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VENM: An Algorithm to Accurately Calculate Neutral Slopes and Gradients

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Mesoscale eddies stir along the neutral plane, and the resulting neutral diffusion is a fundamental aspect of subgrid-scale tracer transport in ocean models. Calculating neutral diffusion traditionally involves calculating neutral slopes and three-dimensional tracer gradients. The calculation of the neutral slope traditionally occurs by computing the ratio of the horizontal to vertical locally referenced potential density derivative. However, this approach is problematic in regions of weak vertical stratification, prompting the use of a variety of ad hoc regularization methods that can lead to rather nonphysical dependencies for the resulting neutral tracer gradients.

Here we introduce VENM; a search algorithm that requires no ad hoc regularization and significantly improves the numerical accuracy of calculating neutral slopes, neutral tracer gradients, and associated neutral diffusive fluxes. We compare and contrast VENM against a more traditional method, using an independent objective neutrality condition combined with estimates of spurious diffusion, heat transport, and water mass transformation rates. VENM is more accurate, both physically and numerically, and should form the basis for future efforts involving neutral diffusion calculations from observations and possibly numerical model simulations.