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Propagation of low-mode internal waves through the ocean

Luc Rainville

Woods Hole Oceanographic Institution (lrainville@whoi.edu)

The baroclinic tides play a significant role in the energy budget of the abyssal ocean. While basic generation and propagation principles are essentially understood, a clear picture of real-world generation and propagation conditions is only now emerging. To advance this effort, we develop a ray model to quantify the effects of spatially variable topography, stratification, planetary vorticity and mesoscale currents on the horizontal propagation of internal gravity modes.

A representative mesoscale field, derived weekly from Topex/Poseidon altimetric measurements, is used to quantify the refraction of tidally generated internal waves at the Hawaiian Ridge. The path of mode 1 is only slightly affected by typical currents, although its phase becomes increasingly random as the distance from its source increases. The effect of the currents becomes more dramatic as mode number increases. For modes 3 and higher, wave phase can vary by $\pm\pi$ only a few wavelengths from the source. This phase variability reduce the magnitude of the baroclinic signal seen in altimetric data, creating a fictitious energy loss along the propagation path.

In the Topex/Poseidon observations, the mode-1 M2 internal tide does appear to lose significant energy as it propagates south-westward from the Hawaiian Ridge. Our simulations suggest that phase modulation by mesoscale flows could be responsible for a large fraction of this apparent loss. In contrast, northeast-propagating internal tides should experience limited refraction. The apparent energy loss seen in the altimetric data might indeed be real.