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The exchange of inorganic carbon on the Canadian Beaufort Shelf

Jacoba Mol (1), Helmuth Thomas (1), Xianmin Hu (2), and Paul G. Myers (2)

(1) Dalhousie University, Department of Oceanography, Halifax, NS, Canada (helmuth.thomas@dal.ca), (2) University of Alberta, Department of Earth and Atmospheric Sciences, Edmonton, Alberta

The Mackenzie Shelf in the southeastern Beaufort Sea is an area that has experienced large changes in the past several decades as warming, sea-ice loss, and increased river discharge have altered carbon cycling. Upwelling and downwelling events are common on the shelf, caused by strong, fluctuating along-shore winds and resulting cross-shelf Ekman transport. Downwelling carries inorganic carbon and other remineralization products off the shelf and into the deep basin for possible long-term storage in the world oceans. Upwelling carries water high in dissolved inorganic carbon (DIC) and nutrients from the Pacific-origin upper halocline layer (UHL) onto the shelf. Profiles of DIC and total alkalinity (TA) taken in August and September of 2014 are used to investigate the cycling of inorganic carbon on the Mackenzie Shelf. The along-shore and cross-shelf transport of inorganic carbon is quantified using velocity field output from a simulation of the Arctic and Northern Hemisphere Atlantic (ANHA4) configuration of the Nucleus of European Modelling of the Ocean (NEMO) model. A strong upwelling event prior to sampling on the Mackenzie Shelf is analyzed and the resulting influence on the carbonate system, including the saturation state of aragonite and pH levels, is investigated. TA and δ18O are used to examine water mass distributions in the study area and analyze the influence of Pacific Water, Mackenzie River freshwater, and sea-ice melt on carbon dynamics and air-sea fluxes of CO_2 in the surface mixed layer. Understanding carbon transfer in this seasonally dynamic environment is key in order to quantify the importance of Arctic shelf regions to the global carbon cycle and to provide a basis for understanding how its role will respond to the aforementioned changes in the regional marine system.