EGU22-7897, updated on 14 Aug 2022
https://doi.org/10.5194/egusphere-egu22-7897
EGU General Assembly 2022

A multidecadal decline of Weddell Sea Bottom Water volume forced by wind-driven sea ice changes

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Antarctic Bottom Water (AABW) is one of the most important deep water masses contributing to the lower limb of the global overturning circulation, which modulates the deep ocean ventilation and oceanic heat/carbon exchanges on multidecadal to millennial timescales. Weddell Sea Bottom Water (WSBW) is a key precursor of the AABW exported from the Weddell Sea. Its formation involves intense air-sea-ice interaction on the continental shelf that releases brine from sea ice formation, and occurs mostly in the austral winter. Here we report a distinct long-term volume decline of WSBW revealed by data collected along repeat occupations of World Ocean Circulation Experiment (WOCE) hydrographic sections. We estimate a >20% reduction of WSBW volume since the early 1990s and a resultant widespread deep Weddell Sea warming associated with a basin-scale deepening of isopycnal surfaces. With the most significant volume reduction concentrating within the densest classes of WSBW and a concurrent decline of sea ice formation rate (>30%) over the southwestern Weddell continental shelf inferred from remote-sensed sea ice concentration data, we propose that the observed WSBW volume reduction is likely to be driven by a multidecadal weakening of dense shelf water production due to the sea ice changes. Reanalysis atmospheric data and ice drift data suggest that the reduction of sea ice formation rate is predominantly linked to changes in wind-driven sea ice convergence in front of Ronne Ice Shelf and Berkner Bank, as a response to a vigorous Amundsen Sea Low deepening that is teleconnected to tropical Pacific SST variability, and associated with the local radiative forcing from long-term ozone depletion.