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Dense Overflow from an Arctic Fjord: Mean Seasonal Cycle, Variability and Wind Influence

F. Geyer (1,2), I. Fer (3,2), T. Eldevik (1,2)

(1) Nansen Environmental and remote Sensing Center, Bergen, Norway (florian.geyer@nersc.no), (2) Bjerknes Center for Climate Research, Bergen, Norway, (3) Geophysical Institute, University of Bergen, Norway

Storfjorden, an Arctic fjord in Svalbard Archipelago, is separated by a submarine sill from the adjacent shelf areas and produces one of the densest water masses in the Barents Sea. The cold and dense brine-enriched shelf water is produced through ice formation in an annually recurrent polynya in Storfjorden and overflows across the sill. We present current profiles and bottom temperature measurements from the Storfjorden sill from 2003 to 2007 and study the interannual variability of the overflow and the influence of atmospheric forcing. The data set is the longest time series collected at this site. The mean structure of the overflow averaged over four seasons shows that the overflow is initially strong with high volume transports early in the overflow season, about 50 m thick and bottom-enhanced, and then gradually diminishes, becoming increasingly intermittent during the last third of the overflow season. The annual average overflow flux across the sill is about 0.03 Sv ($1\ \mathrm{Sv} \equiv 10^6\ \mathrm{m^3\,s^{-1}}$). Overflow was observed 55% of a total record length of 958 days and cross-sill flow averaged in the bottom 20 m was greater than 10 $\mathrm{cm\,s^{-1}}$ for 49% of the overflow duration. The overflow strength increased with decreasing near-bottom temperatures. The comparison of four consecutive overflow seasons reveals annual variability within 0.01 Sv whereas the variability within one season can be as large as 0.05 Sv. In spite of the relatively constant annual overflow flux, the onset of the overflow can vary by as much as 50 days. Variability on the scale of 1-2 weeks is strongly connected to wind forcing, indicated by the significant coherence between the rotary components of the current at the Storfjorden sill and wind measurements at two meteorological stations on Edgeøya and Hopen Island. The physical connection is the surface Ekman transport. Surface Ekman transport and the ice conditions in the Barents sea also influence seasonal intra-development and interannual variability of the overflow.