Geophysical Research Abstracts Vol. 20, EGU2018-5581, 2018 EGU General Assembly 2018 © Author(s) 2018. CC Attribution 4.0 license.



The Horizontal Residual Mean: addressing the limited spatial resolution of models

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Horizontal eddy fluxes of heat and other scalar quantities in the ocean are due to correlations between the horizontal velocity and tracer fields. However, the limited spatial resolution of ocean models means that these correlations are not fully resolved using the velocity and temperature evaluated on the model grid. We derive a method for estimating the horizontal flux due to spatially unresolved spatial correlations, based on calculating an additional non-divergent velocity to advect all scalar variables. The sum of the Eulerian-mean velocity and this extra advection we call the Horizontal Residual Mean velocity. The calculation of the extra advection is based on the depth-integrated horizontal transport from the sea floor to the density surface whose spatially averaged height is at the height of the calculation. In this way the Horizontal Residual Mean velocity has a similar interpretation to the Temporal Residual Mean velocity (as commonly parameterized by the Gent-McWilliams scheme), with the former accounting for unresolved spatial correlations and the latter the unresolved temporal correlations. We find that in the Southern Ocean this new HRM advection accounts for 0.2PW of meridional heat flux.