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Spurious drift of the AMOC in global ocean sea-ice models related to subarctic freshwater forcing

Erik Behrens, Arne Biastoch, and Claus W. Böning
GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany (ebehrens@geomar.de)

Global ocean sea-ice models with an atmospheric forcing based on bulk formulations of the air-sea fluxes exhibit spurious trends in key flow indices like the Atlantic Meridional Overturning Circulation (AMOC), constraining their use in investigations of multi-decadal ocean variability. To identify the critical model factors affecting the temporal evolution of the AMOC on time scales of up to 60 years, a series of experiments with both eddy-permitting (0.25°) and non-eddying (0.5°) ocean-ice models has been performed, focusing on the influence of specifications for the freshwater forcing. The atmospheric forcing builds on the proposal for Coordinated Ocean-ice Reference Experiments (CORE), utilizing the refined atmospheric reanalysis products for 1948-2006 compiled by Large and Yeager. Sensitivity experiments with small variations in precipitation (within the observational uncertainty) and sea surface salinity restoring in the subarctic Atlantic produce a wide range of AMOC transports, between upward drifts to more than 22 Sv and nearly-collapsed states with less than 7 Sv, reflecting the excessive role of the salinity feedback in such simulations. In all cases the AMOC is tightly related to the density of the Denmark Strait overflow; changes in that density are governed by the salinity in the Nordic Seas; and in turn, that salinity is strongly affected by the properties of the inflowing North Atlantic water. The experiments expose the influences of various salinity restoring choices: the results suggest that the excessive sensitivity to precipitation can be exploited to minimize the spurious drift, and to devise model configurations with very weak restoring.