



Introducción a las Observaciones Hiperespectrales de PACE para el Monitoreo de la Calidad del Agua

3^{ra} Sesión: Acceso y Visualización de Datos de PACE/OCI usando Software de Python/Jupyter Notebook

Instructora de ARSET: Amita Mehta

Instructoras Invitadas: Anna Windle (NASA GSFC/SSAI) & Carina Poulin (NASA GSFC/SSAI)

9 de octubre de 2024



Esquema de la Capacitación

Parte 1

Introducción a la Misión PACE (Plankton Aerosol, Cloud, ocean, Ecosystem) para el Monitoreo de la Calidad del Agua

25 de septiembre de 2024

2:00-3:30 PM

Parte 2

Resumen General, Acceso y Análisis de los Datos de PACE Ocean Color

2 de octubre de 2024

2:00-3:30 PM

Parte 3

Acceso y Visualización de Datos de PACE/OCI usando Software de Python/Jupyter Notebook

9 de octubre de 2024

2:00-3:30 PM

Tarea

Abre el 9 de octubre – Fecha límite: 24 de octubre – Publicada en la Página Web de la Capacitación

Se otorgará un certificado de finalización de curso a quienes asistan a todas las sesiones en vivo y completen la tarea asignada antes de la fecha límite.



Repaso de la 2^{da} Sesión

- Programa de Aplicaciones: Informar a las actividades de toma de decisiones relacionadas con los recursos hídricos, la pesca, áreas de ecosistemas.
- Ejemplos de primeros usuarios de PACE: Selección de sitios de acuicultura, modelos del riesgo de cólera mejorados, monitoreo de la calidad del agua de lagos y estuarios con [Hypercoast](#).
- Descripción y acceso a múltiples niveles de datos de PACE: [Página Inicial de Acceso a Datos de PACE](#)
- Acceso a datos: A través del [OB.DAAC](#) y [Earthdata](#).
- [NASA Worldview](#): Útil para imágenes en color real de PACE y la visualización de datos de concentración de clorofila-a en tiempo casi real.
- Demostración de SeaDAS: Útil para el análisis y la visualización de datos de PACE.



3^{ra} Sesión - Objetivos

Al final de la 3^{ra} sesión, os participantes podrán :

- Acceder a las reflectancias de teledetección de OCI y los parámetros de la calidad del agua de 2^{do} y 3^{er} Nivel de Earthdata utilizando software Python de código abierto/Jupyter Notebooks.
- Visualizar las reflectancias de teledetección de OCI y los parámetros de la calidad del agua de 2^{do} y 3^{er} Nivel utilizando software Python de código abierto/Jupyter Notebooks
- Identificar los pasos para personalizar el software de Jupyter Notebook proporcionado para otras áreas de interés y períodos de tiempo



Cómo Hacer Preguntas

- Por favor escriba sus preguntas en la casilla denominada “Questions” y las responderemos al final de este webinar.
- No dude en escribir sus preguntas mientras vayamos avanzando. Intentaremos responder todas las preguntas durante la sesión de preguntas y respuestas después del webinar.
- Las preguntas que no podamos contestar las responderemos en el documento de preguntas y respuestas, el cual será publicado en la página web de la capacitación aproximadamente una semana después de esta.



3^{ra} Parte – Instructores

Anna Windle

Becaria Posdoctoral
NASA GSFC, SSAI



Carina Poulin

Diseñadora Científica
NASA GSFC, SSAI





**Acceso y Visualización de Datos de PACE/OCI Usando
Software de Python/Jupyter Notebook
Resumen General**

PACE: Una Nueva Era para el Monitoreo de la Calidad del Agua

- Lanzamiento de PACE: 8 de febrero de 2024
- Nuevas Oportunidades en cuanto a Datos:
 - Datos hiperespectrales del color del océano
 - Datos polarimétricos hiper- y multiespectrales
- ¡Nuevos desafíos respecto a los datos!





Orientación sobre Acceso a Earthdata Cloud

¿Dónde Se Encuentran los Datos de PACE?

- ¡En la nube!



- Específicamente, una nube AWS que está físicamente en Oregón, Estados Unidos.
- Esta se conoce como la región AWS us-west-2.
- Los datos de PACE se encuentran en Baldes (buckets) de almacenamiento en la nube “AWS Cloud Data Storage (S3)” en esta nube.
- [NASA Earthdata Cloud Cookbook](#)



¿Cómo Puedo Acceder a los Datos de PACE que Están en la Nube?

Tres opciones:

1. [Portal del Earthdata Search OB.DAAC](#)
2. [OB.DAAC Level 3 & 4 Browser](#)
3. [OB.DAAC File Search](#)

Note: El navegador OB.DAAC de Nivel 1 y 2 no permite acceso a los datos de PACE



R.I.P.

The screenshot shows the Earthdata Search interface. On the left, there are search filters for various data sources like MODIS, VIIRS, and SeaWiFS. The main area displays a world map with a color-coded overlay. Below the map, there is a table of search results with columns for date, location, and data type. The table shows data for various dates from 2010 to 2014, with some cells containing numerical values and others containing text like 'No data available'.



El Portal de Earthdata Search OB.DAAC

1. Navegue a:
<https://search.earthdata.nasa.gov/search>
2. En la parte superior izquierda, haga clic en “Browse Portals”
3. Haga clic en “OBDAAC”
4. Elija “OCI” en las opciones de filtrar colecciones

The screenshot displays the Earthdata Search interface. The top navigation bar includes the Earthdata logo and a search bar. The main content area shows a list of 20 matching collections. The 'Browse Portals' section is highlighted with a red circle, and the 'OBDAAC' portal is also highlighted. The 'Filter Collections' section is expanded, showing a list of instruments with 'OCI' selected and highlighted by a red circle.

Earthdata Search Interface Details:

- Search Bar:** Find a DAAC -
- Navigation:** Browse Portals (circled in red)
- Filter Collections:**
 - Features: Available in Earthdata Cloud, Customizable, Map Imagery
 - Keywords: (empty)
 - Platforms: (empty)
 - Instruments: 1 Selected
 - HARP2: 6
 - HawkEye: 2
 - MERIS: 26
 - MODIS: 20
 - OCI: 20** (circled in red)
 - OLCI: 20
 - SeaWiFS: 22
 - SPEXone: 4
 - VIIRS: 102
 - Organizations: 1 Selected

Organization	Description
CWIC	CEOS WIGISS Integrated Catalog
GHRC	Global Hydrometeorology Resource Center
IDN	CEOS International Directory Network
OBDAAC	Ocean Biology Distributed Active Archive Center (circled in red)
ORNL DAAC	Oak Ridge National Laboratory Distributed Active Archive Center
PO.DAAC	Physical Oceanography Distributed Active Archive Center
PO.DAAC Cloud	Physical Oceanography Distributed Active Archive Center
SNWG	Satellite Needs Working Group



Datos de Interés

Nombre abreviado →

OBDAAC (Ocean Biology Distributed ...)
20 Matching Collections
Showing 20 of 20 matching collections

PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, version 2.0
23,066 Granules 2024-02-25 ongoing Earthdata Cloud
1 to 4 days
The Ocean Biology DAAC produces near real-time (quicklook) products using the best-available combination of ancillary data from meteorological and...

PACE OCI Level-1B Science Data, version 2
23,072 Granules 2024-02-25 ongoing Earthdata Cloud
The primary sensor aboard the PACE spacecraft is the Ocean Color Instrument (OCI). It is a highly advanced optical spectrometer that will be...

PACE OCI Level-3 Global Mapped Chlorophyll (CHL) - NRT Data, version 2.0
528 Granules 2024-02-25 ongoing Earthdata Cloud 1 to 4 days
The Ocean Biology DAAC produces near real-time (quicklook) products using the best-available combination of ancillary data from meteorological and...

PACE OCI Level-2 Regional Biogeochemical Properties, Near Real-time (NRT) Data, version 2.0
23,068 Granules 2024-02-25 ongoing Earthdata Cloud
The Oce... Looking for more collections? Leave the OBDAAC Portal

Search Results (20 Collections)

PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, version 2.0

PACE_OCI_L2_AOP_NRT Version 2.0

Related URLs

[View More Info](#)

Temporal Extent

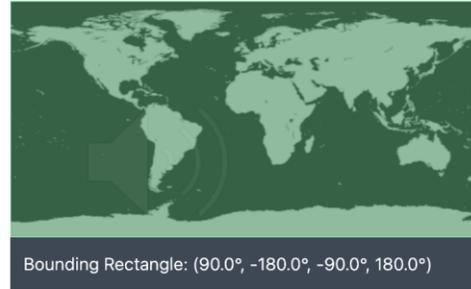
2024-02-25 ongoing

GIBS Imagery Projection Availability

None

Science Keywords

EARTH SCIENCE ATMOSPHERE ATMOSPHERIC RADIATION



The Ocean Biology DAAC produces near real-time (quicklook) products using the best-available combination of ancillary data from meteorological and...

For Developers

OBPG

PROCESSOR

No contact information for this data center.

NASA/GSFC/SED/ESD/GCDC/OB.DAAC

DISTRIBUTOR ARCHIVER

sdps@oceancolor.gsfc.nasa.gov

Fax: 301-286-0268

Cloud Access

AWS Cloud

Available for access in-region with AWS Cloud

Region

us-west-2

Bucket/Object Prefix

s3://ob-cumulus-prod-public/

AWS S3 Credentials

[Get AWS S3 Credentials](#) | [Documentation](#)

Descargar Datos

Al seleccionar un archivo, se resalta el gránulo en el mapa.

Descargue archivos individuales directamente.

Agregue varios archivos para descargar.

The screenshot displays a search results page for 'PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, version 2.0'. It shows 20 of 23,066 matching granules. The interface includes a table of granules with columns for file name, start/end times, and download options. A red arrow points from the text 'Descargue archivos individuales directamente.' to the download icon of the first granule. Another red arrow points from the text 'Agregue varios archivos para descargar.' to the plus icon of the second granule. To the right, a map of Africa is shown with a green box highlighting a specific location in Nigeria, labeled with the coordinates '2024-08-28 11:50:53' and '2024-08-28 11:55:52'. A red arrow points from the text 'Al seleccionar un archivo, se resalta el gránulo en el mapa.' to this highlighted location on the map.

File Name	START	END	Download
PACE_OCI.20240828T120553.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 12:05:53	2024-08-28 12:10:52	- [Download]
PACE_OCI.20240828T115053.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 11:50:53	2024-08-28 11:55:52	+ [Download]
PACE_OCI.20240828T102235.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 10:22:35	2024-08-28 10:27:34	+ [Download]
PACE_OCI.20240828T101735.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 10:17:35	2024-08-28 10:22:34	+ [Download]
PACE_OCI.20240828T101235.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 10:12:35	2024-08-28 10:17:34	+ [Download]
PACE_OCI.20240828T100735.L2.O_C_AOP.V2_0.NRT.nc	2024-08-28 10:07:35	2024-08-28 10:12:34	+ [Download]

Search Time: 0.1s

Remove Download 2



Analizar los Datos en la Herramienta de su Elección

The screenshot shows a web interface for downloading data. On the left, a sidebar displays 'Untitled Project' with '2 Granules 1 Collection 150.2 MB'. Below this, a project summary for 'PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, version 2.0' is shown with '2 Granules Est. Size 150.2 MB' and an 'Edit Options' link. The main area is titled 'Edit Options' and contains two steps: 1. 'Choose how you want to download your data' with a selected option 'Download all data' (Direct download of all selected data). 2. 'Select a service and customize options' with a message: 'No customization options are available for the selected access method.' At the bottom, there is a 'Download Data' button and a 'Done' button next to 'Collection 1 of 1'.

Download Status

This page will automatically update as your orders are processed. The Download Status page can be accessed later by visiting <https://search.earthdata.nasa.gov/downloads/4436229390> or the [Download Status and History](#) page.

The screenshot shows the 'Download Status' page for 'PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, version 2.0'. It displays a table with columns for Status, Access Method, and Granules. The status is 'Complete (100%)', the access method is 'Download', and there are '2 Granules'. Below the table, there is a section for 'Download Files' with tabs for 'Download Files', 'AWS S3 Access', and 'Download Script'. A progress bar shows 'Retrieved 2 files for 2 granules' at '100%'. A red arrow points to the 'Download Files' button, which is highlighted in green. Below the progress bar, two URLs are listed: https://obdaac-tea.earthdatacloud.nasa.gov/ob-cumulus-prod-public/PACE_OCI.20240828T115053.L2_OC_AOP.V2_0.NRT.nc and https://obdaac-tea.earthdatacloud.nasa.gov/ob-cumulus-prod-public/PACE_OCI.20240828T120553.L2_OC_AOP.V2_0.NRT.nc. Other buttons like 'Copy', 'Save', and 'Expand' are also visible.

Puede extraer estos archivos locales en el sistema al que esté acostumbrado a utilizar para analizar datos satelitales: Python, Matlab, R, SeaDAS, etc.

O...



earthaccess – Biblioteca de Python

- Una forma sencilla de buscar, descargar, o transmitir datos de ciencias de la Tierra de la NASA utilizando unas cuantas líneas de código.
- earthaccess está en desarrollo activo.
 - Siéntase libre de enviar preguntas en su Github si algo no funciona o tiene alguna sugerencia.
- ¡Cualquiera puede contribuir! Visite la [Guía de Cómo Contribuir](#).
- Esto es lo que usaremos para acceder a los datos de PACE en los tutoriales de Jupyter Notebook.



earthaccess
A Python Library for NASA Earthdata



Dos Formas de Ejecutar Jupyter Notebooks

1. Localmente: siguiendo las instrucciones enumeradas en los prerequisites
 - Use el entorno **environment.yml** predefinido para instalar JupyterLab y las bibliotecas de Python necesarias
1. En la nube
 - Si tiene acceso a un Elastic Compute Cloud (EC2), como un JupyterHub basado en la nube
 - Ejemplos: JupyterHubs mantenidos por Openscapes, CryoCloud, el NASA Goddard Open Science Studio
 - El EC2 debe ejecutarse en AWS us-west-2 region
 - Consulte el “recetario” [NASA Earthdata Cloud Cookbook](#) para obtener más información sobre la computación en la nube

Como no todos tienen el mismo acceso a un EC2, demostraremos cómo ejecutar los cuadernos localmente.





Tutorial de Acceso a Earthdata en la Nube

Dirigido por: Anna Windle, Postdoc
Laboratorio de Ecología Oceánica NASA GSFC



Visualización de Datos de Teledetección Óptica para el Monitoreo de la Calidad del Agua

Datos de PACE

- Tabla de Datos de PACE

Calibrated Radiometry and Polarimetry Calibrated and geolocated radiometry and polarimetry as observed at sensor.					
Product	Description and Use	Units	Availability	Status	Additional Info
Top-of-atmosphere radiances from OCI	Spectral radiance observed at the top of the atmosphere.	$W m^{-2} \mu m^{-1} sr^{-1}$	Level-1B 1-km at nadir; daily - Level-1C daily	Provisional	Level-1C draft data format and examples
Top-of-atmosphere radiances and polarimetry from SPeXone	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C daily	Provisional	Level-1C draft data format and examples
Top-of-atmosphere radiances and polarimetry from HARP2	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C daily	Provisional	Level-1C draft data format and examples

Ocean Properties to be Produced by OCI Bio-optical and biogeochemical properties of seawater constituents in the sunlit upper ocean.					
Product	Description and Use	Units	Availability	Status	Additional Info
Color sensing reflectances	Spectral color of the ocean in the ultraviolet-to-near infrared spectral range. Used as input into algorithms to retrieve information about colored dissolved organic matter, phytoplankton, non-algal particles, and other aquatic constituents. Provided in continuous 2.5-nm steps from 350 to 717.5-nm with a resolution (bandwidth) of 5-nm.	sr^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Stamm In situ measurement protocols
Reflectance	Effective reflectance of the Earth's surface as observed by OCI. Used as an input to downstream ocean data products. Includes inland waters as well as ocean surface reflectance.	unitless	Level-2 1-km (at nadir); daily - Level-3 spatial resolution TBD; daily, 8-day, monthly	Test	Current product: L2gen; investigating MAIAC (Lyapustin et al.)
Remote-sensing reflectance	An optical water classification index reported as the weighted harmonic mean of visible-range R_{rs} wavelengths (400-700 nm)	nm	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD
Water attenuation coefficients	Spectral diffuse attenuation of downwelling irradiance at multiple wavelengths between 350 and 700 nm. Provides indices of water clarity and light penetration.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD SAT members: Boss, Stramski, Odermatt In situ measurement protocols
Phytoplankton absorption coefficients	Spectral absorption coefficients for total phytoplankton absorption at multiple wavelengths between 350 and 700-nm. Provides information on phytoplankton physiology, abundance, and community composition.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Shuchman, Pal, Barnes, Stammes, Chowdhary In situ measurement protocols
Non-algal particle plus dissolved organic matter absorption coefficients	Spectral absorption coefficients for non-algal particulates and dissolved organic matter at multiple wavelengths between 350 and 700-nm. Provides information on the concentrations of the dissolved component of organic carbon and the detrital (non-algal) component of the particulate assembly.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Barnes, Stamm In situ measurement protocols
Chromophoric dissolved organic matter absorption coefficients	Spectral absorption coefficients for dissolved organic matter at multiple wavelengths between 350 and 700-nm. Provides information on the concentration of the dissolved component of organic carbon.	m^{-1}	TBD	Test	SAT member: Stramski In situ measurement protocols
Absorption coefficients of chromophoric dissolved organic matter	Absorption spectral slope coefficients of chromophoric dissolved organic matter for multiple wavelength ranges: 275-295, 350-400, 380-600 nm. Provides information on the contribution of land-derived dissolved organic matter, relative contribution of land- versus marine-derived dissolved organic matter, and as a relative measure of solar photobleaching.	nm^{-1}	TBD	Test	SAT member: Stramski In situ measurement protocols
Non-algal particle matter absorption coefficients	Spectral absorption coefficients for non-algal particulate matter at multiple wavelengths between 350 and 700 nm. Provides information on the concentration of non-phytoplankton particulate components.	nm^{-1}	TBD	Test	SAT member: Stramski In situ measurement protocols
Particulate matter absorption coefficients	Spectral absorption coefficients for particulate matter at multiple wavelengths between 350 and 700 nm. Provides information on the concentration of particulate matter in the water column.	nm^{-1}	TBD	Test	SAT member: Stramski In situ measurement protocols
Particulate matter backscattering coefficients	Spectral backscattering of the light associated with particulate material, at multiple wavelengths between 350-700 nm. Provides an indicator of the concentration of particles in the ocean and a proxy indicator of particulate carbon concentrations.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Shuchman, Pal, Stammes, Chowdhary, Zhang, Odermatt
Surface light	Light leaving the surface ocean due to the sun induced chlorophyll fluorescence. Provides an indicator of phytoplankton physiology (health?).	$W m^{-2} \mu m^{-1} sr^{-1}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD SAT member: Westberry
Photosynthetically available radiation (PAR)	The amount of sunlight that is useful for photosynthesis, defined here as the 400-700 nm spectral range, that reaches the surface of the ocean over a day. As phytoplankton require light to convert inorganic carbon to organic carbon, PAR provides a critical parameter for understanding the oceanic carbon cycle.	Einsteins $m^{-2} d^{-1}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT member: Boss
Concentration of chlorophyll-a	Near surface concentration of the photosynthetic pigment chlorophyll-a. Provides proxies	$mg m^{-3}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD



Datos de PACE

- [Tabla de Datos de PACE](#)

Ocean Properties to be Produced by OCI						
Bio-optical and biogeochemical properties of seawater constituents in the sunlit upper ocean.						
Product	L2 Suite	Description and Use	Units	Availability	Status	Additional Info
Spectral remote sensing reflectances	OC_AOP	Spectral color of the ocean in the ultraviolet-to-near infrared spectral range. Used as input into algorithms to retrieve information about colored dissolved organic matter, phytoplankton, non-algal particles, and other aquatic constituents. Provided in continuous 2.5-nm steps from 350 to 717.5-nm with a resolution (bandwidth) of 5-nm.	sr ⁻¹	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Stamnes, Zhang In situ measurement protocols
Surface reflectance	SFREFL	Effective reflectance of the Earth's surface as observed by OCI. Used as an input to downstream ocean data products. Includes inland waters as well as ocean surface reflectance.	unitless	Level-2 1-km (at nadir), daily - Level-3 spatial resolution TBD; daily, 8-day, monthly	Test	Current product: L2gen; investigating MAIAC (Lyapustin) and ISOFIT
Apparent visible wavelength	OC_AOP	An optical water classification index reported as the weighted harmonic mean of visible-range Rrs wavelengths (400-700 nm)	nm	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD



Datos de PACE – lo que Debe Saber sobre los Sensores

- [Lo que Debe Saber sobre los Datos de PACE](#)

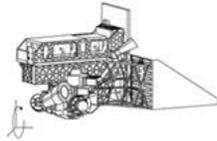
This is a summary of the general information one needs to use PACE data. See the complete release notes for the most current PACE data on the [OB.DAAC website](#).

Orbit

The PACE satellite is in a Sun-synchronous polar orbit, with a local Equatorial solar crossing time of 1 pm for the ascending (daytime) node. The descending orbital node happens during local nighttime, and none of PACE's sensors collect science data at night.

PACE Instruments

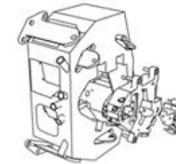
OCI
Ocean Color Instrument



HARP-2
Hyper Angular Rainbow
Polarimeter



SPEXone
Spectro-Polarimeter for
Planetary EXploration



OB.DAAC Data processing levels

Level 1A

Raw instrument data and spacecraft telemetry in netCDF4

Level-1B

Calibrated & geolocated instrument data

Level-1C

Calibrated, geolocated, and co-registered to a common grid

Level-2

Derived geophysical science data products

Level-3

Temporally and spatially composited (binned and mapped) global products

Level-4

Geophysical products derived from combined Level-3 inputs and/or models

Product maturity levels

Standard

Provisional

Test

Diagnostic



Datos de PACE – lo que Debe Saber sobre los Niveles de Datos

- [Lo que Debe Saber sobre los Datos PACE](#)

OB.DAAC Data processing levels

Level 1A

Raw instrument data and spacecraft telemetry in netCDF4

Level-1B

Calibrated & geolocated instrument data

Level-1C

Calibrated, geolocated, and co-registered to a common grid

Level-2

Derived geophysical science data products

Level-3

Temporally and spatially composited (binned and mapped) global products

Level-4

Geophysical products derived from combined Level-3 inputs and/or models

Product maturity levels

Standard

Products are produced by an algorithm that has community consensus and have been validated.

Provisional

Results have been reviewed and are in family with heritage data products or other basis of expectation, but which have not yet been validated and may still contain significant errors.



Test

Results have not yet been reviewed by algorithm developers and or may be known to have substantial errors in implementation that are under investigation.

Diagnostic

Products that are produced to support analysis of algorithm behavior, but that are not intended for science.

Known data issues

PACE is already providing high-quality data. However, some issues have to be noted before using it. Some particular bands, influenced by instrument or atmospheric characteristics, should be avoided for the moment.

Other issues affect the entire dataset, and some events affect data availability. See below for details.

Reference spectra (for indicative purposes)

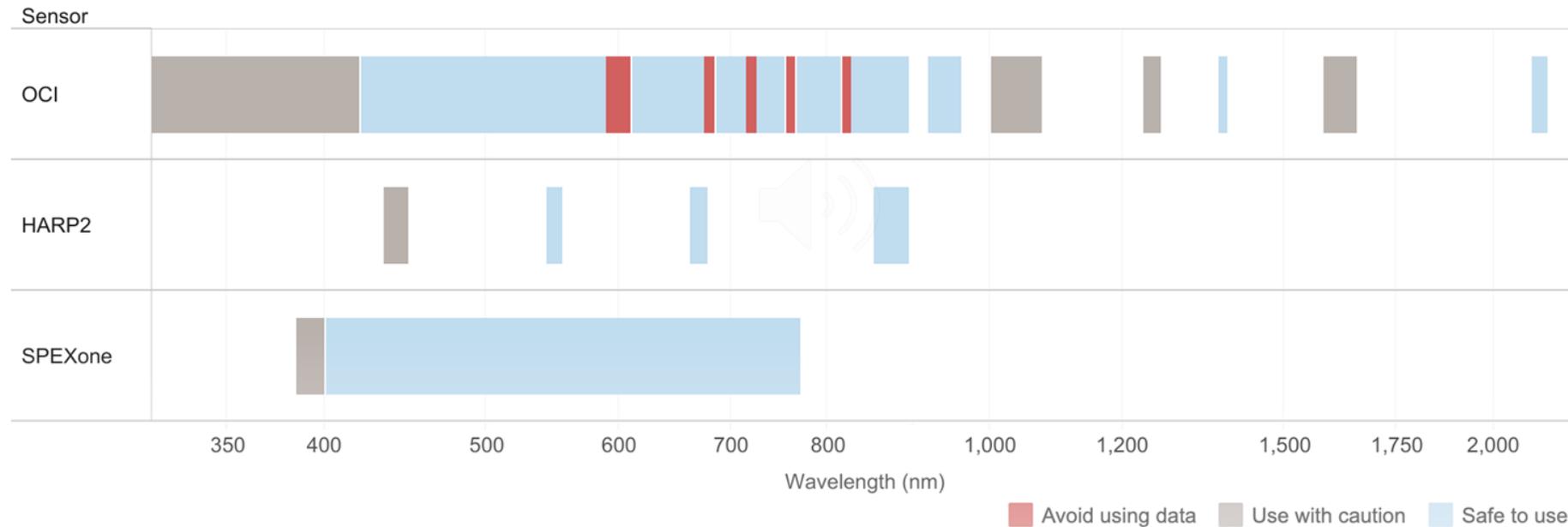


Datos de PACE – lo que Debe Saber sobre las Bandas

- [Lo que Debe Saber sobre los Datos PACE](#)

Problematic bands

Hover over the bands to get more information about the issues. The ocean normalized surface reflectance (ρ_{rs}) and atmosphere transmittance spectra are shown as a reference.



Issues affecting all bands

Sensor	Processing le..	Product suite..	Issue details
HARP2	Level 1A/B/C	NA	Alignment related false polarization needs further evaluation and improvement

Geolocation performance is subject to more comprehensive evaluation.

Filter Sensor or Processing Level

- Sensor
- (All)
 - HARP2
 - OCI



Datos de PACE – lo que Debe Saber sobre los Eventos que Afectan los Datos

- [Lo que Debe Saber sobre los Datos PACE](#)

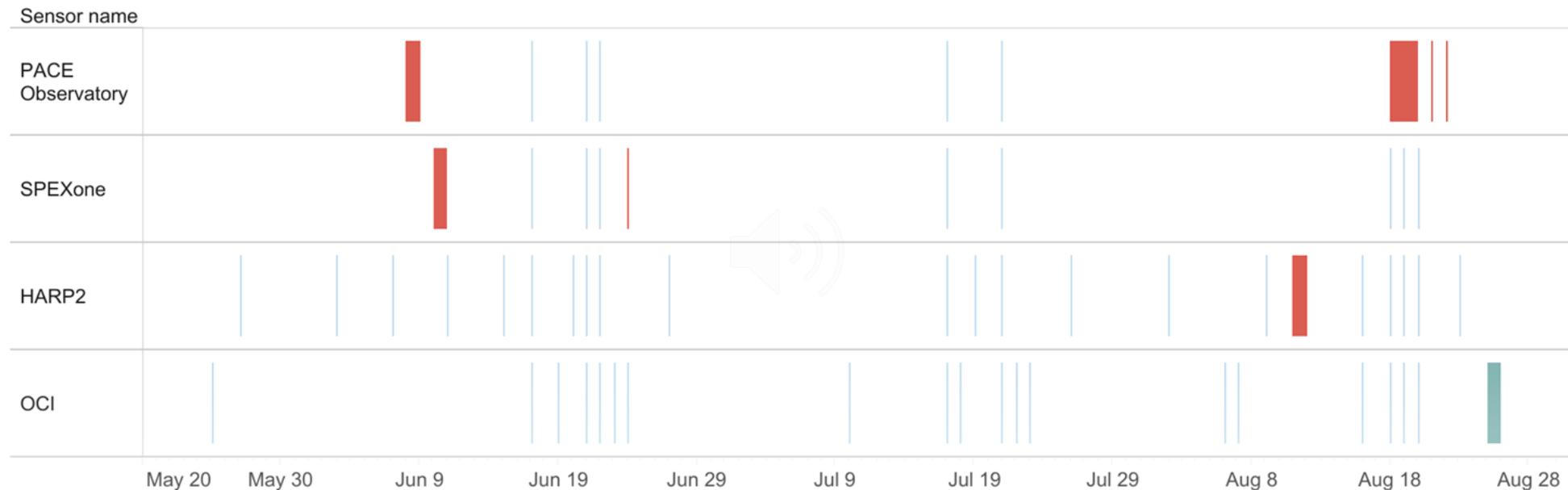
Events potentially affecting data

Hover for details. See complete list of events on the [OB.DAAC website](#).

Filter date range

5/25/2024

8/25/2024



SWIR bands missing pixels

Some SWIR bands have missing pixels on either edge of the swath in L1B files. This is due to the fact SWIR have a different detector and are not registered to OCI's CCD bands. See [L1A User Guide](#) for more technical details.

Bands affected

on western edge of swath

on eastern edge of swath



Ejemplos de Visualización de Datos de PACE para Hoy

Ahora que sabe más sobre los datos de PACE, estamos listos para visualizarlos.

En el siguiente Jupyter Notebook, hará:

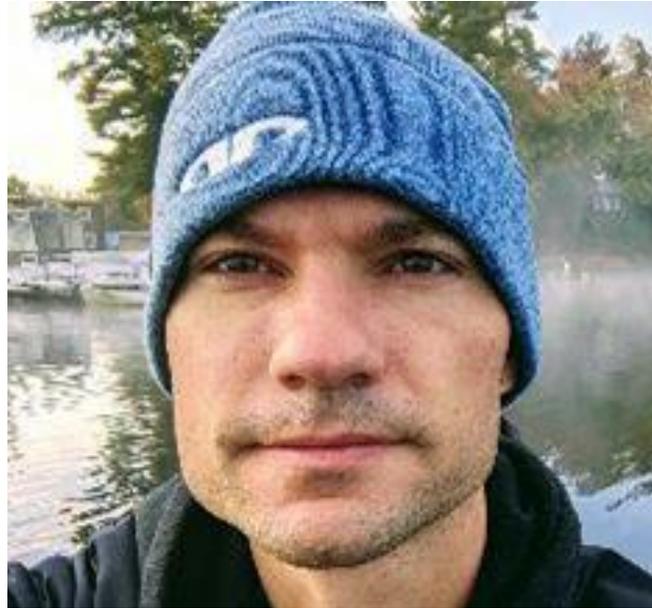
- Un mapa global sencillo de la clorofila-a
- Un mapa de los océanos del mundo en color casi real
- Un espectro RRS completo de los océanos globales
- Un mapa de parámetros de calidad del agua de un área específica



Agradecimientos

Ian Carroll

Científico Investigador
NASA GSFC, UMBC





Resumen de la Capacitación

Los Sensores de PACE

- Los datos de PACE están disponibles para océanos/estuarios, atmósfera y tierra en PACE-OCI, HARP2 y SPEXone.
- Observaciones de OCI útiles para aplicaciones de calidad del agua:
 - Hiperespectrales de 315 nm a 895 nm, con muestreo espectral de 2.5 nm
 - Permiten la separación de los constituyentes acuáticos y la composición de comunidades de fitoplancton
 - Observaciones hiperespectrales con cobertura global casi diaria
 - Increíble relación señal/ruido, incluso para anchos de banda de 5 nm
 - 9 bandas infrarrojas de onda corta (SWIR) para corrección atmosférica incluyendo las aguas turbias (3 sensibles al océano)
- HARP2 y SPEXone ayudan en la corrección atmosférica.



PACE Ocean Color- Avances y Limitaciones

Avances :

- Hiperespectral de 315 nm a 895 nm
- Resolución espectral de anchos de banda de 5 nm para el rango hiperespectral
- Muestreo espectral de 1.25 o 2.5 nm para la parte hiperespectral (184 bandas)
- Increíble relación señal/ruido, incluso para anchos de banda de 5 nm
- Alta sensibilidad UV desde ~340 nm
- 9 bandas infrarrojas de onda corta (SWIR) para corrección atmosférica, incluyendo las aguas turbias (3 sensibles al océano)
- Cobertura global casi diaria
- HARP2 y SPEXone ayudan en la corrección atmosférica

Limitaciones :

- La resolución espacial de ~1.1 km restringe el uso a aguas interiores o costeras y cerca de témpanos de hielo

Desafíos :

- Falta de algoritmos hiperespectrales verificados
- Necesidad de mediciones de campo hiperespectrales más completas



Datos de PACE Ocean Color, Acceso y Análisis

- Varios Niveles de Datos de PACE: 
 - [Página Inicial de PACE Data Access](#)
- Acceso a Datos:
 - [OB.DAAC](#) y [Earthdata](#)
- [NASA Worldview](#):
 - Útil para imágenes en color real de PACE y la visualización de datos de concentración de clorofila-a en tiempo casi real.
- SeaDAS:
 - Útil para el análisis y la visualización de datos PACE.

Product	L2 Suite	Description and Use	Units	Availability	Status	Additional Info
Spectral top-of-atmosphere radiances from OCI	N/A	Spectral radiance observed at the top of the atmosphere.	$W m^{-2} \mu m^{-1} sr^{-1}$	Level-1B 1-km at nadir; daily - Level-1C: daily	Provisional	Level-1C draft data format and examples
Spectral top-of-atmosphere radiances and polarimetry from SPExone	N/A	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C: daily	Provisional	Level-1C draft data format and examples
Spectral top-of-atmosphere radiances and polarimetry from HARP2	N/A	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C: daily	Provisional	Level-1C draft data format and examples

Ocean Properties to be Produced by OCI						
Bio-optical and biogeochemical properties of seawater constituents in the sunlit upper ocean.						
Product	L2 Suite	Description and Use	Units	Availability	Status	Additional Info
Spectral remote sensing reflectances	OC_AOP	Spectral color of the ocean in the ultraviolet-to-near infrared spectral range. Used as input into algorithms to retrieve information about colored dissolved organic matter, phytoplankton, non-algal particles, and other aquatic constituents. Provided in continuous 2.5-nm steps from 350 to 717.5-nm with a resolution (bandwidth) of 5-nm.	sr^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Starnes, Zhang In situ measurement protocols
Surface reflectance	SFREFL	Effective reflectance of the Earth's surface as observed by OCI. Used as an input to downstream ocean data products. Includes inland waters as well as ocean surface reflectance.	unitless	Level-2 1-km (at nadir), daily - Level-3 spatial resolution TBD; daily, 8-day, monthly	Test	Current product: L2gen; investigating MAIAC (Lypaxint) and ISOFIT
Apparent visible wavelength	OC_AOP	An optical water classification index reported as the weighted harmonic mean of visible-range Rrs wavelengths (400-700 nm)	nm	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD
Spectral diffuse attenuation coefficients	OC_IOP	Spectral diffuse attenuation of downwelling irradiance at multiple wavelengths between 350 and 700 nm. Provides indices of water clarity and light penetration.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD SAT members: Boss, Stramski, Odermatt In situ measurement protocols
Spectral phytoplankton absorption coefficients	OC_IOP	Spectral absorption coefficients for total phytoplankton absorption at multiple wavelengths between 350 and 700-nm. Provides information on phytoplankton physiology, abundance, and community composition.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Shuchman, Pahlevan, Siegel, Barnes, Starnes, Chowdhary In situ measurement protocols
Spectral non-algal particle plus dissolved organic matter absorption coefficients	OC_IOP	Spectral absorption coefficients for non-algal particulates and dissolved organic matter at multiple wavelengths between 350 and 700-nm. Provides information on the concentrations of the dissolved component of organic carbon and the detrital (non-algal) component of the particulate assembly.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Barnes, Starnes, Chowdhary In situ measurement protocols
Spectral particle backscattering coefficients	OC_IOP	Spectral backscattering of the light associated with particulate material, at multiple wavelengths between 350-700 nm. Provides an indicator of the concentration of particles in the ocean and a proxy indicator of particulate carbon concentrations.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Twardowski, Stramski, Shuchman, Pahlevan, Barnes, Starnes, Chowdhary, Zhang, Odermatt
Fluorescence line height		Light leaving the surface ocean due to the sun induced chlorophyll fluorescence. Provides an indicator of phytoplankton physiology (health?).	$W m^{-2} \mu m^{-1} sr^{-1}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD SAT member: Westberry
Daily photosynthetically available radiation (PAR)	OC_PAR	The amount of sunlight that is useful for photosynthesis, defined here as the 400-700 nm spectral range, that reaches the surface of the ocean over a day. As phytoplankton require light to convert inorganic carbon to organic carbon, PAR provides a critical parameter for understanding the oceanic carbon cycle.	Einsteins $m^{-2} d^{-1}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT member: Boss
Concentration of chlorophyll-a	OC_BGC	Near surface concentration of the photosynthetic pigment chlorophyll-a. Provides proxies for algal biomass, ecosystem health and function, and eutrophication.	$mg m^{-3}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Provisional	ATBD SAT members: Gaube, Shuchman, Siegel, Pahlevan, Zhai, Chowdhary, Odermatt In situ measurement protocols
Concentration of particulate organic carbon	OC_BGC	Near surface concentration of the particulate organic carbon. It is a proxy for all living material (phytoplankton, zooplankton, bacteria) and detritus. It is also a venue through which organic carbon, sequestered through the photosynthesis, is transferred towards higher trophic levels and into the deep ocean.	$mg m^{-3}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD In situ measurement protocols
Concentration of particulate inorganic carbon		Concentration of particulate inorganic carbon in the surface of the ocean. Used to track the presence and abundance of calcite containing phytoplankton in the open ocean (coccolithophores).	$mol m^{-3}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD
Concentration of phytoplankton carbon	OC_BGC	Concentration of carbon contained in phytoplankton cells. Provides a proxy for phytoplankton biomass that is often used in primary productivity algorithms and biogeochemical and Earth System models.	$mg m^{-3}$	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	SAT member: Westberry ATBD



Acceso a Datos PACE de Color del Océano de usando Python/Jupyter Notebooks

- Los datos de PACE se encuentran en un balde (bucket) de almacenamiento de datos en la nube (S3) de Amazon Web Service (AWS).
- Descripción general de las bibliotecas de Python para la búsqueda, descarga y visualización de datos, y transmisión de datos desde Earthdata Cloud utilizando:
 - earthdata_cloud_access.jp
 - ARSET_PACE_visualization.jp
- El software y los archivos de datos de muestra utilizados en la capacitación están disponibles en la página web de la capacitación.



Tarea y Certificados

- **Tarea:**

- Habrá una tarea asignada
- Abre el 9 de octubre de 2024
- Acceso desde la [página web de la capacitación](#)
- Debe enviar sus respuestas vía Formularios de Google
- **Fecha límite: 24 de octubre de 2024**



- **Certificado de finalización de curso:**

- Asista a las tres sesiones en vivo (la asistencia se registra automáticamente)
- Complete la tarea dentro del plazo estipulado
- Recibirá un certificado por correo electrónico aproximadamente dos meses después de la conclusión del curso.



Datos de Contacto

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 - carina.poulin@nasa.gov

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Abreviaturas

- CZCS: Coastal Zone Color Scanner Experiment
- EMIT: Earth Surface Mineral Dust Source Investigation
- EnMAP: Environmental Mapping and Analysis Program
- EO-1: Earth Observing One Satellite
- HARP2: Hyper-Angular Rainbow Polarimeter-2
- HICO: Hyperspectral Imager for the Coastal Ocean
- MODIS: Moderate Resolution Imaging Spectroradiometer
- OCI: Ocean Color Instrument
- PACE: Plankton, Aerosol, Cloud, and ocean Ecosystem
- PRISMA: PRecursores IperSpettrale della Missione Applicativa
- SeaDAS: Sea, Earth, and Atmosphere Data Analysis System
- SeaWiFS: Sea-Viewing Wide Field-of-View Sensor
- SPEXone: Spectro-Polarimeter for Planetary Exploration
- VIIRS: Visible Infrared Imaging Radiometer Suite



Recursos

- [Tutoriales y Recetas de Datos de OBPG](#)
 - [Cuaderno de Estructura de Archivos de OCI](#)
 - [Cuaderno de Herramientas de OCSSW](#)
 - [Cuaderno de Visualizaciones de Datos HARP2](#)
- [Página Web de PACE Hackweek](#)
- [SeaDAS](#)





¡Gracias!

