Part 1 Questions & Answers Session

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Amita Mehta (amita.v.mehta@nasa.gov).

Question 1: Is field data collected to verify the remote sensing data?
Answer 1: Yes, teams of scientists are collecting field data across the global oceans to validate PACE data. More info here: https://pace.oceansciences.org/pvstdoi.htm.

Question 2: How do you distinguish aerosols from algae?
Answer 2: The scientific community has developed algorithms to retrieve aerosol properties and algae. The ocean is very dark in the infrared (IR) wavelengths of the electromagnetic spectrum (due to water absorption), hence, the IR signal measured by the satellite sensor can be used to estimate aerosols. Algae impart a signal in the visible wavelengths including at specific wavelengths to retrieve chlorophyll-a (primary algal pigment) as well as other pigments. We do run into difficulty distinguishing absorbing aerosols (brown carbon and soot/black carbon aerosols) which absorb intensely in the ultraviolet (UV) and lower blue wavelengths. PACE OCI's UV bands will help us better detect absorbing aerosols and distinguish aerosols from algae.

Question 3: If all these contributors to ocean color are present in a given location, can PACE detect several? Or could a few potentially mask others? For example, a phytoplankton bloom happening in really turbid coastal water with a lot of DOM and sediment – would PACE be able to distinguish all those particles?
Answer 3: It is challenging to identify water constituents in optically complex waters, or waters that contain high concentrations of a mix of different types of absorbing and scattering constituents (phytoplankton, sediment, CDOM) such as coastal and estuarine waters. Most ocean color algorithms are designed for open ocean waters where optically active constituents co-vary with each other. Algorithms tend to have higher uncertainties in optically complex waters; but this is an active area of research. PACE OCI's UV, UV-Vis-NIR hyperspectral and SWIR capabilities will enable advanced algorithms to be applied for improved separation of the various in-water constituents at lower uncertainties than heritage multi-spectral algorithms. A few algorithms exist such

as AQUAVERSE and others. Others are in development. AQUAVERSE is being implemented for inland and coastal waters as test water quality products.

Question 4: Since aerosols impact climate, is there a particular aerosol or constituent that we want more of or less of, and how can PACE help with that?
Answer 4: With PACE, we aim to better understand how aerosols impact the warming or cooling of the Earth and thus better model/predict climate change. Whether "we" humans may want more or less of one aerosol type (for example, cooling) is a policy question for policy makers and Earth's citizens. Geoengineering (such as taking actions to increase cooling aerosols) may have negative side effects. Our goal (as scientists) is to understand how the Earth functions and convey this to stakeholders to make policy decisions that are most beneficial.

Question 5: Can we use reflectance to identify phytoplankton functional types?
Answer 5: Yes, phytoplankton contain different pigments that absorb and scatter light differently. The hyperspectral remote sensing reflectance signal that we retrieve from PACE OCI can be inverted to retrieve phytoplankton absorption, which can tell us what pigments are found in phytoplankton present in the water, giving us a better idea of what types of phytoplankton are in the water. This mostly works in open ocean waters; it gets more complicated in optically complex (coastal/turbid waters) because of a mix of optically active constituents.

Question 6: How does the presence of clouds affect images gathered by PACE?
Answer 6: Cloudy pixels are masked in PACE ocean color data. There are studies being conducted to bring about the ability to see through clouds.

Question 7: Are HICO, PRISMA, EnMAP, and EMIT data freely available?
Answer 7: Yes.

- Level 1 HICO data can be downloaded from NASA Earthdata here https://search.earthdata.nasa.gov/search?fi=HICO&lat=0.0703125&long=-0.0703125
- HICO Level 2 data are available from the NASA OB.DAAC Level 1 and 2 browser: https://oceancolor.gsfc.nasa.gov/cgi/browse.pl

- EMIT data are also available from NASA Earthdata https://search.earthdata.nasa.gov/search?fi=EMIT%20Imaging%20Spectrometer&lat=0.0703125&long=-0.0703125
- Note you need a NASA Earthdata account to access and download NASA Earth observation data. Register here: https://urs.earthdata.nasa.gov/users/new
- EnMAP and PRISMA data access information is available from their respective agencies, please see their websites: EnMAP: https://www.enmap.org; PRISMA, http://www.prisma-i.it/index.php/en/

Question 8: Can land surface reflectance be used to monitor freshwater quality?
Answer 8: Potentially, but this is not enabled at this time due to unknown data quality. Inland/freshwater surfaces are processed through the same pathway as ocean color processing. See answer to question 15 for more details.
There are two NASA PVST projects funded in the Great Lakes region of North America that are investigating PACE data quality in freshwater.

Question 9: Does anyone have an idea about phytoplankton bloom initiation, termination, peak? Have you ever detected bloom initiation, termination, or peak using Python/R/Matlab?
Answer 9: Phytoplankton bloom chronology has been studied by oceanographers and limnologists in the field and the laboratory with cultures for over a century. Python/R/Matlab are software tools, they cannot detect such things on their own. Algorithms coded in any of these software programming tools can be applied to study phytoplankton blooms. Sensitivity in detection of bloom initiation depends on many factors, especially the concentration of the algae (signal available for satellite sensor to detect).

Question 10: Can we access PACE data in Google Earth Engine?
Answer 10: No, PACE data is not currently in the Google Earth Engine Data Catalog. However, it is possible for it to be added like MODIS-Aqua data was; however, that is Google's decision, not the NASA Ocean Biology Processing Group's. Users can request remote sensing datasets to be added to GEE here:
https://developers.google.com/earth-engine/help#dataset_requests
KML and KMZ files can be generated using NASA's SeaDAS satellite data processing and imaging software.

Question 11: Could PACE be capable of detecting, measuring, and determining some ecology communities as water lily blooms, mangrove island evolutions?
Answer 11: Potentially. PACE has a spatial resolution of 1 kilometer. Hence, mangrove islands much larger than 1km and specifically changes in mangroves >1+ km can be observed. I'm not familiar with water lily blooms; I believe these are generally much smaller in area than PACE OCI's pixel dimension of 1.2km x 1.2km.

Question 12: Is there a use case for lagoon waters using PACE?
Answer 12: Not that I'm aware of at present. Lagoons larger than approximately 4 km x 4 m can be studied by PACE OCI. There are challenges with shallow waters, but there has been work to develop algorithms to apply PACE OCI data to study shallow water bodies such as lagoons.

Question 13: How are hyperspectral algorithms used to better inform PACE?
Answer 13: We do expect to have better quality products using hyperspectral algorithms. These algorithms can help to better distinguish water constituents among other use cases due to differences in the spectral shapes of the various in-water constituents. See answer to question 3.

Question 14: How can we access the spectral information from PACE? For example, if I wanted to download a dataframe which included a time series, and the value of spectral irradiance measured for every wavelength for each timestamp, for one geographic site, how could I do that?
Answer 14: Part 3 of this training will introduce Python code to access and analyze PACE spectral information. You can also download and pull data files into SeaDAS to visualize spectral information. We will also demonstrate how to open multiple PACE files to conduct a time series analysis during Part 3 of this training. You can retrieve daily photosynthetic available radiation (PAR) from PACE files which is similar to spectral irradiance. More info on PACE data products can be found here: https://pace.oceansciences.org/data_table.htm#12.

Question 15: How are inland waters masked in PACE products? What water mask or what is used for determination of inland waters?

Answer 15: If you go to NASA Worldview or Earthdata and look at OCI products, masking is used. The PACE project is using CyAN (https://oceancolor.gsfc.nasa.gov/about/projects/cyan/) product evaluations with OCI. Any pixel that goes through the OCI data processing gets assigned several flags, one of which being for land. If the pixel is designated water, it goes through the water (ocean color) pathway for calculating surface reflectance. As long as the water body is large enough to be resolved with the PACE OCI land mask, it will be processed as water. The mask included in l2_flags is a land mask, which can be inverted to become a water mask, including inland lakes and rivers but also the ocean. The only inland-waters-only mask we have is the MERIS/OLCI shapefile (https://oceancolor.gsfc.nasa.gov/about/projects/cyan/), which resolves much more than OCI can see.

Question 16: Can you better explain the tilt and sun glint downs for water quality retrieval? and specifically for pace?
Answer 16: OCI has a tilt mechanism that significantly reduces the sun glint affected areas imaged by OCI. PACE orbits South to North on the day side of its orbit (North to South on the night side of its orbit). OCI is tilted aft (southerly direction) as it images the southern hemisphere to avoid much of the Sun Glint Tilt mechanism tilts OCI forward (northerly direction) over the tropics. The tilt increases the ocean color retrievable areas of the global ocean by significant amounts compared to non-tilting instruments such as VIIRS and MODIS.

Question 17: Could you please elaborate further on the "tilt" feature? Does it imply that the scenes captured are not orthographic images (taken at nadir)?
Answer 17: Correct. Image acquisition by OCI is not nadir viewing. See answer to question 16 for further details. The two multi-angle polarimeters do observe at nadir as one of their angular observing modes.

Question 18: Could PACE be capable of detecting, measuring and determining some ecology communities as water lily blooms, mangrove islands evolutions? I'm trying to improve a hydrology/oceanic model locating and mapping these kinds of ecology units.
Answer 18: See answer to question 11.

Question 19: Will the efficiency of PACE increasing cause other monitoring devices like VIIRS to decommission, or will they continue to be improved to match PACE?
Answer 19: VIIRS is a sensor on NOAA weather satellite missions that will continue for another 10-15 plus years. PACE has no impact on continuation of VIIRS. NOAA will make a determination on their next generation ocean color capabilities in the coming years.

Question 20: Are there calibrated algorithms for integrating PACE OCI with data from other platforms (e.g., VIIRS) for time series reconstruction?
Answer 20: Not at present, but it's only a matter of time when these will become available, perhaps in 1 year.

Question 21: Also, in your opinion, what are the current research priorities at [the moment] for PACE that external researchers could contribute to?
Answer 21: A priority is to produce more and higher quality PACE data products including the (1) development of algorithms that take advantage of OCI's spectral capabilities… hyperspectral (extending from ultraviolet to near infrared - 340-895 nm), high spectral resolution and sampling (5 nm bands at 2.5 nm or 1.25 nm steps), and UV bands, (2) new data products that support water quality applications, and (3) collection and submission of high quality field measurements to NASA's SeaBASS data archive that can be used by researchers to develop new PACE algorithms and to validate PACE data products. By expanding the quality and types of data products, many research topics can be addressed including climate change trends on ocean ecosystems, water quality characterization, improving our understanding of the global carbon cycle (including ocean and land primary production; exchange of carbon from land-to-sea and across air-sea interface).

Question 22: Is there any summer internship for next year on hyperspectral observations for water quality monitoring with respect to the PACE Mission?
Answer 22: We are not aware of summer internships specific to PACE and water quality monitoring, but you are encouraged to search the NASA internship program website https://stemgateway.nasa.gov/public/s/explore-opportunities/internships and https://www.nasa.gov/learning-resources/internship-programs/. There are a few NASA sponsored external training courses that cover hyperspectral remote sensing,

water quality monitoring, and ocean optics: The Cornell Satellite Remote Sensing Training, the Maine Ocean Optics course, and the IOCCG Summer Lecture Series.

Question 23: When would it be possible to create data subscriptions for PACE products via the ob.daac data dashboard?
Answer 23: There is a subscription option via the Earthdata Search Client. However, this is not working at present. The OB.DAAC staff have contacted the NASA Earthdata Search Client product owner to get subscriptions working from their tool. The OB.DAAC has begun exploring adding PACE to the ocean color data dashboard. We do not have a timeline for this. NASA has moved data access for new missions to the Cloud, so tools and services such as data subscriptions for heritage missions (e.g., OB.DAAC data dashboard) may not be available for new missions like PACE due to NASA Earth data distribution policy changes.

Question 24: In the phytoplankton Community, is PACE OCI capable of identifying cyanobacteria species or ends at the genus level like Prochlorococcus?
Answer 24: With PACE OCI, our aim is to retrieve taxonomic groups of phytoplankton such as diatoms, dinoflagellates, pico-eukaryotes, etc. There are phytoplankton groups that OCI can quantify at the genus level such as Prochlorococcus, Synechococcus, “armored” Coccolithophorids such as Emilania huxleyii, Mycrocystis, and hopefully, a few other HABs. See material in the training 1 module on the MOANA algorithm developed for the Atlantic Ocean that provides cell concentrations for Prochlorococcus, Synechococcus, and pico-eukaryotes.

Question 25: PACE OCI reflectance data have so many negative values. Are there any data preprocessing steps to handle negative values?
Answer 25: Yes! Improving PACE OCI data is a work-in-progress as the OCI engineering and science teams fine tune the on-orbit calibration using the solar diffusers, scans of the moon, and in-water ocean reflectance to implement a vicarious calibration. All of these will be implemented in the version 3 reprocessing, which is planned within 2 months.

Question 26: At this stage, can we use PACE for scientific validating with our own field data and subsequent publishing purpose?

Answer 26: You can use field data to validate PACE OCI. PACE OCI data products are still going through validation and calibration processes. To understand the current level of data maturation, please see the PACE science data product release notes for data reprocessing Version 2 (https://oceancolor.gsfc.nasa.gov/data/reprocessing/V2.0/pace-oci/), the current data version when this course was presented. Also see our "What you should know about PACE data" webpage https://pace.oceansciences.org/about_pace_data.htm

Question 27: Are there plans to have regular validation (field measures based) for some of the OCI products?
Answer 27: Yes, teams of scientists are collecting field data across the global oceans to validate PACE data. More info here: https://pace.oceansciences.org/pvstdoi.htm.

Question 28: Are these WQ suites collections of data from the satellite that you would then use software like SeaDAS or Jupyter Notebook to interpret?
Answer 28: The water quality suites are NetCDF4 files that contain water quality relevant data products. You can then use any software or code that is able to open and process NetCDF4 files, including SeaDAS.

Question 29: PACE OCI reflectance data have so many negative values. Are there any data preprocessing steps to handle negative values?
Answer 29: PACE Science Data are reprocessed every so often to incorporate improved calibration knowledge and improve data quality. You can read more about V2 reprocessing here: https://oceancolor.gsfc.nasa.gov/data/reprocessing/V2.0/pace/. Negative OCI reflectance data will be addressed in future reprocessing. See answer to question 25.

Question 30: Does PACE project investigate marine plastic/microplastic?
Answer 30: Dr. Heidi Dierssen is conducting research on remote detection of microplastics:
https://cce.nasa.gov/ocean_biology_biogeochemistry/details.html?itemType=project&itemProgID=8&itemID=4380&projType=project&projID=4380&progID=8

Question 31: Could anyone share more information about the AQUAVERSE algorithm?

Answer 31: You can find more information on Dr. Nima Pahlevan's Aquaverse algorithm here: https://pace.oceansciences.org/people.htm?id=44. A related publication can be found here: https://doi.org/10.1016/j.rse.2023.113706

Question 32: The spatial resolution for L3 data is 4Km compared to L2 1Km. Are we losing some information here?
Answer 32: Yes. L3 data is typically data products that have been binned to cover the globe, so the lower resolutions of 0.1 degree and 4 km keep datasets to a reasonable size. For higher spatial resolution of the same products, level 2 data can be used.

Question 33: Are there big issues with cloud coverage in tropical regions?
Answer 33: Just like other Sun-synchronous satellite missions, PACE is affected by cloud coverage in tropical regions. Temporally compositing data over 8 days, a month, or more is one way to increase coverage.

Question 34: It was mentioned that some products are currently only in the 'test' phase, is this the case for all products until they are reprocessed under the V3, or are products ready to be used for data validation and publications?
Answer 34: Some products are "Provisional", which means they are more refined than test products. They 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. The status of the data products is regularly updated on this web page: https://pace.oceansciences.org/data_table.htm.

Question 35: In shallow water, how to separate the spectra of the water leaving radiance from the reflected radiance from the bottom surface? Is there a mature algorithm for this?
Answer 35: Nothing specific to PACE. This topic has been addressed to some extent in the scientific literature. see answer to question 44 regarding PACE efforts on shallow waters.

Question 36: Is there an estimated timeline for when the aerosol product will be available for aerosol studies?
Answer 36: By December 2024. .

Question 37: Why does the PACE team use L1C data for L2d data, not L1B? If I want to use joint data from OCI, HARP-2 and SPEXone, it would be useful.

If I want to retrieve aerosol properties from only one specific satellite for using data that have good spatial resolution, using L1B data will be more useful, right?

If I work with only HARP-2 with 4 wavelengths, cloud masking and turbid water masking can be more difficult. And then when I make it, I can't be sure of accuracy. So do you recommend using L1C data with the other satellites, or using polarization information?

Answer 37: L1C data are derived from L1B. There is more technical information about level 1C in this guide : https://oceancolor.gsfc.nasa.gov/files/PACE_L1C_Users_Guide.pdf. If you want to use data from all three sensors, then L1C is the simplest option. If you wish to retain spatial resolution of each sensor, then you will need to work with L1B files from each of the three sensors and perform your own data integration of the three data streams. Yes, use L1B to maintain the finest spatial resolution if you only wish to work with a single PACE satellite instrument.

Without knowing your particular application of aerosol properties in your 3rd question, it is impossible to advise. At this early stage of the PACE mission, data quality is improving rapidly; see v3 reprocessing within 2 months. Please look for upcoming training and webinars on aerosol products for further guidance.

Question 38: When you say "Near Daily" coverage, how frequent is that in practice? For example, let's say I wanted every image of the Long Island sound from July 1 to September 30. How many usable images could I expect during those 92 days?

Answer 38: PACE OCI has a revisit time for most of the globe of 1-2 days, so that is the greatest frequency you can expect. From there, frequency of coverage in any given region is determined by the frequency of clouds in that region. Cloudy pixels are masked, meaning no data available, as PACE OCI cannot detect the water surface through the clouds. I would estimate 30-40% cloud-free images or roughly 30 images. You can check on NASA Worldview PACE OCI chlorophyll-a product and generate a movie loop for 2024 for those 92 days to get a better estimate of usable images (cloud-free and chl-a viable).

Question 39: I'm wondering about the HARP-2. While analyzing HARP-2 L1B data, I noticed missing values appearing as stripes near the nadir. Why does this phenomenon occur specifically around the nadir?
Answer 39: HARP-2 is not being applied to derive water quality products as it was designed for cloud and aerosol properties, which will aid in OCI atmospheric correction. Your comments will be forwarded to the HARP-2 instrument and data processing teams for follow-up.

Question 40: Which radiometer is used to collect in situ hyperspectral reflectances?
Answer 40: In situ sensors used by NASA funded teams for vicarious calibration (HyperNAV and MarONet) and validation of PACE data products are numerous. The validation radiometer sensors are commercial off-the-shelf systems from vendors such as SeaBird Scientific, Biospherical Instruments (multi-spectral), TriOS, In-situ Marine Optics, etc.
HyperNAV - https://misclab.umeoce.maine.edu/HyperNAV/
MarONet - https://web3.physics.miami.edu/~voss/MOBY2/MarONet.html

Question 41: What about PACE data and Machine Learning research? Do you have any info about datasets or any ML oriented activities? How about oil spill detection using hyperspectral data?
Answer 41: There are undoubtedly efforts on each of these topics. Some specificity on the first two questions would help with providing answers. For oil spill detection, Dr. Chuanmin Hu has been doing some work on the topic - https://pace.oceansciences.org/people_ea.htm?id=38. Also, Dr. Matteo Ottaviani was funded by NASA to explore oil slick detection using PACE's multi-angle polarimeters - see https://pace.oceansciences.org/people.htm?id=43.

Question 42: Regarding flood monitoring and flood risk assessment, how to use PACE in this research domain?
Answer 42: Follow the approach applied with MODIS data for flood monitoring and risk assessment would be a reasonable starting point. For example, by analyzing sequential PACE OCI (or MODIS) imagery (flooded surfaces are very dark in the NIR and SWIR compared to land surfaces) from pre-inundation to post-inundation, you can

estimate the area that is land (bright in the IR) and flooded (dark in the IR) before and after inundation to determine the area flooded and map it. By investigating precipitation data over the region and many flood events, one can derive a flood risk assessment. Again, we advise looking into the approach implemented for MODIS and that scientific literature.

Question 43: I would like to ask if Dr. Mannino has an idea of when PACE L4 data products will be available with all/almost all challenges solved? Perhaps in 1 year? Or more?
Answer 43: L4 data products are model output or results from analyses of lower level data, which may be derived from multiple measurements. We expect the L4 NPP (ocean net primary productivity) product to be released by the end of 2024. Other products will come online starting sometime in 2025. With regards to whether all/almost all challenges will be solved, this is impossible as the PACE project relies on external sources of inputs such as algorithms, model outputs, etc., which are beyond our control. The PACE project (and instrument partner teams) and the OB.DAAC strive to improve data products through various methods, rigorous on-orbit calibrations of sensors, validation of data products based on in situ or other observations, improved ancillary data sources, and regular reprocessing of PACE data when and if such reprocessing yield measurable improvements in data products.

Question 44: Earlier benthic features were mentioned, how would PACE be able to distinguish seagrass and coral, for example, if limitations are 1.1km?
Answer 44: Benthic features were mentioned, but clearly PACE OCI's spatial resolution limits PACE's ability for distinguishing benthic habitats. NASA funded Drs. Brian Barnes and Chuanmin Hu several years ago to develop algorithms for (1) classification of benthic habitats at sub-pixel scale, (2) assessment of condition (i.e., ecosystem health) change over time, and (3) assessment of uncertainties associated with each of these parameters - see https://pace.oceansciences.org/proposals_more.htm?id=20 for more details. Algorithms and data products will be implemented once delivered by the investigators, translated into the PACE data processing stream, tested and evaluated.

Question 45: How do you validate the global ocean algorithm to be applied in shallow waters such as coastal waters? How can PACE help with this compared to other missions?
Answer 45: This is indeed a challenging topic. Global algorithms may or may not be appropriate for shallow waters and can be impacted by bottom reflectances (e.g., Bahamas coastal waters). See the details on the PACE website regarding validation https://pace.oceansciences.org/pace_data_matchups.htm. For coastal waters, validation can be performed with a subset of available data subset for shallow waters or geographically to determine the data quality for any particular region of interest.

Question 46: What is the RPD value for the PACE product in bland altmon plot?
Answer 46: RPD = relative percent difference.

Question 47: How are pigments distinguished, and how reliable is remotely sensed data to identify phytoplankton composition?
Answer 47: There are multiple algorithms that can be applied to distinguish phytoplankton pigments and identify phytoplankton composition. The approaches involve (1) direct relationships between hyperspectral remote sensing reflectance and pigments, (2) relationships between hyperspectral absorption products and pigments, (3) others - see Chase et al. 2017 https://doi.org/10.1002/2017JC012859; Lange et al. 2018 https://doi.org/10.1364/OE.398127; Kramer et al. 2019 https://doi.org/10.1029/2019JC015604; Kramer et al. 2022 https://doi.org/10.1016/j.rse.2021.112879; Cetinić et al. 2024 https://doi.org/10.1016/j.rse.2023.113964

Question 48: Do phytoplankton react to water temperature changes?
Answer 48: Yes.

Question 49: Is there a way we can assist with some of the validation work? Doing a quick scan of the validation page I don't see inland waters listed. Please reach out using my registration information if there's something we can assist with.
Answer 49: If you have validation data for inland waters, then please submit your data to NASA's SeaBASS data archive, which the PACE project applies for validation. We do

not have your name or registration. Please reach out to Dr. Morgaine McKibben for further inquiries. There is validation work being done in the Great Lakes. Both projects, led by PIs Grunert and Sayers, are listed in our table of PACE Validation Science Team efforts: https://pace.oceansciences.org/pvstdoi.htm. A blog entry about the Grunert campaign specifically is also available: https://blogs.nasa.gov/pace/2024/08/20/brice-grunert-the-great-campaign-of-the-great-lakes/

Question 50: Are there level 2 or 3 data available to help us monitor freshwater quality? Does the Chla product capture ones in terrestrial freshwater bodies?
Answer 50: The data are captured in a 1.2km resolution. So products are available for freshwater bodies that are large enough to be seen at that resolution. Chla is one of the products that can be used for water quality. There is also the Apparent Visible Wavelength (avw). You can learn more about the data products here: https://pace.oceansciences.org/data_table.htm.

Question 51: Will PACE be able to detect atmospheric pollutants and combustion byproducts to the level where we could better detect pollution sources?
Answer 51: Yes, please review the list of aerosol products from OCI, HARP-2 and SPEXone https://pace.oceansciences.org/data_table.htm.

Question 52: Is there a library database of reflectance of phytoplankton types?
Answer 52: I am not aware of a large library of phytoplankton type-relevant spectral reflectances that is available. There is work being done in the research community to provide large libraries of inherent optical property measurements, which are useful for modeling your own spectral reflectances for different phytoplankton types. Some examples of these IOP libraries include:

- Lab-based inherent optical property dataset: Lomas, Michael et al. (2023). Phytoplankton optical fingerprint libraries for development of phytoplankton ocean color satellite products. https://doi.org/10.5061/dryad.rbnzs7hfg
- Modeled inherent optical property dataset: Lain, L.R., Kravitz, J., Matthews, M. et al. Simulated Inherent Optical Properties of Aquatic Particles using The Equivalent Algal Populations (EAP) model. https://doi.org/10.1038/s41597-023-02310-z

Question 53: Can we detect heavy metals present in water bodies using this?
Answer 53: not likely

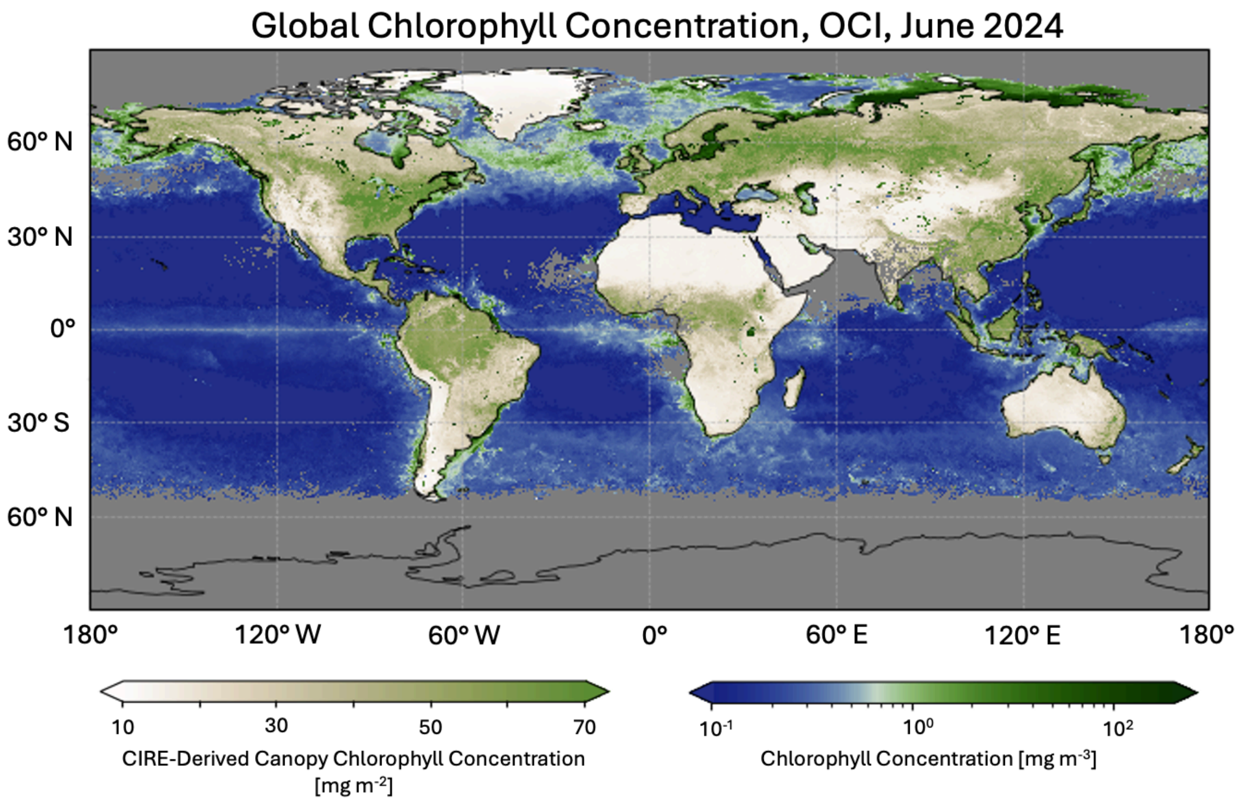
Question 54: Can PACE be used on a small scale, such as in case studies of rivers, lakes, or reservoirs and dams?
Answer 54: The spatial resolution is 1.2km, so the smallest possible water body it can work with is 3 to 4 times that spatial resolution

Question 55: Is PACE can be also used for identification of different species vegetation on coastal areas (e.g., salt marsh and mangroves ecosystems).
Answer 55: There are no products planned for that yet, but people are welcome to use PACE data to work on algorithms that would do that.

Question 56: Are there future plans to improve the spatial resolution of PACE data to allow for inland water studies?
Answer 56: The spatial resolution that PACE-OCI detects at is fixed per the instrument optical design and not a matter of data analysis.

Question 57: How "deep" can PACE see? Can the data be used to derive info about cultures on sea-bed too? Or is it good for the surface only?
Answer 57: The instruments aboard PACE are measuring sunlight going to Earth and back to the satellite. It can only see as deep as the photons can go (e.g. first optical depth; approximately 1/Kd). So in very clear waters it can see deeper, and in murky water it can only see the very surface. In general, it can be considered that it mostly sees the surface water layer.

Here is an “eye candy” OCI image (L3) generated by one of our PACE project scientists showing global chlorophyll concentrations on land and in water for the month of June.


Global Chlorophyll Concentration, OCI, June 2024
60° N
30° N
0°
30° S
60° N
180°
120° W
60° W
0°
60° E
120° E
180°
10
30
50
70
CIRE-Derived Canopy Chlorophyll Concentration [mg m-2]
10-1
100
102
Chlorophyll Concentration [mg m-3]