





# NAAMES: *Linking Plankton, Aerosols, Clouds & Climate*

## NAAMES Mission Overview:

The North Atlantic plankton bloom is among the most conspicuous biological events that is recorded each year by satellite ocean color measurements. Yet, the science underpinning how this bloom comes about remains highly controversial! For example, does the bloom begin in springtime as is traditionally thought, or does it actually begin in the autumn as suggested by a new, emerging theory based on the satellite record? Unless we can resolve this scientific impasse, it will be impossible for society to assess how future climate changes will affect the carbon cycle, ocean management practices, and the feedback between ocean-derived atmospheric particles and clouds. NAAMES is a 5-year study employing ship, aircraft, float and drifter, and satellite observations across the annual plankton cycle to resolve these important processes in the North Atlantic Ocean.

Four field campaigns constitute the core of the baseline NAAMES mission, with each campaign aligned to a specific event in the annual plankton cycle. Ship-based measurements provide detailed characterization of plankton stocks, rate processes, and community composition. Ship measurements also characterize seawater volatile organic compounds, their processing by ocean ecosystems, and concentrations and properties of gases and particles in the overlying atmosphere. These diverse data are extended over broader spatial scales through airborne remote sensing measurements and in situ aerosol sampling. The airborne data provide the crucial link between local-scale processes and properties quantified at the basin-scale through satellite remote sensing. Satellite data and in-water autonomous sensor measurements create the sustained observational record for evaluating climate-ecosystem model results and for testing how far into the future current models can accurately predict outcomes.

Through this integration of ship, airborne, modeling, and sustained satellite and autonomous sensor approaches, conflicting hypotheses on system functioning are resolved and predictions of ocean ecosystem and aerosol changes in a future warmer ocean are improved.

## NAAMES Instruments:

All NAAMES ship, aircraft, and autonomous in situ measurements are conducted using mature instruments with extensive field deployment histories. To resolve the competing theories on ocean ecosystem drivers, eighteen NAAMES instruments target the following core ocean ecosystem properties:

- ➡ Phytoplankton Biomass
- ➡ Phytoplankton Division Rate
- ➡ Phytoplankton Loss Rate
- ➡ Phytoplankton Accumulation Rate
- ➡ Ecosystem Spatial and Temporal Variability
- ➡ Zooplankton Biomass
- ➡ Zooplankton Feeding Rates
- ➡ Viral Infection Rates
- ➡ Ecosystem production and consumption of aerosol precursors
- ➡ Composition of Phytoplankton, Zooplankton, Virus and Bacterial Communities
- ➡ Transfer of aerosols from the ocean to atmosphere

Meanwhile, twenty-five NAAMES instruments are used to constrain aerosols and their precursors, with specific focus on the following atmospheric properties:

- ➡ Aerosol and Trace Gas Composition
- ➡ Aerosol and Microphysical Properties
- ➡ Cloud Microphysical Properties
- ➡ Continental and Anthropogenic Influences
- ➡ Aerosol Spatial and Temporal Variability

Part of the NAAMES payload includes state-of-the-art remote sensors that reflect the next generation of NASA spaceborne Earth observing system:

- ➡ NASA Langley Research Center (LaRC) High Spectral Resolution Lidar (HSRL)
- ➡ NASA Goddard Institute for Space Studies (GISS) Research Scanning Polarimeter (RSP)
- ➡ NASA Goddard Space Flight Center (GSFC) GEO-CAPE Airborne Simulator (GCAS)
- ➡ NASA Ames Research Center (ARC) Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)

A complete list of the specific instruments can be found on the NAAMES Website:

<http://naames.larc.nasa.gov>

## NAAMES Platforms:

NAAMES ship-based measurements are conducted on the University-National Oceanographic Laboratory System (UNOLS) R/V *Atlantis* based in Woods Hole, MA. Airborne measurements are performed on NASA's C-130 Hercules aircraft based at St. John's International Airport in Newfoundland, Canada.

## NAAMES Baseline Science Objectives:

- ➡ **Objective #1:** Characterize plankton ecosystem properties during primary phases of the annual cycle in the North Atlantic and their dependence on environmental forcings.
- ➡ **Objective #2:** Determine how primary phases of the North Atlantic annual plankton cycle interact to recreate each year the conditions for an annual bloom.
- ➡ **Objective #3:** Resolve how remote marine aerosols and boundary layer clouds are influenced by plankton ecosystems in the North Atlantic.

