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A steady-state, variable-density, 2-layer, ocean model (VLOM) is used to investigate basic dynamics of the Atlantic meridional overturning circulation and Southern Ocean. The domain consists of idealized (rectangular) representations of the Atlantic, Southern, and Pacific Oceans. The model equations represent the depth-averaged, layer-1 response.
A hierarchy of solutions is obtained in which forcings and processes are individually introduced. The complete solution set includes a wide variety of solution types: with sinking in the northern North Atlantic and with sinking near Antarctica; with and without wind forcing; with, without, and for two parameterizations of northern-boundary sinking that represent cooling external to and within the North Atlantic; for a wide range of mesoscale-eddy mixing strength and wind stress in the Antarctic Circumpolar region; and for different closures for mesoscale-eddy mixing. Novel aspects of the model and solutions include the following: use of VLOM, which allows buoyancy forcing to be introduced realistically; the aforementioned closure, which allows eddy-induced transport to be determined when layer 1 represents _both_ the surface mixed layer (h=h_m) and the depth of subsurface isopycnals (h>h_m); latitude where layer 1 outcrops in the Southern Ocean being _internally_ determined rather than externally specified; and a boundary layer, based on Gill's (1968) solution, that smoothly connects the Southern- and Atlantic-Ocean responses across the latitude of the southern tip of South America. Finally, some solutions in the set are comparable to solutions to idealized, ocean general circulation models (OGCMs); in these cases, our solutions provide insight into the underlying dynamics of the OGCM solutions, for example, pointing toward processes that may be involved in eddy saturation and compensation.

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