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Sensitivity of response of Southern Ocean Dynamics to wind patterns and intensity

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The response of Southern Ocean dynamics and biogeochemistry, particularly air-sea CO_2 fluxes, to the current climate trend in the SAM is under debate. At the crux of that debate is the role played by mesoscale eddies in moderating air-sea CO_2 fluxes. Eddies are a key feature of Southern Ocean dynamics, but they are poorly resolved in coarse-resolution ocean models that have been used to diagnose changes in these fluxes. Moreover, there have been few related sensitivity experiments regarding the trend in the SAM. Here, we examine the sensitivity of Southern Ocean circulation and tracer distributions to perturbed winds and mesoscale eddies in a coupled ocean-sea ice model (NEMO) forced by atmospheric reanalysis. Its regional configuration includes all ocean south of 30°S, and it is run at both coarse (1/2°) and eddying resolutions (1/4° and 1/8°). A series of simulations over recent decades were made where wind patterns and intensity were modified. Our focus here is on the simulated ACC transport, overturning circulation, and tracer distributions. Resolving eddies substantially modifies the Southern Ocean response to winds, and that response strongly depends on the spatial structure of wind anomalies. Our results suggest that (i) coarse-resolution models do not accurately capture the response of the Southern Ocean dynamics and biogeochemistry to changes in atmospheric forcing and (ii) the spatial structure of the SAM is critical in the Southern Ocean response to the SAM.