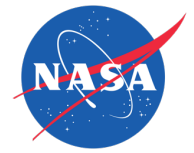


National Aeronautics and
Space Administration



PACE

Our ocean supports one in 45 American jobs and contributes over \$350B to the US GDP every year.
Ocean color observations by PACE will assist fisheries management and toxic algae bloom response.
PACE measurements of the ocean and atmosphere will inform water, air quality, and weather forecasts, improve national security and our understanding of Earth's climate.
PACE products will aid decisions makers in policy, military, commercial sectors, and the public.



The U.S. ocean economy contributes over \$350 billion to the Gross Domestic Product (GDP, based on 2014 data) and supports more than 3.1 million jobs, equivalent to 1 in 45. Currently, this ocean economy, including the Great Lakes, is growing faster than the total U.S. economy in both contributions to inflation-adjusted GDP (15.6% since 2007 compared to 5.8%) and jobs (8.1% compared to flat).

Earth's ocean teems with life, supporting economies, food security, and our everyday well-being. Key to ocean health are phytoplankton: microscope plants and algae. These diverse organisms fuel the marine food web, reduce atmospheric carbon dioxide, and have produced half of the oxygen on Earth. On the other hand, some species are harmful and can contaminate drinking water, kill fish, or force the closure of recreational areas.

PACE, scheduled to launch in 2024, will be the first mission to provide measurements that enable prediction of the "boom-bust" cycle of fisheries, the appearance of harmful algae, and other factors that affect commercial and recreational industries. While current satellites provide essential tools for monitoring the ocean, coasts, and Great Lakes, they cannot be used effectively to evaluate changes to fisheries or identify harmful algae. Without PACE, we will continue to be blind to the impacts of diversity changes in our marine resources.

PACE will also observe clouds and tiny airborne particles that absorb and reflect sunlight, known as aerosols. Industry, the Department of Defense, National Oceanic and Atmospheric Administration (NOAA), policy makers, and scientists all rely on these key data to forecast weather, visibility, and air quality. PACE will observe the ocean, clouds, and aerosols together to better understand their interactions. Its data will reveal new details about the exchange of carbon dioxide, how some aerosols can fuel phytoplankton growth, and how phytoplankton can release particles to the atmosphere that lead to the formation of clouds. Overall, these processes affect how much heat is trapped by Earth's atmosphere and thus are vital for accurate weather and climate predictions.

Ultimately, PACE will provide atmospheric and oceanic observations that benefit society in ways that current satellites cannot. For operational users, policy implementers, the commercial sector, and scientists, PACE will offer unprecedented opportunities to monitor fisheries and harmful algae, while improving our understanding of water resources, the impact of disasters, ecological forecasting, human health, and air quality.

Example PACE user communities

- Natural and coastal resource managers focused on water quality for human health, commercial fishing, resource management, and disaster management
- Researchers and computer modelers in the fields of ocean biology-ecology-biogeochemistry, clouds, and aerosols
- Military users of ocean optical data for environment characterization along with clouds and aerosol data for weather and visibility forecasts for operational regions
- Government agencies, including NOAA, U.S. Geological Survey, and the Environmental Protection Agency, who will use PACE data to manage fisheries and determine human health predictors such as air and water quality
- Renewable energy and commercial sectors with interest in environmental technology development, resource management tools, and environmental forecasting
- Educators of the general public
- Policy makers and economists at local, state, regional, tribal, federal, and international levels



Societal benefits and applications of ocean color - examples and testimonials

Wild fish location forecasting and fishing regulation enforcement

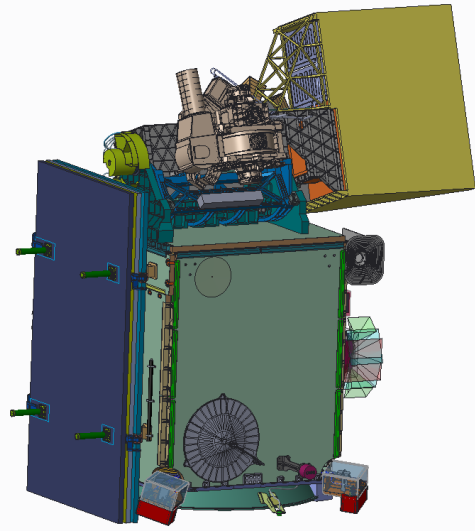
- *Roffer's Ocean Fishing Forecasting Service (ROFFS) routinely uses ocean color imagery in their fishing advisories that 'improve the fisherman's efficiency up to 50% of their operational costs in fuel and time.'* – Dr. Mitch Roffer, ROFFS, Inc.
- *'The commercial fishing business is not easy. As the ocean is warming, stocks are shifting northward. People who survive in this business are using this technology to find fish more efficiently, comply with all the rules and regulations and limit bycatch and waste.'*
– Capt. Bill Bright, Northwest Atlantic fishing fleet

Aquaculture farming

- *'Knowing the type of plankton my shellfish are eating at any given time greatly increases my awareness and informs my decision-making process. All this information helps me to be a better and more efficient fisherman which makes my business more sustainable.'*
– Bernard Friedman, Santa Barbara Mariculture Co.
- *Harmful algal blooms have emerged in Narragansett Bay, with the potential to harm Rhode Island's \$14 million oyster and clam wild and farmed harvests. Toxic dinoflagellates (Alexandrium tamarense, Alexandrium peruvianum, Alexandrium fundyense) can have neurological impacts if consumed. These observations are the first in New England and the third on the East Coast of North America.* – 41°N, Rhode Island's Ocean & Coastal Magazine

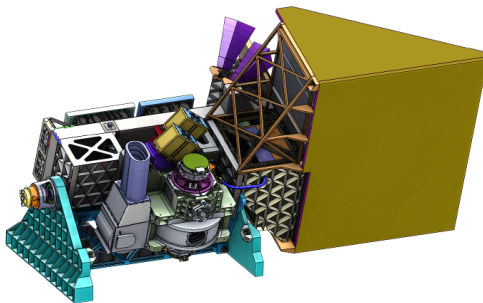
Water quality and clarity (e.g. drinking water, recreation & tourism - beach closures, Navy diving operations)

- *From California to Maine and Florida to Michigan, we've seen an increase in the occurrence of harmful algal blooms in recent years, along with an increase in their harmful effects, such as the shutdown of the Toledo water supply for two days. LimnoTech provides enhanced real-time monitoring, data management and communications systems to disseminate critical information to water resource managers and stakeholders.* – Scott B. Bell, Vice President of LimnoTech
- *'I live in east central Illinois and use these products for outdoor recreation. I kayak on rivers and Lake Michigan (itself an inland sea), and when I realized I could check the water quality, it made a big difference in when and where I go kayaking and/or deep-water swimming.'*
– Aisha Sobh, concerned citizen

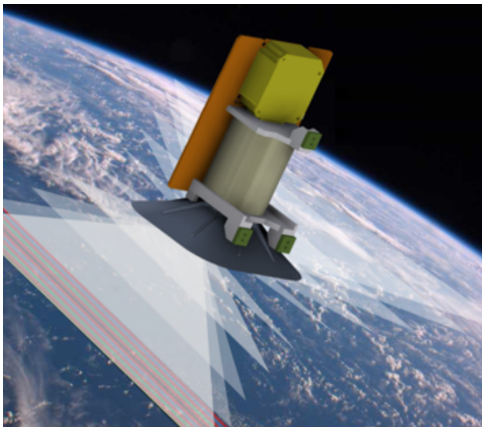


PACE observatory design concept. Ocean Color Instrument (OCI) is at top. Two polarimeters (HARP2, SPeXone) are located at far right, below the OCI. Folded solar panels are shown at far left.

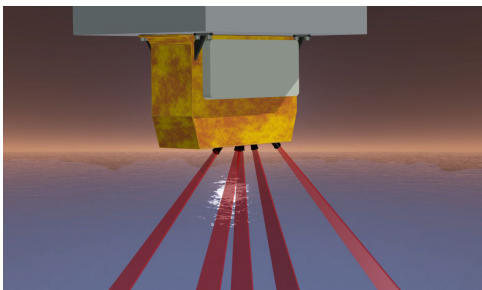
The PACE observatory and OCI are being built by Goddard Space Flight Center.



PACE's OCI is a highly advanced optical spectrometer that will enable continuous measurement of light at finer wavelength resolution than previous NASA satellite sensors.



HARP2 polarimeter is being contributed by the University of Maryland, Baltimore County. It will provide cloud-observing capabilities beyond those required by the OCI, along with wide-swath aerosol observations.



SPeXone polarimeter is being contributed by SRON Netherlands Institute for Space Research and Airbus Defence and Space Netherlands. It will be excellent for aerosol characterization and address aerosol climate objectives beyond those required of the OCI.