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The impact of warm summers on winter convection in the subpolar North Atlantic

Marilena Oltmanns, Johannes Karstensen, and Jürgen Fischer
GEOMAR, Kiel, Germany (moltmanns@geomar.de)

The subpolar North Atlantic (SPNA) is one of the few locations where deep ocean convection occurs and an integral part of the climate system. Some studies have indicated that ocean convection in the SPNA is threatened by enhanced melt water input from Greenland into the Irminger and Labrador Seas. Others have suggested that increased sea surface temperatures in the North Atlantic will lead to a negative North Atlantic Oscillation (NAO) setting several months later. As a negative NAO is associated with decreased ocean heat losses and a larger throughput of warm saline water from the subtropics into the SPNA, both mechanisms — the surface freshening and the warming in a warm summer — could combine to impede ocean convection in the following winter. However, the link between the summer forcing and winter convection has not yet been investigated.

Here we present the analysis of a variety of oceanic and atmospheric data sets, including more than a decade long records of moored observations in the Irminger and Labrador Seas, Argo float profiles, remote sensing data and an atmospheric reanalysis, that have been used to investigate the atmospheric and upper ocean variability from summer through winter. We show that particularly warm summers are associated with distinct fresh surface patches in the SPNA that intensify in fall through increased precipitation and persist long into winter while heat losses are reduced. At the same time, the subsurface water is warmer and more saline than after cold summers. Based on the summer forcing, we identify a significant predictive skill of the atmospheric circulation and ocean stratification in winter and illustrate the consequences with regard to the warming, melting and heat flux trends over the last 25 years.