Can loss of balance from mesoscale eddies adequately power deep ocean mixing?

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The global ocean thermohaline circulation is partly composed of the sinking of dense surface waters at high latitudes. But in order to close the circulation and maintain the abyssal stratification, the dense waters must rise up again through vertical mixing. This process requires a source of energy roughly estimated to be 2 TW. Previous work has concluded that tides and winds may adequately supply the required power, but the conceivable role of loss of balance from mesoscale eddies, resulting in the generation of internal inertia-gravity waves and associated vertical mixing, has hitherto been considered to be “of unknown importance” (Wunsch and Ferrari, 2004).

We investigate the potential role of loss of balance, by studying the generation of internal inertia-gravity waves by balanced flow in a rotating two-layer annulus laboratory experiment (Williams et al., 2008). As the Rossby number of the balanced flow decreases, the amplitude of the emitted inertia-gravity waves also decreases, but much less rapidly than is predicted by several dynamical theories. This finding suggests that inertia-gravity waves might be far more energised than previously thought.

The balanced flow leaks roughly one per cent of its energy each rotation period into internal inertia-gravity waves at the peak of their generation. Crude extrapolation of this result to the global ocean suggests that the flux of energy from mesoscale eddies into internal waves may be as large as 1.5 TW. We claim no accuracy for this figure which is only indicative. Nevertheless, we are persuaded that generation of inertia-gravity waves from the balanced mesoscale flow may be an important source of energy for deep interior mixing, and deserves further study.

Reference

Williams, PD, Haine, TWN and Read, PL (2008) Inertia-Gravity Waves Emitted from Balanced Flow: Observations, Properties, and Consequences. Journal of the Atmospheric Sciences, 65(11), pp 3543-3556. doi:10.1175/2008JAS2480.1