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Beaufort Gyre Exploration Project: Fresh water (FW) accumulation & release

Despite the numerous observations carried out during the relatively long period of BG exploration there still remained a number of important scientific questions related to this region. The major reason for the initiation of the BG Exploration Project in 2003 was to field an experiment designed to test the hypothesis of *Proshutinsky et al.* [2002, hereinafter referred to as P2002] on the origin of the salinity minimum in the center of the BG (Figure 1). Hydrographic climatology shows that because of this salinity minimum, which extends from the surface to 400 m depth (Figure 2), the Canada Basin contains approximately 45,000 km3 of fresh water [*Aagaard and Carmack, 1989*]. This value calculated relative to a reference mean salinity (34.8) of the Arctic Ocean specifies how much fresh water is accumulated in this region from different sources (ice melting and freezing, rivers, atmospheric precipitation and water transport from the Pacific and Atlantic Oceans via straits).

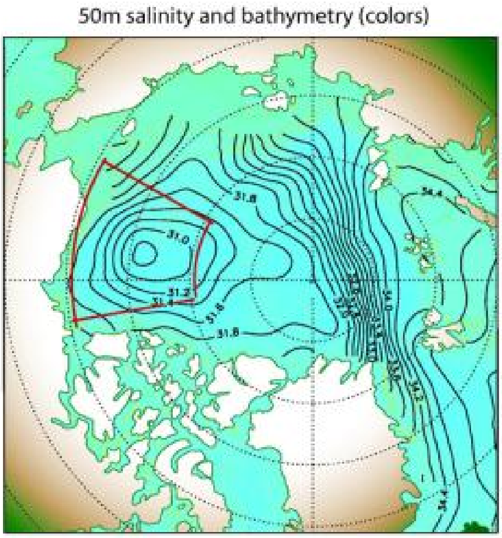

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Figure 1. Climatological (1950-1980) water salinity at 50 m from EWG (1997, 1998). There is a salinity minimum in the center of the BG (region bounded by thick red line). 50-m bathymetry contour as shown by the yellow dotted line.

P2002 hypothesized (see Figure 2) that in winter, the wind (a dynamic factor) drives the ice and ocean in a clockwise (anticyclonic) sense so that the BG accumulates fresh water mechanically through a deformation of the salinity field (Ekman convergence and subsequent downwelling). In summer, winds (Figure 2) are weaker (and may even reverse to be counterclockwise) and the summer resultant anomaly in Ekman convergence releases fresh water, thereby relaxing salinity gradients and reducing BG Fresh Water Content (FWC). P2002 tested this mechanical hypothesis for fresh water accumulation and release by employing a relatively simple model (Figure 2, bottom panels) where wind was the major driving force (the influences of sea ice and ocean thermodynamics were neglected). At the same time, P2002 pointed out that thermodynamic processes may also be important – in winter, ice growth and subsequent salt release reduce the FWC of the BG, and in summer ice melt increases the FWC. The interplay between dynamic and thermodynamic forcing is no doubt complicated. These mechanisms of the seasonal fresh water transformations was investigated by *Proshutinsky et al* [2009] and are provided in section FWC seasonal transformations.

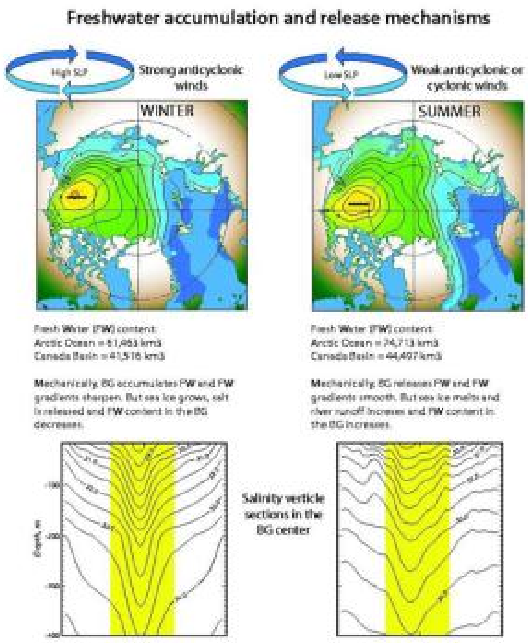

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Figure 2. Panels show conceptual mechanisms of freshwater accumulation and release in the BG during a seasonal cycle. Freshwater content in summer and winter is shown in meters (isolines) calculated relative to salinity 34.8.

References

Aagaard, K., and E. Carmack (1989), The Role of Sea Ice and Other Fresh Water in the Arctic Circulation, *J. Geophys. Res.*, 94, 14,485– 14,498.

Proshutinsky, A., R. H. Bourke, and F. A. McLaughlin (2002), The role of the Beaufort Gyre in Arctic climate variability: Seasonal to decadal climate scales, *Geophys. Res. Lett.*, 29(23), 2100, doi:10.1029/2002GL015847.

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Mail: Woods Hole Oceanographic Institution, 266 Woods Hole Road, Woods Hole, MA 02543, USA.
E-Contact: info@whoi.edu; press relations: media@whoi.edu, tel. (508) 457-2000
Problems or questions about the site, please contact webdev@whoi.edu