Fresh Water as an Essential Climate Variable in the Arctic Climate System

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New insights gained from the analysis of observational records indicate that the Arctic has been experiencing substantial changes in the major environmental parameters in the 21st century. Arctic climate state is characterized by several climate variables such as sea ice thickness and concentration, air temperature, precipitation, sea-level atmospheric pressure, river and glacier runoff, ocean and sea ice circulation. This study considers fresh water (FW) as an essential climate variable of the Arctic ocean-ice-atmosphere system that can be used as an indicator and predictor of the Arctic change processes. FW plays a major role in the Arctic ocean-ice-atmosphere system impacting thermohaline processes, sea ice formation, and air-sea heat fluxes. Several conceptual models were suggested to explain quasi-decadal variability of the Arctic climate in the 20th century. In these models, the FW flux from the Arctic Ocean to the North Atlantic is a key factor controlling climate variability in the region. Since 1997, the Arctic climate has been transforming under rapidly changing environmental parameters. The conceptual models do not have a mechanism to explain and predict the recently observed changes of the Arctic system. One of the recently proposed explanations of observed Arctic climate change is related to the unabated Greenland Ice Sheet melt. It is surmised that under current climate conditions, accelerating FW flux from the Greenland Ice Sheet impacts thermohaline processes in the sub-Arctic seas influencing Arctic climate variability. The study investigates recent changes in salinity fields in the Arctic Ocean and the sub-Arctic seas (Baffin Bay, Labrador Sea, Subpolar Gyre, and the Nordic Seas), FW fluxes from the Arctic Ocean to the sub-Arctic seas, and Greenland FW discharge. In situ and satellite observations are analyzed in attempt to evaluate the evidence of Greenland FW in the sub-Arctic Seas. The interannual variability of the air-sea heat fluxes in the North Atlantic is discussed in order to relate this factor with observed thermohaline changes and air-sea fluxes in the area. Results from a numerical experiment that track propagation of the Greenland FW are discussed.