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Water Mass Transformation in the Antarctic shelf

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Antarctic Bottom Water (AABW) forms around Antarctica, sinks to the ocean's abyss and fills more than 30% of the ocean's volume. The formation of AABW includes mixing of distinct water masses, such as High Salinity Shelf Water (HSSW), Ice Shelf Water (ISW) and Circumpolar Deep Water on the continental shelf. Despite its climatic importance, the mechanisms of AABW formation are poorly known due to the lack of observations and the inability of climate models to simulate those mechanisms. We applied the Water Mass Transformation (WMT) framework in density space to simulations from a circumpolar ocean-ice shelf model (WAOM, with horizontal resolution ranging from 10 to 2 km) to understand the role of surface fluxes and oceanic processes to water mass formation and mixing on the Antarctic continental shelf, including the ice shelf cavities. The salt budget dominates the water mass transformation rates, with only secondary contribution from the heat budget. The buoyancy gain at relatively light density classes ($27.2 < \sigma_\Theta < 27.5$ kg/m^3) is dominated by basal melting. At heavier densities ($\sigma_\Theta > 27.5$), salt input associated with sea-ice growth in coastal polynyas drives buoyancy loss. The formation of HSSW occurs via diffusion of the surface fluxes, but it is advected towards the cavities of large ice shelves (e.g., Ross, Ronne-Filchner), where it interacts with ice shelf through melting and refreezing and forms ISW. The sensibility of those mechanisms to the model horizontal resolution was evaluated. The basal melting and associated buoyancy gain rates largely decrease with increased resolution, while buoyancy loss associated with coastal polynyas are less sensible to resolution as surface fluxes are estimated from sea ice concentration observations. These results highlight the importance of high resolution to accurately simulate AABW formation, where mixing processes occurring below ice shelf cavities play an important role in WMT.