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Comparing Estimates of Isopycnal Diffusivities in Zonal Jets Obtained from Eulerian Analysis and Lagrangian Particle Statistics

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Previous studies have shown that material transport in zonal jets is anisotropic. Specifically, the difference of zonal and meridional diffusivity constants calculated from Lagrangian single-particle dispersion indicate that diffusivity tensors used in parameterizations of unresolved transport properties should be anisotropic. However, some of these results suggest that asymptotic values of single-particle statistics do not capture essential properties of baroclinically unstable jets, such as mixing barriers caused by strong potential vorticity gradients in the jet core and the vertical increase of mixing around the critical layer depth. We analyze the velocity field of a 3-dimensional eddy-permitting model with multiple zonal jets in a periodic channel and compare the meridional and vertical distribution of diffusivities estimated from three different methods: First, a Eulerian analysis which involves time-averaging to obtain diffusivities from both the mean tracer field and eddy correlation fluxes. Second, single-particle statistics from Lagrangian floats, and third, two-particle statistics from Lagrangian floats. We observe that all three methods indicate different distributions of diffusivity with a variable degree of anisotropy. However, only the Eulerian analysis and two-particle statistics show similar vertical distributions of meridional diffusivity which correspond to the notion of a depth above which meridional mixing is inhibited by a mixing barrier. This indicates that asymptotic values of single-particle statistics obtained from observational float data might not be capable of capturing the vertical distribution of mesoscale transport properties in jet-like features.