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On the role of sea ice for Southern Ocean stratification

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The formation, subsequent lateral transport, and melt of sea ice represents a key process for the determination of upper ocean stratification in the Southern Ocean. Sea ice is transported northward in large parts of the Southern Ocean by strong near-surface winds and melts along the ice edge south of the polar front, an important upwelling region. Here, it adds freshwater to the surface ocean, lowers the sea-water density, and possibly reduces upwelling by increasing the stratification. Consequently, this redistribution of freshwater in time and space affects the vertical overturning circulation which is an important determinant of the ocean-atmosphere CO_2 exchange and, thus, of the global climate. We investigate the Southern Ocean sea-ice ocean system using satellite observations together with simulations with a newly developed regional ocean sea-ice model on the basis of ROMS. As it is not possible yet to derive sea-ice volume transport from remote sensing data due to a lack of ice thickness data, we quantify the freshwater flux exerted by the sea ice from the model and compare it to the observed sea-ice area transport. This shows that the transport is large in the Weddell and Ross Seas where sea ice extends to its lowest latitudes. We assess the importance of sea-ice freshwater transport on the stratification and circulation by comparing this flux to the net atmospheric freshwater flux from reanalysis data and by perturbing our model simulations.