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Sinking of North Atlantic waters in a global ocean model: location and controlling factors

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The Atlantic Meridional Overturning Circulation (AMOC) plays an important role in climate. The classical view of an ocean conveyor belt with northward surface currents and southward return currents transporting convectively-formed waters from the subpolar North Atlantic Ocean to other ocean basins suggests a tight relation between convection and sinking. However, convection regions feature very little vertical mass transport. Instead, it has been argued that the sinking of waters must take place near boundaries where ageostrophic processes affect the flow. So far, this has been confirmed in highly idealized regional model studies and in laboratory experiments. It is, however, unclear how well the sinking of dense waters is represented in the current generation of global ocean models and climate models, and whether the factors driving and controlling the sinking in these models are in accordance with the developed theory. This is of crucial importance for our confidence in projections of the future behavior of the AMOC, which are based on this type of model.
In this study, we analyze the characteristics of the vertical transport in two global ocean models: an eddy-permitting model at 0.25 degree resolution and its coarser 1.0 degree resolution counterpart.
We show that the sinking indeed predominantly occurs in a narrow region close to the boundary in both model simulations, and not in deep convection regions. Notably, the amount of vertical transport that is found along the edges of the North Atlantic Ocean is highly variable in space, and large differences exist between the two model versions. In the eddy-permitting model, the magnitude of the local sinking appears to be governed by alongshore variations in density near the boundary, in line with theory.