PACE Website

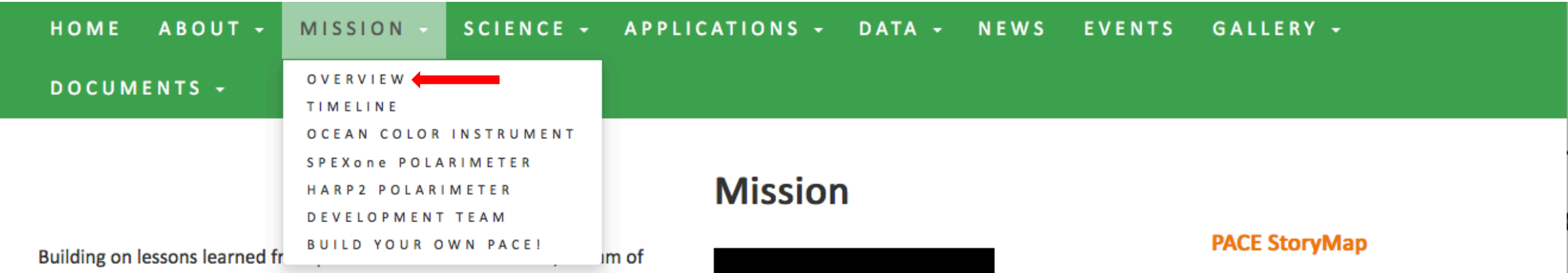
A quick tour around the PACE website (https://pace.gsfc.nasa.gov)

- Technical Resources (“Tech”)
- Outreach, communications & educational Resources (“Outreach”)
- Future Updates

Annette deCharon
PACE Web Lead
avdecharon@gmail.com

PACE Website “Tech”: Mission

- Overview (https://pace.oceansciences.org/mission.htm)
  - Observatory Overview & Polarimeter tables
  - Links to PACE observatory visualizations
  - Overview of PACE Resolution, Orbit, Coverage, etc.
- Subpages for OCI, SPEXone, and HARP2

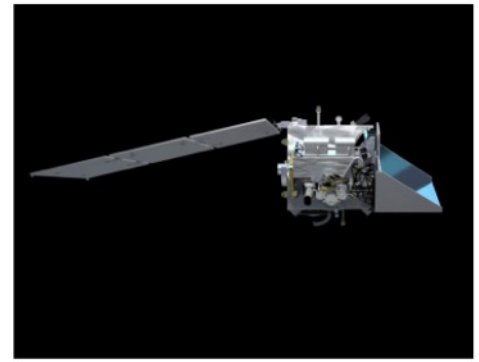


Mission

Building on lessons learned from previous ocean color studies, a team of dedicated people is bringing PACE to life. PACE will face a series of important milestones during its mission development. The Development Team at Goddard Space Flight Center (GSFC) will guide PACE through each phase as the instruments, spacecraft, and observatory are built, tested, and flown.

Observatory

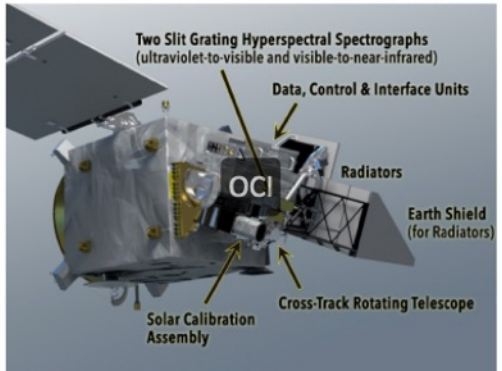
GSFC is responsible for the principal mission elements, including the design and fabrication of the spacecraft, development of scientific instrumentation.

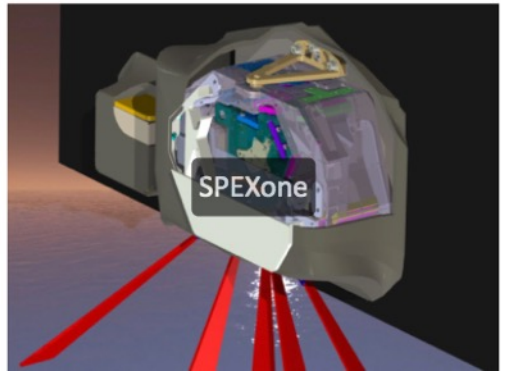


Build your own PACE!

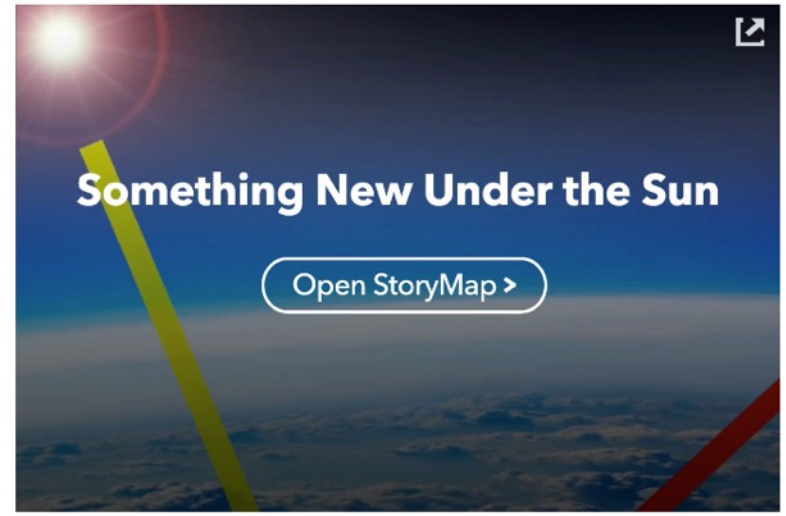
Observatory Overview	
Mass with fuel	Not to exceed 1700 kg (3748 lb)
Dimensions	1.5 m x 1.5 m x 3.2 m (4.9 ft x 4.9 ft x 10.5 ft)
Power	1000 Watts
Communications	S-Band - Command & Telemetry Ka-Band - Science Data

Instruments





PACE StoryMap

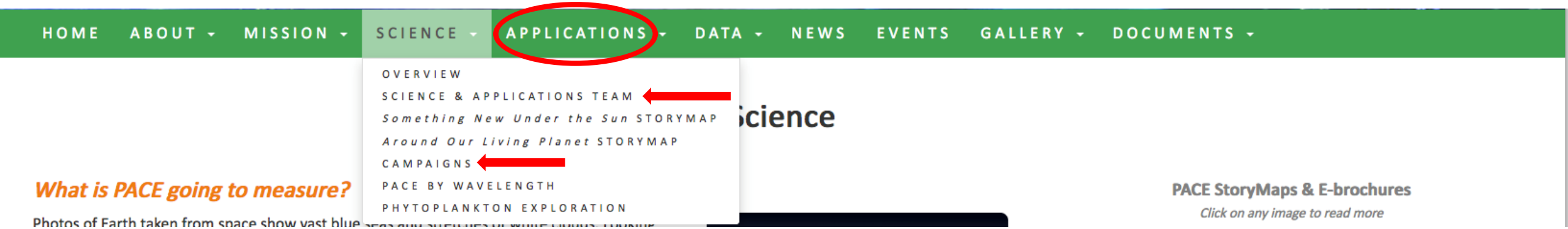


Visualizations of PACE in Orbit

Click image to view movie. Credit: NASA Scientific Visualization Studio.

PACE Website "Tech": Science

- Science & Applications Team (https://pace.oceansciences.org/science_applications_team.htm)
  - SAT members (including links each profile page)
  - Link to Publications (https://pace.oceansciences.org/publications.htm)
  - Science Meeting archives
  - Science Accomplishments and Consensus Documents
- Campaigns
  - Short overviews of PACE-related field campaigns such as EXPORTS



Science and Applications Team

PACE will make climate-quality global measurements that are essential for understanding ocean biology, biogeochemistry, ecology, aerosols, and cloud properties. Its data will be used to determine the role of the ocean and atmosphere in global biogeochemical cycling, ocean ecology, and how perturbations to Earth's energy balance affect – and are affected by – climate change.

With advanced global remote sensing capabilities PACE is expected to provide high-quality observations that will contribute substantially to basic research and applications and extend the current time series of climate-relevant data to enable detection of long-term trends. Check out the Applications Capability Matrix to learn about the questions being addressed by PACE Early Adopters.

Science and Applications Leadership

Heidi Dierssen

University of Connecticut

PACE Science and Applications Team Lead

Atmospheric Correction Over Bright Water Targets with Non-Negligible Radiances in the Near Infrared

Lorraine Remer

University of Maryland Baltimore County

PACE Deputy Science and Applications Team Lead

Unified Algorithm for Aerosol Characterization from OCI on PACE 19-PACESAT19-0014

See Co-Investigators

Science and Applications Team

Brian Barnes

About Us

The selected Science and Applications Team (SAT) is a diverse group of investigators who cumulatively bring end-to-end knowledge of different aspects of the breadth of basic and applied research and applications possible from the PACE observatory, as well as the scientific, algorithm, and modeling approaches of measurements and data products needed to address the science questions of the mission.

View our Publications Page

Previous Science Teams

Science Meetings

[View all presentations]

- 2020 Science and Applications Team Meeting
- 2018 Science Team Meeting
- 2017 Science Team Meeting
- 2016 Science Team Meeting
- 2015 Science Team Meeting
- 2012 Science Definition Team Meeting
- 2011 Science Definition Team Meeting

LORRAINE REMER

Email | Website

Joint Center for Earth Systems Technology, University of Maryland Baltimore County

Title: PACE Deputy Science and Applications Team Lead

ROSES Proposals

Unified Algorithm for Aerosol Characterization from OCI on PACE 19-PACESAT19-0014 (2020)

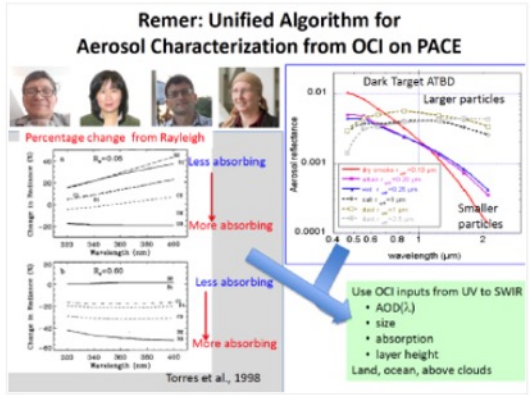
Co-Is: N. Christina Hsu, NASA Goddard Space Flight Center (GSFC); Robert C. Levy, NASA GSFC; Omar Torres, NASA GSFC

Read More

Aerosol Absorption Retrievals from Base-Line OCI Observations: Risk Reduction for Atmospheric Correction of the PACE Mission (2013)

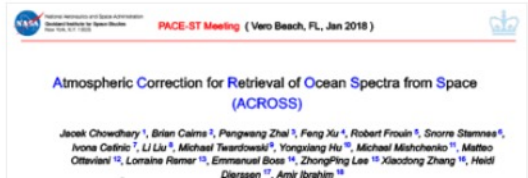
Read More

Science Meeting Presentations (10)



Unified Algorithm for Aerosol Characterization from OCI on PACE

Remer, L., Hsu, N.C., Levy, R.C., and Torres, O. (03-Jun-20) PDF (735 KB)



Atmospheric Correction for Retrieval of Ocean Spectra from Space (ACROSS)

Chowdhary, J., Cairns, B., Zhai, P., Xu, F., Frouin, R., Stamnes, S., Cetinić, I., Liu, L., Twardowski, M., Hu, Y., Mischenko, M., Ottaviani, M., Remer, L., Boss, E., Lee, Z., Zhang, X., Dierssen, H., and Ibrahim, A. (16-Jan-18). Topics: 1) RT benchmark results, 2) ACROSS-II hydrosol model, 3) plankton particle scattering, 4) ocean surface polarization studies, and 5) PACE RT chapter. Click here to view this presentation with audio.

Publications

This list of PACE-relevant publications can be filtered by topic (i.e., aerosols, clouds, mission, ocean color, polarimetry). You can also sort publications by Author, Title, or Year by selecting the button and clicking "SORT."

Filter: Select:

SORT Author Title Year

Publications (154)

Ackerman, S., Strabala, K., Menzel, W., Frey, R., Moeller, C. and Gumley, L. (1998). Discriminating Clear Sky from Clouds with MODIS, J. Geophys. Res., 103, 32141-32157, doi: 10.1029/1998JD200032. AGU »

Ahmad, Z., Franz, B.A., McClain, C.R., Kwiatkowska, E.J., Werdell, P.J., Shettle, E.P., and Holben, B.N. (2010). New Aerosol Models for the Retrieval of Aerosol Optical Thickness and Normalized Water-leaving Radiances from the SeaWiFS and MODIS Sensors Over Coastal Regions and Open Oceans, Appl. Opt., 49(29), 5545-5560, doi: 10.1364/AO.49.005545. OSA »

Alexandrov, M., Cairns, B., Emde, C., Ackerman, A., and van Diedenhoven, B. (2012). Accuracy Assessments of Cloud Droplet Size Retrievals from Polarized Reflectance Measurements by the Research Scanning Polarimeter, Rem. Sens. Envir., 125, 92-111, doi: 10.1016/j.rse.2012.07.012. ELSEVIER »

Bailey, S.W., Franz, B.A., and Werdell, P.J. (2010). Estimation of Near-infrared Water-leaving Reflectance for Satellite Ocean Color Data Processing, Opt. Express, 18(7), 7521-7527, doi: 10.1364/OE.18.007521. OSA »

Berthelot, H., Duhamel, S., L'Helguen, S., Maguer, J.F., Wang, S., Cetinić, I., and Cassar, N. (2018). NanoSIMS Single Cell Analyses Reveal the Contrasting Nitrogen Sources for Small Phytoplankton, ISME J., 13(3), 651, doi: 10.1038/s41396-018-0285-8. NATURE »

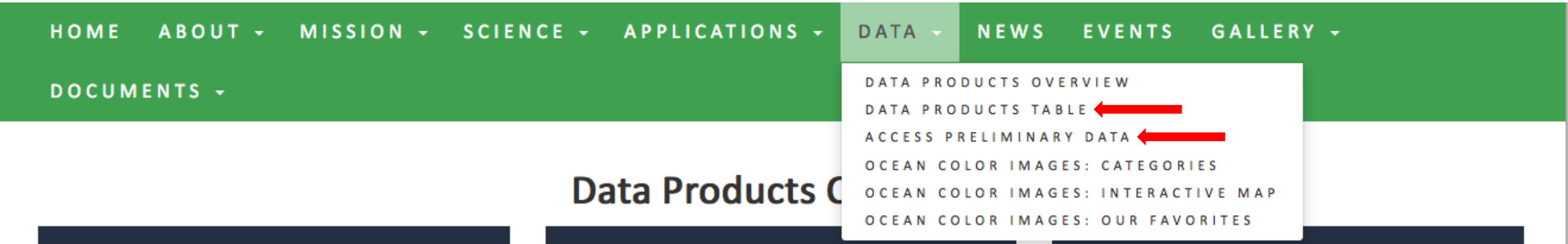
Boss, E., D'Sa, E., Freeman, S., Fry, E., Mueller, J., Pegau, S., Reynolds, R., Roesler, C., Röttgers, R., Stramski, D., Twardowski, M., and Zaneveld, R. (2018). Volume 1: Inherent Optical Property Measurements and Protocols: Absorption Coefficient, in A.R. Neeley, A. Mannino (eds.), Ocean Optics & Biogeochemistry Protocols for Satellite Ocean Colour Sensor Validation, IOCCG, Dartmouth, NS, Canada. IOCCG »

Boss, E., Haëntjens, N., Ackleson, S., Balch, B., Chase, A., Dall'Olmo, G., Freeman, S., Liu, Y., Loftin, J., Neary, W., Nelson, N., Novak, M., Slade, W., Proctor, C., Tortell, P., and Westberry, T. (2019). Volume 4: Inherent Optical Property Measurements and Protocols: Best Practices for the Collection and Processing of Ship-Based Underway Flow-Through Optical Data, in A.R. Neeley, A. Mannino (eds.), Ocean Optics & Biogeochemistry Protocols for Satellite Ocean Colour Sensor Validation, IOCCG, Dartmouth, NS, Canada. IOCCG »

Boss, E., Twardowski, M., McKee, D., Cetinić, I., and Slade, W. (2019). Volume 2: Beam Transmission and Attenuation Coefficients: Instruments, Characterization, Field Measurements and Data Analysis Protocols, in A.R. Neeley, A. Mannino (eds.), Ocean Optics & Biogeochemistry Protocols for Satellite Ocean Colour Sensor Validation, IOCCG, Dartmouth, NS, Canada. IOCCG »

PACE Website "Tech": Data

- Data Products Table (https://pace.oceansciences.org/data_table.htm)
  - Series of tables grouped by type
  - Include *Product*, *Description and Use*, *Units*, *Availability*, *Status*, *Additional Info*
- Link to "Access Preliminary Data" from the Ocean Color Web
  - This is where to access simulated PACE data



Data Products Table

Calibrated Radiometry and Polarimetry | Ocean Properties to be Produced by OCI | Atmospheric Properties to be Produced by OCI | Land Data Products to be Produced by OCI | Aerosol and Ocean Properties from HARP2 and SPEXone | Ocean Surface Properties from HARP2 | Aerosol and Land Surface Properties from HARP2 and SPEXone | Cloud Properties from HARP2 and SPEXone

Calibrated Radiometry and Polarimetry

Calibrated and geolocated radiometry and polarimetry as observed at sensor.

Product	Description and Use	Units	Availability	Status	Additional Info
Spectral top-of-atmosphere radiances from OCI	Spectral radiance observed at the top of the atmosphere.	W m^{-2} um^{-1} sr^{-1}	Level-1B 1-km at nadir; daily - Level-1C TBD; daily	Standard product	Level-1C draft data format and examples
Spectral 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 TBD; daily	Standard product	Level-1C draft data format and examples
Spectral 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 TBD; daily	Standard product	Level-1C draft data format and examples

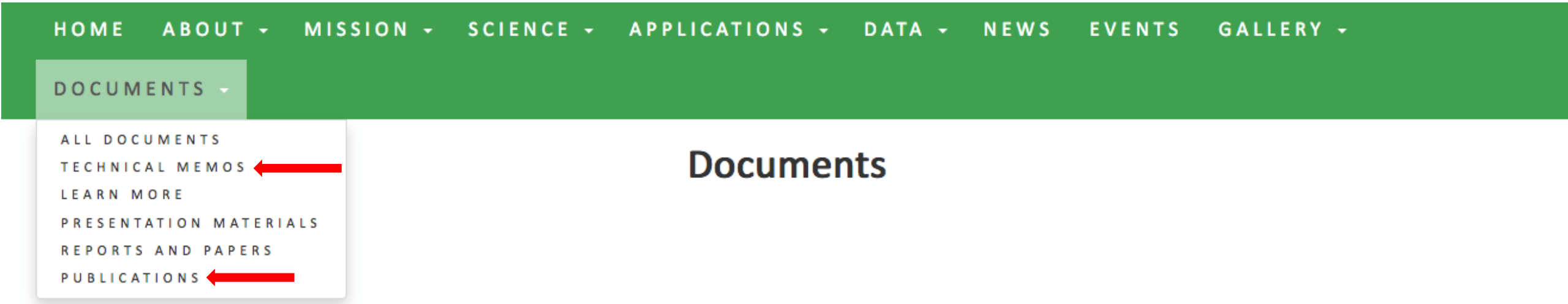
Ocean Properties to be Produced by OCI

Bio-optical and biogeochemical properties of seawater constituents in the sunlit upper ocean.

Product	Description and Use	Units	Availability	Status	Additional Info
Spectral remote 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	Standard product	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Stamnes, Zhang In situ measurement protocols
Spectral diffuse attenuation	Spectral diffuse attenuation of downwelling	m^{-1}	Level-2 1-km at nadir; daily	Standard	ATBD

PACE Website “Tech”: Documents

- Technical Memos (https://pace.oceansciences.org/documents.htm?id=memo)
- Publications can be directly accessed from here

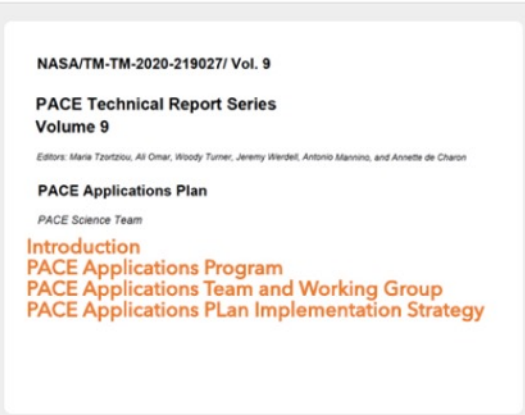


Technical Memos

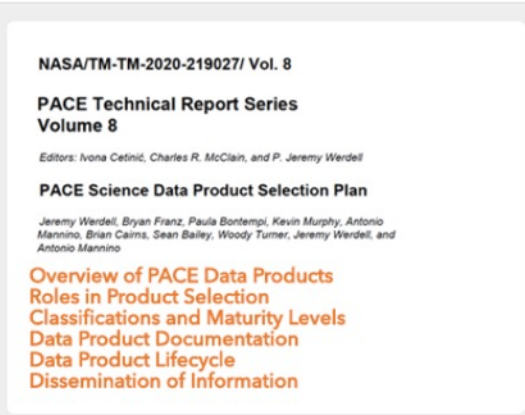
Documents: (16)

Title ○ Date ● SORT

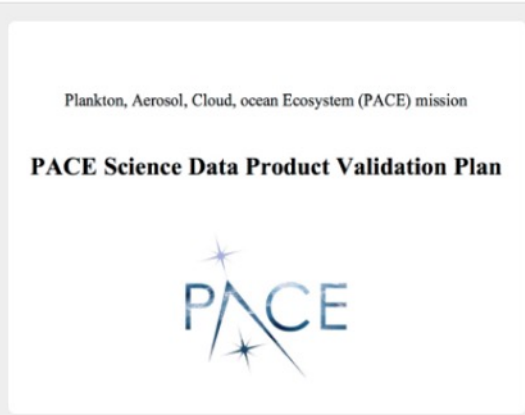
Learn More | Presentation Materials | Reports and Papers | All Documents



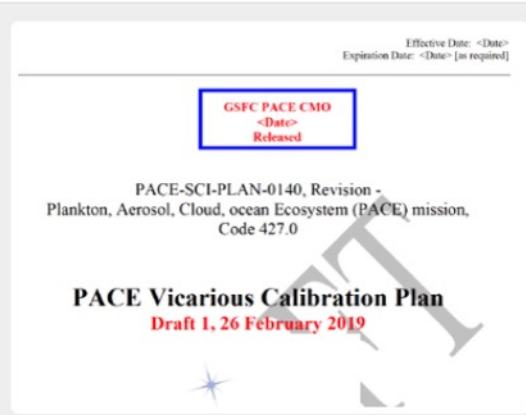
[Oct-20] PACE Applications Plan PDF (1.7 MB) »



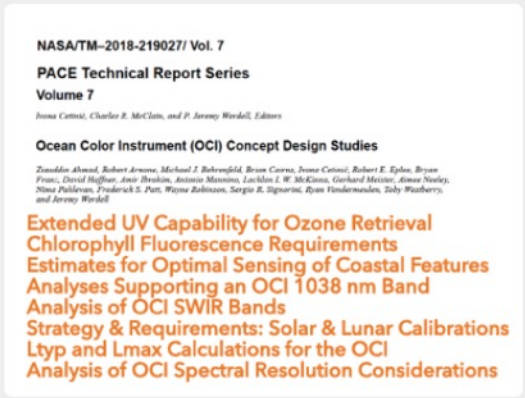
[Oct-20] PACE Science Data Product Selection Plan PDF (664 KB) »



[Jul-20] PACE Science Data Product Validation Plan PDF (973 KB) »

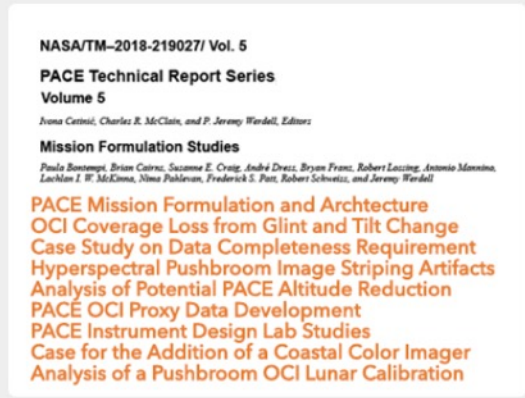


[Feb-19] PACE Vicarious Calibration Plan MORE »



[Dec-18] Ocean Color Instrument (OCI) Concept Design Studies MORE »

[Dec-18] Data Product Requirements and Error Budgets Consensus Document MORE »

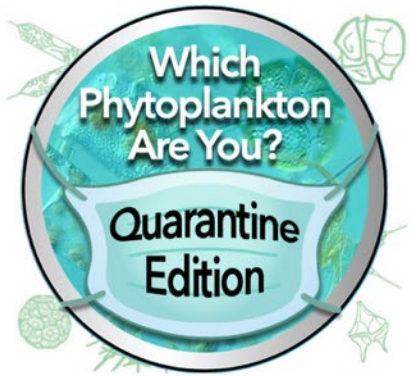


[Dec-18] Mission Formulation Studies MORE »

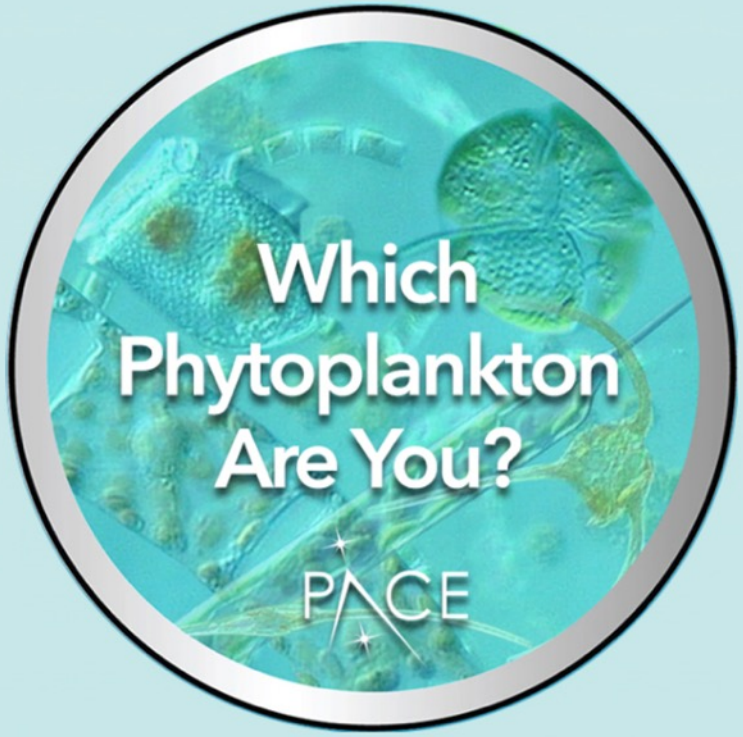
[Oct-18] Cloud Retrievals in the PACE Mission: PACE Science Team Consensus Document

PACE Website "Outreach": Homepage

- PACE Quizzes
  - Which Phytoplankton Are You?
    - 19,200 responses
  - Quarantine Edition
    - 2,300 responses
  - What in the World are Aerosols?
    - 930 responses



Card for each SAT member appears in random order

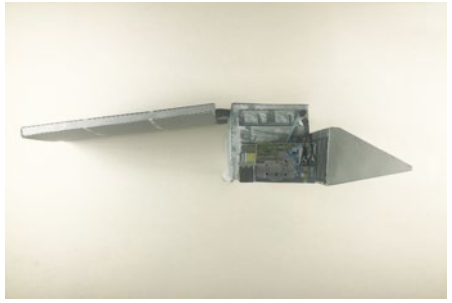


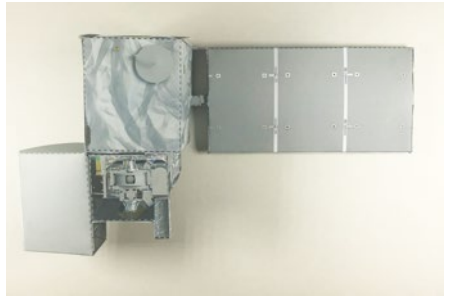
Answer four questions to discover which of these diverse organisms is most like you!

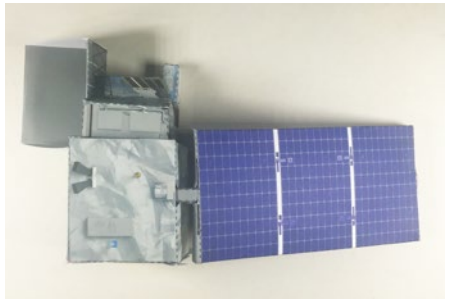
GET STARTED press Enter ↵

PACE Website "Outreach": Mission

- Build Your Own PACE (https://pace.oceansciences.org/paper_model.htm)
  - Tested with high school students
  - Detailed instructions and videos online







HOME ABOUT MISSION SCIENCE APPLICATIONS DATA NEWS EVENTS GALLERY

DOCUMENTS

- OVERVIEW
- TIMELINE
- OCEAN COLOR INSTRUMENT
- SPEXone POLARIMETER
- HARP2 POLARIMETER
- DEVELOPMENT TEAM
- BUILD YOUR OWN PACE!

Building on lessons learned fr … m of

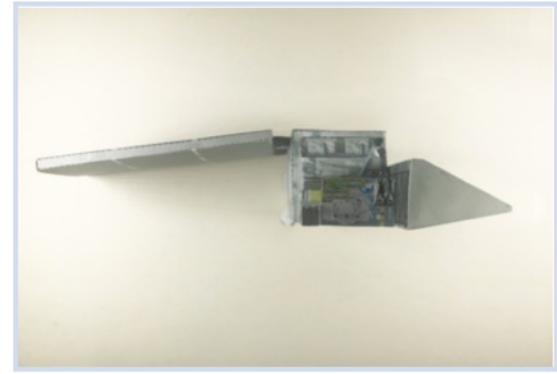
Mission

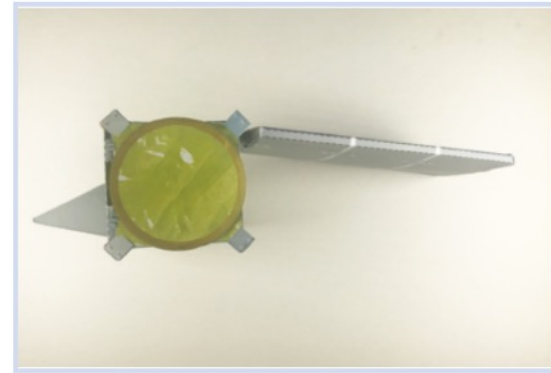
PACE StoryMap

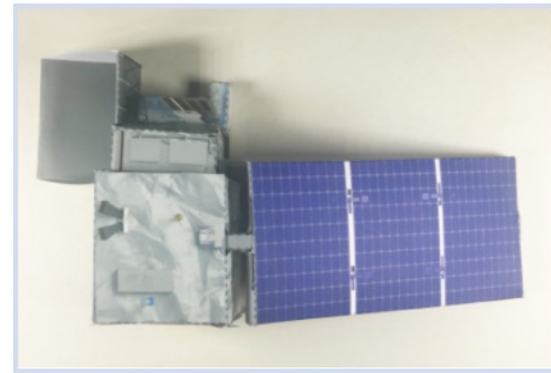
Build Your Own PACE!

The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) spacecraft is designed to provide new insight into Earth's ocean and atmosphere. PACE will provide the first-ever global measurements to identify communities of microscopic algae that float in our ocean: phytoplankton. This will help us understand Earth's changing marine ecosystems, manage natural resources such as fisheries, and detect harmful algal blooms. Its atmospheric data will be used to study key issues such as air quality.

It usually takes years to build a satellite that can survive the extremes of space. This paper model replica of PACE has five parts plus an optional 'Hinge'. Just like NASA, you will create the final spacecraft model by assembling the parts together...but in a tiny fraction of the time!







Materials

- Scissors
- Glue
- Metal ruler to make sharp folds
- *Optional: Hole punch (3/8 inch is best)*

Patterns

Dashed line

- - - - - - - -

Mountain fold

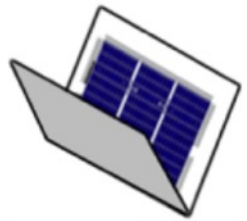
Fold so that the printed pattern faces out.

Dotted line

. . . . . .

Valley fold

Fold so that the printed pattern faces in.

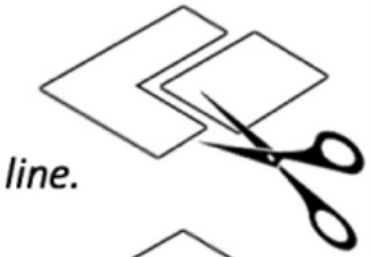


Solid line

Cut parts out along this line.

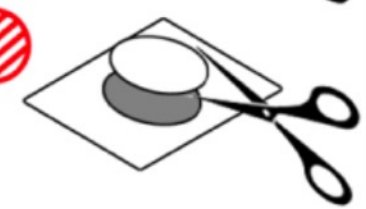
Solid red line

Cut a notch along this line.



Diagonal red lines

Cut these areas out.



Green dots

Glue tabs to another place on that part.

See how it's done! Check out the PACE videos for help in constructing the model

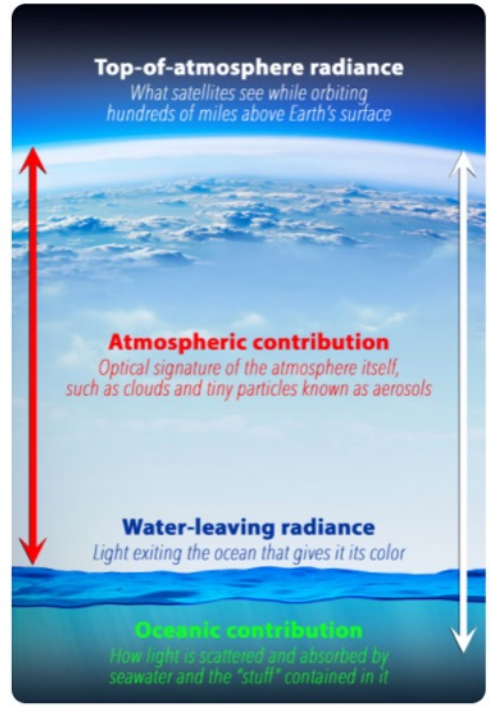
PACE Website "Outreach": Science

- Overview (https://pace.oceansciences.org/science.htm)
  - Background on PACE
  - E-brochures
    - *Colorful World*, *Sea the Light*, *The Air Down There*, *A Climate Story*
- StoryMaps
  - *Something New Under the Sun* (https://pace.oceansciences.org/storymaps.htm?id=1887)
- Phytoplankton Exploration (https://pace.oceansciences.org/phytopia.htm)

Most Popular

What is PACE going to measure?

Photos of Earth taken from space show vast blue seas and stretches of white clouds. Looking more closely – and beyond what we can see by eye – reveals important details about our living ocean and climate.



In orbit, PACE will measure light emitted by Earth, or its "radiance," at the top of the atmosphere. This signal will include everything below it; thus, scientists will need to separate contributions from the atmosphere and ocean.

Being located farther from the satellite, only a small fraction of light will come from the ocean. Subtracting the signal of the atmosphere helps to determine a key value, "water-leaving radiance." This can be used to learn more about microscopic algae (phytoplankton) at the ocean surface. How? Phytoplankton have various shapes, sizes, and pigments; all of which affect ocean color. To help decipher phytoplankton types, PACE will sense color at very high resolution and over a broad spectrum: from ultraviolet to infrared wavelengths.

Color is not the only property of light that tells us about our planet. Light's polarization – how it oscillates within a geometric plane – is another important dimension of information. For example, when sunlight interacts with clouds or aerosols, its polarization can change. Measuring these types of changes will help us better understand our atmosphere and climate.

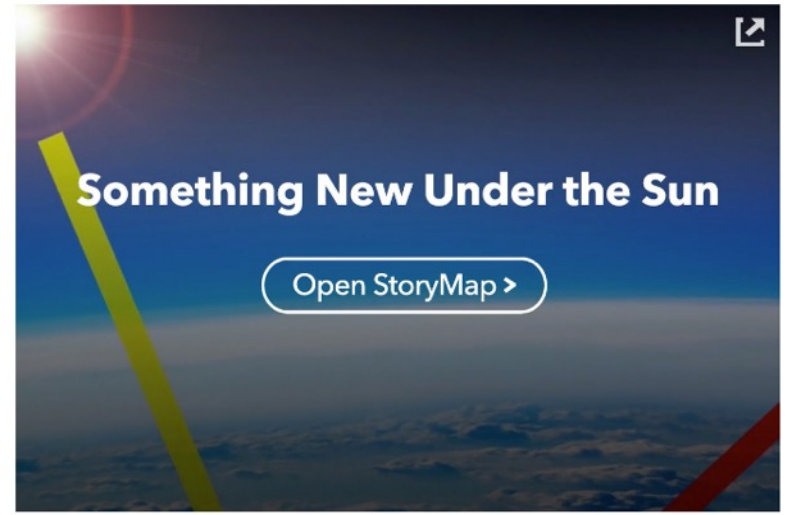
PACE by Wavelength »
Phytoplankton Exploration *(Phytopia)* »
Science and Applications Team & Meeting Archives »
Previous Science Teams »
Satellite Remote Sensing: Ocean Color (Werdell & McClain, 2019) »

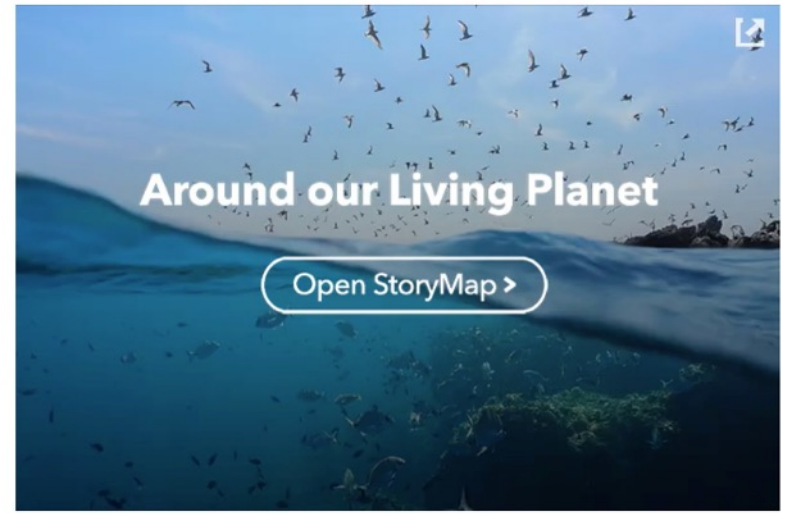
How will it work?

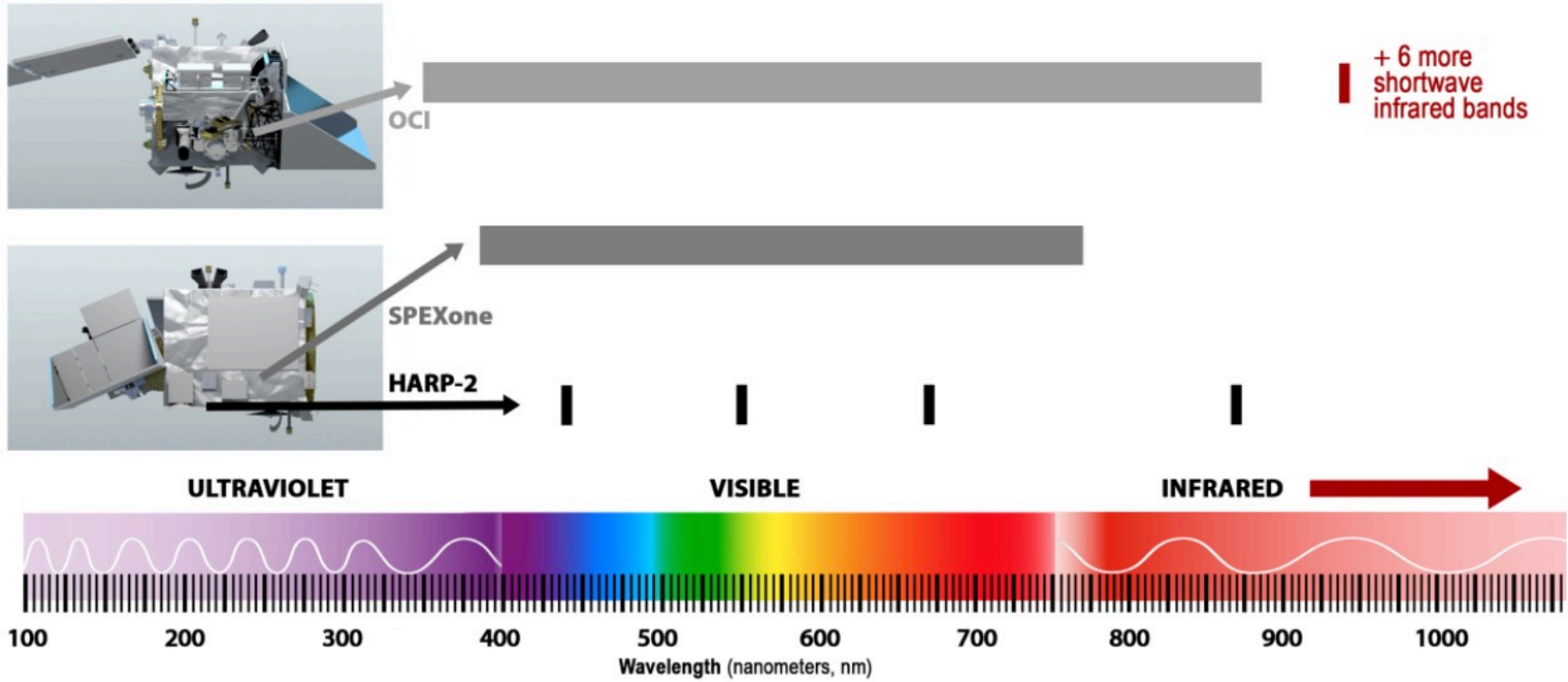
PACE's primary sensor is the Ocean Color Instrument (OCI). Its unprecedented coverage of broad wavelengths at high resolution will not only benefit ocean science but atmospheric science, as well. OCI data will be complemented by

PACE StoryMaps & E-brochures

Click on any image to read more







Details of each PACE instrument are shown, with OCI spanning from ultraviolet to infrared wavelengths plus several shortwave infrared bands (940, 1038, 1250, 1378, 1615, 2130, and 2260 nm). SPEXone spans from ultraviolet to red. HARP2 includes four wavelengths ranging from blue to near infrared.

> PACE's polarimeters and the OCI will complement each other beautifully, providing unmatched views of our seas and skies.

PACE - Colorful World

Phytoplankton Exploration

Phytoplankton are tiny plants and algae that live in the upper sunlit layer of almost all water bodies on Earth. Powered by the sun's energy, they come in many shapes and sizes. They serve as the base of the marine food web, and produce oxygen vital to life. Studying this incredibly diverse group is key to understanding the health - and future - of our ocean and life on earth. PACE's advanced ocean color technology is designed to help to distinguish "who's who" in terms of phytoplankton communities.

Phytopia

Phytopia lets you explore the fascinating world of phytoplankton. The tool uses concept maps — which highlight connections — to display complex information. Use Phytopia to learn about the roles these plankton play in the ecosystem, whether they are harmful or not... or just explore the beauty of these tiny titans.

Phytoplankton Exploration

Choose a starting point below or view the Phytopia Tutorial

Mighty Phytos

Tiny but mighty

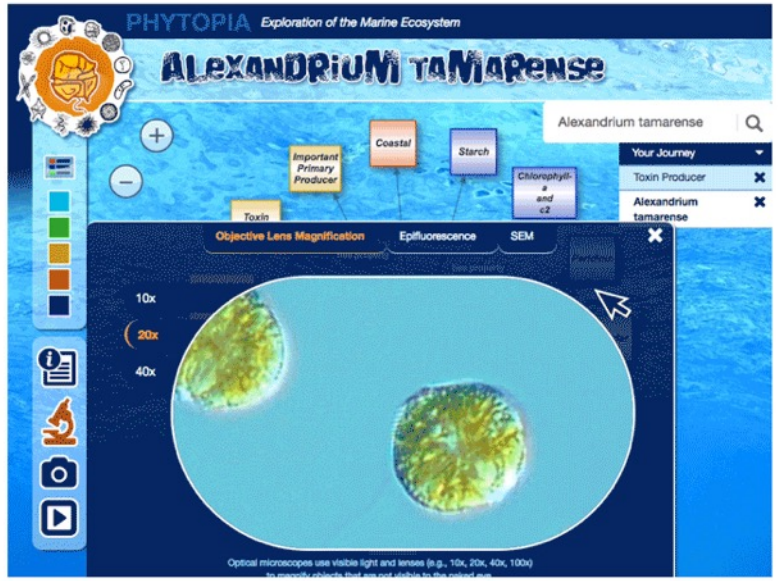
What PACE Will Measure

Who's who?

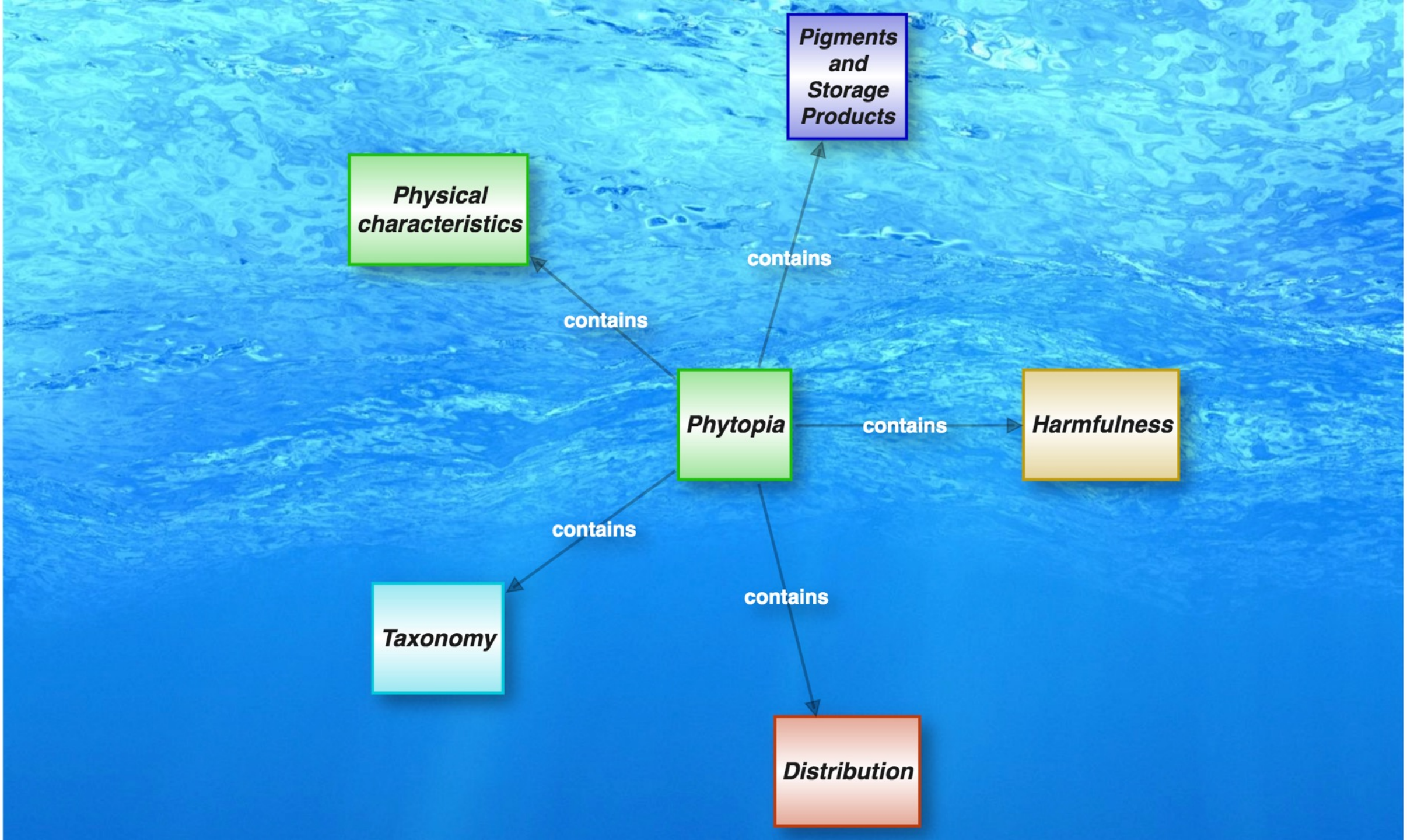
Get To Know Phytos

Explore the characters

Take Our Quizzes!

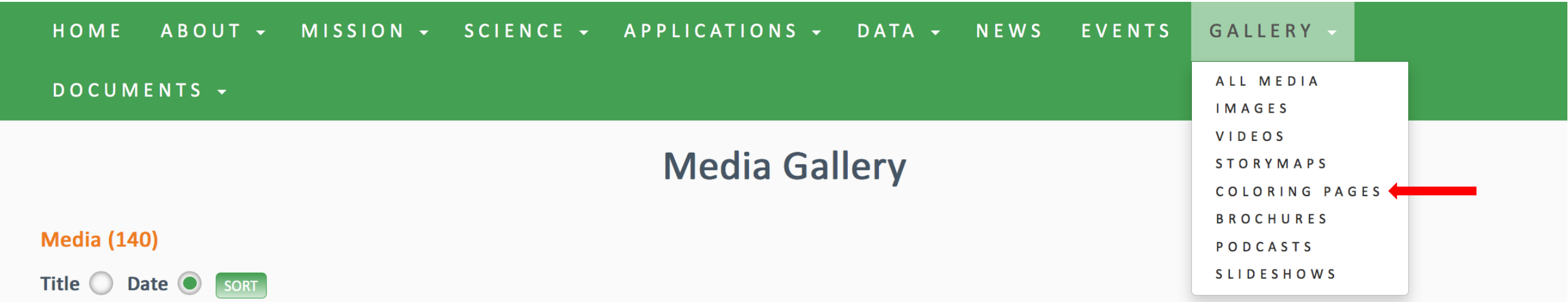


Phytopia provides definitions and explanations. Its endless connections allow you to explore the depth and breadth of the phytoplankton ecosystem.


Pigments and Storage Products
Physical characteristics
contains
contains
contains
Phytopia
contains
Harmfulness
contains
Taxonomy
contains
Distribution

PACE Website "Outreach": Gallery

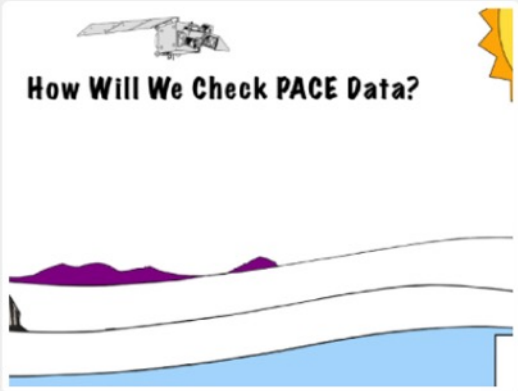
- Many types of media are available (https://pace.oceansciences.org/gallery.htm)
  - Images, Videos, StoryMaps, Coloring Pages, Brochures, Slideshows
  - Time for an activity!
    - *What Will PACE Help Us See?* (https://pace.oceansciences.org/coloring/coloring01.htm)
    - *How Will We Check PACE Data?* (https://pace.oceansciences.org/coloring/coloring02.htm)



Title Date SORT

Images | Videos | StoryMaps | Coloring Pages | Brochures | Podcasts | Slideshows

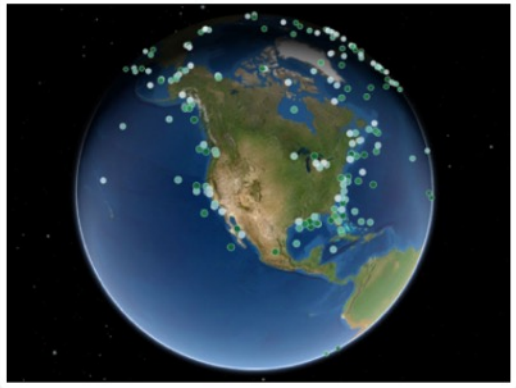
[10-May-21] INTERACTIVE - What Will PACE Help Us See?



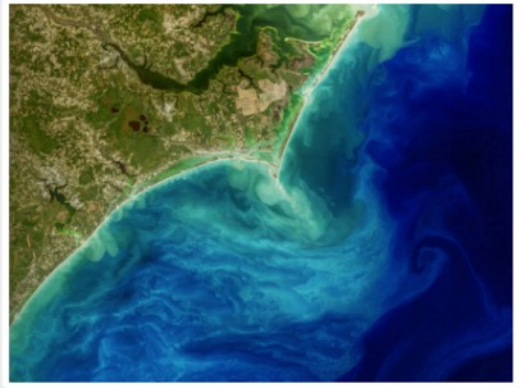
[10-May-21] INTERACTIVE - How Will We Check PACE Data?

[07-May-21] EXPORTS Field Campaign, Spring 2021 VIEW ALL »

[17-Mar-21] Something New Under the Sun



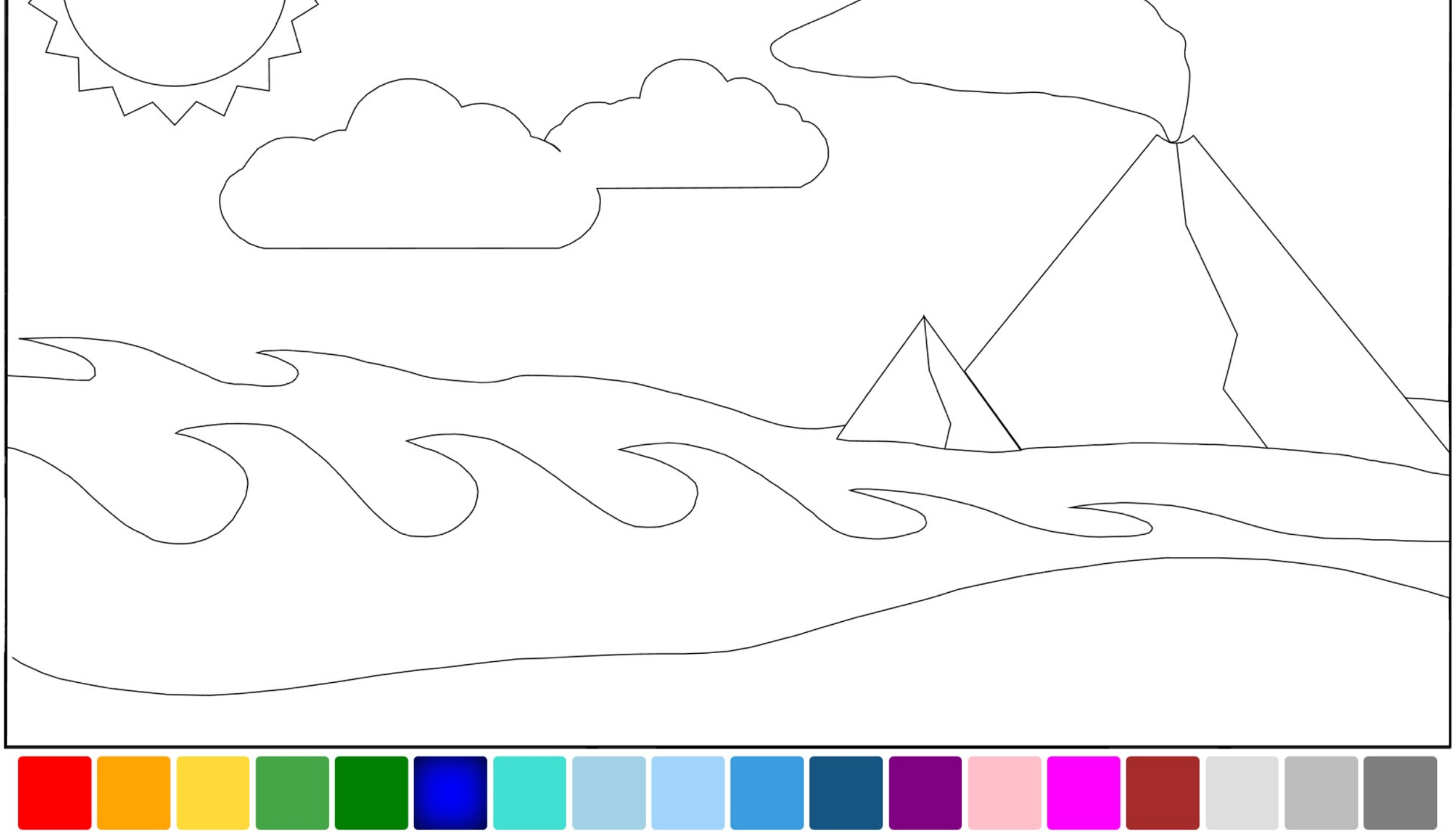
[25-Dec-20] Ocean Color Images: Interactive Map



[25-Dec-20] Ocean Color Images: Our Favorites

[22-Nov-20] Keeping the PACE with NASA's Plankton, Aerosol, Cloud, ocean Ecosystem Mission MORE »

[14-Aug-20] Actually It's Phytoplankton! [6 episodes] MORE »



PACE Website: Future Updates

- Interested in contributing to the PACE website?
- Have you seen anything online that would make a good addition to the PACE website?

Feel free to contact me…

avdecharon@gmail.com

… or Jeremy.

THANK YOU!