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The role of isopycnal heat fluxes in the overturning circulation of the Southern Ocean

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Simple conceptual models of the overturning circulation involve upwelling of North Atlantic Deep Water over the Antarctic Circumpolar Current and then its northwards return as warmer, lighter intermediate and thermocline waters. The relative importance of surface heating and freshwater input in driving this buoyancy gain is unclear.

The higher average temperature of the lighter waters suggests that surface heat input dominates. Here we show that this may not necessarily be the case. We diagnose the 1/12 degree OCCAM run, that has realistic freshwater forcing, including the melt of northward moving ice, and find zonally integrated isopycnal transports of heat up to 0.4 PW. These result both from i) the transient eddies and ii) the 'steady eddies'–zonal correlations between time-mean velocity and temperature on density layers. Surface freshwater input over the ACC can thus be exchanged for heat, allowing water to move into warmer, lighter layers.