Low Cost Expendable Buoys for Under Ice Data Collection

Daniel Langis[1], Phyllis Stabeno[1], Calvin Mordy[2], Chris Meinig[1], Jessica Cross[1], Heather Tabisola[2]

[1] National Oceanic and Atmospheric Administration
[2] University of Washington Joint Institute for the Study of Atmosphere and Ocean
Pacific Marine Environmental Lab, 7600 Sand Point Way NE, Seattle, WA 98015

Conditions directly under Arctic sea ice during spring and early summer months are largely a mystery, but it is clear that` they play a critical role in shaping one of the world's most highly productive ecosystems. Massive phytoplankton blooms have been identified under Arctic sea ice (Arrigo et al., 2012), but the prevalence of such events and their impact on ocean ecology and carbon fixation is unknown (Horvat et al., 2017). Additionally, the character of the ice edge environment is changing with the loss of multiyear sea ice and overall thinning of the ice matrix, and this has complex implications for the physical and chemical systems and the attendant food web. The remote and harsh conditions in the Arctic make data collection under sea ice notoriously difficult. Autonomous platforms in conjunction with high resolution sensing technologies represent a unique opportunity to improve the basic understanding of this environment and to cost-effectively monitor future changes.

The Pacific Marine Environmental Lab (PMEL) has designed a new, low-cost, expendable under-ice float capable of collecting oceanographic data at the water-ice boundary to address gaps in knowledge during these critical periods. These low cost expendable buoys are designed to be deployed to the ocean bottom from a vessel during the ice-free season, where they remain anchored and collect continuous data until the ocean's surface is covered in sea ice. After a pre-programmed time delay, the instruments release from their anchors, collect a vertical profile of the water column during ascent, and come to rest just under the ice. The buoys remain under ice collecting data until they reach open water through break-up and melting, transmitting their data to shore via satellite when they arrive at the surface. This presentation and paper will describe advances made through each design iteration as well as measurements collected.

Preliminary versions of the instrument were deployed in the Chukchi Sea in 2015 (Gen 1) and Bering Sea in 2017 (Gen 2, Figure 1a, 1b), collecting data on temperature, depth, and Photosynthetically Active Radiation . These deployments have successfully demonstrated the viability of the low-cost design, its robust nature, and its ability to provide high-quality data. The newest version of the buoy (Gen 3) will also measure fluorescence and collect daily images for situational awareness and to assess the abundance of ice-associated algae. Onboard GPS provides precise location data from open water and all data are transmitted to shore using Iridium Short Burst Data.

One of the most critical elements of the project has been to minimize the cost of each buoy at every level. Low-cost pressure housings, sensors, electronics, and materials all needed to be integrated without sacrificing performance in order to make this a viable technology. These compact instruments are optimized for use in the relatively shallow waters of the Arctic

continental shelf. Cost advantages can be best leveraged to provide improved spatial coverage over this enormous area, where observations are typically few and far between during this season. Opportunities for future development such as providing sea surface temperature when in open water and expanding the sensor suite are currently being explored.

The pop-up float was developed at PMEL for the Innovative Technology for Arctic Exploration program (Cross et al., 2015). Funding for the Innovative Technology for Arctic Exploration program is provided by NOAA Research and the Pacific Marine Environmental Laboratory with in-kind support for the pop-up floats from Ecosystems and Fisheries-Oceanography Coordinated Investigations (NOAA/PMEL). ITAE is a collaborative research effort by University of Washington and NOAA engineers and scientists at the Pacific Marine Environmental Lab.

Figure 1a: Left. Top View of Under-Ice Buoy (Gen 2) showing PAR, Depth, and Temperature Sensors. GPS and Iridium Antennas are embedded under the cap to prevent them from being damaged by ice. Figure 1b: Right. Side View of Under-Ice Buoy (Gen 2) showing pressure housing and release mechanism. Diameter of housing is 34 cm and height from top of buoy to bottom of frame is 90 cm.

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