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Sensitivity of the recent increase in Antarctic sea ice in ocean models

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We study the recent increase in Antarctic sea ice using a coupled ocean–sea ice model forced by atmospheric reanalysis. We investigate the impact on sea ice from both model parameters (e.g. vertical mixing and eddy parameterisation) as well as external forcing (e.g. precipitation and melt water from the Antarctic continent). We use the NEMO ocean model coupled to the CICE sea-ice model at 1 degree horizontal resolution forced with ERA-Interim reanalysis. The results will have impacts for our understanding of the Southern Ocean, its sea ice and their representation in future coupled climate-model studies, e.g. CMIP6.

Since the dawn of the satellite era there has been a slow increase in Antarctic sea ice with pronounced spatial structure. The reason for this increase is not yet fully understood and very few climate-model simulations reproduce the observed mean state and/or increase. By varying model parameters and external forcing, we determine that obtaining a realistic sea ice cover requires a complex balance of horizontal and vertical mixing as well as fresh water input.

The surface fresh water balance impacts the vertical salinity gradient and thus vertical fluxes of heat and salt. Underestimation of precipitation or melt water results in deep convection in the open ocean and the opening of large polynyas in the Weddell and Ross sea. The presence of polynyas reduces the sea ice extent.
The depth of the mixed layer has a large impact on the sea ice seasonal cycle.
The summer mixed layer must be sufficiently deep to prevent SST from becoming too high but not so deep as to mix up heat and salt from below. In winter, a deep mixed layer lets brine rejected from sea ice mix down to depths below that of the summer mixed layer thus maintaining a necessary stratification.