Freshwater-driven feedbacks between the Arctic and North Atlantic Ocean circulations

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Freshwater plays a key role in the Arctic - North Atlantic climate system, linking ice, ocean and atmospheric dynamics. In particular, large freshwater releases into the subpolar region drive extreme cold anomalies, create sharp sea surface temperature fronts, destabilise the overlying atmosphere, and trigger shifts in the North Atlantic current system. Considering the expected increased freshwater fluxes in future due to more melting, it is critical to understand the resulting climate feedbacks.

Combining observations and models, we present evidence that past changes in Arctic freshwater outflow paced transitions between wind- and buoyancy-dominated circulation regimes in the North Atlantic. The identified freshwater cycle explained over 50% of the sea surface temperature variability in the subpolar North Atlantic region and was particularly pronounced on decadal timescales. However, new findings indicate that an enhanced, recent freshwater input due to more melting has increased the amplitude and frequency of this freshwater cycle, leading to a shift of power from decadal to interannual timescales in the North Atlantic climate variability. At the same time, the interference of the past, natural freshwater cycle by more melting has reduced Arctic freshwater exports and contributed to the storage of freshwater in the Arctic Ocean, where it now poses the risk of a non-linear and disruptive change to the North Atlantic Ocean circulation if the freshwater were released. In light of newly identified, Arctic feedbacks to the increased freshening of the North Atlantic, we suggest that an Arctic freshwater release is becoming increasingly likely.