PHYTOPLANKTON
& Climate Change

Phytoplankton are the ocean's primary producers, basic food source and carbon recycler—even a slight change in their productivity could affect the world's climate. NASA's North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) is collecting data on the complete plankton cycle for a better understanding of its impact on ecosystem change. For more on optics and the health of our oceans, see "Optics in Oceanography," beginning on p. 34.

A **bloom** takes place when phytoplankton reproduce at a rapid rate, multiplying quickly in a short amount of time.

Atmospheric oxygen that comes from phytoplankton is estimated to range from **50–85%**

MINIMUM OF THE PLANKTON CYCLE
Winter 2015

INCREASING BIOMASS
Spring 2018

NAAMES is studying the **4 PRIMARY PHASES** of the annual plankton cycle in the North Alantic

CLIMAX OF THE PLANKTON BLOOM
Summer 2016

DECREASING BIOMASS
Autumn 2017

Phytoplankton possess less than **1%** of total global vegetation biomass, but account for **~45%** of plant productivity and **40%** of carbon sequestration

As the ocean surface warms in response to **increasing greenhouse gases**, there is less vertical mixing of nutrients from deep waters, and phytoplankton productivity is predicted to decline.

Findings from NAAMES deployments have already confirmed a **shift in the annual cycle** of the phytoplankton bloom and **lack of larger-sized plankton** during peak bloom.

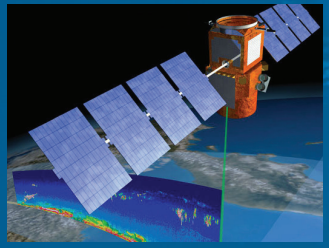
Observing Plankton Productivity

By combining ship, airborne, computer modeling, satellite and autonomous sensor data with a multi-season observational strategy of phytoplankton, NAAMES scientists hope to improve predictions of how the Earth's ecosystem is changing over time.

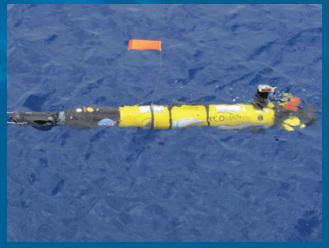
SHIP-BASED
Woods Hole Oceanographic Institute's Atlantis provides detailed characterization of plankton stocks, rate processes and composition, and also analyzes sea water volatile organic compounds and gases and particles in the overlying atmosphere.

AIRCRAFT-BASED
NASA's C-130 Hercules characterizes the properties of atmospheric particles, gases and clouds, and captures broad-scale ocean properties around the ship, providing the link between local ship-based and larger satellite-based measurements.

SATELLITE
Satellites like CALIPSO, a joint NASA and CNES mission, use lidar to see through the layers of the atmosphere—providing large-scale analysis from clouds and atmospheric particles in the sky to the depths of the phytoplankton bloom.



IN-SITU OCEAN SENSORS
Autonomous floats and drifters like the Ecomapper tie together data from NAAME's four seasonal campaigns for a comprehensive story of the North Atlantic phytoplankton bloom and its important implications on aerosols, clouds and climate.



Background: 6 July 2016 phytoplankton bloom in the Barents Sea / NASA image by Jeff Schmaltz and Joshua Stevens
Sources: NASA, https://naames.larc.nasa.gov, https://climate.nasa.gov, Opt. Express **26**, A293-A300 (2018) / Infographic by Alessia Kirkland