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The Beaufort Gyre observing system: Making a contribution to the ocean observing system at polar latitudes

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The Canadian Basin, including the Beaufort Gyre (BG), contains about 45,000 cubic kilometers of fresh water (anomaly relative to a salinity of 34.8). This constitutes the major fresh water reservoir of the Arctic Ocean: its volume is 10-15 times larger than the total annual river runoff to the Arctic Ocean and approximately three times larger than the amount of fresh water stored in the sea ice. A release of only 5% of this fresh water is enough to cause a salinity anomaly in the North Atlantic with the magnitude of the Great Salinity Anomaly of the 1970s. Sustained observations of the BG have been made since 2003; under current NSF funding observations will continue until 2014. The major goal of this project is to investigate basin-scale mechanisms regulating freshwater content (FWC) in the Arctic Ocean, particularly in the BG. The main hypothesis is that the BG accumulates a significant amount of fresh water from different sources under anticyclonic (clockwise) wind forcing, then releases this fresh water when the forcing weakens or changes orientation to a cyclonic (counterclockwise) rotation. The major objective of the BG observational program is to determine FWC and freshwater fluxes in the BG on seasonal, interannual and longer time scales. To quantify the state of the BG, the established Beaufort Gyre Observing System (BGOS) supports time series measurements of temperature, salinity, currents, geochemical tracers, sea ice draft, and sea level, data that are being acquired by a team of Woods Hole Oceanographic Institution scientists in collaboration with researchers from the Institute of Ocean Sciences, Canada and the Japan Agency for Marine Earth Science and Technology using moorings, drifting buoys, shipboard, and remote sensing measurements. A detailed description of the project can be found at www.whoi.edu/beaufortgyre. The BGOS moorings have precisely measured variations of the vertical distribution of FWC, sea level variability, and changes in sea ice draft at representative locations. The annual hydrographic surveys have examined the variations by radius from the center of the BG. The remote sensing program has characterized the variability of the sea ice thickness and sea surface height horizontal structure. Synthesis of these data has allowed us to conclude that the major cause of the large FWC in the BG region is the process of Ekman pumping due to the Arctic High anticyclonic circulation centered over the BG. The mean seasonal cycle of liquid FWC appears the result of complex interplay between regional sources of liquid fresh water (river runoff and sea ice melt) and the time-varying, spatially-variable Ekman pumping resulting in multiple FWC maxima and minima through the year. Interannual changes in FWC during 2003-2010 are characterized by a strong positive trend in the region, varying by location, with a maximum of approximately 170 cm per year in the center of Ekman-pumping-influenced region. Over this period, the BG accumulated more than 5000 cubic kilometers of freshwater, a ~25 percent gain. Decadal FWC variability in the period 1950-2000 is dominated by a significant change in the 1990s forced by an atmospheric circulation regime change. The center of maximum FWC shifted to the southeast and appeared to contract in area relative to the pre-1990s climatology.