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Simulation of Coastal Polynyas in the Western Weddell Sea

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Coastal polynyas play a prominent role in the formation and modification of water masses in the polar oceans. A coastal polynya is usually kept open mechanically, primarily by winds, and the ocean surface is at freezing point. Thus a major fraction of the annual ice production of the high-latitude oceans occurs in polynyas and hence the duration and extent of their appearance has a substantial effect on bottom water formation. In the western Weddell Sea, recurring coastal polynyas are formed in front of the Filchner-Ronne Ice Shelf and in the area of the decayed Larsen A/B Ice Shelf. Simulations to study polynya formation and their impact on ice production and bottom water formation in the western Weddell Sea were performed with the Finite Element Sea ice-Ocean Model (FESOM) of Alfred-Wegener-Institute (AWI). FESOM is a fully coupled system of a primitive-equation, hydrostatic ocean model and a dynamic-thermodynamic sea ice model. The simulations were conducted on a global grid with a resolution varying between roughly 300 km in tropical latitudes and <5 km along the coast of the southwestern Weddell Sea. In vertical direction, the grid uses terrain-following coordinates. The model results give insight into the mechanisms governing the formation of transient and persistent polynyas and their influence on ice production and deep water formation. Water mass formation and ice export rates are quantified and compared to observation-based estimates.