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Using Eulerian and Lagrangian Approaches to Investigate Wind-Driven Changes in the Southern Ocean Abyssal Circulation

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This study uses a global ocean eddy-permitting climate model to explore the export of abyssal water from the Southern Ocean and its sensitivity to projected twenty-first-century poleward-intensifying Southern Ocean wind stress. The authors investigate the abyssal flow pathways and transport using a combination of Lagrangian and Eulerian techniques. In an Eulerian format, the equator- and poleward flows within similar abyssal density classes are increased by the wind stress changes, making it difficult to explicitly diagnose changes in the abyssal export in a meridional overturning circulation framework. Lagrangian particle analyses are used to identify the major export pathways of Southern Ocean abyssal waters and reveal an increase in the number of particles exported to the subtropics from source regions around Antarctica in response to the wind forcing. Both the Lagrangian particle and Eulerian analyses identify transients as playing a key role in the abyssal export of water from the Southern Ocean. Wind-driven modifications to the potential energy component of the vorticity balance in the abyss are also found to impact the Southern Ocean barotropic circulation.