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Long-Endurance, Ice-capable Autonomous Seagliders

Craig Lee, Jason Gobat, Geoff Shilling, and Beth Curry
University of Washington, Applied Physics Laboratory, Seattle, United States (craig@apl.washington.edu)

Autonomous Seagliders capable of extended (many months) operation in ice-covered waters have been developed and successfully employed as part of the US Arctic Observing Network. Seagliders operate routinely in lower-latitude oceans for periods of up to 9 months to provide persistent sampling in difficult, remote conditions, including strong boundary currents and harsh wintertime subpolar seas. The Arctic Observing Network calls for sustained occupation of key sections within the Arctic Ocean and across the critical gateways that link the Arctic to lower-latitude oceans, motivating the extension of glider technologies to permit operation in ice-covered waters. When operating in open water, gliders rely on GPS for navigation and Iridium satellite phones for data and command telemetry. Ice cover blocks access to the sea surface and thus prevents gliders from using these critical services. When operating under ice, ice-capable Seagliders instead navigate by trilateration from an array of RAFOS acoustic sound sources and employ advanced autonomy to make mission-critical decisions (previously the realm of the human pilot) and identify and exploit leads in the ice to allow intermittent communication through Iridium.

Davis Strait, one of the two primary pathways through which Arctic waters exit into the subpolar North Atlantic, provided a convenient site for development of ice-capable Seagliders at a location where the resulting measurements could greatly augment the existing observing system. Initial testing of 780 Hz RAFOS sources in Davis Strait, substantiated by the performance of the operational array, indicates effective ranges of 100-150 km in ice-covered waters. Surface ducting and reflection off the ice bottom significantly degrade the range from the 500+ km expected in ice-free conditions. Comparisons between GPS and acoustically-derived positions collected during operations in ice-free conditions suggest 1-2 km uncertainty in the acoustically-derived positions. The first successful section across the ice-covered Davis Strait occurred in 2006, while the first full mission took place September – February 2008. Mission duration was 25 weeks, with over 800 km of under-ice transit over 51 days. The glider was able to identify and surface through leads 10 times during under-ice operations. Most recently, a pair of successful missions collected continuous sections across Davis Strait from October 2010 through June 2011, including operations between January and June, when the strait was nearly entirely ice-covered and the glider rarely gained access to the surface. These missions provide the first year-round time series of high-resolution sections across Davis Strait. In the Antarctic, ice-capable Seagliders successfully transited beneath a 40-km ice bridge and self-extracted after being carried beneath the Ross ice shelf during missions conducted without the support of an acoustic navigation array.

Ice-capable Seagliders can provide sustainable, continuous occupation of critical sections in ice-covered regions, including the marginal ice zone, with typical horizontal resolution of 3 km and routine sampling of the important, but hazardous, region near the ice-ocean interface. Future directions include development of basin-scale acoustic navigation (‘underwater GPS’ for the Arctic) and use of existing high-frequency acoustic communications for short-range data transfer.