Abstract View

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Neutral Surfaces

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ABSTRACT

Scalar properties in the ocean are stirred (and subsequently mixed) rather efficiently by mesoscale eddies and two-dimensional turbulence along “neutral surfaces”, defined such that when water parcels are moved small distances in the neutral surface, they experience no buoyant restoring forces. By contrast, work would have to be done on a moving fluid parcel in order to keep it on a potential density surface. The differences between neutral surfaces and potential density surfaces are due to the variation of α/β with pressure (where α is the thermal expansion coefficient and β is the saline contraction coefficient).

By regarding the equation of state of seawater as a function of salinity, potential temperature, and pressure, rather than in terms of salinity, temperature, and pressure, it is possible to quantify the differences between neutral surfaces and potential density surfaces. In particular, the spatial gradients of scalar properties (e.g., *S*, θ, tritium or potential vorticity) on a neutral surface can be quite different to the corresponding gradients in a potential density surface. For example, at a potential temperature of 4°C and a pressure of 1000 db, the lateral gradient of potential temperature in a potential density surface (referenced to sea level) is too large by between 50% and 350% (depending on the stability ratio R_p of the water column) compared with the physically relevant gradient of potential temperature on the neutral surface. Three-examples of neutral surfaces are presented, based on the Levitus atlas of the North Atlantic.

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