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

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THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

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
- GHOSt (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

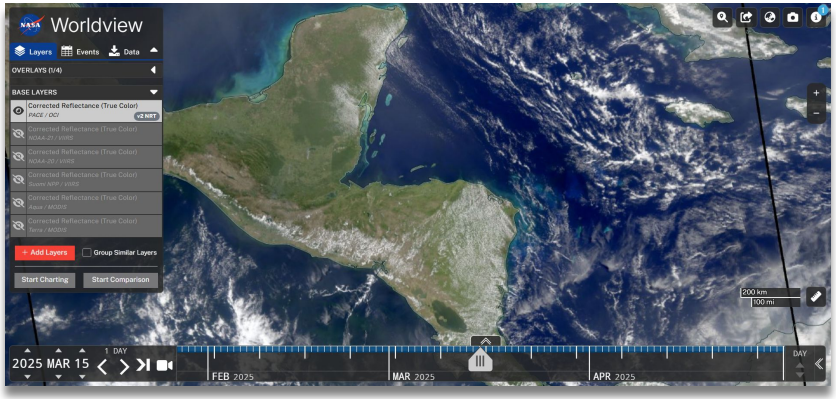
- *Spectral* Surface Reflectance
- Normalized Difference Vegetation Index (NDVI)
- Photochemical Reflective Index (PRI)
- Aerosol optical depth in the near infrared
- BRDF/albedo and model parameters **
- Modified Anthocyanin Reflectance Index (mARI)

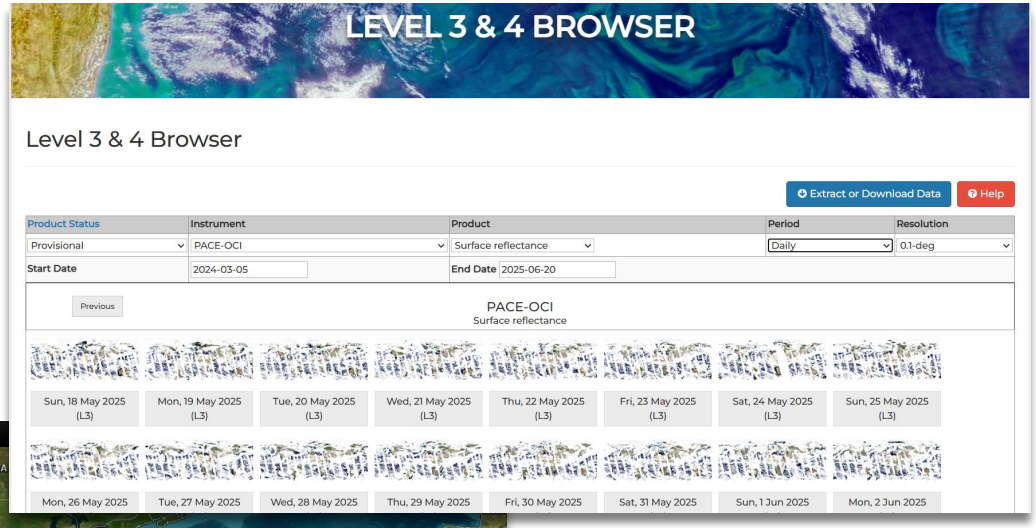
←**DATA PRODUCT TABLE** https://pace.oceansciences.org/data_table.htm

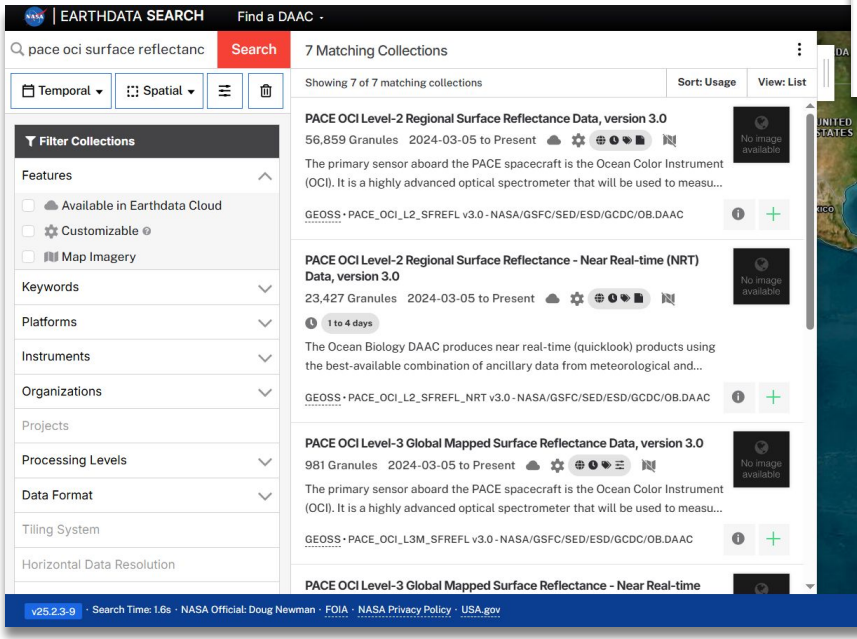
*Live, up-to-date list of all **currently available** and **future** PACE data products. More added over time.*

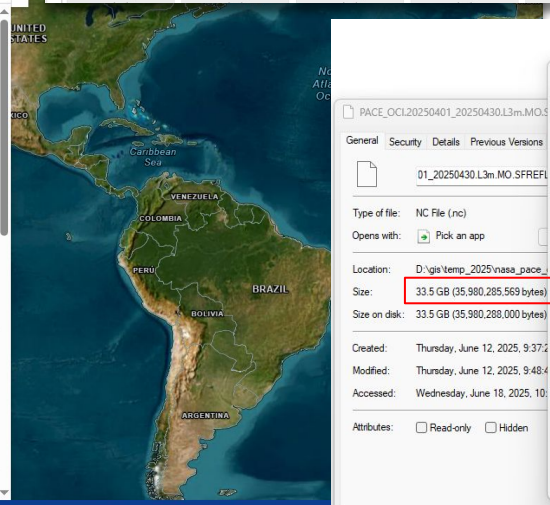
*** Not all products shown above are available yet. See PACE Data Product Table for the latest.*

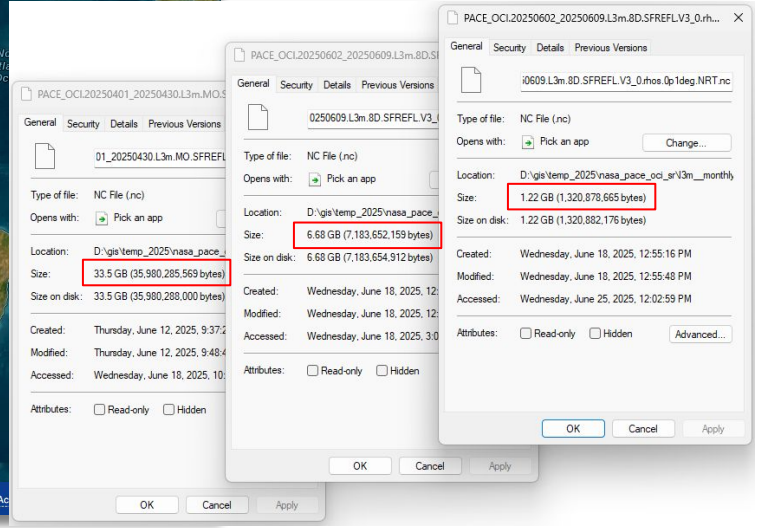
source: M. McKibben, 2025


Worldview
Layers
Events
Data
OVERLAYS (1/4)
BASE LAYERS
Corrected Reflectance (True Color)
PACE / OCI
+2 NRT
Add Layers
Group Similar Layers
Start Charting
Start Comparison
200 km
100 mi
1 DAY
2025 MAR 15
FEB 2025
MAR 2025
APR 2025
DAY


LEVEL 3 & 4 BROWSER
Level 3 & 4 Browser
Extract or Download Data
Help
Product Status
Provisional
Instrument
PACE-OCI
Product
Surface reflectance
Period
Daily
Resolution
0.1-deg
Start Date
2024-03-05
End Date
2025-06-20
Previous
PACE-OCI
Surface reflectance
Sun, 18 May 2025 (L3)
Mon, 19 May 2025 (L3)
Tue, 20 May 2025 (L3)
Wed, 21 May 2025 (L3)
Thu, 22 May 2025 (L3)
Fri, 23 May 2025 (L3)
Sat, 24 May 2025 (L3)
Sun, 25 May 2025 (L3)
Mon, 26 May 2025
Tue, 27 May 2025
Wed, 28 May 2025
Thu, 29 May 2025
Fri, 30 May 2025
Sat, 31 May 2025
Sun, 1 Jun 2025
Mon, 2 Jun 2025


EARTHDATA SEARCH
Find a DAAC
pace oci surface reflectanc
Search
7 Matching Collections
Temporal
Spatial
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 measu...
GEOSS · PACE_OCI_L2_SFREFL v3.0 - NASA/GSFC/SED/ESD/GCDC/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
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...
GEOSS · PACE_OCI_L2_SFREFL_NRT v3.0 - NASA/GSFC/SED/ESD/GCDC/OB.DAAC
PACE OCI Level-3 Global Mapped Surface Reflectance Data, version 3.0
981 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 measu...
GEOSS · PACE_OCI_L3M_SFREFL v3.0 - NASA/GSFC/SED/ESD/GCDC/OB.DAAC
PACE OCI Level-3 Global Mapped Surface Reflectance - Near Real-time
No image available
v25.2.3-9 · Search Time: 1.6s · NASA Official: Doug Newman · FOIA · NASA Privacy Policy · USA.gov


Caribbean Sea
VENEZUELA
COLOMBIA
PERU
BRAZIL
BOLIVIA
ARGENTINA


PACE_OCI.20250602_20250609.L3m.8D.SFREFL.V3_0.rh...
General
Security
Details
Previous Versions
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Opens with: Pick an app
Change...
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Size: 1.22 GB (1,320,878,665 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, 12:55:48 PM
Accessed: Wednesday, June 25, 2025, 12:02:59 PM
Attributes: Read-only Hidden Advanced...
OK
Cancel
Apply
PACE_OCI.20250602_20250609.L3m.8D.SFREFL.V3_0.rhos.0p1deg.NRT.nc
Location: D:\gis\temp_2025\nasa_pace_...
Size: 6.68 GB (7,183,652,159 bytes)
Size on disk: 6.68 GB (7,183,654,912 bytes)
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Accessed: Wednesday, June 18, 2025, 3:0...
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PACE_OCI.20250401_20250430.L3m.MO.S...
01_20250430.L3m.MO.SFREFL...
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Size on disk: 33.5 GB (35,980,288,000 bytes)
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Modified: Thursday, June 12, 2025, 9:48:4...
Accessed: Wednesday, June 18, 2025, 10:...
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*

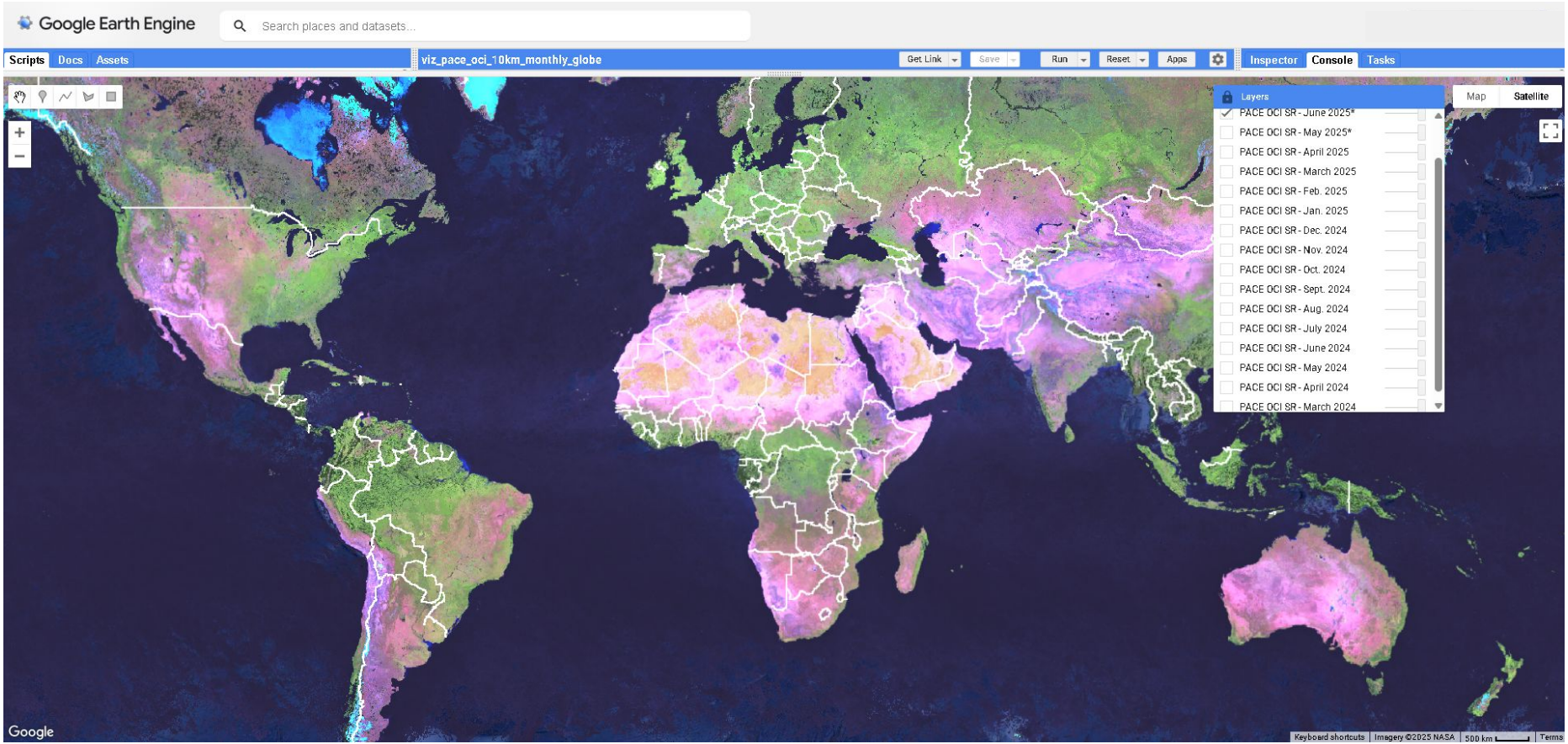
   → *GEE facilitates comparisons w/ other data (e.g., EMIT, GEDI, MODIS, etc.)*

2. Provide basic tools for interacting with that PACE data

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

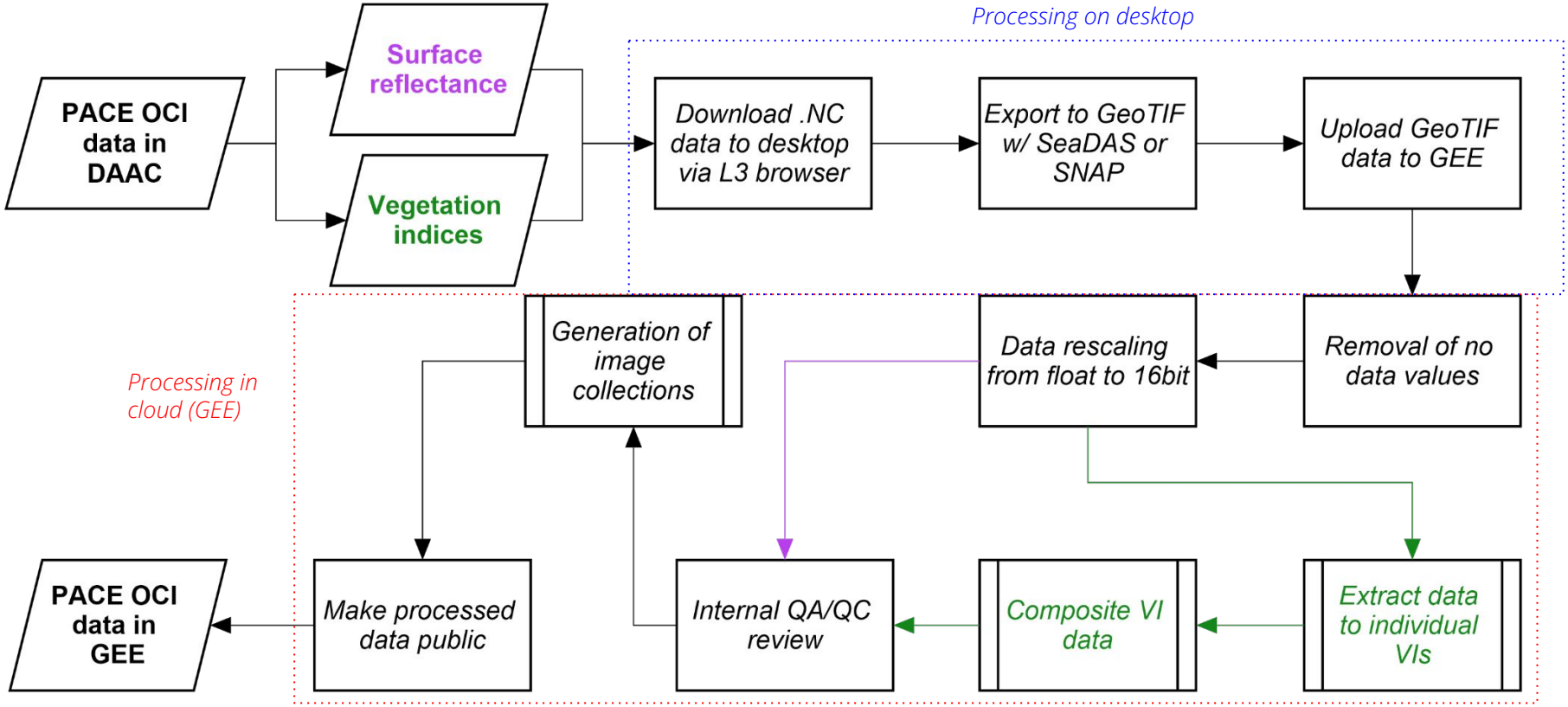
   → *give prospective users a head start*

source: NASA



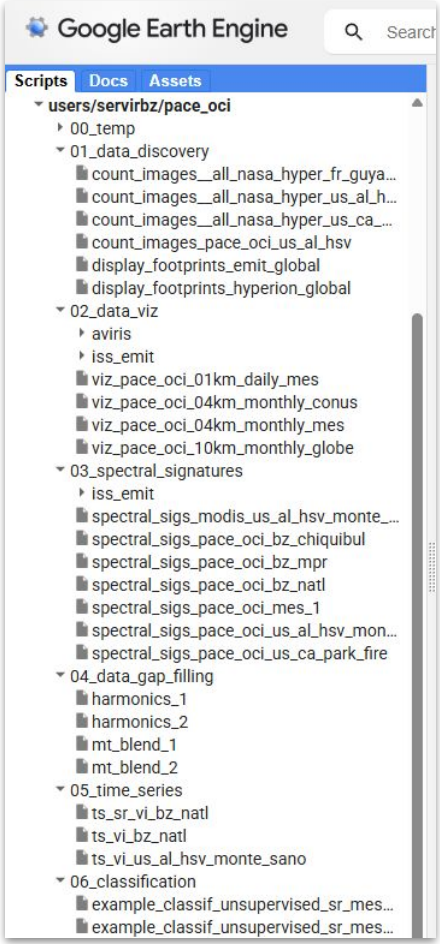
https://code.earthengine.google.com/?scriptPath=users%2Fservirbz%2Fpace_oci%3A02_data_viz%2Fviz_pace_oci_10km_monthly_globe

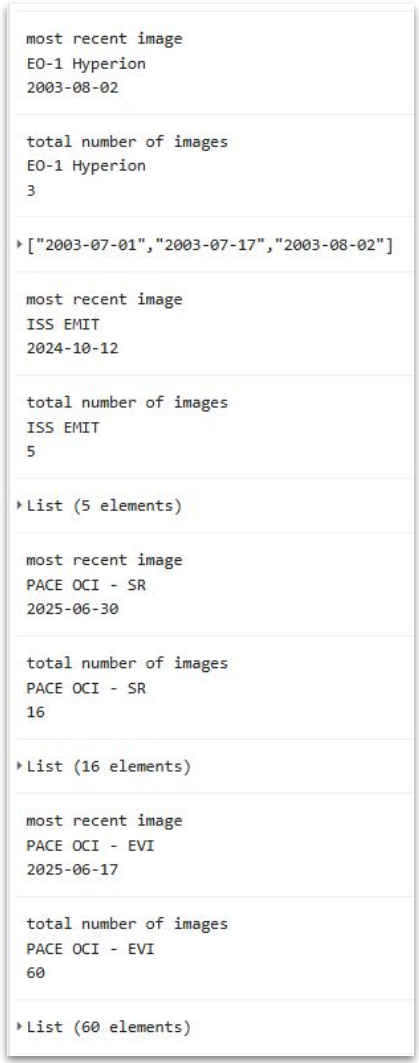
How: Pipeline for ingesting prov. PACE OCI land data into GEE



Toolkit features (What)

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





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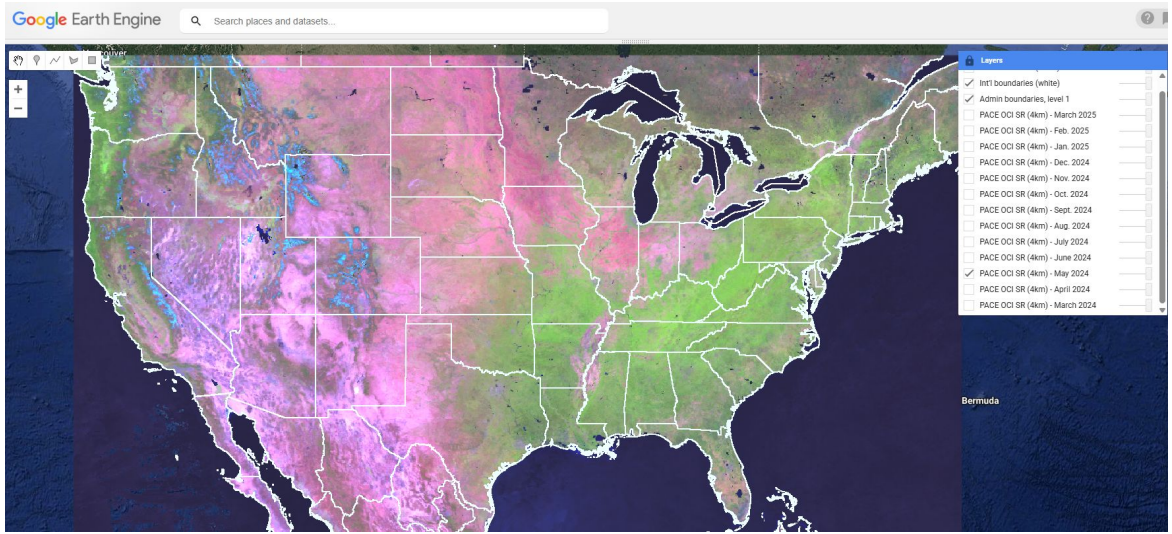

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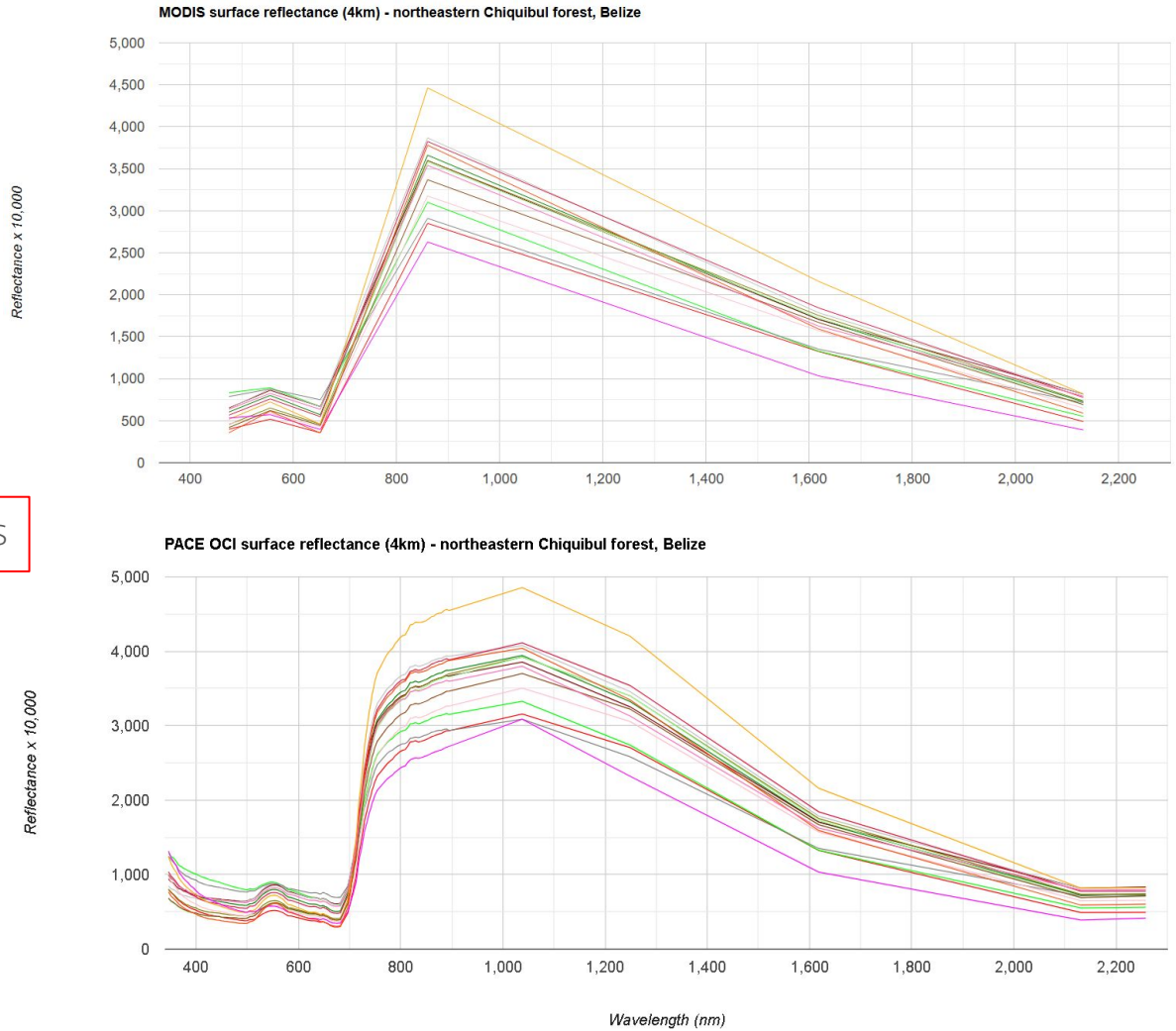

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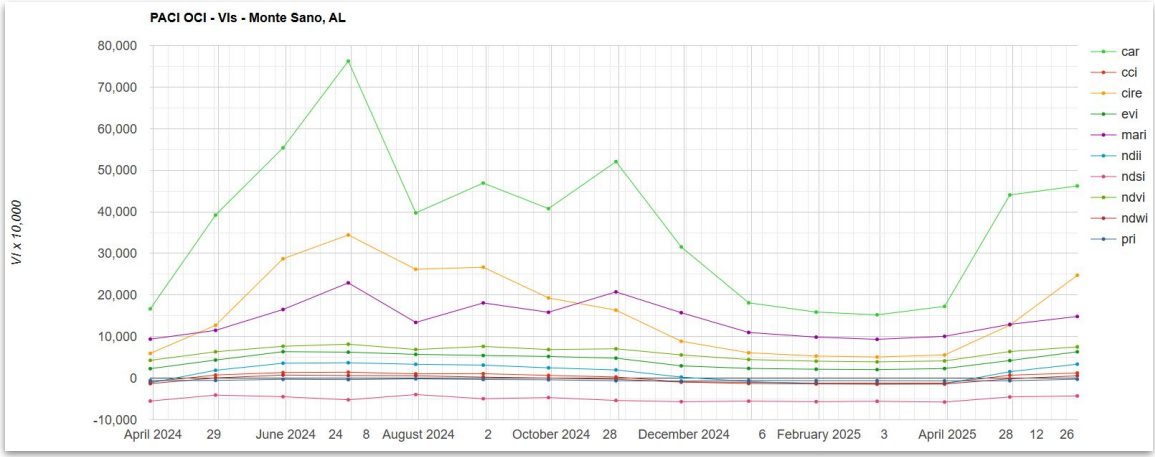

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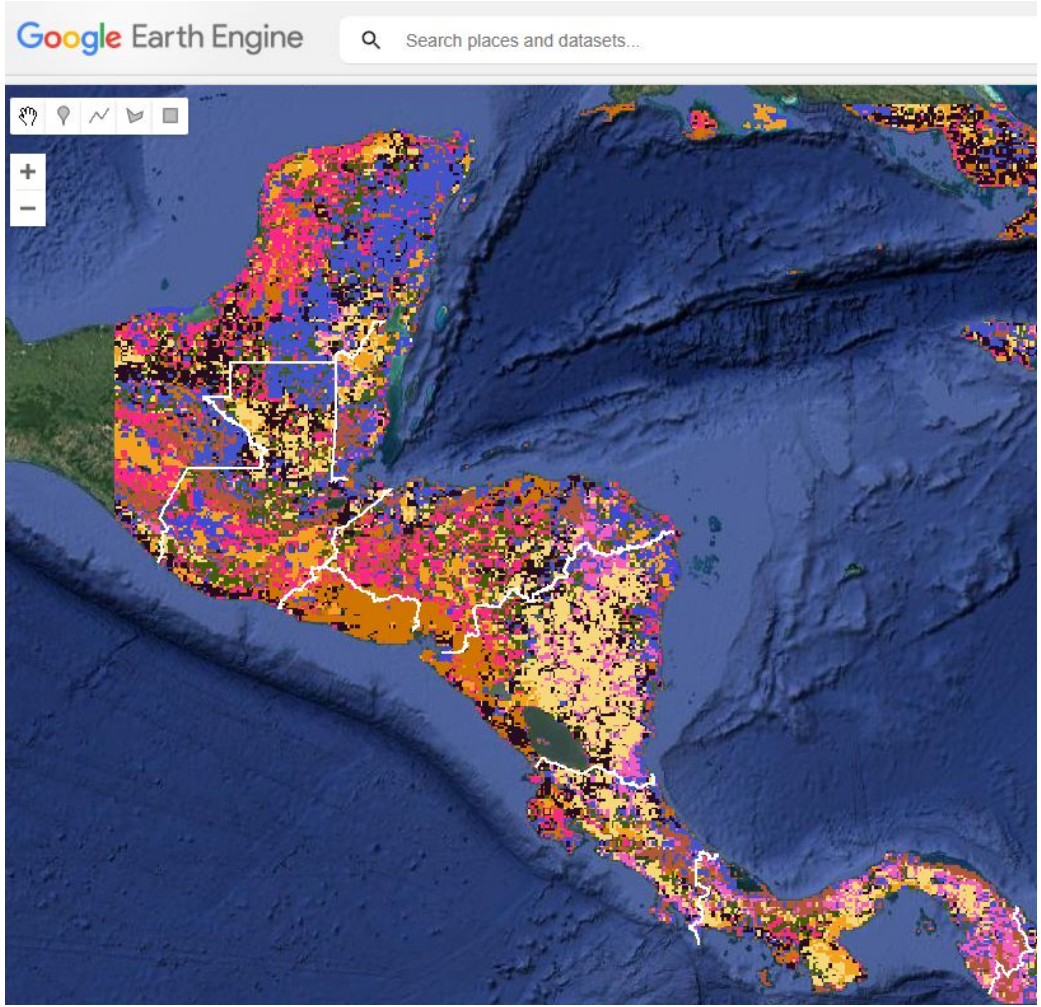


Dependency packages

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 = [346, 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, 586, 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

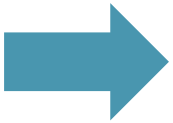
Land Vegetation Index (VI) data

- 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