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CITATION

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SIDEBAR | A Rosette for Sampling Ice-Covered Water

By William M. Smethie Jr., Dale Chayes, Richard Perry, Peter Schlosser, and Ronny Friedrich

The Arctic Ocean is changing rapidly as Earth's climate warms. To document and understand these changing ocean conditions, we developed a rosette that collects high-quality oceanographic data and is deployed from an aircraft through a 30.5 cm diameter hole drilled in the ice (Figure 1). The rosette is modular, with the modules attached vertically on a conducting hydrowire to achieve a small diameter. Typically, three modules with four 4-liter bottles each are positioned above the conductivity-temperature-depth (CTD) module (Figure 2). The rosette package is lowered through the ice and retrieved at speeds up to 40 meters per minute using a small winch mounted in the aircraft. The hydrowire leads from the aircraft to a sheave hung from a tripod on the ice above the hole inside a tent that is heated to prevent water samples and sensors from freezing (Figure 3). The CTD data are acquired and displayed in real time on a laptop computer, and bottles are closed at desired depths electronically. Upon recovery, each water-bottle module is immediately placed in a cooler with bags of snow, which provide thermal stability within ± 2°C of the in situ temperature. The modules are returned to a base camp where they can be sampled and the samples processed under controlled conditions. A wide variety of water samples can be collected. Thus far, we have collected samples for salinity, dissolved oxygen, nutrients, helium isotopes, oxygen isotopes, chlorofluorocarbons, SF_6, tritium, CO_2, barium, and ^{129}I. The quality of all samples has been excellent. Smethie et al. (2011) provide a detailed description of the rosette and its performance.

Building on previous studies by ourselves and others, we have used this rosette extensively in an ongoing study of variability in circulation and water mass properties in the Lincoln Sea, located north of Greenland and Ellesmere Island. One of the objectives of this study is to better understand the freshwater budget for this region. The sources of freshwater to the Arctic Ocean are meteoric water (river runoff plus precipitation), sea ice melt, and inflow from the Pacific Ocean. Using salinity, $\delta^{18}O$, nitrate, and phosphate measurements made on samples collected with the rosette, we determined the distribution of the freshwater components in this region. As an example, Figure 4 presents a section from Ellesmere Island to the North Pole (Figure 5) taken in April/May of 2009. The lowest-salinity water and hence largest amount of freshwater is found in the central and southern portions of the section. At the southern end, low-salinity water primarily results from a relatively high concentration of meteoric water and, to a lesser extent, Pacific Ocean freshwater. Sea ice melt is negative for much of the section, indicating more freshwater is removed by sea ice formation than is added by sea ice melting. In the central portion of the section, sea ice melt is positive, and this freshwater input, plus the contribution from Pacific freshwater, results in the relatively high freshwater content. Comparison of data taken from 2007 through 2010 in this region shows freshening in 2008 and 2009 that is driven primarily by an increase in meteoric water

Figure 1 (left). Twin Otter airplane on sea ice taking a rosette/CTD station.

Figure 2 (middle). Modular Rosette with the CTD module at the bottom and three water bottle modules stacked above the CTD module. The length of the package is about 4 m.

Figure 3 (right). Deployment of the modular rosette from a Twin Otter airplane. This view is from the tent door looking into the aircraft showing the rosette, tripod, and winch.

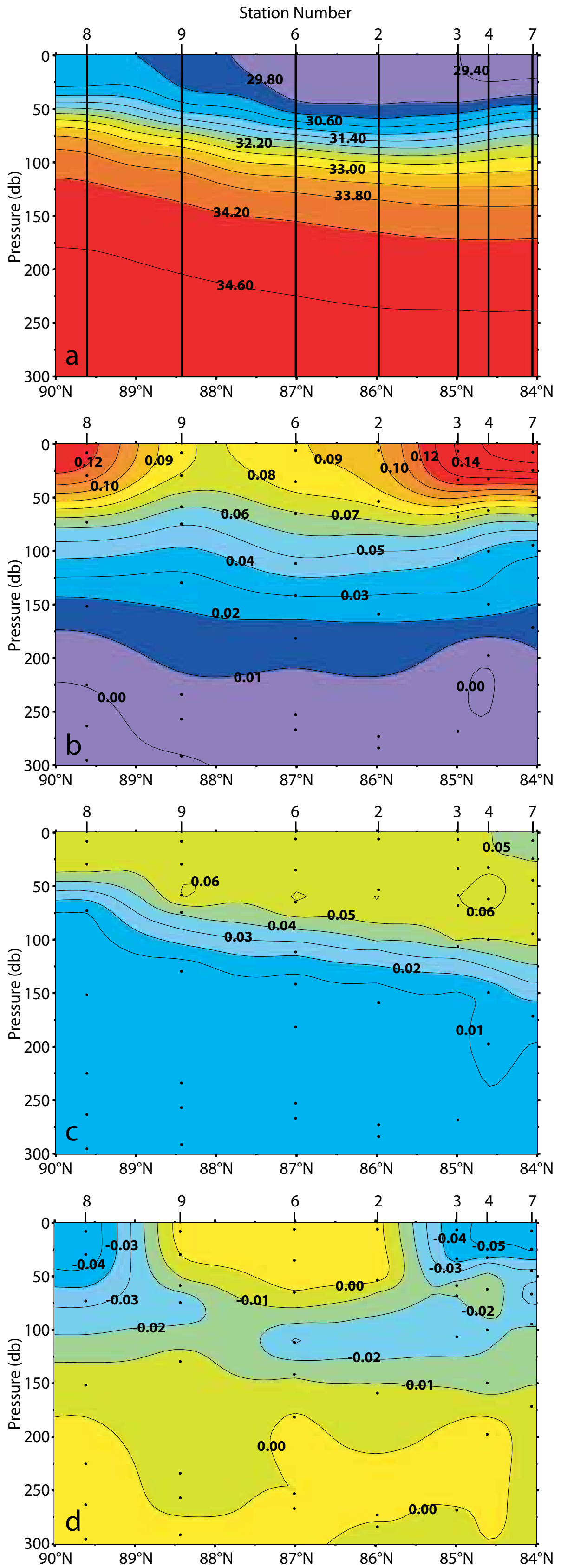

Figure 4. Vertical sections of (a) salinity, (b) meteoric water, (c) Pacific freshwater, and (d) sea ice meltwater along the section shown in Figure 5.

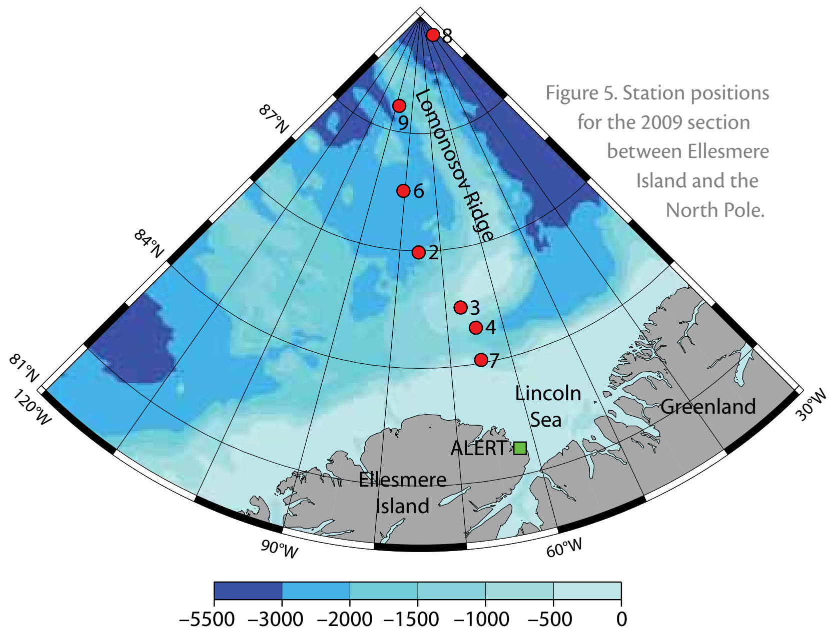

Figure 5. Station positions for the 2009 section between Ellesmere Island and the North Pole.

in 2008 and sea ice meltwater in 2009. The increase in sea ice meltwater may have originated from the strong melting event that occurred in 2007. Analysis of data collected during this period is in progress.

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REFERENCE

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