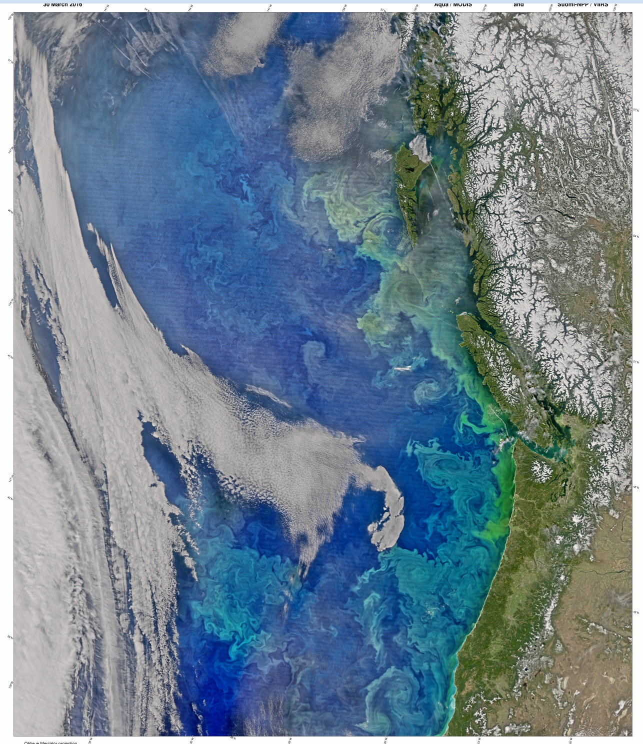
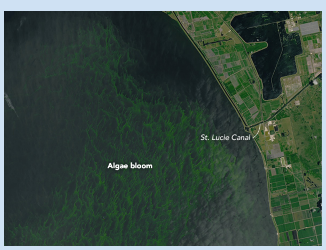
Science & Applications

Combining PACE data with other observations and models, scientists will study how marine ecosystems are impacted by nutrient and carbon cycling in the Earth system to answer fundamental questions about algal blooms, how the ocean stores carbon and the ocean's role in climate processes.



The American Pacific Northwest is at increasing risk from ocean acidification and reduced oxygen content with warming. Image from MODIS/VIIRS composite collected on March 30, 2016 via NASA GSFC Ocean Biology Processing Group.

Observing phytoplankton communities and the ocean's response to changes helps us better plan for disruptions such as harmful algal blooms.



Lake Okeechobee, Florida toxic blue-green algae bloom visible In July 2, 2016 OLI/Landsat 8 natural color image via NASA Earth Observatory.

NASA Goddard Space Flight Center ensures the accuracy of ocean color satellite data and makes it available to users around the world since 1989. PACE builds on a legacy of NASA Goddard ocean color missions such as SeaWiFS (1997-2010).

After its launch in 202**4** and for at least three years, PACE will measure global phytoplankton diversity, airborne particles and clouds for advanced applications of ocean ecology and climate.

PACE is implemented by NASA Goddard, who manages the project, designs and builds the Ocean Color Instrument and spacecraft, runs operations and science data processing.

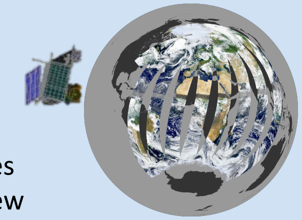
NASAOcean *pace.gsfc.nasa.gov*

www.nasa.gov NP-2016-9-490-GSFC

National Aeronautics and Space Administration

Mission Overview

Over the past century, humans have accelerated the use of natural resources such as fossil fuels, old growth forests and groundwater. This has warmed the ocean and atmosphere, changed their chemistry and caused extra runoff from land. From analysis of data collected by satellites and sensors over the past few decades, we know these multiple stressors impact microscopic life in the ocean as well as airborne particles and clouds, but we do not know to what extent or whether changes will reach a tipping point. The new Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will measure and help resolve the complex role of these interrelated Earth systems and their impact on fisheries, ocean chemistry and nutrients, climate feedbacks and human health.



Ocean Color

PACE will primarily monitor the health of our ocean through biological and chemical properties derived from the observed light properties of the water.

Aerosols and Clouds

Detailed remote sensing of the atmosphere will include airborne particles - such as dust, smoke and pollution - to study their role in cloud formation and to correct the ocean color scenes.

Advanced Engineering

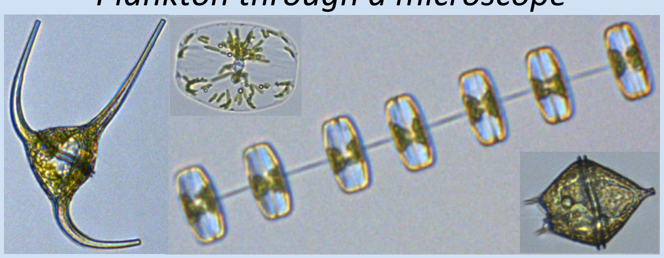
The main sensor on PACE, Ocean Color Instrument, will sense over an exceptionally broad spectrum of wavelengths with *hyperspectral* resolution enabling PACE to take the most advanced global observations of phytoplankton communities, including where they live and how they move or change.

How healthy is the ocean?

Ocean ecosystem health depends upon what's in it, which in turn determines how visible light is transmitted or absorbed. Satellites measure the visible light spectrum of the ocean's surface to detect **chlorophyll**, a green pigment in phytoplankton – microscopic algae.

Phytoplankton form the base of the marine food web and create about half of Earth's oxygen. Where they bloom - and which kind – impacts fisheries, water quality and how much carbon dioxide ocean biology draws out of the air.

Plankton through a microscope

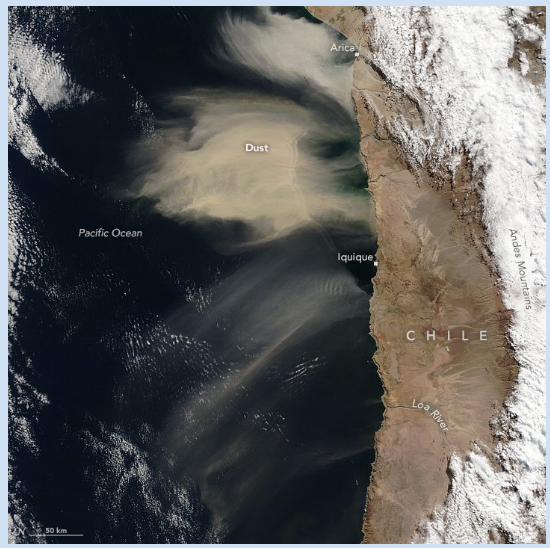


Different colors, shapes, sizes of phytoplankton in the ocean

PACE will be used to distinguish kinds of phytoplankton around the world and how they change over space and time.

What is the impact of aerosols on climate?

Tiny particles lofted into the atmosphere from natural and human sources, called aerosols, can reflect or absorb incoming solar radiation and change the amount of sunlight received on Earth. Aerosol types such as dust, smoke and dirty urban pollution absorb radiation and heat the atmosphere. Mineral dust from deserts can be blown over the ocean where it may fall and fertilize plankton blooms.



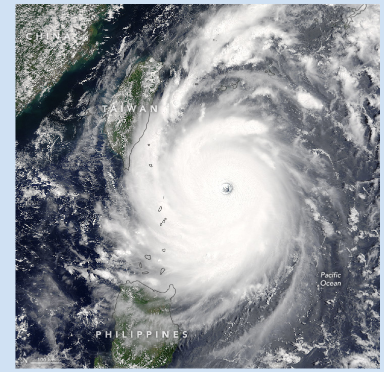
South America in July 8, 2016 MODIS/Terra natural color image of airborne dust off the coast of Chile via NASA Earth Observatory.

Quantifying the absorption of sunlight by aerosols globally at high resolution will be a new capability with PACE. Looking simultaneously at ultra-violet, visible, near-infrared and short-wave infrared wavelengths will reveal aerosol types, sizes and absorption levels.

How do aerosols contribute to cloud formation?

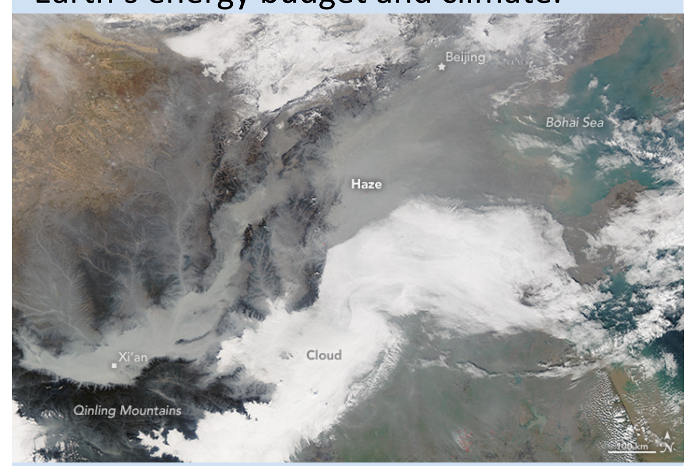
Clouds strongly impact the transfer of radiative energy (e.g. solar and infrared) into and out of the planet.

Cloud particles form around aerosols. How cloud properties are modified by aerosols from human sources is an important open question.



Clouds associated with Typhoon Nepartak neared Taiwan on July 7, 2016 in this MODIS/Terra natural-color image via NASA Earth Observatory.

Advanced measurements of aerosols and clouds by PACE will aid understanding of cloud processes and how they impact Earth's energy budget and climate.



Thick haze over eastern China in December 7, 2015 MODIS/Aqua natural-color via NASA Earth Observatory. The haze extended southwest from Beijing for hundreds of kilometers. Authorities in Beijing issued the first "red alert" for air pollution during this event.