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Random movement of mesoscale eddies in the global ocean

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In this study we track and analyze eddy movement in the global ocean using 20 years of altimeter data and show that, in addition to the well-known westward propagation and slight polarity-based meridional deflections, mesoscale eddies also move randomly in all directions at all latitudes as a result of eddy-eddy interaction. The speed of this random eddy movement decreases with latitude and equals the baroclinic Rossby wave speed at about 25° of latitude. The tracked eddies are on average isotropic at mid and high latitudes, but become noticeably more elongated in the zonal direction at low latitudes. Our analyses suggest a critical latitude of approximately 25° that separates the global ocean into a low-latitude anisotropic wavelike regime and a high-latitude isotropic turbulence regime. One important consequence of random eddy movement is that it results in lateral diffusion of eddy energy. The associated eddy energy diffusivity, estimated using two different methods, is found to be a function of latitude. The zonal-mean eddy energy diffusivity varies from over 1500 m^2 s^{-1} at low latitudes to around 500 m^2 s^{-1} at high latitudes, but significantly larger values are found in the eddy energy hotspots at all latitudes, in excess of 5000 m^2 s^{-1}. Results from this study have important implications for recently-developed energetically-consistent mesoscale eddy parameterization schemes which require solving the eddy energy budget.