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Title: On the Stability of the Atlantic Meridional Overturning Circulation in our Warming Climate

Abstract: The key role of diapycnal mixing in maintaining the meridional overturning circulation (MOC) has long been clear (Munk, 1966). Scaling analysis and numerical models show that if mixing is represented by a constant eddy diffusivity K , then the amplitude of the MOC is proportional to $K^{2/3}$ (Zhang, Schmitt, and Huang, 1999). We have developed a new scaling for the MOC that uses improved knowledge of the dependence of diapycnal mixing on energy dissipation and stratification, and the role of the tides in deep ocean mixing, to determine that the MOC is proportional to the energy dissipated in mixing and varies inversely with the meridional density contrast. Thus, contrary to popular belief, if polar waters become lighter by warming or freshening, the constancy of the tidal energy source that interacts with bottom topography to drive deep ocean mixing will cause the MOC to increase, not decrease, because a smaller density contrast is more easily mixed and yields a larger diffusivity. We know that the Atlantic is saltier than the Pacific because of strong transport of water vapor across Central America, and that it is becoming saltier in our warming climate (Lu, et al, 2024), contrary to the incorrect notion that the Atlantic Meridional Overturning Circulation (AMOC) causes its higher salinity. This means that its denser waters make the Atlantic the preferred ocean for the meridional heat transport required to balance the Northern Hemisphere radiation budget. The over-hyped notion of immanent AMOC collapse arises from incorrect treatment of mixing in the current generation of models, energetically impossible estimates of Greenland ice melt in hosing experiments and a misunderstanding of the role of deep convection. Moreover, recent paleo data indicates that a robust AMOC was maintained during the last ice age (Wharton et al, 2026). It was widespread sea ice that insulated oceanic heat from the atmosphere and cooled Europe, not a decline in AMOC. The AMOC is stable and always will be with the present arrangement of the continents and is likely to intensify with global warming.

References:

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