Geophysical Research Abstracts
Vol. 19, EGU2017-7651, 2017
EGU General Assembly 2017

How ocean eddies contribute to enhanced downwelling in the North Atlantic Ocean

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Within the North Atlantic Ocean, enhanced downwelling closes the loop of the Atlantic Meridional Overturning Circulation consisting of northward flowing surface water masses and southward flowing water masses at depth. This enhanced downwelling is thought to occur along the coastline of marginal seas in the North Atlantic within boundary currents where ageostrophic processes are important. In particular, ocean eddies shed from these boundary currents are thought to play an important role in the sinking, because they exchange heat, salt and vorticity between the boundary current and the interior and therefore strongly influence the properties of the boundary current itself.

In our study, we investigate which processes are responsible for enhanced downwelling along the coastline and determine its strength and location. To this end, we use eddy-resolving idealized model simulations of a marginal sea as well as strongly-eddying realistic global circulation models at 0.1 degree resolution. By diagnosing the vorticity budget, we are able to distinguish the role of the mean flow from that of eddies on the sinking. In particular, we show how eddies can contribute to the downwelling in regions of enhanced eddy shedding like the west coast of Greenland and along the northwestern coast of Norway. By comparing the results of the high-resolution simulations with non-eddy resolving simulations, we investigate to which extent the downwelling in coarse resolution climate models is biased by not directly resolving the eddies.