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Quantifying the consequences of the ill-defined nature of neutral surfaces

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It has been shown that the hydrography of the world's oceans occupies surprisingly little volume in salinity-temperature-pressure space. That is, the world's hydrographic ocean data almost lie on a single surface in this three-dimensional space. A consequence of this sparseness is that the ambiguity in defining neutral surfaces is quite small. But due to the ill-defined nature of neutral surfaces the lateral motion of water parcels is along helical neutral trajectories instead of approximate neutral surfaces. This flow through neutral surfaces causes vertical advection which has not been quantified before and therefore its importance compared to other processes of vertical advection/diffusion is not known. In order to quantify this vertical transport, velocity data is needed so we use model data from a global ocean circulation model. The first step in this analysis is to adopt the best way to label the dataset with neutral density to make sure that the calculated differences between the approximate neutral surface is due to the mean vertical advection caused by the helical shape of neutral trajectories and not due to any numerical errors. From these labelled data we calculate the approximate neutral surfaces and by using the difference in slope from these surfaces and the neutral trajectories and the lateral velocities we estimate the mean vertical transport. To compare model output to climatologies we look at the differences in thickness between the surfaces in salinity-temperature-pressure space on which the world's hydrography lie. This corresponds to a difference in helicity and therefore a different mean vertical advection.