Observations beneath Petermann Ice Island–B (PII–B) in the Canadian Arctic

A.L. Forrest[1], A.K. Hamilton[2], V. Schmidt[3], B.E. Laval[2], D.R. Mueller[4], A. Crawford[4], S. Brucker[5], J. Gagnon[6], J.E. Tremblay[6], R. Yeo[7], L. Braithwaite[8]

1. Civil Engineering, University of California Davis Tahoe Environmental Research Center, Incline Village NV, USA
2. Civil Engineering, University of British Columbia, Vancouver BC, Canada
3. Center for Coastal Ocean Mapping, University of New Hampshire, Durham NH, USA
4. Department of Geography and Environmental Studies, Carleton University, Ottawa ON, Canada
5. Ocean Mapping Group, Department of Geodesy and Geomatics Eng., University of New Brunswick, Fredericton NB, Canada
6. Département de Biologie, Université de Laval, Quebec City PQ, Canada
7. AUV Consultants, Reykjavik, Iceland
8. Canadian Ice Service, Environment Canada, Ottawa ON, Canada
[*] Contact: alforrest@ucdavis.edu

A number of tabular ice islands (10s of kilometers across) are currently adrift in the Canadian Arctic as a result of the collapse of several ice shelves and floating glacier tongues. These ice islands may drift for several years, but can also ground on shoals for extended durations, or drift to southern latitudes where they pose a hazard to shipping and offshore industries prior to deteriorating in warmer waters. Grounded and free floating ice islands deteriorate by different processes, with grounded ice islands eroding through the complex interaction of near-shore currents with the seabed and the underside of the ice island. Understanding this process requires direct observations in the vicinity and, importantly, beneath ice islands. This work presents initial measurements of ice draft and ocean conditions beneath the partially grounded Petermann Ice Island–B (PII–B; 69º 37' N, 65º 46' W) in October 2011. We used a combination of three-dimensional digital terrain mapping sonar systems, including an interferometric sonar mounted on *UBC-Gavia*, a small Autonomous Underwater Vehicle (AUV), to map a 500 m x 500 m portion of the underside of PII-B (90 km^2) in conjunction with a sidewall survey conducted by a surface vessel-mounted multibeam sonar. This survey revealed a pronounced submarine ice 'skirt' extending beyond the subaerial ice cliff, indicating intense surface wave erosion of the exposed sidewall. The draft of the ice island keel increased from 40 m depth at the sidewall to approximately 65 m at a distance of 500 m from the ice edge with a relatively uniform basal topography. Estimates of surface roughness show the underside of this ice island to be smooth compared to the sidewalls. *UBC-Gavia* also measured several water properties (i.e., temperature, conductivity, chlorophyll-*a*, turbidity, and water velocity) along transects in the cavity beneath the ice island. Vertical water column profiles and nutrient samples were collected from a support vessel at stations located 100, 200 and 400 m from the ice island, both upstream and downstream, along the primary axis of current flow. Variations in salinity, stratification and other ocean properties are apparent among the stations due to ice island presenting an obstacle to current flow. The combined mapping surveys produced a three dimensional map of this portion of the ice island that allow the water properties to be placed in the context of their complex geophysical setting. The combination of traditional vertical profiling from surface vessels and innovative AUV-based measurements presented here provide a better understanding of a complex overhead ice environment, and the methods could be transferred to investigations of submarine melting and ice mass loss in similar complex environments, such as under floating glacier tongues and ice shelves.