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The role of northern sea ice cover for the weakening of the thermohaline circulation under global warming

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An increase in atmospheric CO_2 concentration and the resulting global warming are typically associated with a weakening of the thermohaline circulation (THC) in model scenarios. For the models participating in the Coupled Model Intercomparison Project (CMIP), this weakening shows a significant dependence on the initial THC strength: it is stronger for initially strong overturning. We propose a physical mechanism for this phenomenon based on an analysis of additional simulations with the coupled climate models CLIMBER-2 and CLIMBER-3α. The mechanism is based on the fact that sea ice cover greatly reduces heat loss from the ocean. The extent of sea ice is determined mainly by the near surface atmospheric temperature in the North Atlantic but also by the strength of the THC itself which transports heat to the convection sites. Initially larger sea-ice cover responds more strongly to atmospheric warming, thus sea ice retreats more strongly for an initially weaker THC. This sea ice retreat provides a stabilising feedback on the THC, and this stabilising feedback is stronger for an initially weaker THC, thus making it weaken less in climate model simulations.