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The key role of the western boundary in linking the AMOC strength to the north-south pressure gradient.

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A key idea in the study of the Atlantic meridional overturning circulation (AMOC) is that its strength is proportional to the meridional density gradient, or more precisely, to the strength of the meridional pressure gradient. A physical basis that would tell us how to estimate the relevant meridional pressure gradient locally from the density distribution in numerical ocean models to test such an idea, has been lacking however. Furthermore, previous work is restricted to posing only a proportionality. This is unsatisfying form a scientific point of view, and here we will offer an precise equation that can be tested quantitatively against model output and observations.
We develop an analytical theory linking the western boundary current circulation below the interface separating the North Atlantic Deep Water (NADW) and Antarctic Intermediate Water (AAIW) to the shape of this interface. The simple analytical model also shows how available potential energy is converted into kinetic energy at each location, and we link the frictional energy dissipation to the global overturning rate via a simple yet accurate formula. The present results suggest that the conversion rate of potential energy may provide the necessary physical basis for linking the strength of the AMOC to the meridional pressure gradient, and that this can be achieved by a detailed study of the APE to KE conversion in the western boundary current. The results presented here help understand the dynamics underlying the response in North Atlantic sinking to past and future climatic changes.