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What drives the meridional overturning circulation?

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Due to its relevance for the global climate, the oceanic meridional overturning circulation (MOC) has been a major research focus for many years. Yet, the question which physical mechanisms ultimately drive the MOC, in the sense of providing its energy supply, remains a matter of controversy. The two main candidates are diapycnal mixing processes in the ocean's interior and wind-induced Ekman upwelling in the Southern Ocean. We give an overwiew of both observational data and model results that clarify the role of the two driving processes. In distinction to the energy source, we also discuss the role of surface heat and freshwater fluxes. They do not supply energy to the overturning itself, but influence the volume transport of the MOC, shape its spatial circulation pattern, and can trigger short-term circulation changes. From our discussion it appears that both wind-driven upwelling and diapycnal mixing are essential driving processes for the current steady-state overturning. We present a concept how they drive the two MOC cells: the North Atlantic Deep Water cell and the Antarctic Bottom Water cell.