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How summer ice depletion in the Arctic Ocean may affect the global THC?

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Record low sea-ice concentrations in the Arctic Ocean observed in the 2007-2010 summers suggest that the Arctic sea-ice is disappearing much faster than was predicted in the early 2000s. One of the expected consequences of the melting Arctic sea ice is an increase of oceanic freshwater outflow from the Arctic Ocean to the lower latitudes. This poses a potential threat for the global thermohaline circulation (THC), a key oceanic meridional heat transporter. A weakening of this global water/heat conveyor could cause dramatic cooling in mid-latitudes with serious consequences for the global climate: the so-called ‘thermohaline catastrophe’. This prediction is based on the notion that the major source of the dense water which feeds the deep equatorward branch of THC is open-ocean convection in the sub-Arctic seas. Although true in the present climate conditions, this statement may not necessarily be valid for a seasonally ice-free Arctic Ocean. Seasonal exposure of waters on the vast Arctic shelves to atmospheric cooling makes them effective producers of dense water with high overflow potential. Flushed out of the Arctic Ocean, this water may provide an amount of dense water similar to that currently formed through open ocean convection in the sub-Arctic seas. To test this hypothesis the full-physics numerical model was applied. The model was forced by the varying salt flux at the surface imitating brine release during ice formation in polynyas. The model was set up for the northwestern Laptev Sea shelf and slope, where intensive dense water formation and cascading were observed in the past. Numerical experiments have demonstrated that variation of surface salt flux leads to substantial changes in cascading parameters. Under the typical thermohaline conditions in the Laptev Sea, increase of surface forcing leads to intensified dense water cascading below the Atlantic Water layer. The net effect of dense water cascading on the deep water masses is cooling and freshening. Non-linear change of fluxes for the strongest forcing (about 2 times) is explained by the intensified upwelling of warm and salty water from the deep Increase of forcing from 0.02 to 0.03 g/m2/s leads to 3-fold increase of shelf-slope volume flux below the warm core of AW (from 0.04 to 0.12 Sv). This increase is sufficient to substitute similar amount of dense water currently forming in the sub-Arctic (GIN) Seas and shows principle possibility of Arctic cascades to maintain global thermohaline circulation (THC) in case if the predicted freshening in the GIN Seas, caused by the Arctic sea ice melting, turns real.