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Role of Greenland meltwater in the changing Arctic

Dmitry Dukhovskoy (1), Andrey Proshutinsky (2), Mary-Louise Timmermans (3), Paul Myers (4), Gennady Platov (5), Jonathan Bamber (6), Beth Curry (7), and Raquel Somavilla (8)

(1) Florida State University, Tallahassee, USA (ddukhovskoy@fsu.edu), (2) Woods Hole Oceanographic Institution, Woods Hole, USA (aproshutinsky@whoi.edu), (3) Yale University, New Haven, USA (mary-louise.timmermans@yale.edu), (4) University of Alberta, Edmonton, Canada (pmyers@ualberta.ca), (5) Institute of Computational Mathematic and Mathematical Geophysics, Novosibirsk, Russia (Platov.G@gmail.com), (6) University of Bristol, Bristol, UK, (7) University of Washington, Seattle, USA, (8) Spanish Institute of Oceanography, Gijon, Spain

Observational data show that the Arctic ocean-ice-atmosphere system has been changing over the last two decades. Arctic change is manifest in the atypical behavior of the climate indices in the 21st century. Before the 2000s, these indices characterized the quasi-decadal variability of the Arctic climate related to different circulation regimes. Between 1948 and 1996, the Arctic atmospheric circulation alternated between anticyclonic circulation regimes and cyclonic circulation regimes with a period of 10-15 years. Since 1997, however, the Arctic has been dominated by an anticyclonic regime. Previous studies indicate that in the 20th century, freshwater and heat exchange between the Arctic Ocean and the sub-Arctic seas were self-regulated and their interactions were realized via quasi-decadal climate oscillations. What physical processes in the Arctic Ocean – sub-Arctic ocean-ice-atmosphere system are responsible for the observed changes in Arctic climate variability? The presented work is motivated by our hypothesis that in the 21st century, these quasi-decadal oscillations have been interrupted as a result of an additional freshwater source associated with Greenland Ice Sheet melt. Accelerating since the early 1990s, the Greenland Ice Sheet mass loss exerts a significant impact on thermohaline processes in the sub-Arctic seas. Surplus Greenland freshwater, the amount of which is about a third of the freshwater volume fluxed into the region during the 1970s Great Salinity Anomaly event, can spread and accumulate in the sub-Arctic seas influencing convective processes there. It is not clear, however, whether Greenland freshwater can propagate into the interior convective regions in the Labrador Sea and the Nordic Seas. In order to investigate the fate and pathways of Greenland freshwater in the sub-Arctic seas and to determine how and at what rate Greenland freshwater propagates into the convective regions, several numerical experiments using a passive tracer to track propagation of Greenland freshwater have been conducted as a part of the Forum for Arctic Ocean Modeling and Observational Synthesis effort. The presentation discusses the role of Greenland meltwater in the Arctic environment and how this can explain observed cessation of the quasi-decadal Arctic variability. The rate and pathways of Greenland meltwater in the sub-Arctic seas derived from the coordinated model experiments are analyzed. The presented study discusses a possible scenario of the Arctic in the future. It is argued that Greenland meltwater being accumulated in the sub-Arctic seas since the 1990s can trigger a negative feedback mechanism that may impede or even reverse processes of Arctic warming observed in the 21st century.