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Response of the Southern Ocean to the Southern Annular Mode: interannual variability and multidecadal trend

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We evaluate the response of the Southern Ocean to the variability and multi-decadal trend of the Southern Annular mode (SAM) from 1972 to 2001, in a global eddy-permitting model of the DRAKKAR project. The transport of the Antarctic Circumpolar Current (ACC) is correlated with the SAM at interannual time scales but exhibits a drift due to the thermodynamic adjustment of the model (the ACC transport decreases due to a low renewal rate of dense waters around Antarctica). The interannual variability of the eddy kinetic energy (EKE) and the ACC transport are uncorrelated, and meridional eddy fluxes of heat and buoyancy remain stable. The contribution of oceanic eddies to meridional transports is an important issue because a growth of the poleward eddy transport could, in theory, oppose the increase of the mean overturning circulation forced by the SAM. In our model, the total meridional circulation at 50S is well correlated with the SAM index (and the Ekman transport) at interannual time scales, and both increase over three decades between 1972 and 2001. However, given the long-term drift, no SAM-linked trend in the eddy contribution to the meridional overturning circulation is detectable. The increase of the meridional overturning is due to the time-mean component, and is compensated by an increased buoyancy gain at the surface. We emphasize that the meridional circulation does not vary in a simple relationship with the the zonal circulation. Our model solution points out that the zonal circulation and the eddy kinetic energy are governed by different mechanisms according to the time scale considered (interannual or decadal).