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Scenario Changes of Atlantic Water in the Arctic Ocean

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We explore possible modifications to the Atlantic Water Layer (AWL)temperature of the Atlantic Water Layer (AWL) induced by climate change, performing simulations for 1970 to 2099 with a coupled ice ocean Arctic model (CIOM). The surface fields to drive CIOM were provided by the Canadian Regional Climate Model (CRCM), driven by the Canadian Global Climate Model (CGCM3) following the A1B climate change scenario. Compared to PHC data, CIOM can reliably reproduce the AWL in the present climate, 1990-2009. Under the A1B climate change scenario, there is a significant increase in water volume transport into the central Arctic Ocean through Fram Strait, due to the weakened atmospheric high pressure over the western Arctic and an intensified atmospheric low pressure over Nordic Seas. Moreover, the AWL temperature tends to decrease from 0.36oC in the 2010s to 0.26oC in the 2060s. In the vertical, the warm Atlantic water core slightly expands before the 2030s, shrinks after the 2050s, and disappears by 2070-2099, in the southern Beaufort. The temperature decrease after 2030 is mainly due to the reduced heat fluxes in the Kara and Barents Sea. In the northeast Barents and Kara Seas, the loss of sea ice increases the heat loss from the Atlantic water and reduces the water temperature near the bottom, contributing to the decreases in heat fluxes into the central Arctic Ocean from the northeast Barents and Kara Seas as well as the decreasing AWL temperature at intermediate layers in the central Arctic Ocean. In addition, the vertically integrated heat loss of AWL also plays an important role in the AWL cooling process.

We also explore possible modifications to the water temperature in the Barents Sea induced by climate. While the CIOM simulations show the observed magnitudes of water volume inflow and heat flux through the Barents Sea Opening, both the CIOM simulation and the observations suggest a positive trend in the Atlantic water volume inflow and associated heat flux into the Barents Sea, due to enhanced storm activity in the region. Under the A1B climate change scenario, the loss in sea ice significantly increases both the solar radiation, and the ocean surface heat loss in the Barents Sea. Moreover, there is an increasing trend in the lateral heat flux into the Barents Sea. Therefore, these changes in the water temperature depend on the heat balance among the solar radiation, surface turbulence heat flux and lateral heat flux. During this period, the average water temperature tends to increase from 0oC to 1oC, in the southwestern Barents Sea, mostly due to the increased lateral heat flux and solar radiation. However, in the northeastern Barents Sea, the average water temperature shows a decreasing trend from ~0.2oC in the 2010s to ~0.6oC in the 2040s, suggesting that the increased surface heat flux is the dominant impact.

Long, Z., Perrie, W., 2015: Scenario Changes of Atlantic Water in the Arctic Ocean. J.Climate, DOI: 10.1175/JCLID1400522.1
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