Transport by Coherent Lagrangian Mesoscale Eddies

Ocean mesoscale eddies contribute significantly to the transport of heat and other tracers in the ocean. However, there is an ongoing debate about how exactly eddies cause transport: is it mostly through stirring on the periphery of the eddy, or is it by “trapping” and transporting fluid inside the eddy core? In this study, we employ recently developed tools from dynamical systems theory to make a comprehensive census of coherent Lagrangian mesoscale eddies in the global ocean. This is the largest-scale Lagrangian eddy census performed to date, with over 100,000 structures identified. The statistics of Lagrangian eddy size and propagation speed are broadly similar to previous eddy tracking results based on sea-surface height anomalies (e.g. Chelton et al. 2011). However, the material nature of our Lagrangian eddies enables a precise quantification of their role in transport. We define a "coherent diffusivity" diagnostic based on the relative meridional dispersion of Lagrangian particles contained within material eddies and show that the the transport due to these structures accounts for less than 1% of the total turbulent meridional transport. We conclude that most of the ocean "eddy flux" is due to incoherent stirring, rather than the bulk translation of coherent structures. Implications for the parameterization of eddy fluxes are discussed.