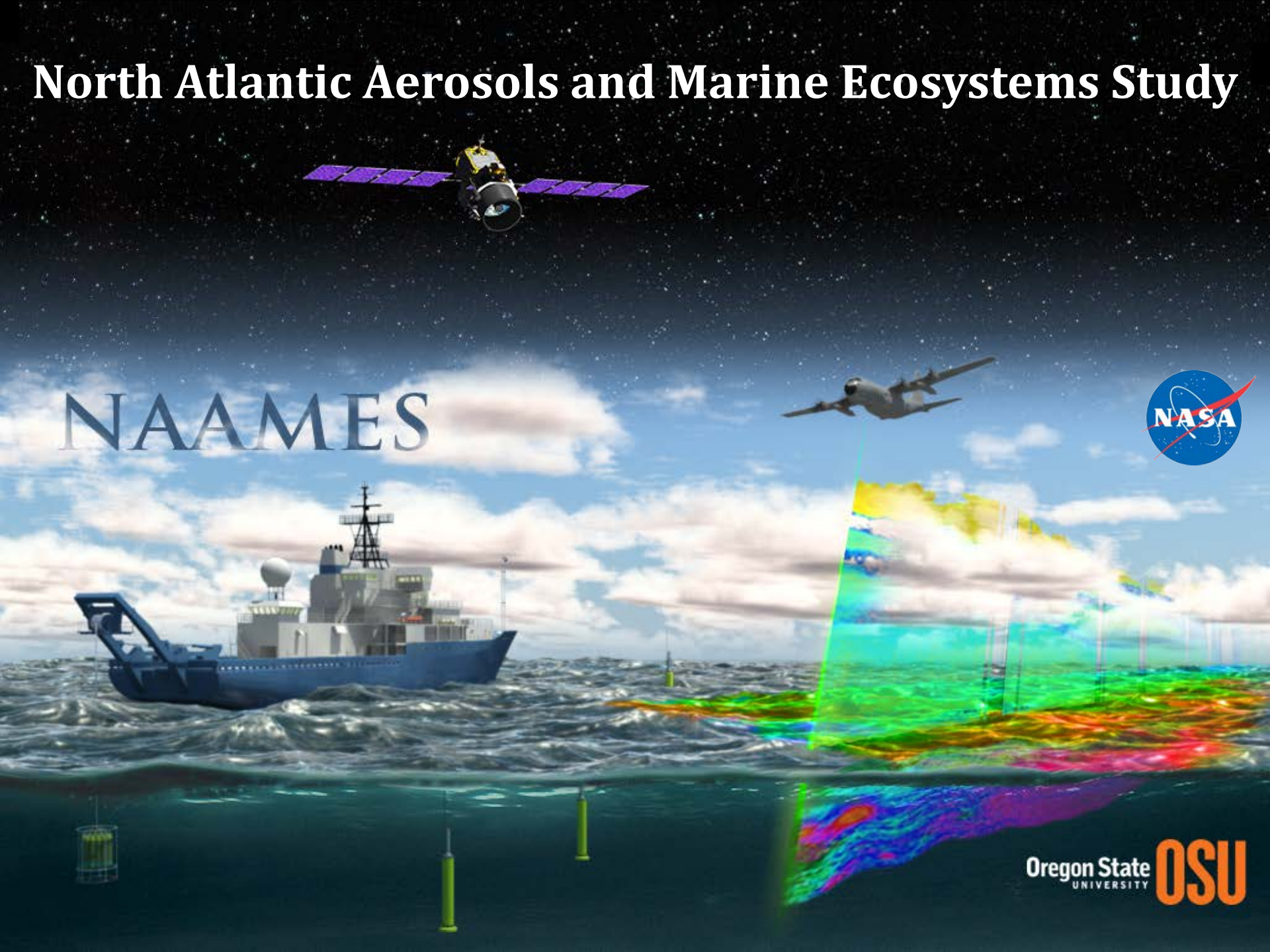
North Atlantic Aerosols and Marine Ecosystems Study



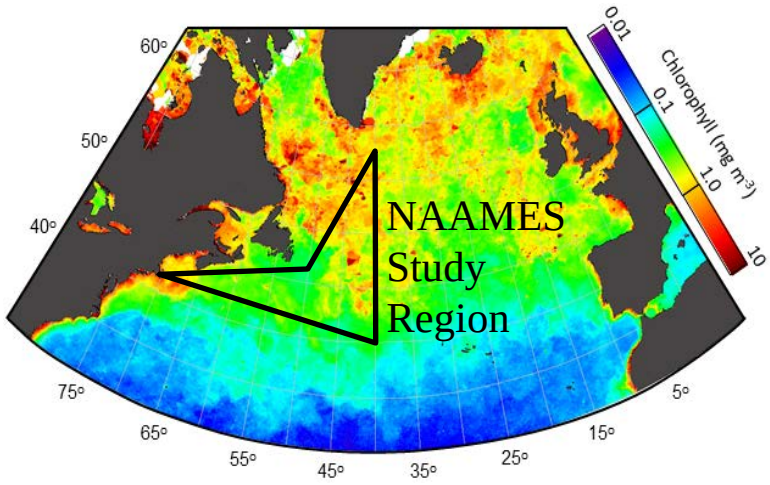
- The annual cycle of North Atlantic plankton recreates each year one of the largest blooms in the global ocean.

"What are the primary ecological and physical interactions governing the annual plankton cycle and its secondary variability?"

- The North Atlantic bloom is associated with significant biogenic aerosol loads, with long-distance transport

"What properties of plankton assemblages are most important in understanding remote marine aerosols and boundary layer clouds over the annual cycle?"

North Atlantic Phytoplankton Bloom



NAAMES in a Nutshell

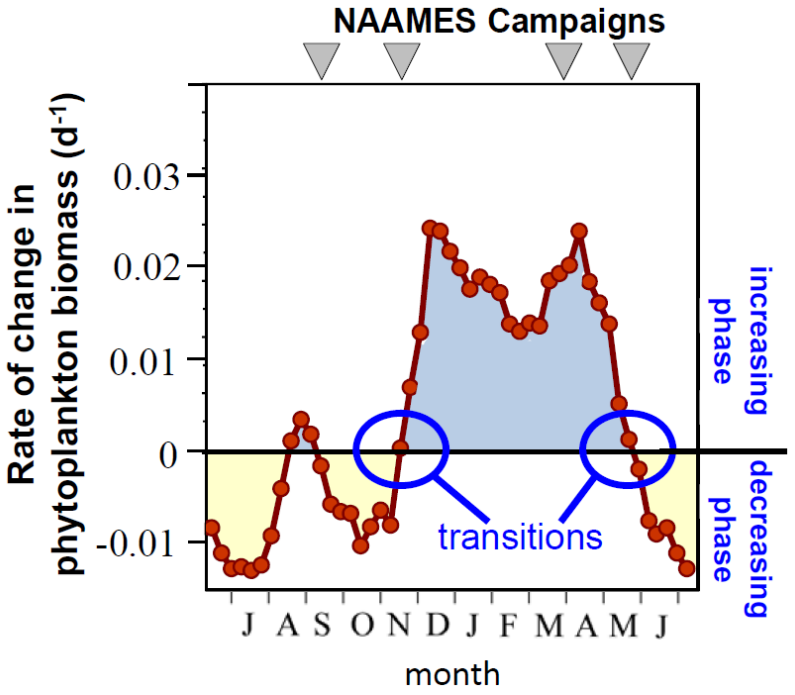
- **Four Field Campaigns**: Each focused on 4 key periods of the annual plankton cycle

  Bloom initiation: *November-December* (2015)
  Accumulation phase: *March* (2018)
  Bloom climax: *May-June* (2016)
  Deceleration phase: *September* (2017)

- **Natural Latitudinal Gradient:** North-South gradient in event timing allows sampling of diverse 'states' during campaigns

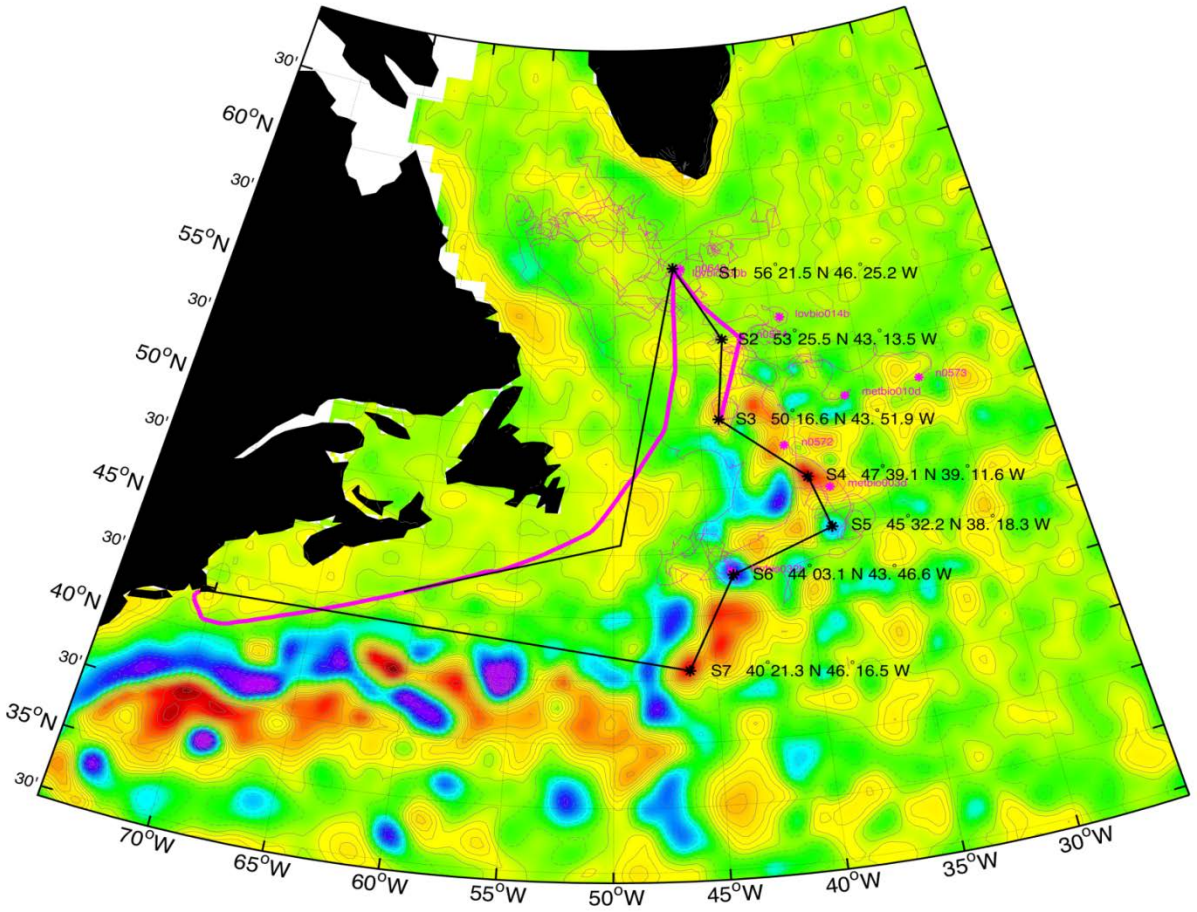
- **Diverse Assets**: Ships, Aircraft, Autonomous Platforms, Satellites, and Supercomputing

- **Five Year Study**: Ramp-up, Campaign #1 & #2, Intermission, Campaign #3 & #4, Wrap-up



Cruise Profiles

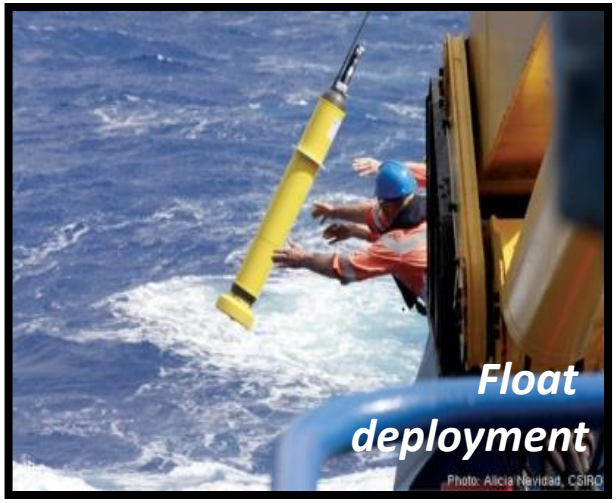
Placement of Intensive Stations in Physical Field



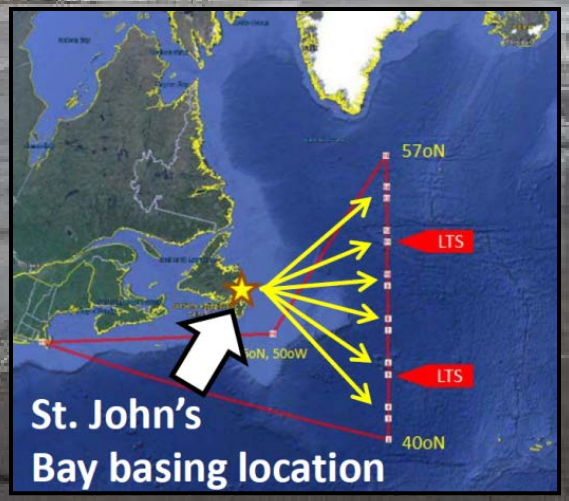
- **Ocean Biological Measurements**: Biological composition & stocks, rates of production, accumulation, and loss processes
- **Aerosol Measurements**: Concentrations and production rates of aerosol precursors in the surface ocean, sea-air transfer rates, lower troposphere biogenic aerosol concentrations/properties
- **Optical Measurements**: Inherent optical properties, apparent optical properties, water leaving radiance spectra - *optical measurements link in-situ data to remote sensing*

- **Autonomous Assets:**

1) 'Bread Crumb Trail' for airborne observations
2) Sustained observations post-campaign
3) 'Weather Forecasting': What is the predictive capacity from ship measurements ('ecological forecasting' skill)?



Airborne Measurements

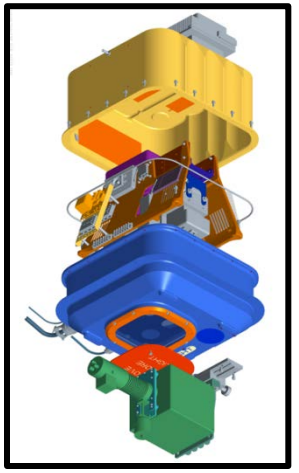






HSRL

GCAS



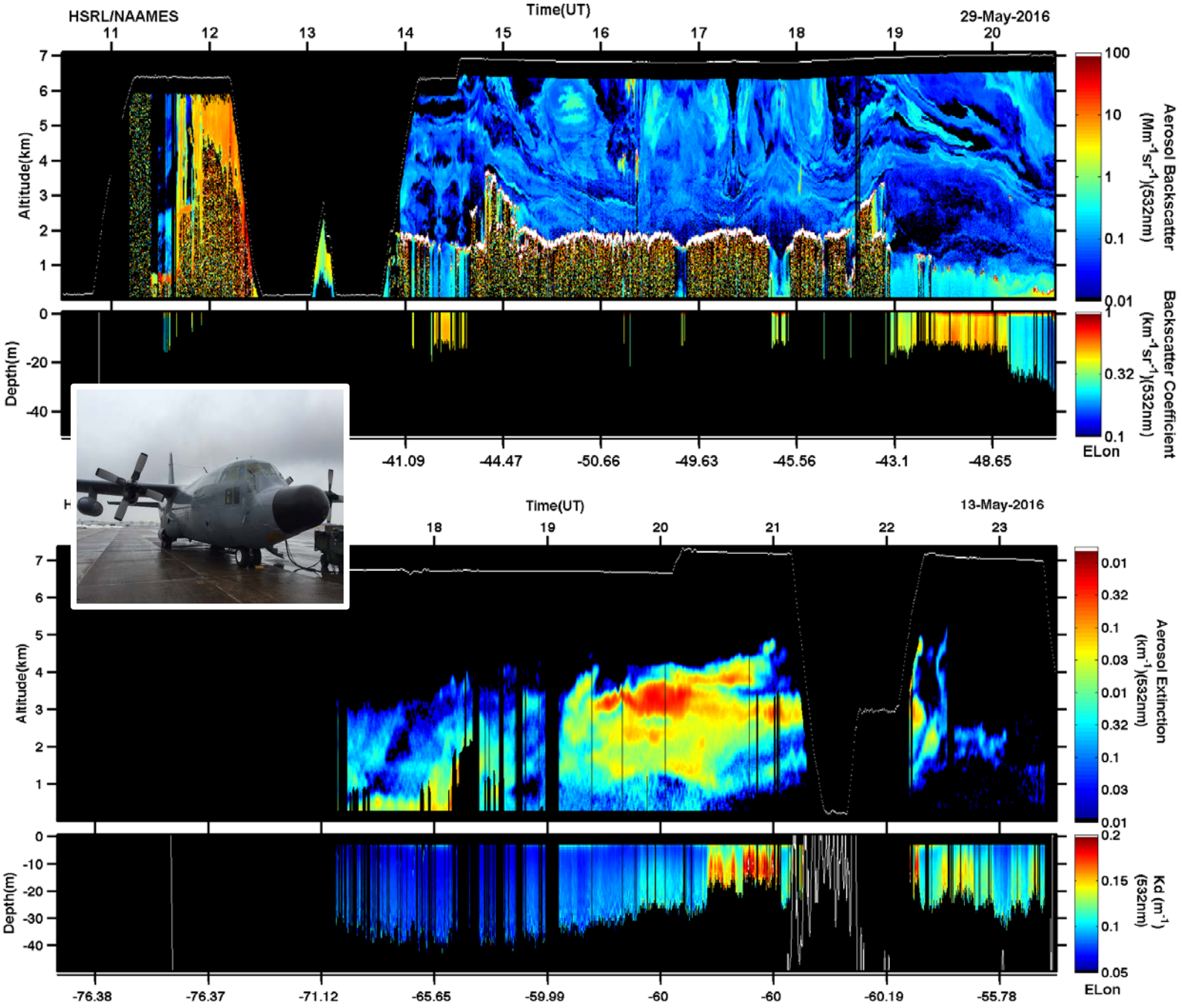
- LARGE: Suite of instruments measuring in situ aerosol concentrations and properties
- High Spectral Resolution Lidar (HSRL): Vertical profiling of clouds, aerosols and ocean plankton
- Research Scanning Polarimeter (RSP): Wide-swath, column-integrated cloud, aerosol, and plankton properties

RSP

4STAR

- GeoCAPE Airborne Simulator (GCAS): Plankton and carbon stocks from hyperspectral ocean color measurements
- Spectrometer for Sky-Scanning Sun-Tracking Atmopheric Research (4STAR): Downwelling sunlight and atmospheric chemical composition

Airborne Lidar Measurements



Campaign #1

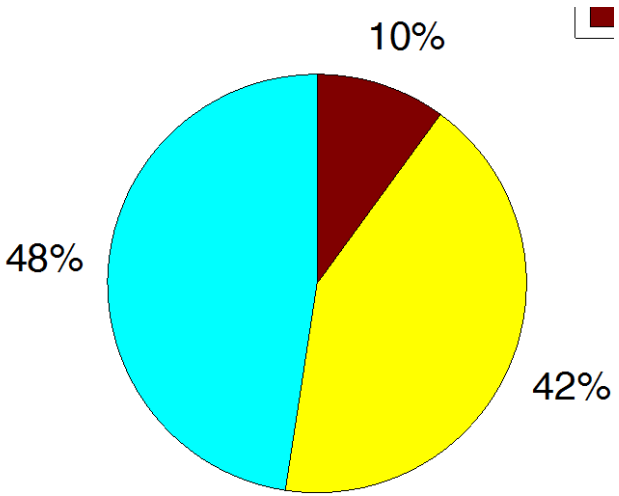
Highlights (preliminary)

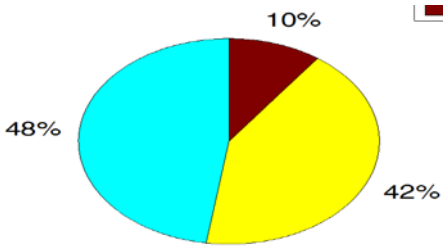
- Phytoplankton concentrations were low, populations were diverse
- Phytoplankton division rates were generally greater than loss rates (i.e., the blooming phase was already beginning)
- Some of the lowest aerosols ever measured (major potential for cloud effects)
- Aerosols were a mixture of sea salts and continental/marine organics

Campaign #2

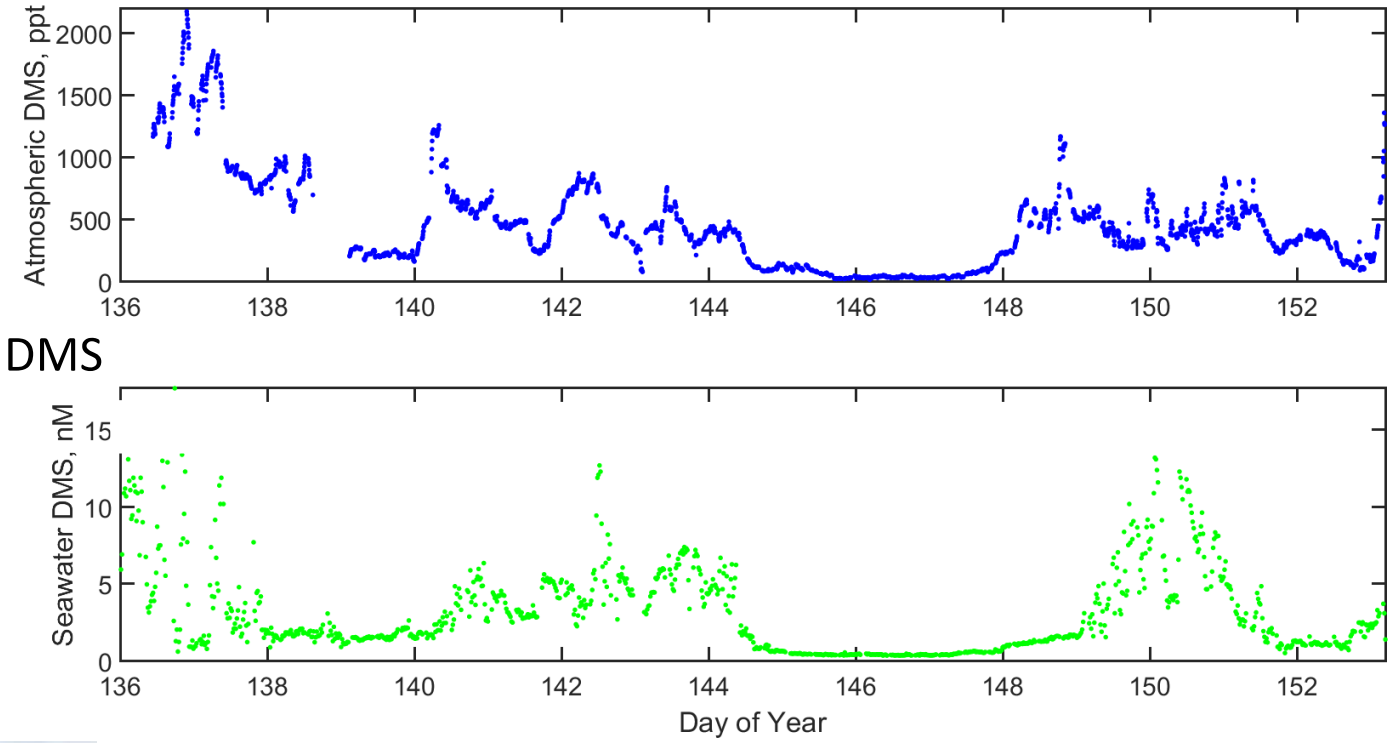
Highlights (preliminary)

- Phytoplankton concentrations near bloom climax, populations were diverse but not dominated by diatoms
- Phytoplankton division and loss rates were both elevated, giving accumulation rates similar to November
- Aerosol levels elevated with significant marine biogenic component
- Witnessed a ‘disturbance - recovery’ event, and documented evolution of plankton populations and biogenic aerosols



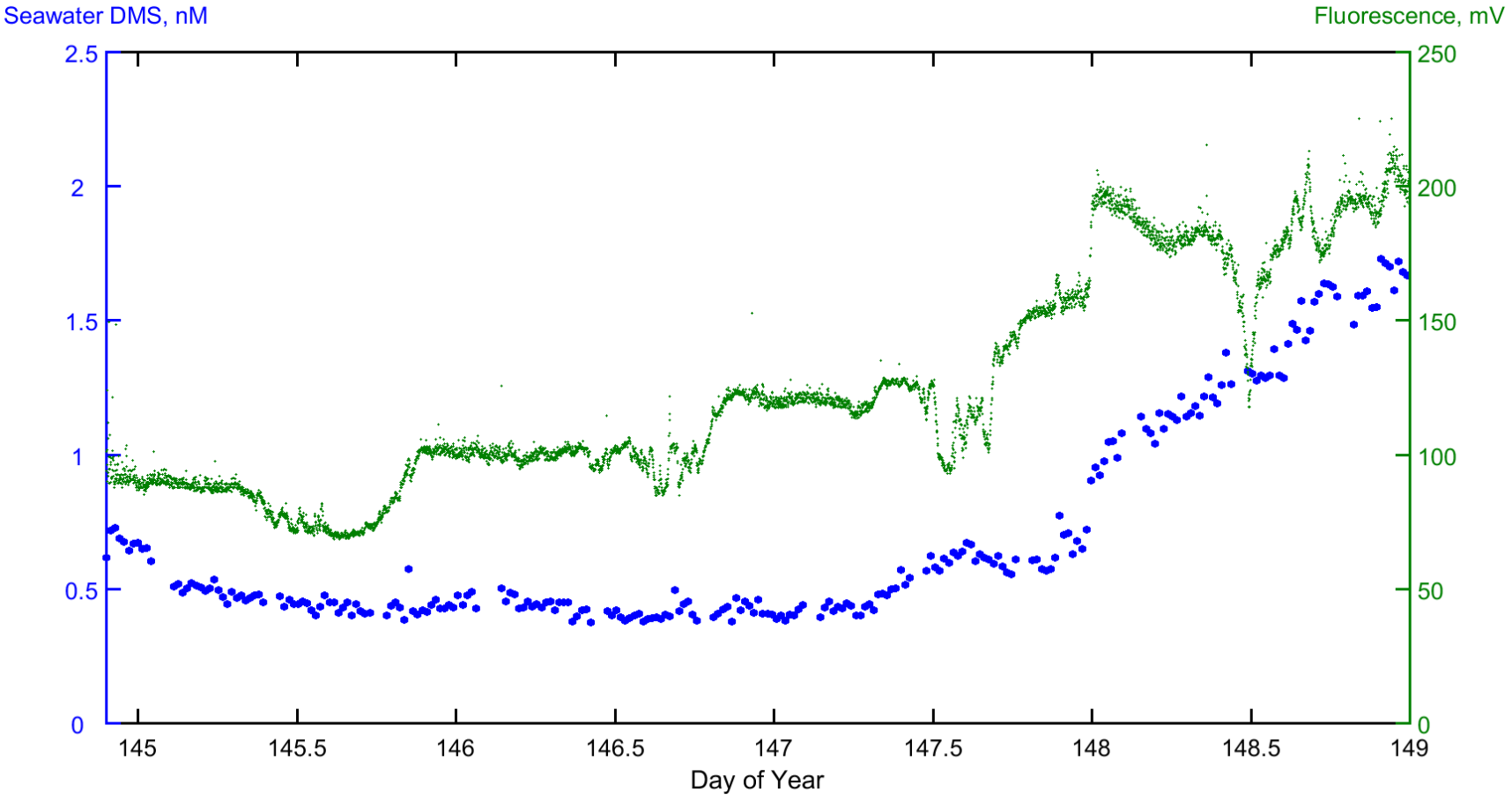


Marine Biogenic Aerosols



Thomas Bell, UCI / Tim Bates, NOAA

Disturbance-Recovery Event



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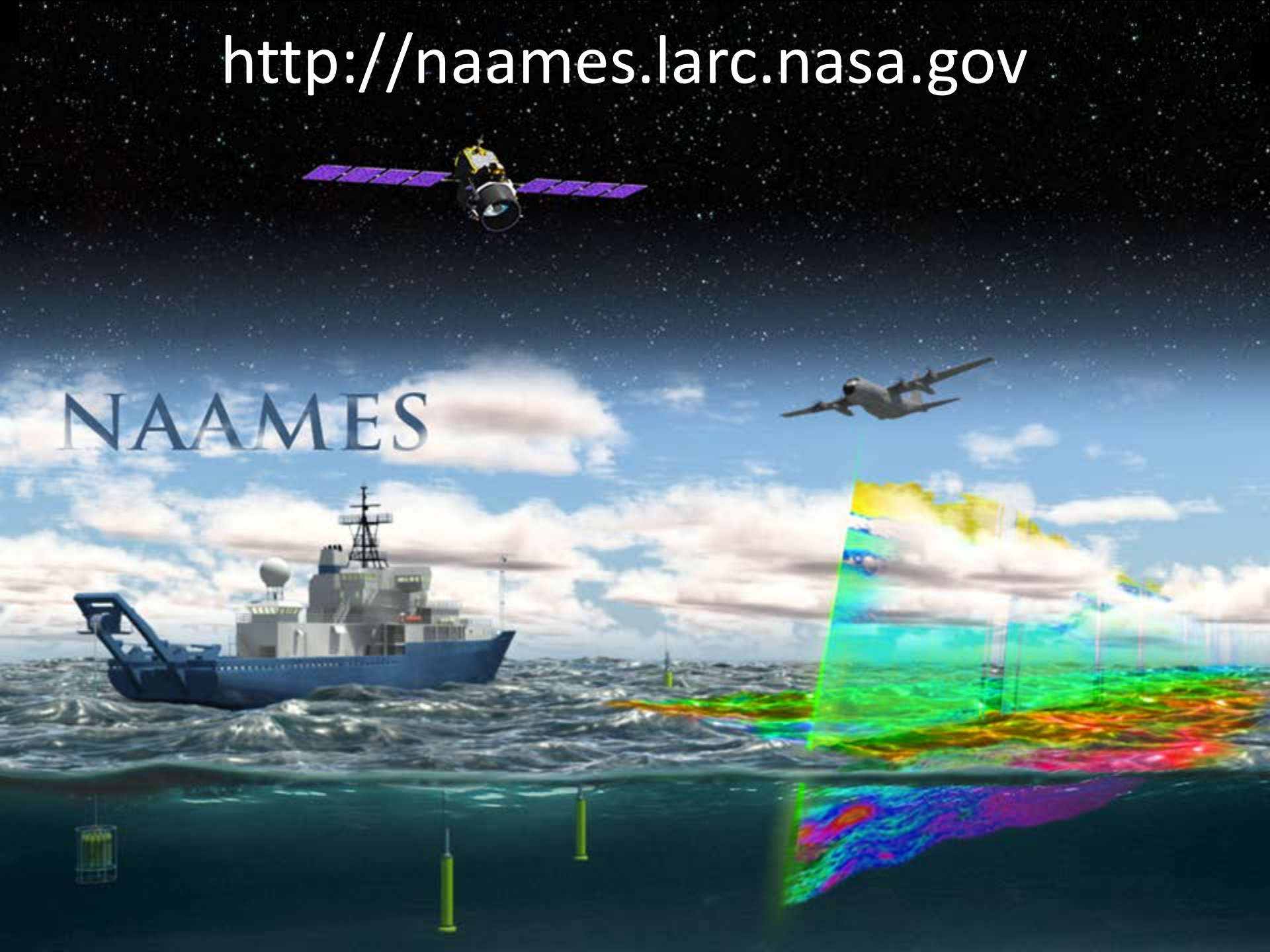
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