

A multi-disciplinary and multi-institutional approach to long-term and high-resolution Arctic marine monitoring

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Advances in instrument technology now allow us to autonomously sample the marine ecosystem from the vantage of multiple disciplines and across multiple trophic levels. A coordinated set of co-located subsurface moorings on the northeastern Chukchi Sea shelf is making observations with high temporal resolution throughout the year, including the under-sampled and poorly understood seasons when sea ice inhibits ship-based sampling. We describe here our approach to mustering and maintaining the resources sufficient for operating this highly instrumented Arctic marine observatory. Through formation of a multi-institutional consortium we are able to achieve as a group far more than any single partner could alone. Led by the University of Alaska's School of Fisheries and Ocean Science, other academic partners include researchers from the University of Washington and Université Laval; Olgoonik-Fairweather is an industry partner; and agency partners are the Alaska Ocean Observing System (AOOS) and the North Pacific Research Board (NPRB).

The success and future resilience of our Chukchi Ecosystem Observatory hinges on:

- Coordinated collaboration of multiple consortium partners
- Sustained financial support over many years - but at moderate levels annually
- Surpassing some critical mass of measurements and activity beyond which new partners want to join and fuel new growth
- Selection of site and measurement parameters that will be important to many stakeholders
- A data policy based on open sharing and rapid dissemination
- Partnering with other programs for observatory servicing through shared ship operations
- Attracting new partners by offering leveraging opportunities for new applications

By achieving a certain "critical mass" of observations at the observatory site, we have been able to attract new partners and measurements that had not been associated with the initially proposed and funded project. Although still in our build-out phase, the fully outfitted observatory will simultaneously record ocean and sea ice physics, nutrient and carbonate chemistry, suspended and sinking particulate matter, phytoplankton, zooplankton, fisheries, and marine mammal data sets, thereby providing an unprecedented view into the mechanistic workings of the Chukchi shelf ecosystem. The observatory site - on the southeastern flank of Hanna Shoal and northwest of the head of Barrow Canyon - is well situated to monitor the shelf's nutrient and carbon cycles and how changing wind, wave, and ice affect the regional oceanography.

Another important aspect of securing the operating funds for the observatory is through the recognition that the observatory data are valuable to multiple stakeholders having many disparate applications. The data provide researchers and resource managers with a broad-spectrum and multi-year set of reference observations that can be applied to evaluating and improving regional and global-scale biogeochemical, ice-ocean circulation and ecosystem models. Sea ice data are important to industry and shipping interests. Data spanning multiple trophic levels are important to an ecosystem approach to resource management.

In order for the full potential of this unique dataset to be realized, we have implemented an important open data policy. Raw data are made public immediately following each recovery cruise to enable time sensitive analyses and applications; fully processed data are published as soon as practical after recovery given the requisite time lags associated with post-season factory calibrations and other unavoidable laboratory/processing bottlenecks.

A single mooring was deployed in September 2014 and recovered in August 2015, comprising the first year of the observatory in the water. The parameters recorded included: currents, temperature, salinity, pressure, significant wave height and direction, ice thickness and keel depth, chlorophyll *a* fluorescence, beam transmission, photosynthetically available radiation and acoustic backscatter at 38/125/200/455 KHz. The 2015 deployment consisted of three co-located moorings carrying an expanded set of instrumentation including a dissolved oxygen sensor, a colored dissolved organic matter sensor, a sediment trap, a passive acoustic recorder, and water column photography. Future deployments will also measure particle size spectra and concentrations as well as several carbonate chemistry parameters. We provide an overview of the CEO consortium and our approach, objectives and observatory design, and highlights from the first year's worth of data returns.