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Arctic Ocean Freshwater Content Changes and their Causes

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Recent observations show dramatic changes of the Arctic atmosphere-ice-ocean system. Here we demonstrate, through the analysis of a vast collection of previously unsynthesized observational data, that over the 20th century the central Arctic Ocean became increasingly saltier whereas long-term freshwater content (FWC) trends over the Siberian shelf show general freshening tendency. These FWC trends are modulated by strong decadal and multidecadal fluctuations with sustained and widespread spatiotemporal patterns. Associated with the multidecadal variability, the FWC record shows two periods in the 1920-30s and in recent decades when the central Arctic Ocean was saltier and two periods in the earlier century and in the 1940-70s when it was fresher. The FWC anomalies excited on arctic shelves (including anomalies resulting from river discharge inputs) and those caused by net atmospheric precipitation were too small to trigger long-term FWC variations in the central Arctic Ocean; to the contrary, they act to moderate the observed long-term central-basin FWC changes. Variability of the intermediate Atlantic Water did not have strong impact on changes of the upper Arctic Ocean water masses. Ice-ocean interactions were the key processes in shaping long-term upper Arctic Ocean FWC changes. Strength of the outflow of the arctic waters (not FWC anomalies) dominates the supply of Arctic fresh water to sub-polar basins. Finally, since the high-latitude fresh water plays a crucial role in establishing and regulating global thermohaline circulation, the multi-decadal fluctuations of the freshwater content discussed here should be considered when assessing long-term climate change and variability.