Frequently Asked Questions

1. What is PACE?

Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) is a NASA ocean color satellite mission that will continue and advance our 20 year record of global ocean biology as well as measuring aerosols and clouds. PACE will build upon the legacies of the NASA CZCS (1978-1986), SeaWiFS (1997-2010), MODIS (Terra, 1999-present; Aqua 2002-present), and Suomi NPP VIIRS (2012-present), among others.

2. Why do we need PACE?

PACE will include the first global spectrometer enabling continuous measurement of light at finer wavelength resolution than ever before, from the ultraviolet to shortwave infrared. Advanced hyperspectral instrumentation will allow scientists to resolve the complex role of interrelated Earth systems – aerosols, clouds, and phytoplankton - and their impact on climate feedbacks and human health, which is not possible with heritage ocean color satellites. Data from PACE will be used to identify harmful algal blooms and improve understanding of air quality. PACE data will benefit society, especially sectors that rely on water quality, fisheries and food security.

3. What are phytoplankton and why should I care about them?

Phytoplankton are microscopic plants and algae that we can see from space through their influence on the color of the ocean. Through photosynthesis, phytoplankton convert sunlight and carbon dioxide into oxygen, energy, and food. In addition to their critical role for ocean life as the base of the marine food web, they produce about half of the oxygen on Earth. When they die and sink to the deep ocean, their carbon is stored away from the atmosphere for hundreds to thousands of years, depending upon the ocean circulation where they sink.

4. What are aerosols and why should I care about them?

Aerosols are airborne particles such as dust, pollen, smoke and haze, of both natural and human causes. They can be microscopic or larger. Some reduce air quality, leading to asthma and respiratory distress among vulnerable people. Aerosols also impact the amount of solar energy reaching Earth by absorbing and scattering incoming radiation and through their role in cloud formation. While certain types of aerosols act as seeds for cloud droplet growth, the impact of human-produced aerosols on cloud growth and climate impact is not completely understood.

5. Why study microscopic phytoplankton from space?

The ocean is huge. Ships are small and expensive to operate, leaving the ocean largely unexplored. Satellites provide a broad view of the ocean’s surface in space and time. This capability has revolutionized our understanding of phytoplankton blooms and mechanisms that cause them, including seasonality and year-to-year variability. Measurements collected at sea are still important for calibrating what satellites observe and giving a view below the surface.

6. Are phytoplankton all the same?

No, phytoplankton come in different shapes, colors, sizes, and nutritional value. Some are beneficial and some are harmful. Toxic blooms consumed by fish and shellfish can then hurt or *kill whoever eats them (i.e. marine mammals, sea birds, people). Too many good phytoplankton can also be bad for the ecosystem if grazers cannot consume them all and their decomposition uses up the oxygen in the water and creates 'dead zones' such as in the Gulf of Mexico. Current satellites show us where phytoplankton are blooming, but cannot tell us what kinds are there. With PACE, NASA will be able to provide information about the diversity of phytoplankton and how they change in different areas to assist decisions by resource managers, policy makers and operational users to save lives and resources and improve food security.*

7. How do warming and pollution impact phytoplankton?

The ocean absorbs extra heat, carbon dioxide and other byproducts of modern living. We know these stressors impact ocean life, but predicting how they interact over long time requires further research into the details of many different mechanisms. For example, the absorption of carbon dioxide changes ocean chemistry and makes it corrosive to coral and shellfish. Through laboratory and modeling studies, we know that some species adapt to a changing environment and some do not. This will influence fisheries yield and how much carbon the ocean can continue to remove from the atmosphere. PACE will give us the ability to observe changes from space related to ocean health, fisheries, water quality and seaside infrastructure.

8. Can we stimulate phytoplankton blooms to remove extra atmospheric carbon dioxide and send it to the deep ocean?

This idea is based on the concept that phytoplankton blooms convert carbon dioxide into organic matter, which can sink into the deep ocean as dead phytoplankton or fecal matter from larger organisms. Targeted experiments have been conducted in ocean areas where phytoplankton growth is limited by the lack of iron. These studies found that adding iron stimulated growth of phytoplankton and large blooms. This fertilization, however, led to unintended consequences such as shifts in the kinds of phytoplankton growing. More research is needed to understand the nature of changes in the ecosystem and how they impact long term carbon storage. Modeling studies indicate that the benefit of such carbon removal may not be long-term. Thus, the international community enacted a moratorium on dumping nutrients such as iron into the sea.

9. How is PACE different from current ocean color satellites?

Existing ocean color sensors enable us to quantify total surface vegetation by the amount of their green pigment chlorophyll without distinguishing the types of phytoplankton. With PACE, we will detect the subtle changes in composition that are predicted by laboratory and modeling studies. An analogy on land would be a forest turning into a meadow. Current ocean color remote sensing capabilities cannot distinguish similar ocean biomes, while PACE is being designed for that purpose. Additionally, PACE observations of aerosols and clouds will help answer questions about these interrelated atmosphere-ocean systems and their roles in climate and human health.

10. Can we use the same technology as PACE to look for life on other planets?

Yes! There is still a lot we don't know about life in our ocean, but methods we develop to search for life on Earth can help us in our search for life elsewhere in our solar system and beyond. Advanced engineering being developed for PACE demonstrates a quantum leap in technology. *Applying these innovative technologies to planetary missions within our own solar system (i.e. moons of Jupiter and Saturn, dwarf planets) will help us answer whether we are alone. PACE technology and the resulting discoveries may also inform future efforts to look for life on planets outside our solar system, when the time comes for a closer look.*