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ARCTIC OCEAN STABILITY, A BALANCE BETWEEN COOLING AND FREEZING, FRESHWATER INPUT AND SEA ICE MELT

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The upper part of the Arctic Ocean has two regimes. In most of the deep basins the stability beneath the upper layer is strong due to input of low salinity shelf water, ultimately derived from river runoff, net precipitation and low salinity Pacific water entering through Bering Strait. The Nansen Basin is different. There the stability is weak and the less saline upper layer is created by sea ice melting on top of and transforming the upper part of Atlantic water entering through Fram Strait. This situation depends upon the availability of sea ice formed elsewhere in the Arctic Ocean and being advected by the wind towards the Nansen Basin and Fram Strait, covering the Atlantic water. In a possible future climate with less net ice formation in and ice export from the Arctic Ocean not enough sea ice might available in the Nansen Basin to be melted and creating a stratification stable enough to allow the upper layer to remain at the surface and maintain an ice cover throughout the winter. If the stability disappears, the upper layer would convect into the Atlantic water below, removing freshwater. As the Atlantic water subsequently rises to the surface, remaining ice would quickly melt and dense water formation and a convective regime would be established. This possible scenario is examined by using a simple mixed layer model, an estimate of the volume of ice melted by the heat supplied by the Atlantic water and an assumption of a geostrophic outflow through Fram Strait. This regime could be entered directly, if the ice has melted before the upper layer reaches the freezing point. The entrainment from below then increases because the stabilizing freshwater input is removed. The Arctic Ocean would no longer be primarily a source of low salinity surface water but instead form denser water and contribute to the Meridional Overturning Circulation. A similar situation holds in the Barents Sea south of the Nansen Basin, and this combined area would then release more oceanic heat to the atmosphere possibly affecting the atmospheric circulation.