

1 July 2025 | *PACE Land data Users' Group (PLUG) meeting*

Development of a Cloud-based Toolkit for PACE OCI Land Data



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bit.ly/pace_toolkit_2025-07-01

Overview

1. Context
2. Main objectives
3. Toolkit features
4. Demo (if time permits)
5. Q&A

Context: Hyperspectral satellites / sensors (*not exhaustive*)

- EO-1 Hyperion (NASA): 2000-2017
- HySIS (ISRO): 2018-present
- ISS DESIS (DLR): 2018-present
- PRISMA (ASI): 2019-present
- EnMap (DLR): 2022-present
- ISS EMIT (NASA): 2022-present
- GHOSSt (Orbital Sidekick): 2023-present
- Resurs-P (ROSCOSMOS): 2024-present
- PACE OCI (NASA): 2024-present
- Tanager-1 (Planet): 2024-present
- Hyperion (~May 2001–March 2017)
 - 30m res. / on demand / 224 bands / 427-2,396 nm
- EMIT (~Aug. 2022 – present)
 - 60m res. / on demand / 285 bands / 381-2,493 nm
- PACE OCI (March 2024 – present)
 - 1.2 km res. / DAILY global / 122 bands / 346-2,258 nm

also see: <https://www.eoportal.org/other-space-activities/hyperspectral-imagingg>

PACE products span the aquatic, atmospheric & terrestrial domains



Topic of today: Terrestrial observations from OCI only. Polarimeter products to come....

Ocean & large inland waters

- *Spectral* Remote Sensing Reflectance
- *Spectral* Particulate Absorption & Backscatter parameters
- Phytoplankton community composition
- *Spectral* K_d (attenuation)
- Net Primary Production**
- Particulate Organic Carbon

Clouds, Aerosols

- Aerosol size distribution**
- Aerosol absorption**
- Spectral aerosol optical depth
- Aerosol complex refractive index
- Aerosol layer height
- Cloud Mask
- Optical thickness of liquid and ice clouds

Land

- *Spectral* Surface Reflectance
- Normalized Difference Vegetation Index (NDVI)
- Photochemical Reflective Index (PRI)
- Aerosol optical depth in the near infrared
- BRDF/albedo and model parameters **
- Modified Anthocyanin Reflectance Index (mARI)



← DATA PRODUCT TABLE

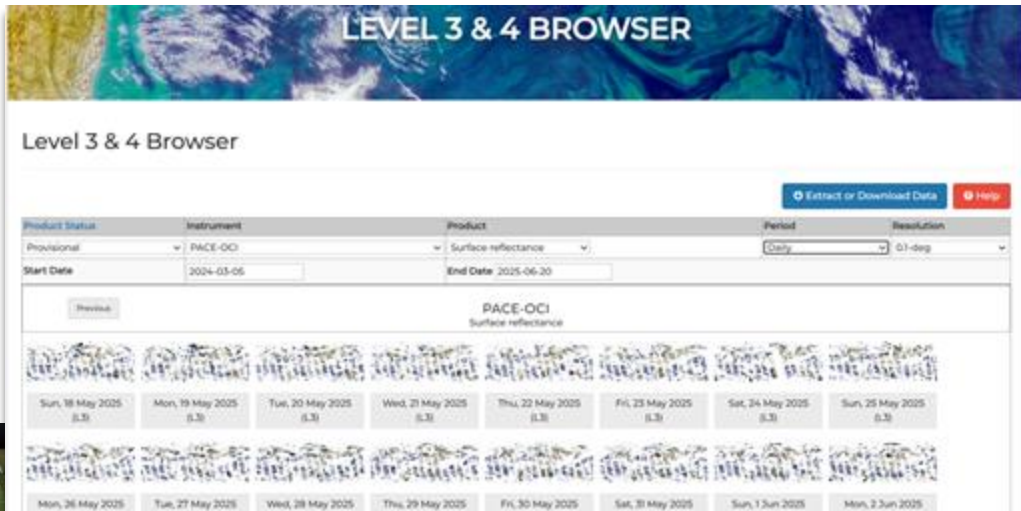
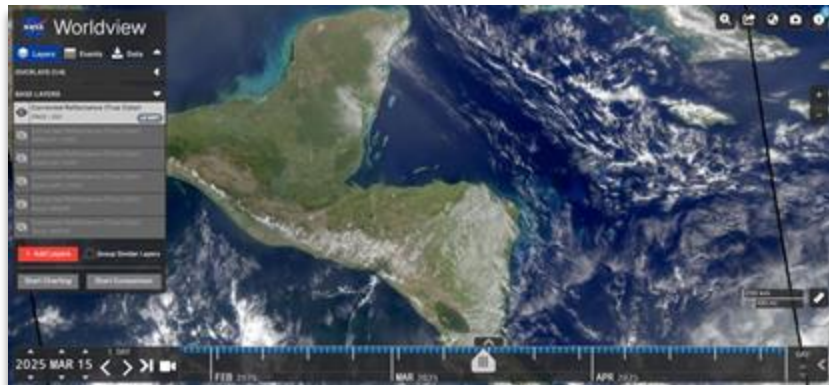
https://pace.oceansciences.org/data_table.htm

Live, up-to-date list of all **currently available** and **future** PACE data products. More added over time.

** Not all products shown above are available yet. See PACE Data Product Table for the latest.

source: M. McKibben, 2025





EARTHDATA SEARCH Find a DAAC

Search **pace oci surface reflectanc** 7 Matching Collections

Showing 7 of 7 matching collections

Sort Usage View List

Filter Collections

Features

- Available in Earthdata Cloud
- Customizable
- Map Imagery

Keywords

Platforms

Instruments

Organizations

Projects

Processing Levels

Data Format

Tiling System

Horizontal Data Resolution

PACE OCI Level-2 Regional Surface Reflectance Data, version 3.0
56,859 Granules 2024-03-05 to Present

The primary sensor aboard the PACE spacecraft is the Ocean Color Instrument (OCI). It is a highly advanced optical spectrometer that will be used to measure...

GEOS5-PAVE_OCI_L2_SFREFL_V3.0-NASA/GSFC/SED/ESD/GCOC/OB.DAAC

PACE OCI Level-2 Regional Surface Reflectance - Near Real-time (NRT) Data, version 3.0
23,427 Granules 2024-03-05 to Present

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

GEOS5-PAVE_OCI_L2_SFREFL_NRT_V3.0-NASA/GSFC/SED/ESD/GCOC/OB.DAAC

PACE OCI Level-3 Global Mapped Surface Reflectance Data, version 3.0
881 Granules 2024-03-05 to Present

The primary sensor aboard the PACE spacecraft is the Ocean Color Instrument (OCI). It is a highly advanced optical spectrometer that will be used to measure...

GEOS5-PAVE_OCI_L3M_SFREFL_V3.0-NASA/GSFC/SED/ESD/GCOC/OB.DAAC

PACE OCI Level-3 Global Mapped Surface Reflectance - Near Real-time



PACE_OCI_20250401_20250401_L3M_SFREFL_V3.0

General Security Details Previous Versions

Type of file: NC File (nc)

Opens with: Pick an app

Location: D:\gs\temp_2025\pace_oci

Size: 6.68 GB (7,183,552,199 bytes)

Size on disk: 33.5 GB (35,985,288,000 bytes)

Created: Thursday, June 12, 2025, 9:37

Modified: Thursday, June 12, 2025, 9:42

Accessed: Wednesday, June 18, 2025, 10

Attributes: Read-only Hidden

PACE_OCI_20250401_20250401_L3M_SFREFL_V3.0

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Location: D:\gs\temp_2025\pace_oci

Size: 6.68 GB (7,183,552,199 bytes)

Size on disk: 33.5 GB (35,985,288,000 bytes)

Created: Wednesday, June 18, 2025, 12

Modified: Wednesday, June 18, 2025, 12

Accessed: Wednesday, June 18, 2025, 3

Attributes: Read-only Hidden

PACE_OCI_20250401_20250401_L3M_SFREFL_V3.0

General Security Details Previous Versions

Type of file: NC File (nc)

Opens with: Pick an app

Location: D:\gs\temp_2025\pace_oci

Size: 1.22 GB (1,320,878,645 bytes)

Size on disk: 1.22 GB (1,320,882,176 bytes)

Created: Wednesday, June 18, 2025, 12:55:16 PM

Modified: Wednesday, June 18, 2025, 12:55:42 PM

Accessed: Wednesday, June 25, 2025, 12:02:59 PM

Attributes: Read-only Hidden

Main objectives (Why a Toolkit?)

1. Support application of PACE OCI land data by integrating data into the widely used Google Earth Engine (GEE) platform

→ *PACE data are big; GEE facilitates work w/ big Earth data*

→ *GEE facilitates comparisons w/ other data (e.g., EMIT, GEDI, MODIS, etc.)*

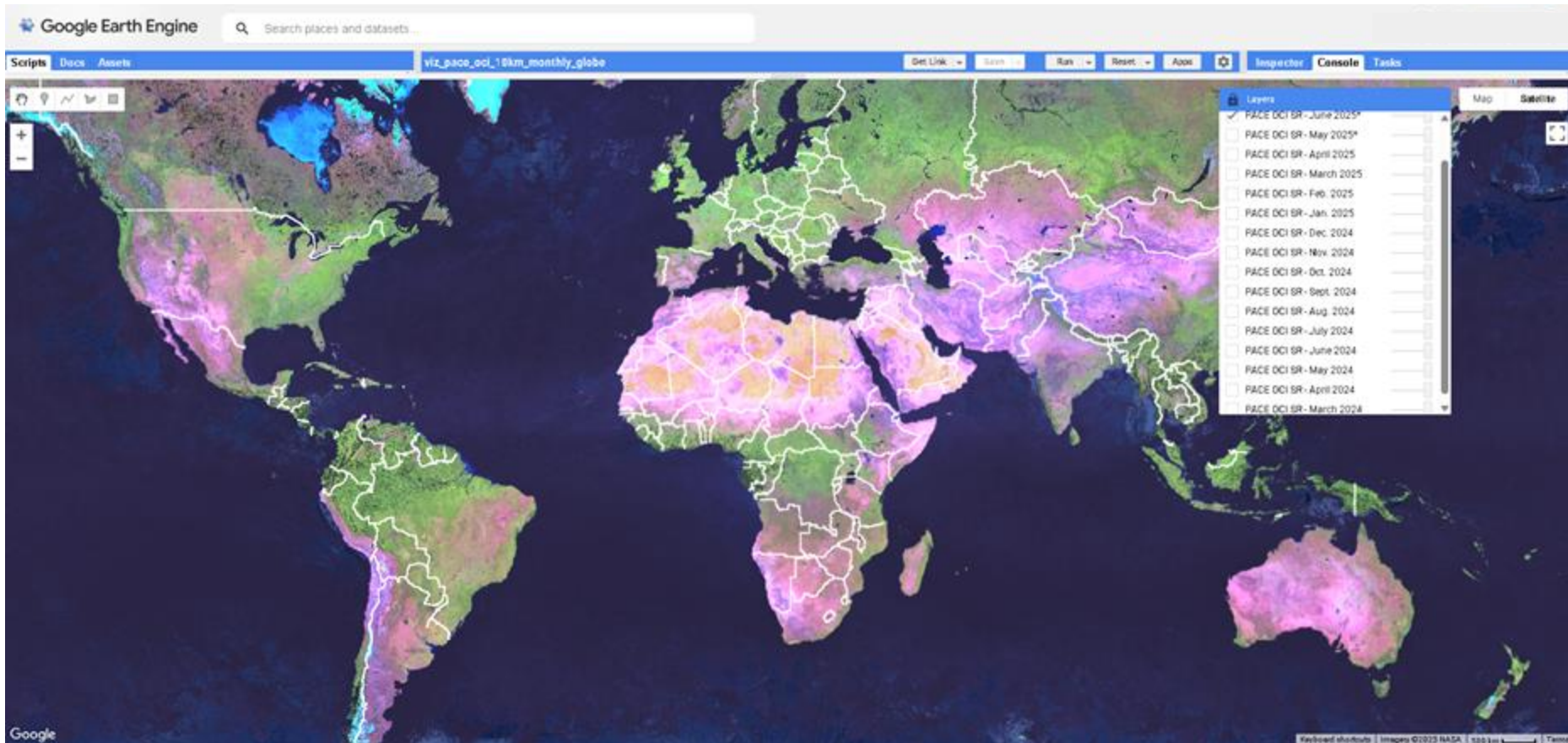
1. Provide basic tools for interacting with that PACE data

→ *because just having the data isn't enough*

→ *give prospective users a head start*

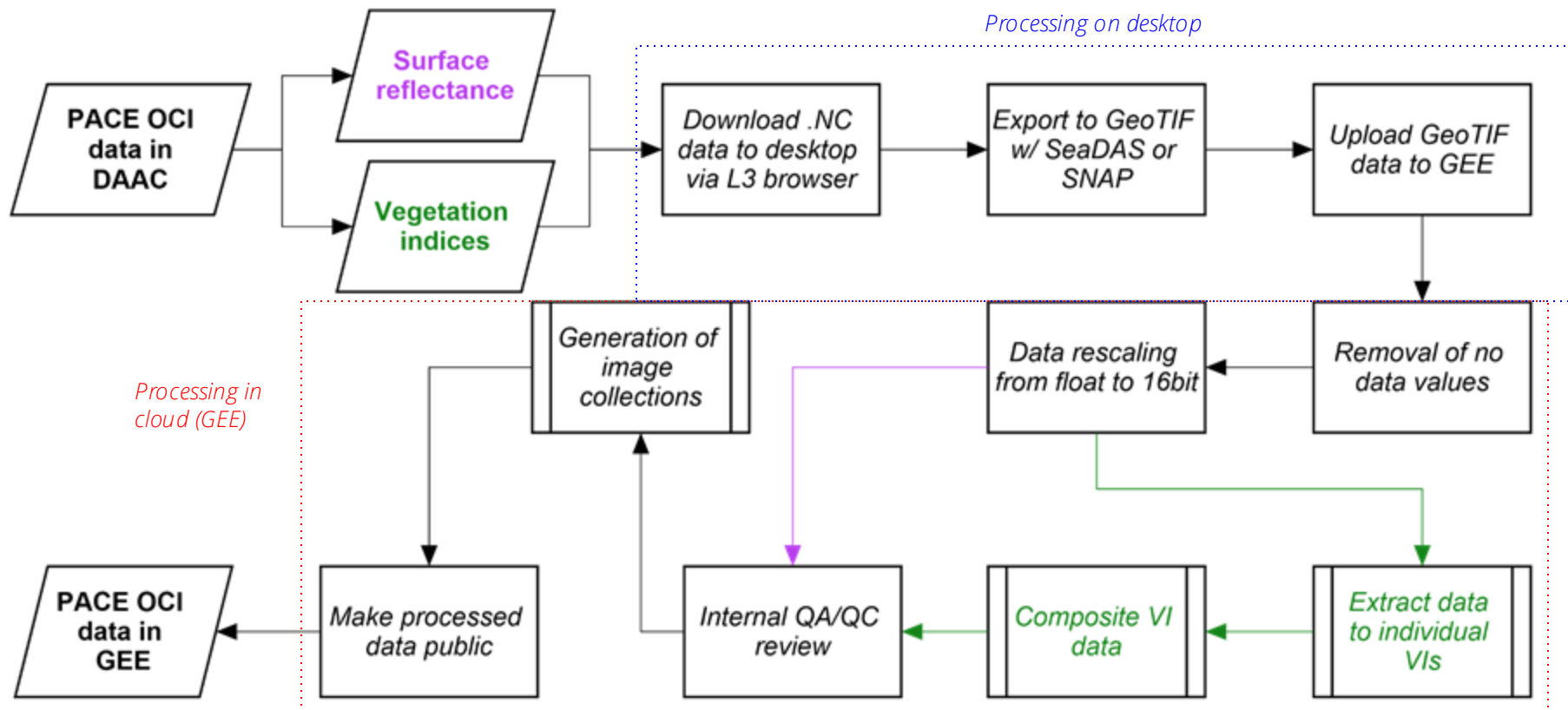


source: NASA



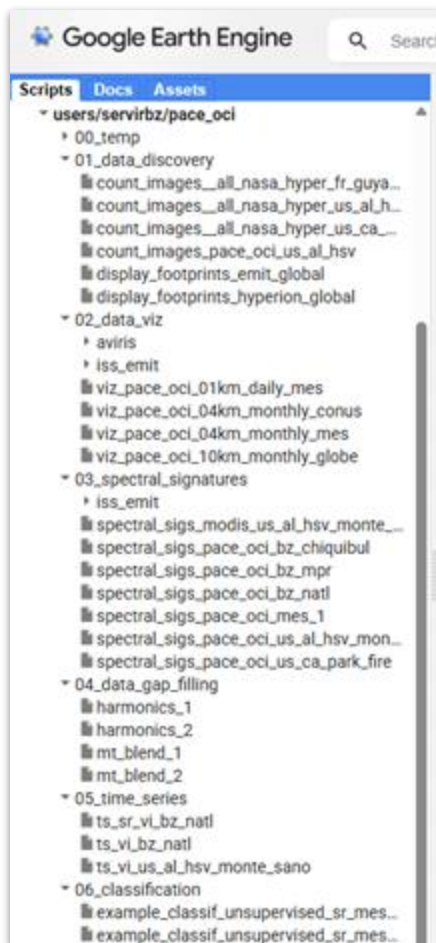
https://code.earthengine.google.com/?scriptPath=users%2Fservirbz%2Fpace_oci%3A02_data_viz%2Fviz_pace_oci_10km_monthly_globe

How: Pipeline for ingesting prov. PACE OCI land data into GEE



Toolkit features (What)

- Data discovery
- Data visualization
 - Viewing images
 - Viewing spectral signatures
- Time series analysis
- Gap-filling
- Image classification



most recent image
EO-1 Hyperion
2003-08-02
total number of images
EO-1 Hyperion
3
▶ ["2003-07-01", "2003-07-17", "2003-08-02"]
most recent image
ISS EMIT
2024-10-12
total number of images
ISS EMIT
5
▶ List (5 elements)
most recent image
PACE OCI - SR
2025-06-30
total number of images
PACE OCI - SR
16
▶ List (16 elements)
most recent image
PACE OCI - EVI
2025-06-17
total number of images
PACE OCI - EVI
60
▶ List (60 elements)

Toolkit features

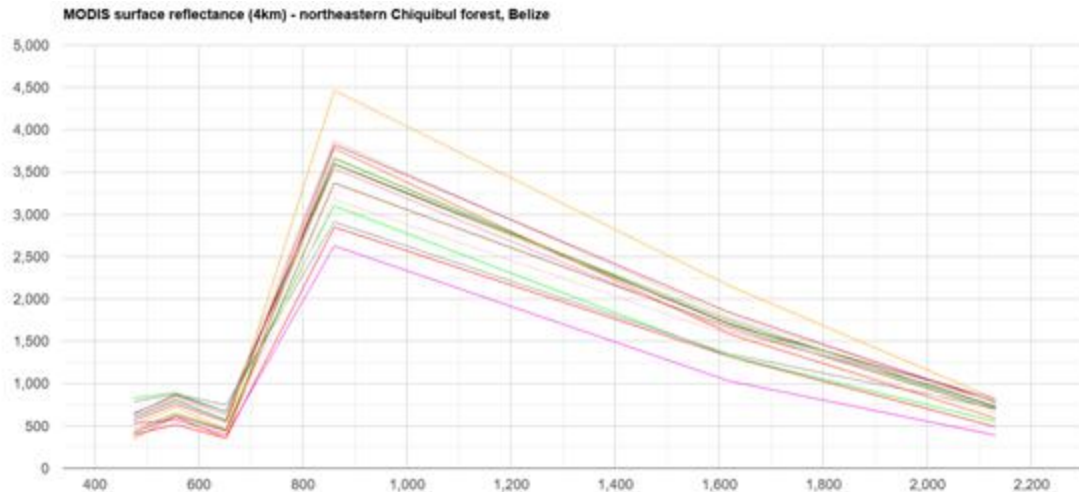
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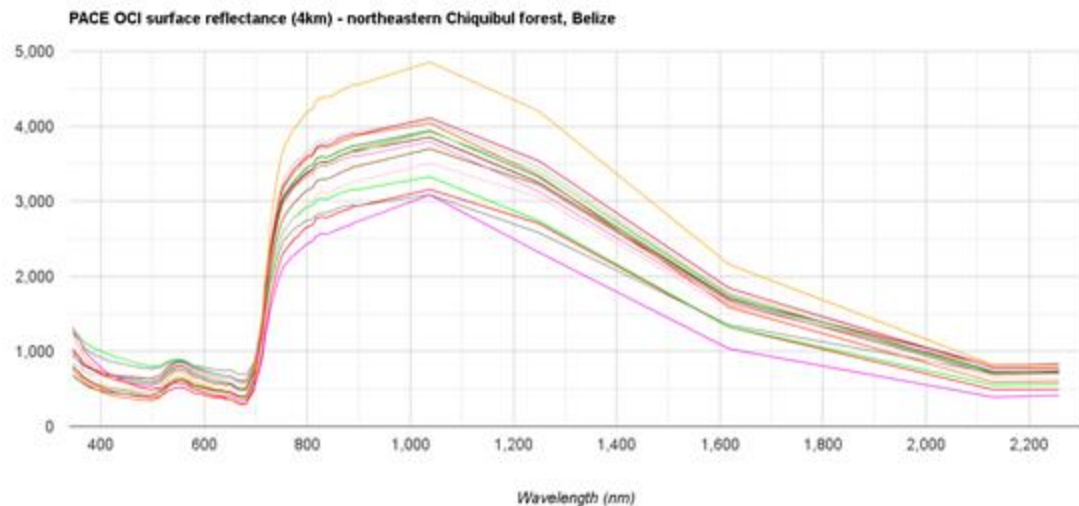
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Reflectance x 10,000

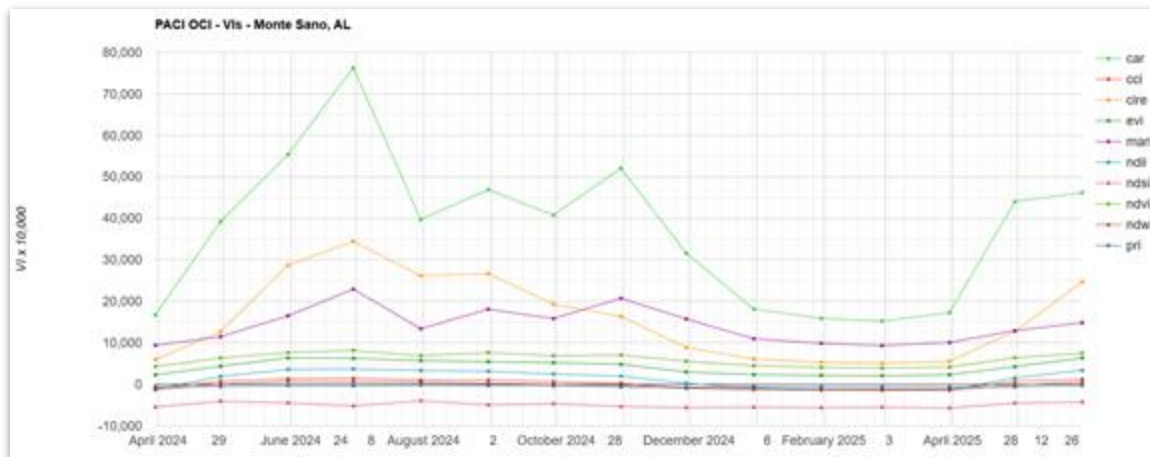


Reflectance x 10,000



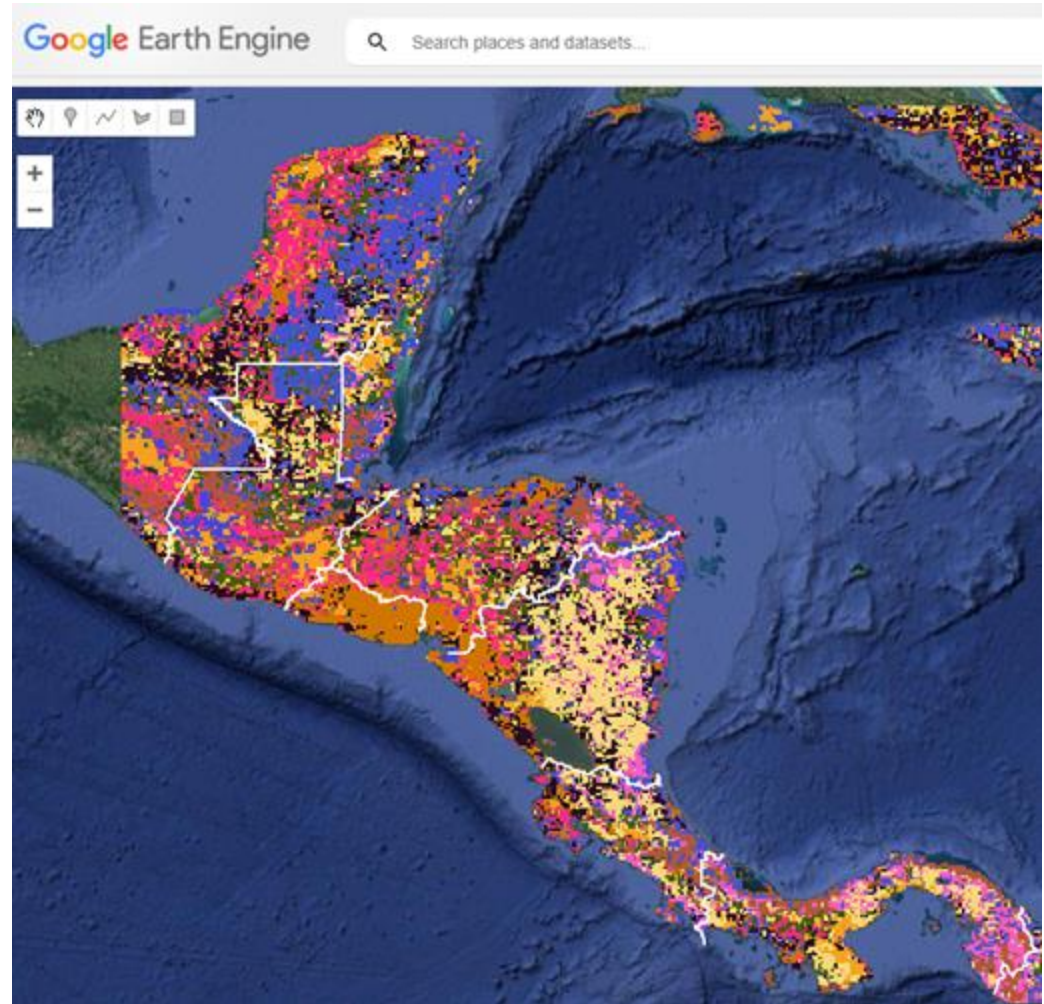
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Dependency packages

1: [Miscellaneous hyperspectral functions](#)

- PACE OCI (v3) wavelengths [122 bands]
- Vegetation index (VI) equations
 - Equations for PACE Land VIs
 - Equations for additional VIs (e.g. NBR)
- Band combinations for visualizations

```
10 //////////////////////////////////////////////////////////////////////////////////////////////////////////////////
11
12 // PLANKTON, AEROSOL, CLOUD, OCEAN ECOSYSTEM - OCEAN COLOR INSTRUMENT (PACE OCI), 2024-PRESENT
13
14 // Wavelengths for the PACE OCI surface reflectance bands (v3) - ALL 122 bands
15 var wl_pace = [345, 351, 356, 361, 366, 371, 375, 380, 385, 390, 395, 400, 405, 410, 415, 420, 425, 430, 435, 440,
16 445, 450, 455, 460, 465, 470, 475, 480, 485, 490, 495, 500, 505, 510, 515, 520, 525, 530, 535, 540,
17 545, 550, 555, 560, 565, 570, 575, 580, 585, 615, 620, 625, 630, 635, 640, 642, 645, 647, 650, 652,
18 655, 657, 660, 662, 665, 667, 670, 672, 675, 677, 679, 682, 697, 699, 702, 704, 707, 709, 712, 714,
19 719, 724, 729, 734, 739, 742, 744, 747, 749, 752, 754, 772, 774, 779, 784, 789, 794, 799, 804, 809,
20 814, 819, 824, 829, 835, 840, 845, 850, 855, 860, 865, 870, 875, 880, 885, 890, 895, 1038, 1249, 1618, 2131, 2258];
21
22 exports.wl_pace = wl_pace;
```

2: [Data loader](#)

- Surface reflectance data - monthly only
 - CONUS (4km)
 - Mesoamerica (1.2 km + 2 km select scenes)
 - Mesoamerica (4km)
 - Global (0.1 degree)
- VIs - 8 day (8D)
 - Global (4km)
- VIs - Monthly
 - Global (4km)

3: [Sample site locations](#)

- Mesoamerica
- USA

Data loader package: PACE OCI data loaded into GEE

Surface reflectance (SR) data [122 bands]

- Global 0.1 degree monthly
 - 16* months (Mar 2024 - June 2025) x 1.2 GB
- CONUS 4km monthly
 - 15 mts x 204 MB
- Mesoamerica 4km monthly
 - 15 mts x 68 MB
- Mesoamerica 1.2 km daily [select scenes]
 - 5 scenes x 300 MB

Land Vegetation Index (VI) data

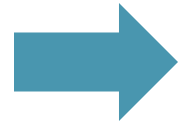
- Global 8D (7 of 10 VIs)
 - 60* periods x 7 VIs x 15 MB
- Global monthly (all 10 VIs)
 - 15* mts x 340 MB

Updating of data:

- *VI data is being updated every 8 days*
- *VI + SR data is being updated monthly*
- *Select 1.2 km uploaded as appropriate*
- *Plans to integrate 2 km data as available*



DEMO



bit.ly/gee_repo_pace_oci

Acknowledgements

- NASA PACE team (Morgaine, Skye, Fred)
- NASA Marshall (Dan, Ashutosh, Eric, Kevin, Kelsey, Africa, Rob)
- Google (Karin, Nick, Justin, Kel, Gena, Simon)



You have access to
PACE land data.

Now what?

Development in progress!



bit.ly/gee_repo_pace_oci

Q & A



*Coming soon:
06.08.2025 webinar*

Additional resources

PACE

- Mission: <https://pace.oceansciences.org>
- Overview presentation: https://pace.oceansciences.org/docs/2025_04_15a-PACE_Overview-McKibben.pdf
- PACE Land data User Group (PLUG): https://pace.oceansciences.org/event_archive/landDataUserGroup.htm
- Level 3 & 4 browser: <https://oceandata.sci.gsfc.nasa.gov/l3/>
- NASA Earth Data: <https://search.earthdata.nasa.gov/search>
- NASA EOSDIS WorldView: <https://worldview.earthdata.nasa.gov>

Google Earth Engine

- Tutorials: <https://developers.google.com/earth-engine/tutorials/tutorials>
- Tutorial videos: <https://developers.google.com/earth-engine/tutorials/videos>
- GEE book: <https://www.eefabook.org>
- Public data catalog: <https://developers.google.com/earth-engine/datasets>
- Community data catalog: <https://gee-community-catalog.org>
- GEE Developers group: <https://groups.google.com/u/1/g/google-earth-engine-developers>