U.S. NAVAL RESEARCH LABORATORY

Remote Sensing of the Coastal Arctic

COASTAL AND OCEAN REMOTE SENSING BRANCH (CODE 7230)

AT A GLANCE

Why the Arctic?

Environmental changes are expected to lead to increased activities in the in the Arctic maritime environment. Understanding, quantifying, and monitoring these changes are crucial for operational readiness and strategic awareness.

What are we doing?

Using passive optical, lidar, and radar measurements from *in situ*, airborne, and spaceborne platforms to quantify changes in the coastal Arctic terrain and the coastal Arctic Ocean.

What are the goals?

(i) Collect data to characterize the environment.
(ii) Develop remote sensing algorithms.
(iii) Establish data- and model-based frameworks to understand, monitor, and predict environmental changes land-ocean interactions in the Arctic.

R&D Sponsor

ONR, NASA, and NOAA

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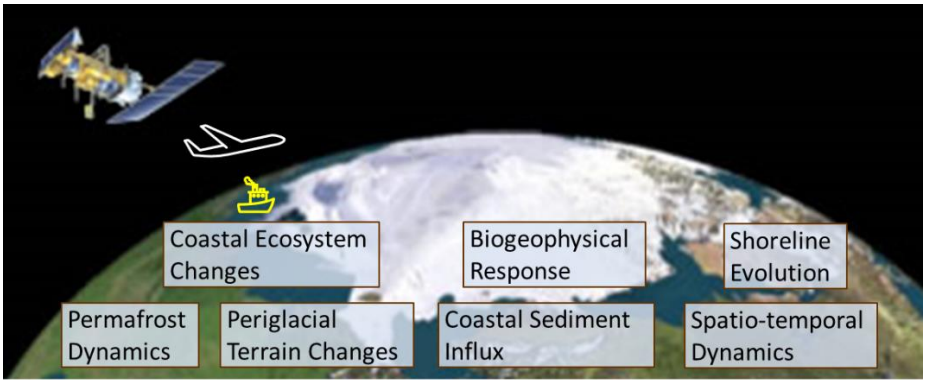
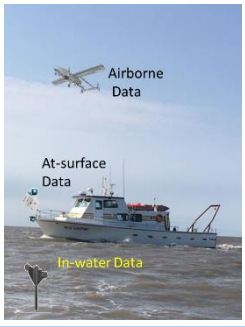


In response to the rapidly occurring environmental changes in the Arctic, the Coastal and Ocean Remote Sensing Branch is conducting research focused on quantifying, understanding, and monitoring changes in the coastal Arctic region, specifically the North Slope region of Alaska. Understanding the terrestrial and aquatic biogeophysical and chemical processes driving and resulting from the environmental changes, monitoring them, and forecasting them are crucial to our nation's readiness to maintain strategic awareness and operate in the Arctic. To this end, NRL is leading several projects dealing with collecting measurements of bio-optical and geophysical properties of the coastal terrain and the coastal ocean, understanding linkages between terrestrial and aquatic processes, and developing algorithms for retrieving critical biophysical parameters from remote sensing data.

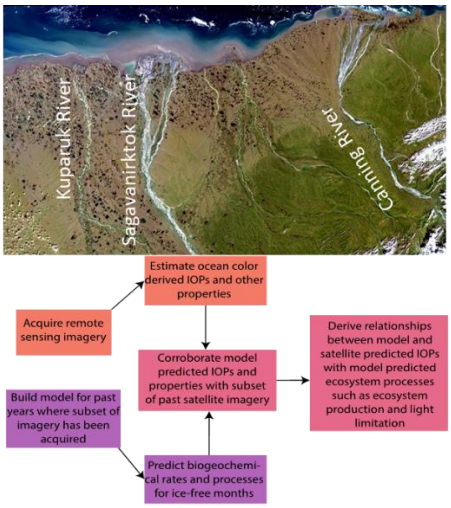
Optical Characterization of Coastal Arctic Waters

Objective: Characterize the optical properties of coastal Arctic waters and thoroughly investigate the components of their remote sensing signal, in preparation for future development of Arctic-specific remote sensing tools.



We use a combination of instruments deployed into the water column, from the water surface, and from an airborne platform to measure concentrations of optically significant constituents in water, their biophysical composition, and their optical and radiometric properties. Focusing on coastal waters near and around the mouths of the three main rivers that drain the North Slope of Alaska, these measurements are used to characterize the bio-optical properties of these waters and establish basic radiative transfer relationships needed to develop satellite-based remote sensing algorithms for coastal Arctic waters.

Study area in the North Slope of Alaska



Satellite image of the North Slope and workflow linking remote sensing data with the ecosystem model

Environmental Changes in Arctic Coastal Aquatic Ecosystems

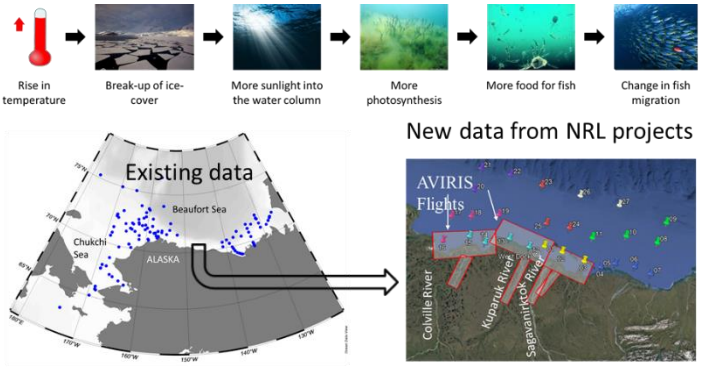
Objective: Understand how riverine materials transported into the coastal Arctic mix with ocean waters and affect primary production and phytoplankton community structure using a combination of *in situ* data, remote sensing measurements, and modeling.

As the temperatures rise and the permafrost thaws, materials released from the thawing permafrost are transported by rivers into the coastal Arctic ocean. The type and composition of the materials transported by the rivers vary depending on the watershed they drain. The influx of materials from riverine transport changes the light environment and, consequently, biological activity in the coastal ocean.

We are developing an aquatic ecosystem model that uses existing data and new measurements to model the light environment in the coastal Arctic Ocean and changes in primary production and phytoplankton community structure in response to increased influx of sediments from riverine transport.

Arctic-Specific Ocean Color Data Products

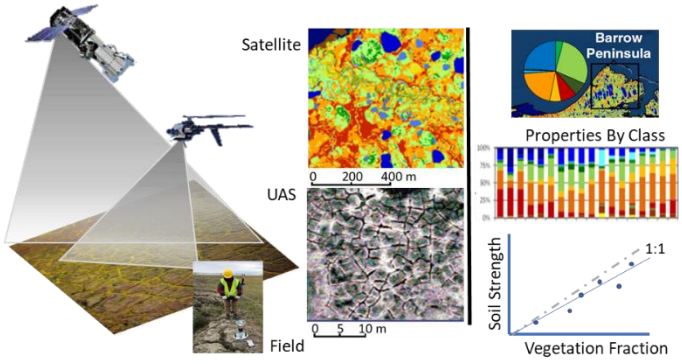
Objective: Produce satellite-based, Arctic-specific ocean color products for the Pacific Arctic region, focusing on the Chukchi and Beaufort Seas.



Accurate satellite-based retrievals of biophysical parameters are needed for monitoring biophysical changes in the Arctic Ocean and their impact on marine life. Collborating with multiple partners, we are developing Arctic-specific data products for chlorophyll-*a*, suspended particulate matter, particulate organic carbon, and light attenuation in the water column – critical parameters in fisheries forecast models.

Arctic Terrain 4D Characterization and Change Assessment

Objective: Characterize and quantify 3D physical structure, vegetation, hydrologic properties and temporal changes (4D) at local and regional scales in the Arctic periglacial/permafrost terrain, especially permafrost disturbance and erosion, using remote sensing tools.



The Arctic region is dominated by permafrost-driven features (periglacial terrain landforms), such as thaw lakes, pingos, meandering beaded streams, and ice wedge polygons, many covered with low tundra vegetation. Cycles of ground-ice formation and thawing drive hydrologic and terrain processes that create frost-heave features across the landscape, posing challenges to how humans, vehicles, or aircraft might access or traverse this landscape in the near or long term.

Based on the hypothesis that terrain features' unique characteristics such as shape, vegetation, soil, and hydro properties strongly influence the freeze/thaw patterns and control permafrost degradation, we are using a multi-platform, data-driven approach to characterize current landscape pattern, understand how it changes, and identify the most influential drivers of change.

Post-Doc Opportunity: Interested in coastal Arctic remote sensing research? Contact Wes Moses (Wesley.Moses@nrl.navy.mil) or Trina Merrick (Trina.Merrick@nrl.navy.mil)