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North Atlantic thermocline vertical velocity reconstruction from ARMOR3D geostrophic meridional velocity field

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Ocean vertical velocities are several orders of magnitude smaller than the horizontal velocity field when looking at patterns larger than the sub-mesoscales, and for this reason, direct measurement in the ocean has not yet been possible. One method for estimating in-situ vertical velocities (w) in the real ocean is through a theoretical approach using observation-based fields. In this work, the Geostrophic Linear Vorticity Balance (GLVB: $\beta v_g = f\partial w/\partial z$) is tested in an eddy-permitting OGCM to find out to what extent it explains the large-scale circulation in the North Atlantic and can be used to reconstruct an observation-based climatological w field. In the first part, we present a thorough baroclinic analysis of the climatological GLVB. The authors find that it holds to first order within the thermocline, below the mixing layer in the interior tropical and subtropical gyres and near the African coast. Within western boundary currents, the equatorial band, and the subpolar gyre significant departures occur due to the importance of other terms in the vorticity budget such as nonlinearities or friction. These results allow us to reconstruct w from climatological ARMOR3D geostrophic meridional velocities and satellite wind field within the thermocline of the North Atlantic tropical and subtropical gyres. In the second part, we discuss discrepancies between our observation-based reconstruction and two other existing estimates of w (one Omega equation derived product and an ocean reanalysis). At last, we revisit the classical Sverdrup explanation of gyre dynamics by adding a baroclinic analysis of some major thermocline currents.