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## Model Based Polynya: Deep water formation in the Southern Ocean

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Dense water is formed when sea ice around Antarctica drifts apart leaving open-water areas called polynyas. Both the processes of cooling sea water in contact with the atmosphere and salt accumulation in sea water during sea ice formation, lead to the sea water getting denser. The dense water formation in the oceans surrounding the Antarctic continent contributes to meridional overturning circulation, making it crucial to understand the changes in the Antarctic sea ice and oceans to improve model predictions. Using NEMO output from both a regional configuration and a coupled global configuration we ask how well are polynyas and deep water formation represented in the models? How do regional trends in sea ice affect the polynyas and deep water formation? In the model we find several types of polynya; including the open-water Great Weddell Sea Polynya and coastal polynyas. We have developed and applied an algorithm for classifying coastal polynyas based on sea ice concentration to identify and separate these from the open water polynya areas, in addition, we include sea ice thickness in the classification of coastal polynyas to select areas where the mixed-layer is deep, and surface salt flux is present. In the coastal polynyas the mixed-layer is deep and densification of the upper ocean is strong due to the surface salt flux. The Great Weddell Sea Polynya is also found to deepen the mixed-layer but the strong salt flux, found along the coast, is not present in the open-water polynya suggesting an alternative mechanism is taking place. The favourable ice divergence in the Weddell Sea builds over several years in both models but the Great Polynya itself does not reoccur after the 1980s. Coastal polynyas make up the largest area of the polynyas but show a negative trend in total area, possibly suggesting a diminishing role of these polynyas in future dense water formation. The study asserts different contributions of the two types of polynyas to deep water production.