calibration is applied by l2gen, as described in Section 3.2.7.

- The temporal and spatial compositing are performed by the l2bin and l3bin programs. The l2bin software accumulates the geophysical values for a single day into equal-area bins, either 9.2 or 4.6 km in size, and l3bin composites data from multiple days (see Level 3 product descriptions below).

- The l3mapgen program re-projects the composited, binned data into standard mapped images based on a specified projection. The standard projection is equi-rectangular (Plate Carreé).

The Level-2 processing also requires dynamic ancillary data from a number of sources. The data are common across sensors, but are product-specific. A summary of ODPS ancillary data types and sources is given in Table 3-1.

The ocean color and SST algorithm theoretical basis documents (ATBDs) are developed and maintained by members of the MODIS and VIIRS Ocean Science Teams and the OBPG, and are available online at: https://oceancolor.gsfc.nasa.gov/atbd/
The Aquarius salinity data processing requires unique, algorithm-specific software to perform the retrieval and compositing steps, as described in Section 3.2.6.

Table 3-1. Ancillary Data Types and Sources

Data Type	Static/ Dynamic	Primary Source	Backup Source(s)
Ozone	D	OMI	TOMS, Climatology
Meteorological	D	NCEP	Climatology (seasonal)

SST	D	Reynolds OISST	Climatology (seasonal)
NO_2	D	OMI	Climatology (seasonal)
Sea Ice	D	NSIDC	Climatology (seasonal)
Land Mask	S	World Vector Shoreline (SeaWiFS)	None
Elevation	S	Digital Elevation Map	None

Data Processing Streams

The processing for each sensor is performed multiple times. There are separate processing streams for the forward-stream (newly received data) processing and reprocessing. In addition, the forward stream is processed twice, initially for Performance Assessment and subsequently for Refined product generation. Each processing stream is described below.

The *Performance Assessment* processing is performed for all operational sensors as soon as the data are acquired by the ODPS. The main purpose of this processing is to detect any instrument anomalies as soon as possible. In most cases the highest quality ancillary data will not be available for this stream, so the processing will be performed with the best available data, which may be climatology.

The *Refined* processing is performed when the highest quality ancillary data are available, typically within three or four weeks of the sensor data acquisition. The Refined products will replace the previously-generated Performance Assessment version in the archive, and will be distributed until such time as reprocessing is performed.

Full-mission *Reprocessing* is performed periodically to incorporate improved sensor calibrations, algorithm improvements and updates to ancillary data (e.g. NCEP reanalysis products). The typical interval between reprocessings can range from several months in the early stages of missions, when calibration and algorithm updates are frequent, to several years for sensors that are well-characterized with stable algorithms. During each reprocessing, the new data products replace the previous version in the archive. It is also standard ODPS practice to synchronize the software and calibration between the reprocessing and forward streams at the inception of reprocessing, to ensure consistency among the products.

3.1.3 Data Archiving, Management and Integrity

During data acquisition and processing, file migration and management involves compressing files and migrating them to their various destinations. Event- or time-based triggering queries associated with each trigger are run periodically by a Scheduler task to select files that are eligible for some type of migratory action and populate a migration queue. Command-line queuing is used for file removal and delayed copies. Migration daemons query the migration queue, perform specified actions on the files, and update the catalog tables.

The ODPS maintains online storage for the current archived versions of all data products from all sensors. In addition, data stores are maintained for evaluation and test products.

Data integrity is maintained through a combination of internal consistency checks and data

backups. File checksums are generated and stored for all data products. Data backups of Level 1 science products are created as the product is generated on the system. Once the product has been copied to the primary storage area, a second copy of the file is created on a separate storage device. The location of each file is retained in the on-line data catalog for easy retrieval. Science products above Level 1 do not receive a second copy as they can be quickly recreated from the Level 1 data.
Cooperative agreements have been established with other projects to provide copies of low-level (Level-0 or 1A) source data in separate locations, in accordance with NASA policy. Specifically, copies of the MODIS and VIIRS source data are also maintained by the Level 1 and Atmosphere Archive and Distribution System (LAADS). Higher-level products are recreated from those files if necessary.

3.1.4 Data Distribution

The data distribution elements of ODPS have been designated as the OB.DAAC.

Several methods of distribution are used by the OB.DAAC. Individual files can be downloaded from the project's data distribution website (https://oceandata.sci.gsfc.nasa.gov/). An order processing system is available on the web site, allowing users to place orders for batches of files. The files are collected from the network attached storage (NAS) and staged onto one or more of the distribution servers for later retrieval by the user. Users can also establish a data subscription, where data is automatically staged to the distribution servers and the user is notified when the data is available. HTTPS is the primary distribution protocol, and limited support is provided for the OpenDAP protocol. All data products are also discoverable via the EOSDIS EarthData Common Metadata Repository (CMR).

Certified source code is also posted to the distribution servers, allowing the science community access to the code used to generate the products. An on-line forum (https://forum.earthdata.nasa.gov) is available to allow members of the science community to interact easily with the OBPG, OB.DAAC and each other.

The interactive, web-based Data Ordering System is currently supporting SeaWiFS, Aqua MODIS, Terra MODIS, OCTS, CZCS, MERIS, Aquarius, SNPP VIIRSJPSS-1 VIIRS, HICO, GOCI, and Hawkeye. The Data Subscription System allows users to define region and products of interest. The Order and Subscription Manager monitors the order and subscription queues and stages files for HTTPS distribution. Web-CGI applications allow users to view and update their orders and subscriptions.

It has been standard ODPS policy to publicly release all versions of all data products as soon as they are processed, except for sensors which have specific restrictions (e.g. commercial data rights). Products that are still undergoing validation are indicated as provisional. Exceptions to this policy are noted for each sensor in the following sections.

3.1.5 Software Configuration Management

All software development and deliveries to the ODPS are controlled through a configuration management system. The repository is organized into build, run, and test directories, where build includes subfolders of source code and makefiles for each distinct processing program or support library, run includes all static data tables and compiled executable programs, and test includes a standard set of test files and scripts to verify the performance of each program after a change is made.

The software developer maintains a working copy of the repository on his or her workstation, and develops, compiles, and tests the code within this working copy. Periodic updates of the working copy are performed to capture changes from other developers. When satisfied that a software change is performing to expectations, the source code, compiled executables, and test results are committed to the repository. All changes are automatically tracked, and the repository configuration can be reverted to a previous version if needed.

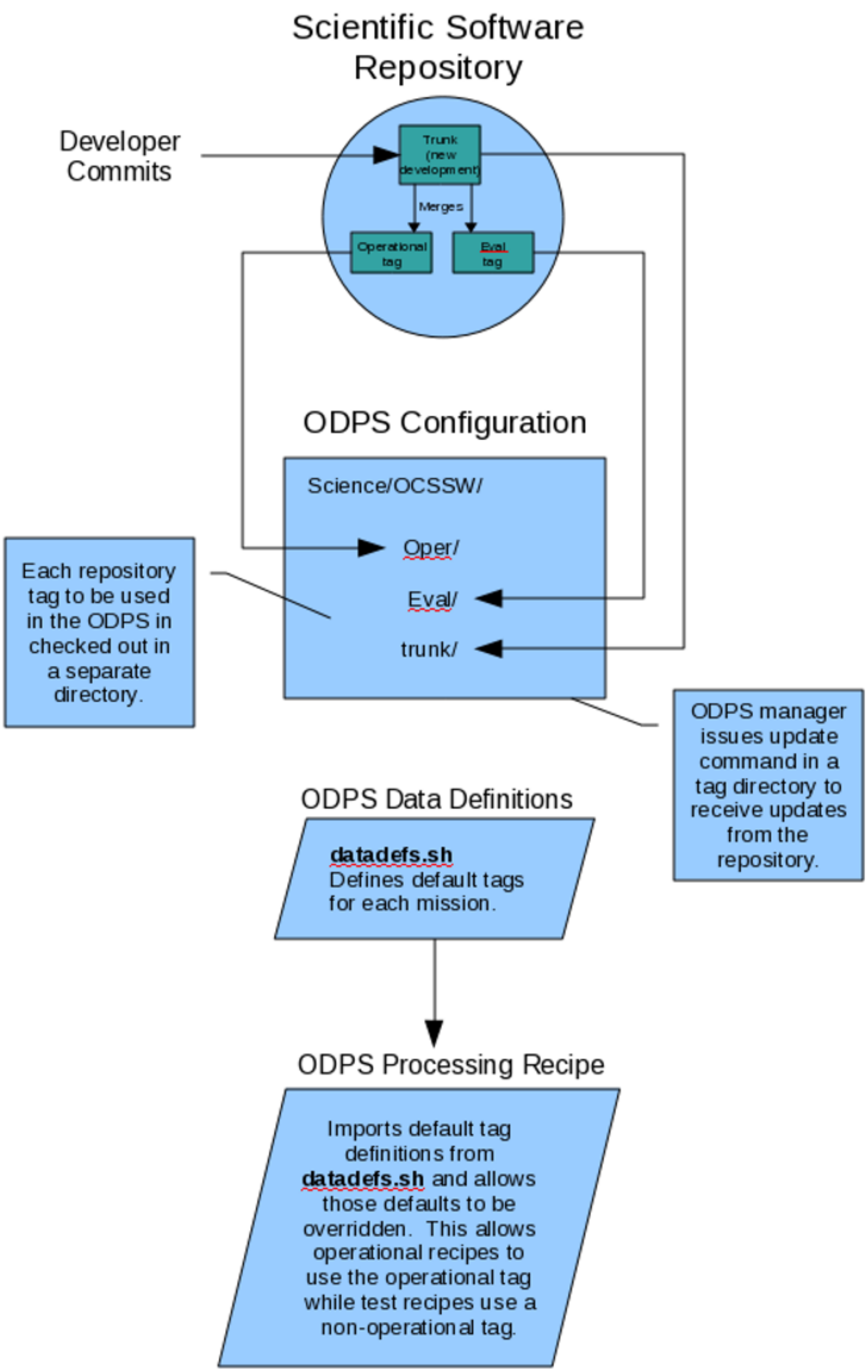
Each processing server within the production processing system also contains a working copy of the "run" path within the software repository. When the time comes to deliver a software update to the production processing system, the lead software developer "tags" the fully tested software repository with a new version number, effectively defining a temporal snapshot of the repository. The lead processing system manager then issues a command on each server to "switch" the current production tag to the new tag. For testing purposes, the data processing has the ability to maintain multiple tagged software versions on the production servers, and to specify which tag to use for a particular test or reprocessing event.

The science processing software is also distributed to the research community through the SeaWiFS Data Analysis System (SeaDAS) software package. The SeaDAS distribution is simply a working copy of the “run” and “build” paths for the current production tag of the software repository. This same approach can be employed to distribute the latest development versions of the software repository to external team members, where each member creates a local working copy of the repository that can be maintained through periodic update commands to the CM server.

3.1.6 Separating Operational and Evaluation Products

The ODPS uses the concept of product suites to distinguish one family of products from another. A product suite is defined in the ODPS database and has associated with it a unique numeric ID, name, and file label among other attributes. The processing recipes, the elements that define a set of processing steps for a processing scheme, are associated with a product suite. The processing scripts used by the recipe apply the attributes of the product suite associated with the recipe to derive the names of the output products. This allows the ODPS to generate unique file names for each product suite. As products are recorded in the ODPS database, the numeric suite ID is stored along with the other product metadata so the products for a particular suite can easily be identified using a basic database query.

For each mission the ODPS supports, there are typically defined a set of operational recipes and a set of testing recipes. The operational recipes are configured to use the operational set of product suites and their configuration rarely changes. The set of testing recipes and product suites are usually more dynamic to accommodate multiple testing configurations, each one requires a unique set of file names. It is during the set up of a processing test that the ODPS manager configures the recipe to use a specific tag of the scientific software repository and to be associated with a numeric suite ID.



3.1.7 Data Preservation

The NASA Earth Science Data Preservation Content Specification requirements are addressed as described below, in compliance with the ***NASA Earth Science Data Preservation Content Specification***, 423-SPEC-001.

Preflight/Pre-Operations Calibration

Support for preflight calibration data is provided for missions and sensors for which the OBPG provided preflight support. This currently includes SeaWiFS, Aquarius, and VIIRS, and OCI. For SeaWiFS, the preflight analyses and results were exhaustively documented in the SeaWiFS Prelaunch Technical Report Series, NASA TM 104566, volumes 1 – 43.

For Aquarius, the OBPG shares responsibility for preflight data and analysis preservation with JPL. The primary repository for instrument characterization data and documentation is at JPL, and the OBPG has access to all of this information.

The VIIRS prelaunch analyses were primarily performed by the NASA VIIRS Characterization Support Team. The OBPG acquired and archived test data sets for characterization tests of particular interest for ocean data products, and also acquired the analysis reports generated by VCST.

The OBPG is currently supporting the OCI prelaunch test data, including acquisition, processing to Level-1A and distribution to the data analysis team. The engineering test unit (ETU) testing concluded in late Summer 2021. Support will resume with the flight unit testing.

Science Data Products

The preservation of the science data products, including the raw data, is described in 3.1.2, Data Management and Integrity. All higher-level data products contain complete granule-level metadata that complies with EOS standards.

Science Data Product Documentation

The OBPG maintains complete science data product documentation for each supported mission/sensor on the Ocean Color web site: https://oceancolor.gsfc.nasa.gov/

Mission Data Calibration

The OBPG is (or was) responsible for on-orbit calibration for SeaWiFS, MODIS, VIIRS and Aquarius, and will be responsible for OCI. The calibration methods and results are documented in peer-reviewed journal articles and conference presentations.

Science Data Product Software

The ODPS science data product software is publicly distributed in the SeaWiFS Data Analysis System (SeaDAS): https://seadas.gsfc.nasa.gov/

A complete description of the product versions and processing history for each mission/sensor is presented under **Processing History** on the Ocean Color web site.

Science Data Product Algorithm Inputs

The ancillary data sets used for science data product generation are archived and distributed by the ODPS. The ancillary data used for each product is included in the algorithm descriptions on the Ocean Color web site.

Science Data Product Validation

The validation methods and results for the ODPS data products are presented under **Quality Assessment** on the Ocean Color web site.

Science Data Software Tools

SeaDAS provides a comprehensive suite of tools for display and analysis of the ODPS data products: https://seadas.gsfc.nasa.gov/

3.2 Sensor-specific Data Flows

This section describes the data flows that are unique for each sensor. This includes all of the data acquisition scenarios, which are always sensor-specific. Some sensors also have additional processing steps that are unique, as described below.

3.2.1 CZCS

The CZCS data for the entire mission were originally produced and stored as Level-1A products, with separate products for each scene. The format was binary, with a fixed record structure.

The reprocessing of the CZCS data with improved algorithms was supported under the Research, Education and Applications Solutions Network (REASoN) Cooperative Agreement Notice (CAN). These files were acquired from the Goddard Earth Science Data and Information Services Center (GES DISC). To facilitate portability and further processing, the CZCS Level-1A data were reformatted by the ODPS. Software was developed to perform the following:

- All files corresponding to a single orbit (daylit side only) were combined into a single product, with any overlaps removed.
- The Nimbus-7 orbit vectors were regenerated for each scan line and stored with the data; this information was not included in the original binary files.

- The products were written using the Hierarchical Data Format (HDF), with metadata and other conventions previously developed by the OBPG for other sensor products.

The reformatted products have been generated and archived by the ODPS, and can be input to l2gen for downstream processing to generate Ocean Color products. The CZCS products are now being distributed by the OB.DAAC as described in Section 3.1.3.

3.2.2 OCTS

The OCTS global data set was acquired from NASDA in 2001 to support the reprocessing of this data by the OBPG to generate Ocean Color products. The data were provided at Level-1A (unpacked), and were subsampled like SeaWiFS GAC data. They were formatted by NASDA using HDF following many of the conventions previously developed by the OBPG, so no further reformatting was necessary. The OCTS data can be input directly into l2gen for downstream processing.

The original reprocessing of OCTS global data was completed in December 2001, and the OCTS Ocean Color products were delivered to the GESDAAC and to NASDA for distribution. Starting in 2005, further algorithm and refinement was supported under the REASoN CAN. The new Ocean Color products developed under the CAN are being distributed by the OB.DAAC as described in Section 3.1.3.

3.2.3 SeaWiFS

The OV-2 spacecraft and the SeaWiFS sensor were owned and operated by GeoEye (now DigitalGlobe). The data were purchased by NASA under "data buy" contracts. The initial contract covered the period from the initial imaging through five years after initial commissioning (September 4, 1997 through December 19, 2002). After that date, a series of contract extensions were negotiated between NASA and GeoEye, up to the end of the mission.

The SeaWiFS data were collected and acquired by two overall scenarios: onboard data recording and direct broadcast. SeaWiFS also had unique restrictions on data distribution because of the terms of the data buy contract.

Onboard Recorded Data

The GAC data and a limited amount of LAC were recorded onboard OV02 and downlinked twice daily. The primary station was located at GSFC Building 28, with a backup downlink collected by the Wallops Flight Facility (WFF). The data were also acquired by GeoEye, and could be acquired from that source if the primary and secondary sources failed. The downlinks were transmitted near local noon and midnight as the satellite passed over the stations.

The raw downlink data were frame-formatted to produce a SeaWiFS Level-0 file. This file was processed to Level-1A using the sensor-specific l1agen_seawifs software, which included the following steps: separating the data into individual scenes (GAC orbits or LAC segments);

unpacking and converting the sensor and selected spacecraft telemetry; performing navigation processing; computing metadata; and writing each scene to a file using HDF. In addition, sensor and spacecraft telemetry in the GAC data were written to a separate file for display and analysis.

The scheduled LAC recording included daily solar, gain and time-delay-integration (TDI) calibrations and monthly lunar calibrations. These data were processed using l1agen_seawifs as part of the normal processing, but were written to special products and saved for offline analysis.

Direct Broadcast

The second data collection method used data that were direct-broadcast by OV-2 in parallel with the GAC data recording, in an HRPT format. In order to collect SeaWiFS HRPT data, a station purchased either a commercial or research license from GeoEye. These data were encrypted, and were decrypted using software and keys provided by GeoEye under the terms of the license. The OBPG collected HRPT passes at the Building 28 station during daylight overpasses (two or three per day). These data, once decrypted and frame-formatted, were also in SeaWiFS Level 0 format, and were identical to recorded LAC data. The data from each overpass were processed using l1agen_seawifs to generate a Level-1A product.

In addition, a large number of stations worldwide provided HRPT products to the OBPG until December 24, 2004. These data were generally processed to SeaWiFS Level-1A format using the l1agen_seawifs software provided to the stations by the OBPG. These products were renavigated upon receipt by ODPS to ensure that the latest navigation updates were incorporated into all of the ODPS-archived products. The renavigation involved a two-step process, in which the received products were first "reversed" to Level-0 format, and then processed using l1agen_seawifs.

In 2002, the OBPG developed the capability to merge all of the full-resolution (LAC and HRPT) data from each orbit into a single product. During this processing, any overlaps in products from nearby stations were removed, with the best-quality data for each scan line retained. The archived HRPT products have since been replaced by the merged LAC (MLAC) products for each orbit, which are distributed by the ODPS.

In mid-2013, NASA and DigitalGlobe reached an agreement that allows NASA to gain access to all SeaWiFS HRPT data that may have been collected by ground stations around the world during the entire mission and to put that data into the public domain. Since then, NASA has been contacting HRPT stations in order to acquire their archived data.

The downstream processing of the SeaWiFS data to generate Ocean Color products is performed using the multi-satellite processing software as described in 3.1.

Data Distribution

Under the terms of the original data buy contract, GeoEye retained all commercial rights to the SeaWiFS data products for five years after data collection. The distribution of NASA SeaWiFS data products within five years of data collection was limited to research and educational users, and all public uses of SeaWiFS data products had to acknowledgement NASA and GeoEye.

As stated above, the 2013 agreement between NASA and DigitalGlobe put all SeaWiFS data input the public domain. Thus, the complete SeaWiFS data set is now available to the international scientific community without restriction. All SeaWiFS data product are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.4 MODIS

The ODPS started acquiring MODIS data in 2003. The MODIS data (from both Terra and Aqua) have been acquired via two means. Originally the data were acquired from NOAA in near-real-time, with the GESDAAC and the MODIS Adaptive Processing System (MODAPS) as backups. More recently, MODAPS has become the primary source of the MODIS data.

The Level-0 files are processed to generate Level-1A, geolocation and Level-1B (calibrated) products, using software provided by MODAPS. The geolocation processing also requires attitude and ephemeris data files that are acquired from the GESDAAC. All of the Level-1 products follow the standard MODIS formats, including HDF-EOS metadata.

The downstream processing of the MODIS data is performed using the OBPG multi-satellite processing software as described in 3.1. The daytime granules are processed to generate the Ocean Color products, and all of the granules are used to generate SST products. All MODIS data product are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.5 MERIS

The MERIS FRS and RR data were acquired through a bulk-data-exchange agreement between NASA and ESA. Global RR Level-1B data were transferred via ftp from the ESA UK-PAC data distribution facility. FRS data were provided by ESA to the LAADS group at NASA on tapes. FRS files were extracted from tape by LAADS and transferred to OBPG for higher-level processing.

The downstream processing of the MERIS Level-1B data is performed using the OBPG multi-satellite processing software as described in 3.1. The data exchange agreement between NASA and ESA included the rights to redistribute the ESA Level-1B data and derived products. These products are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.6 Aquarius

The Aquarius data products and processing software were unique within the ODPS, since the microwave data processing and salinity retrieval algorithms were completely different from those for Ocean Color and SST. The ODPS systems that support Aquarius were referred to as the Ground Segment (GS), and the software and capabilities that are used to support Aquarius data processing were referred to as the Aquarius Data Processing System (ADPS). In addition, the joint effort with NASA and CONAE involved some unique strategies for scheduling and acquiring the instrument data downlinks. The following subsections describe the data acquisition and data processing scenarios for Aquarius.

Data Acquisition

The Aquarius data were downlinked from the SAC-D satellite to the CONAE ground station in Cordoba, Argentina at every opportunity. A station in Matera, Italy also acquired downlinks daily during the early mission, and regularly since then as scheduled by CONAE. SAC-D was in a terminator orbit, so the downlinks were near 6 AM and 6 PM local time. There were two or three overpasses of sufficient duration each morning and evening. During each downlink the Aquarius data were transmitted in parallel with SAC-D spacecraft telemetry and other instrument data.

Aquarius recorded data in onboard memory. The memory allocation was equivalent to 18 hours of science data. The total memory contents required about 4 minutes to downlink. Since most passes were longer than this, the strategy was to downlink the data repeatedly during the contact. Thus, some data were downlinked up to three times during a single pass. Also, for downlinks on consecutive orbits, most of the data were duplicated among the passes.

Each Aquarius high-rate-data (HRD) downlink file was processed to remove transmission protocol and stored on the Customer User Segment Service (CUSS) FTP site at CONAE. Additional files containing spacecraft ephemeris and housekeeping telemetry (HKT) were also provided by CONAE on the FTP site. The details of the interface between CONAE and the ADPS are described in reference 1. The HRD and HKT files were staged and acquired after each downlink, while the ephemeris files were acquired daily.

Data Processing

The processing flow for the Aquarius data is shown in Figure 3.2.5-1. The processing steps and product levels followed the EOS standard data product levels described in Section 4. The Aquarius science data processing consisted of the following steps:

- Level-0 Preprocessor – process each HRD downlink file to produce a single time-ordered set of Aquarius science blocks.
- Level-0-to-1A – separate Level-0 files into orbits, unpack science data, incorporate overlapping ephemeris and SAC-D HKT and convert Aquarius HKT.
- Telemetry Analysis – HKT data from Level-1A files are analyzed for web display on the Aquarius web site.
- Level-1A Merge – consolidate Level-1A files from overlapping downlinks into a single, best-quality full orbit product.
- Level-1A-to-2 – perform calibration, atmospheric correction and salinity retrieval for Aquarius science data; this includes Level-1B processing.
- Level-2-to-3 Binning – Level-2 salinity retrievals for one day are geographically projected and collected into equal-area bins.
- Level-2-to-3 Smoothing – Level-2 salinity retrievals for one day are optimally interpolated into equal-area bins.
- Level-3 Binning – Level-3 binned files are aggregated to longer time periods (weekly, monthly, etc.).

- Level-3 Mapping – Level-3 binned files are reprojected onto a 1-degree equal-angle grid to generate global map products.

The Level-0 and 1A processing algorithms and software were developed by the OBPG. The Level-1B and 2 algorithms and science code were developed by the Aquarius Science Team. The radiometer code was developed by Remote Sensing Systems (RSS) in Santa Rosa, CA, and the scatterometer code by JPL. The code was delivered to the OBPG, who were responsible for the implementation of the operational software, including data product input/output and quality flags. The Level-3 binning software was adapted from the existing Ocean product software. The Level-3 smoothing algorithms were provided by the Science Team and implemented in software by the OBPG. The Aquarius ATBDs are maintained by the PO.DAAC (Reference 8).

The ancillary data requirements for Aquarius were also unique. The ancillary data types and sources are summarized in Table 3-2.

Data Distribution

The products were delivered to the Physical Oceanography DAAC (PO.DAAC) at JPL for permanent archiving and public distribution, as described in Reference 3.

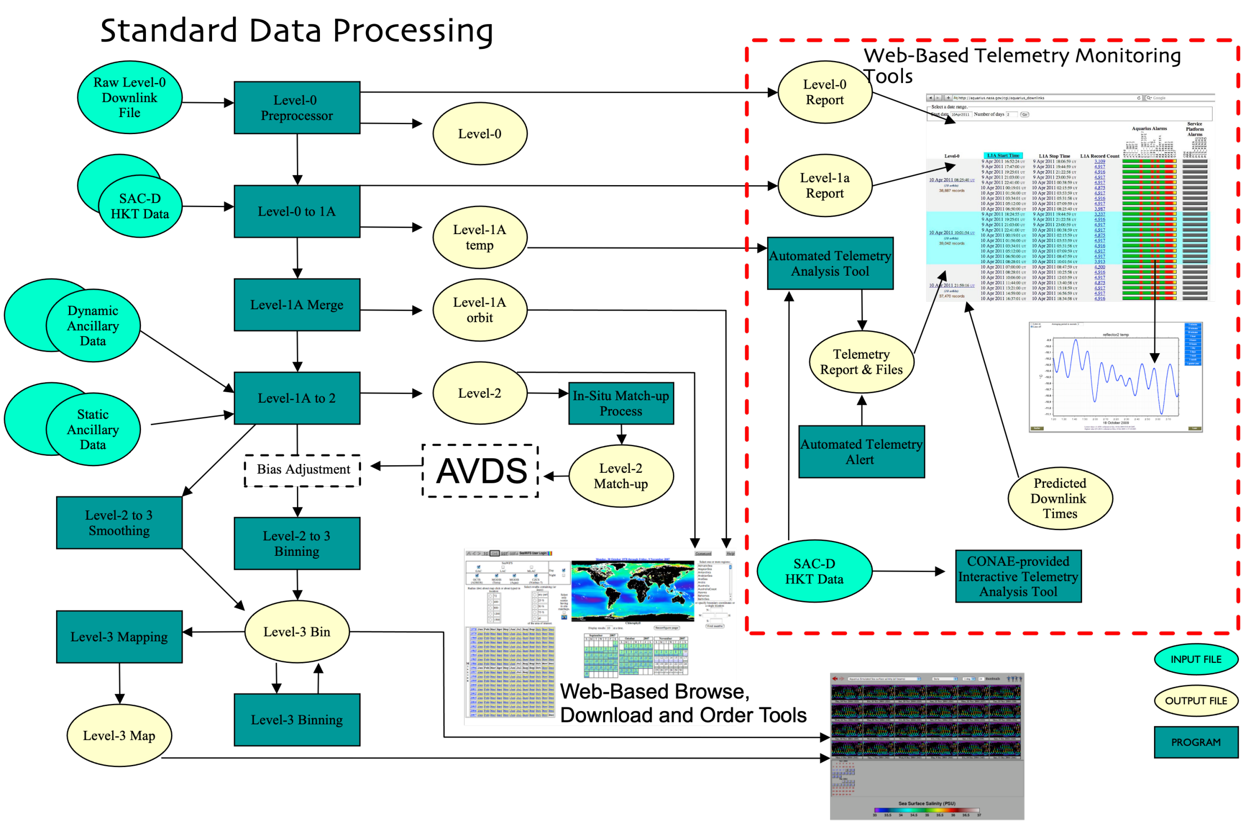


Figure 3-1. Aquarius Data Processing Flow

Table 3-2. Aquarius Ancillary Data Types and Sources

Data Type	Static/ Dynamic	Primary Source	Backup Source(s)
Pressure, Temperature, Water Vapor Profiles	D	NCEP	
Sea Surface Temperature	D	CMC (RSS)	Reynolds MISST/GHRSST
Sea Surface Wind Speed	D	NCEP	SAC-D MWR DMSP
Significant Wave Height	D	NCEP	
Total Atmospheric Liquid Water	D	NCEP	SAC-D MWR GPM
Sea Ice Concentration/Extent/Age	D	NCEP	NSIDC
Solar Flux and Flares at 1.4 GHz	D	USAF (NGDC)	
Sea Surface Salinity	D	HYCOM	
Land Mask	S	RSS	
Galactic Background at 1.4 GHz	S	RSS	
Uncertainty Fields	D	RSS	
Rain Impact Model (RIM)	D	UCF/CFRSL	

3.2.7 VIIRS

The VIIRS support within ODPS has changed dramatically since launch. Originally NASA had no official responsibility for data product generation, archiving or distribution for SNPP.

In November 2013, when NASA issued the Research Opportunities in Space and Earth Sciences (ROSES) solicitation for the VIIRS Science Team, it also included Science Investigator-led Processing Systems (SIPSs) for discipline-based processing of SNPP instrument data using NASA Science Team algorithms. The ODPS proposed for and was selected as the VIIRS Ocean SIPS. The solicitation also specified that the Level-0 data would be provided to the SIPSs by the EOS Data and Operations System (EDOS), and that Level-0 to 1B software would be developed to replace the current IDPS software. Following the release of that solicitation, the SNPP Project Scientist, Dr. James Gleason, chartered the formation of the VIIRS Level-1 Algorithm/Software Working Group (L1ASWG), a confederation of the VIIRS SIPSs, to perform this software development for VIIRS. The first version of the VIIRS Level-1 software was completed in October 2015.

The following subsections describe the Data Acquisition, Processing and Distribution for VIIRS.

Data Acquisition

EDOS delivers raw VIIRS and spacecraft packet data in the form of project data sets (PDSs). The PDSs are of two types: session-based PDSs (S-PDSs) contain the data from a single downlink (about one orbit), and are delivered with minimal delay for near-real-time processing; time-based PDSs (T-PDSs) contain data for a fixed time period (two hours for VIIRS), and are generated after all of the data for the time period have been received, using the best-quality data. The VIIRS PDSs are delivered by EDOS to the VIIRS Land SIPS and acquired from there by ODPS using the active scan method. The EDOS-to-SIPS interface is described in Reference 9, and the VIIRS Ocean to Land SIPS interface in Reference 10. The S-PDSs are deleted after a specified period, and the T-PDSs are archived permanently.

Originally the VIIRS raw data were acquired from the NOAA IDPS in the form of Raw Data Records (RDRs).
EDOS started routine delivery of PDSs in mid-2015. To achieve a consistent, mission-long Level-0 data archive, software was developed by the OBPG to generate T-PDSs from RDRs, and this was run on the entire ODPS archive of RDRs starting from VIIRS power-on. These PDSs are made available to the other VIIRS SIPSs but are not publicly distributed.

Data Processing

The PDSs are processed to generate Level-1A, Level-1B and Geolocation using the NASA software developed by the L1ASWG. The processing is performed initially using the S-PDSs as input, to generate performance assessment data products. After the T-PDSs are received, these files are processed to generate the refined data products. The L1B processing uses calibration LUTs generated by the OBPG for the Vis/NIR bands.

The downstream processing of the VIIRS data is performed using the OBPG multi-satellite processing software as described in 3.1. The daytime granules are processed to generate the Ocean Color products, and all SNPP VIIRS granules are processed to generate SST.

Data Distribution

All VIIRS data products generated by the ODPS are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.8 HICO

NASA negotiated an agreement with the ONR in 2013 for acquisition, processing and public release of the HICO data by the OBPG. As the first step in implementing that agreement, the Level-0 data set from the start of data collection in October 2009 was delivered in bulk by NRL to the ODPS, along with the software to process the data to Level-1B. The following subsections describe the Data Acquisition, Processing and Distribution for HICO.

Data Acquisition

On January 1, 2013 NASA became the sponsor for HICO operations onboard the ISS. In March of 2013, the OBPG acquired the HICO data collected from January 1, 2013 and began routine operations for the forward stream Level 0 HICO data from NRL via FTP. In June of 2013, NASA reached an agreement with ONR and NRL-DC to acquire and distribute the bulk of the complete HICO dataset collected from the start of HICO operations in October 2009 until the transition to NASA sponsorship in January 2013. Only a few select scenes collected over sensitive locations were withheld. These historical HICO data were acquired by the OBPG in July 2013. Acquisition of HICO data continued on a routine basis until the instrument failed in September 2014.

Data Processing

In late July 2013, ODPS began production of HICO Level-1B data using code provided by NRL. The code consisted of Unix shell scripts, Interactive Data Language (IDL) code and FORTRAN code. The HICO L0 files are binary files. The NRL code calibrates and geolocate these data and produce output in binary format. A separate program, also provided by NRL-DC, converts these files into the HDF5 L1B files distributed by the OB.DAAC.

Data Distribution

All HICO data products generated by the ODPS are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.9 GOCI

NASA negotiated a Memorandum of Understanding (reference 11) with the Korea Institute of Ocean Science and Technology (KIOST) in April 2016 for acquisition, processing and public release of the GOCI data by the OBPG. The following subsections describe the Data Acquisition, Processing and Distribution for GOCI.

Data Acquisition

GOCI collects a scene of the Korean peninsula and the surrounding oceans once per hour, between ~00:00 and 08:00 UTC (08:00 and 16:00 local time). Each scene is collected as a series of 16 “slots” arranged as a 4x4 array, so that each slot represents about 1/16 of the total image area. Within a slot, each band is collected in succession by rotation of the filter wheel in front of the detector array, resulting in a time delay between the bands.

The raw data are processed to Level-1B (calibrated, geolocated radiances) by the KIOST. As part of the processing, the data from the 16 slots are mapped to generate a single calibrated image. Data from the small overlaps between slots are selected according to the distance from the slot centers.

The L1B data are packaged as one zipped file per scene. The files are staged on an anonymous HTTP server and are acquired by ODPS using the active scan method.

Data Processing

The downstream processing of the GOCI data is performed using the OBPG multi-satellite processing software as described in 3.1. The timing of the data collection requires unique processing, as the time delay between slots needs to be accounted for in the calculation of the solar angles. In addition, the successive collection of the bands within a slot results in visible cloud motion among the bands; this issue is still being worked.

Data Distribution

By agreement with the KIOST, the GOCI data product distribution is delayed for 14 days from the time of data acquisition. After the delay, the GOCI L1B and L2 Ocean Color data products are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.10 OLCI

Data Acquisition

The OBPG acquires the S3A and S3B OLCI reduced resolution (ERR) and full resolution (EFR) Level 1B (L1B) products via the NASA Sentinel Gateway (NSG), an ESDIS-supported system that acts as the NASA/ESA communication portal for data collected by the various Sentinel-series missions. The S3A and S3B OLCI L1B products come in two flavors: Near real time (NRT) and Non Time Critical (NTC). The NRT granules are optimally available within a few hours of observation while the NTC products are optimally available within 48 hours of observation. The OBPG has implemented a replacement scheme whereby the acquisition of an NTC granule queues removal of its NRT counterpart. Nominally the OBPG would only generate quick-look products from the NRT granules so that any issues with data quality can be detected as soon as possible. Refined products would be made from the NTC granules. The exception to the nominal cases is one where a granule only receives an NRT or NTC version. In the case where only an NRT version is received, no quick-look products would be generated. In the case where no NTC version is received, the refined products would be generated from the NRT version.

Data Processing

The downstream processing of the OLCI Level-1B data is performed using the OBPG multi-satellite processing software as described in 3.1. Currently, all S3A-OLCI L1B products received by the OBPG are first processed to produce a L1-Browse product and to record the L1-related meta data for the ODPS database. Included in these metadata are values for the granule's start and stop times, its day-night flag, and its geo-box information. These meta-data values will be used by the ODPS to schedule Level-2 processing at a later date.

Data Distribution

The data exchange agreement between NASA and ESA included the rights to redistribute the ESA Level-1B data and derived products. These products are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.11 Hawkeye

The OBPG operates the Hawkeye Science Operations Center (SOC), which is responsible for scheduling the image data collection and downlink events. The Hawkeye image data, including interleaved spacecraft telemetry data, are downlinked via X-band to NASA Near Earth Network (NEN) ground stations at WFF and the Alaska Satellite Facility (ASF). The downlinks are scheduled by the NEN based on the SOC requests. The combined image collection and downlink scheduled are delivered by NEN to the ODPS. The data are processed to generate individual Level-1A products for each image, and then to downstream products using the OBPG multi-satellite processing software as described in 3.1. All data products are distributed by the OB.DAAC as described in Section 3.1.3.

3.2.12 OCI, HARP-2 and SPEXone

The OBPG was designated by NASA to be the Science Data Segment (SDS) for PACE when the mission was awarded to GSFC in December 2014. The SDS performs the science operations and science data processing activities for all three PACE instruments. It interfaces with the Mission Operations Center (MOC) for science operations.

Data Acquisition

The three PACE instruments all collect science data only when viewing the sunlit Earth, approximately from the Southern to Northern terminator. The data collection periods and other instrument activities (e.g., calibration maneuvers) are scheduled by the SDS in collaboration with the MOC, according to the SDS-MOC ICD and the PACE Science Operations Plan. The instrument schedules are uploaded as stored command loads to the spacecraft by the MOC. The science data, including instrument housekeeping telemetry (HKT), are transmitted by the instruments to the spacecraft Data Storage Board (DSB) via SpaceWire, and stored as files of packets on the DSB. Data from each instrument are stored in separate files. The data are downlinked via Ka-band, during station contacts scheduled by the MOC, to the Near Earth Network (NEN) Alaska, Punta Arenas and Svalbard stations. The data are transmitted by the NEN to Amazon Web Services (AWS), where the packet data files are reconstructed by the Data Acquisition Processing & Handling Network Environment (DAPHNE) and retained for 30 days. The SDS acquires the packet files from AWS. The interface is described in Reference 14.

In parallel with the onboard science data collection and downlink, the spacecraft and instrument HKT are collected and stored onboard. The HKT files are downlinked via S-band during the NEN station contacts, and transmitted to the MOC. The MOC will generate an HKT packet file for each downlink and stage it for acquisition by the SDS.

Data Processing

The OCI L0 data are processed to L1A and L1B (including geolocation) using software developed by the SDS. The downstream processing is performed using the OBPG multi-satellite processing software as described in 3.1. The l2gen software has been enhanced to support ocean color processing for hyperspectral data, and also aerosol and cloud product generation. The algorithms for the aerosol and cloud processing are the heritage algorithms used for MODIS and VIIRS processing by other discipline SIPSs. The ocean color, aerosol and cloud products are generated in separate processing streams, including the L3 binning and mapping processing.

The HARP-2 and SPEXone data are processed to L1A, L1B, and L1C using software developed and maintained as a collaborative effort by SDS, UMBC and SRON. The requirements are for SDS to generate the products through L1C; L2 and above processing will be performed on a best-effort basis. Cross-instrument algorithms and products are also anticipated, but have not been specified yet.

Data Distribution

All PACE data products will be distributed by the OB.DAAC as described in Section 3.1.3.

3.2.13 GLIMR

The OBPG was designated by NASA to be the Science Data Segment (SDS) for GLIMR when the mission was awarded to the University of New Hampshire in August 2019. The SDS will perform the science data processing activities.

Data Acquisition

The GLIMR instrument will collect science data only when viewing the sunlit Earth, in an imaging region from ~ 50°N to 50°S and ~ ±50° longitude of its nadir location.

In parallel with the onboard science data collection and downlink, the spacecraft and instrument HKT are collected and transmitted to the ground to be used in the processing of the science data.

Data Processing

The GLIMR L0 data are processed to L1A and L1B (including geolocation) using software developed by the SDS. The downstream processing is performed using the OBPG multi-satellite processing software as described in 3.1. The l2gen software has been enhanced to support ocean color processing for hyperspectral data. The algorithms for the science data processing are the heritage algorithms used for MODIS, VIIRS and the PACE OCI instrument.

Data Distribution

All GLIMR data products will be distributed by the OB.DAAC as described in Section 3.1.3.

4.0 DATA PRODUCTS

The following section summarizes the data product levels as defined by EOS, and then present the specific products generated for each sensor. All data products are formatted using either the Network Common Data Format (netCDF) or HDF.

4.1 Data Product Definitions

The OBPG data products generally follow EOS standard data product levels (Reference 4):

- Level-0 data products are reconstructed, unprocessed instrument/payload data at full resolution; any and all communications artifacts, e.g. synchronization frames, communications headers, duplicate data removed.

- Level-1A data products are reconstructed, unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters, e.g., platform ephemeris, computed and appended but not applied to the Level-0 data.

- Level-1B data products are Level-1A data that have been processed to sensor units (not all instruments will have a Level 1B equivalent).

- Level-2 data products are derived geophysical variables at the same resolution and location as the Level-1 source data.

- Level-3 data products are variables mapped on uniform space-time grid scales, usually with some completeness and consistency.

4.2 Data Products by Sensor

The defining data product characteristics for each sensor are the temporal coverage, either the granule periods (Level-1 and 2) or compositing periods (Level-3). This information is summarized in Table 4-1.

The Ocean Color (OC) products all include combinations of the following derived geophysical parameters: normalized water-leaving radiance (nLw) or remote sensing reflectance (Rrs) at multiple visible wavelengths; chlorophyll-A concentration (chl-a); aerosol optical thickness (AOT), τ, in one NIR or (for CZCS) red band; angstrom coefficient, Å; the diffuse attenuation coefficient at 490 nm, K490; calcite concentration or particulate inorganic carbon (PIC); particulate organic carbon (POC); photosynthetically available radiation (PAR); fluorescence line height (FLH); and inherent optical properties (IOPs), which include absorption and backscattering coefficients in the visible bands. The MODIS SST products include 4-micron

(nighttime only) and 11-micron (daytime and nighttime) SST. For the Level-3 products, each binned product contains multiple geophysical parameters, while the standard mapped image (SMI) products contain one parameter per granule.
All products include metadata that contain information about the mission, sensor and granule. In addition, each product level contains additional specific data fields. Level-1 products contain sensor and satellite telemetry in raw or converted form. Level-2 products include flags and masks for each pixel that indicate algorithm success and data quality. Level-3 binned products contain statistical information about the samples in each bin.

The following subsections describe the specific products for each sensor, including any unique products. The detailed product format descriptions are provided in the format specifications listed as references 7 and 8.

Table 4-1 – Data Product Temporal Characteristics

Sensor	**Level-1 and 2 Granule Period(s)**	**Level-3 Compositing Periods**
CZCS	Variable (original product size) Variable, up to 40 minutes (MLAC)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
OCTS	50 minutes (daylit orbit)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
SeaWiFS	40 to 43.66 minutes[1] (GAC) Variable, 30 – 120 seconds (LAC) Variable, up to 15 minutes (HRPT) Variable, up to 43.66 minutes (MLAC)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
MODIS	5 minutes	Daily, 8 days, Monthly, Seasonal, Annual, Mission
MERIS	Variable, up to 43 minutes (RR) Variable, up to 15 minutes (FRS)	Daily, 8 days, Monthly, Seasonal, Annual, Mission
Aquarius	1 orbit (98 minutes; Level-1A includes 10 minutes overlap with adjacent orbits)	Daily, Weekly, Monthly, Seasonal, Annual
VIIRS	6 minutes	Daily, 8 days, Monthly, Seasonal, Annual, Mission
HICO	30 seconds	N/A
GOCI	1 hour	N/A
OLCI	Variable, approximately 180 seconds (FR) Variable, approximately 43 minutes (RR)	N/A
Hawkeye	100 seconds	N/A
OCI	6 minutes	Daily, 8 days, Monthly, Seasonal, Annual, Mission
HARP-2	TBD	N/A
SPEXone	Approximately 49 minutes (daylit orbit)	N/A
GLIIMR	Variable	N/A

[1] The SeaWiFS GAC recording period was extended on September 23, 2000 from 40 minutes to 43 minutes 40 seconds. It was changed back to 40 minutes on November 9, 2010.

4.2.1 CZCS

The CZCS distributed data products include the Level-1A MLAC, Level-2 MLAC Ocean Color, Level-3 binned and Level-3 SMI.

Table 4-2 – CZCS Data Products

Product	Fields	Resolution
Level-1A MLAC	Raw instrument counts for CZCS bands	800 m
Level-2 MLAC OC	Rrs (at 443, 520, 550 and 670 nm), chl-a, τ670, and K490	800 m
Level-3 Binned	Rrs, chl-a, τ670, and K490	9 km
Level-3 SMI	Rrs, chl-a, τ670, and K490	9 km

4.2.2 OCTS

The OCTS distributed data products include the Level 1A GAC, Level 2 GAC Ocean Color and IOP, Level-3 binned and Level-3 SMI.

Table 4-3 – OCTS Data Products

Product	Fields	Resolution
Level-1A GAC	Raw instrument counts for OCTS bands	3.5 km
Level-2 GAC OC	Rrs, chl-a, τ862, Å443, K490, and PIC	3.5 km
Level-2 GAC IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	3.5 km
Level-3 Binned	Rrs, chl-a, τ862, Å443, K490, PIC and IOPs.	9 km
Level-3 SMI	Rrs, chl-a, τ862, Å520, K490, PIC and IOPs.	9 km

4.2.3 SeaWiFS

The SeaWiFS distributed data products include the Level 1A GAC and MLAC, Level 2 GAC and MLAC Ocean Color, Level 2 GAC IOP, Level-3 binned and Level-3 SMI. The Level-3 products also include photosynthetically available radiation (PAR), land surface reflectance (LSR) and normalized difference vegetation index (NDVI).

Table 4-4 – SeaWiFS Data Products

Product	Fields	Resolution
Level-1A GAC Level-1A MLAC	Raw instrument counts for SeaWiFS bands	4.4 Km 1.1 km
Level-2 GAC OC Level-2 MLAC OC	Rrs, chl-a, τ865, Å443, K490, PIC, and POC	4.4 km 1.1 km

Level-2 GAC IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	1.1 km
Level-3 Binned	Rrs, chl-a, τ865, Å510, K490, PIC, POC, PAR, IOPs, and NDVI	9 km
Level-3 SMI	Rrs, chl-a, τ865, Å510, K490, PIC, POC, PAR, IOPs, LSR, and NDVI	9 km

4.2.4 MODIS

The MODIS distributed data products include Level-1A, Level-2 Ocean Color, IOP and SST, Level-3 binned, and Level-3 SMI.

Table 4-5 – MODIS Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for MODIS bands	1 km
Level-2 OC	Rrs, chl-a, τ869, Å443, K490, PIC, POC, PAR, and NFLH	1 km
Level-2 IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	1 km
Level-2 SST	11 micron (day/night) and 4 micron (night only) SST	1 km
Level-3 Binned	Rrs, chl-a, τ869, Å443, K490, PIC, POC, PAR, FLH, IOPs, 11 micron day SST, 11 micron night SST and 4 micron SST	4 km
Level-3 SMI	Rrs, chl-a, τ869, Å443, K490, PIC, POC, PAR, FLH, IOPs, 11 micron day SST, 11 micron night SST and 4 micron SST	4 and 9 km

4.2.5 MERIS

The MERIS distributed data products include Level-1B, Level-2 Ocean Color, Level-3 binned and SMI.

Table 4-6 – MERIS Data Products

Product	Fields	Resolution
Level-1B	Calibrated TOA radiances for MERIS bands	300 m
Level-2 FRS OC Level-2 RR OC	Rrs, chl-a, τ865, Å443, K490 and PAR	300 m 1.2 km
Level-3 Binned	Rrs, chl-a, τ869, Å443, K490 and PAR	4 km
Level-3 SMI	Rrs, chl-a, τ869, Å443, K490 and PAR	4 and 9 km

4.2.6 Aquarius

The Aquarius data products include Level 1A, Level-2 salinity products, and Level 3 binned and mapped salinity products.

Table 4-7 – Aquarius Data Products

Product	Fields	Resolution
Level-1A	Raw radiometer and scatterometer counts for each horn and polarization	~100 km

Level-2	Radiometer brightness temperatures and scatterometer signal return strength for each beam and polarization; SSS for each beam; ancillary data fields interpolated to beam times and locations; surface density and spice	~100 km
Level-2 Soil Moisture	Volumetric soil moisture	~100 km
Level-3 Binned	Binned Level-2 data fields	1 degree
Level-3 SMI	SSS, wind speed, optimally smoothed SSS (monthly only), ancillary SST, soil moisture, surface density and spice	1 degree

4.2.7 VIIRS

The VIIRS distributed data products include Level-1A, Level-2 Ocean Color and IOPs, Level-3 binned, and Level-3 SMI.

Table 4-8 – VIIRS Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for VIIRS bands and SNPP spacecraft diary (orbit and attitude) data	750 m and 375 m
Level-2 OC	Rrs, chl-a, τ862, Å443, K490, PIC, POC, and PAR	750 m
Level-2 IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	750 m
Level-3 Binned	Rrs, chl-a, τ869, Å443, K490, PIC, POC, PAR and IOPs	4 km
Level-3 SMI	Rrs, chl-a, τ862, Å443, K490, PIC, POC, PAR and IOPs	4 and 9 km

4.2.8 HICO

The HICO data product includes Level 1B.

Table 4-9 – HICO Data Products

Product	Fields	Resolution
Level-1B	Calibrated TOA radiances for HICO bands	90 m

4.2.9 GOCI

The GOCI data products include Level 1B and Level-2 Ocean Color.

Table 4-10 – GOCI Data Products

Product	Fields	Resolution
Level-1B	Calibrated TOA radiances for GOCI bands	500 m
Level-2 OC	Rrs, chl-a, τ865, Å443, K490, PIC, POC, and PAR	500 m

4.2.10 OLCI

The OLCI data product includes Level 1B.

Table 4-11 – OLCI Data Products

Product	Fields	Resolution
Level-1B	Calibrated TOA radiances for OLCI bands	300 m

4.2.11 Hawkeye

The Hawkeye data products include Level 1A and Level-2 Ocean Color.

Table 4-12 – Hawkeye Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for Hawkeye bands	120 m
Level-2 OC	Rrs, chl-a, τ865, Å443, K490, PIC, and POC	120 m

4.2.12 OCI

The OCI data products include Level 1A and 1B, Level-2 Ocean Color, IOP, Aerosol and Cloud, Level-3 binned, and Level-3 SMI.

Table 4-13 – OCI Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for OCI bands	1 km
Level-1B	Calibrated, geolocated radiances for OCI bands	1 km
Level-2 OC	Rrs, chl-a, τ862, Å443, K490, PIC, POC, and PAR	1 km
Level-2 IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	1 km
Level-2 Aerosol	Aerosol optical depth, aerosol fine mode fraction	1 km
Level-2 Cloud	Cloud layer detection; cloud top pressure; optical thickness, effective radius and water path for liquid and ice clouds	1 km
Level-3 Binned	All OC, aerosol and cloud	4 km
Level-3 SMI	All OC, aerosol and cloud	4 and 9 km

4.2.13 HARP-2

The HARP-2 data products include Level 1A, 1B and 1C.

Table 4-14 – HARP-2 Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for HARP-2 bands	2 km
Level-1B	Calibrated, geolocated radiances for HARP-2 bands	2 km
Level-1C	Co-registered radiances for HARP-2 bands	TBD km

4.2.14 SPEXone

The SPEXone data products include Level 1A, 1B and 1C.

Table 4-15 – SPEXone Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for SPEXone views and bands	2.5 km
Level-1B	Calibrated, geolocated radiances for SPEXone views and bands	2.5 km
Level-1C	Co-registered radiances for SPEXone bands	TBD km

4.2.15 GLIMR

The GLIMR data products include Level 1A and 1B, Level-2 Ocean Color, IOP

Table 4-16 – GLIMR Data Products

Product	Fields	Resolution
Level-1A	Raw instrument counts for GLIMR bands	300 m
Level-1B	Calibrated, geolocated radiances for GLIMR bands	300 m
Level-2 OC	Rrs, chl-a, $\tau 862$, Å443, K490, PIC, POC, and PAR	300 m
Level-2 IOP	a, bb, aph, adg, bbp, adg-s, bbp-s, and uncertainties	300 m

5.0 DATA RIGHTS AND RULES FOR DATA USE

The ODPS policy is to publicly release all versions of all data products as soon as they are processed, except for sensors, which have specific restrictions (e.g. commercial data rights or interagency agreements). Products that are still undergoing validation are indicated as provisional. Exceptions to this policy were noted for each sensor in Section 3.2.

6.0 REFERENCES

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APPENDIX A- ACRONYM LIST

ADEOS	Advanced Earth Observing Satellite
ADM	Archive Device Manager
ADS	Archive Data Segment
ATBD	Algorithm Theoretical Basis Document
CAN	Cooperative Agreement Notice
CCD	Charge-coupled device
CDOM	Chromophoric dissolved organic matter
CLASS	Comprehensive Large Array Stewardship Segment
CONAE	Comision Nacional de Actividades Espaciales
CUSS	CONAE User Segment Service
CZCS	Coastal Zone Color Scanner
DAAC	Distributed Active Archive Center
DAPHNE	Data Acquisition Processing & Handling Network Environment
DoD	Department of Defense
EDOS	EOS Data and Operations System
EDR	Environmental Data Record
EOS	Earth Observing System
ESA	European Space Agency
FLH	Fluorescence line height
GAC	Global Area Coverage
GES DISC	Goddard Earth Sciences Data and Information Services Center
GLIMR	Geostationary Littoral Imaging and Monitoring Radiometer
GSFC	Goddard Space Flight Center
HARP-2	Hyper-Angular Rainbow Polarimeter #2
HDF	Hierarchical Data Format
HICO	Hyperspectral Imager for the Coastal Ocean
HKT	Housekeeping telemetry
HRPT	High-resolution Picture Transmission
HRD	High-rate data
I&TSE	Integration and Test Support Element
IDL	Interactive Data Language
IDPS	Interface Data Processing Segment
ISS	International Space Station
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System
KIOST	Korea Institute of Ocean Science and Technology
L1ASWG	Level-1 Algorithm/Software Working Group
LAC	Local Area Coverage
MODAPS	MODIS Adaptive Processing System
MERIS	Medium Resolution Imaging Spectrometer
MLAC	Merged LAC
MODIS	Moderate-resolution Imaging Spectroradiometer
MOU	Memorandum of Understanding
NDVI	Normalized difference vegetation index

NetCDF	Network Common Data Format
nLw	Normalized water-leaving radiance
NOAA	National Oceanic and Atmospheric Administration
NRL	Naval Research Laboratory
OB.DAAC	Ocean Biology DAAC
OBPG	Ocean Biology Processing Group
OCI	Ocean Color Instrument
OCTS	Ocean Color and Temperature Scanner
ODPS	Ocean Data Processing System
OEL	Ocean Ecology Laboratory
ONR	Office of Naval Research
OSC	Orbital Sciences Corporation
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem
PAR	Photosynthetically available radiation
PDS	Project Data Set
PEATE	Product Evaluation and Analysis Tools Element
PIC	Particulate inorganic carbon
POC	Particulate organic carbon
PO.DAAC	Physical Oceanography DAAC
RDR	Raw Data Record
REASoN	Research, Education and Applications Solutions Network
Rrs	Remote sensing reflectance
RSS	Remote Sensing Systems
SAC-D	Satelite de Aplicaciones Científicas D
SIPS	Science Investigator-led Processing System
SD3E	Science Data Depository and Distribution Element
SDR	Sensor Data Record
SDS	Science Data Segment
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SNPP	Suomi National Polar-orbiting Partnership
SPEXone	Spectro-Polarimeter for Planetary Exploration
SSS	Sea surface salinity
SST	Sea surface temperature
TDI	Time delay integration
VDC	Visual Database Cookbook
VIIRS	Visible and Infrared Imager/Radiometer Suite