The impact of high-frequency, synoptic wind variability on Labrador Sea deep convection and the Atlantic meridional overturning circulation

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Abstract

The majority of climate models simulate a slowing-down of the Atlantic meridional overturning circulation (AMOC) during the late 20th century in response to global warming. In contrast, many ocean-only model simulations forced by best estimates of atmospheric forcing show rather stable AMOC, or even an upward trend in AMOC strength for this period, raising questions about future projections of AMOC changes. In a recent study, we hypothesize that AMOC changes are affected by not only subpolar ocean surface buoyancy increase, but also intensified storm activities over deep convective regions in response to global warming. In this study, we further test this hypothesis within the framework of an ocean/sea-ice model, POP2. We first conducted a control simulation by forcing POP2 with observed atmospheric forcing, COREII, from 1948-2007, and then carried out a set of simulations where synthetic forcings were used. The synthetic forcings were constructed by artificially suppressing or enhancing storm-induced wind variability over the Labrador Sea (LS) region. Comparisons between control and synthetic forcing simulations show that the storm-induced wind variability decisively controls turbulent heat fluxes and deep convection in the southern LS, where the deep convection is almost suppressed (more active) in the case of removing (enhancing) storm-induced wind variability. The changes in the southern LS deep convection result in a change in mean AMOC strength by about 3 Sv, compared to the control simulation value. More importantly, the storm-induced wind variability in the LS region is found to have an effect on the trend of the AMOC, lending support to the hypothesis that the intensified storm track activities over the North Atlantic in response to global warming may make an important contribution to long-term changes in the AMOC.