Spectral analysis

Wave properties are inferred here from internal wave energy densities calculated from velocity and buoyancy perturbations. Using the dispersion relations of internal waves from internal wave theory. Estimation of intrinsic frequency and wavenumber components can help separate lee waves from other types of internal waves. Velocity and density measurements are separated into mean and perturbation components to isolate the wave driven effects.

$$U = \bar{u} + u'$$

$$\rho = \bar{\rho} + \rho'$$

Kinetic and potential energy densities are estimated using the power spectral density of the perturbations integrated between a range of vertical wavelengths, following the work of several previous internal wave investigations[1,2]. The Fourier transforms are performed on half overlapping segments of 1024 meters. Integration limits are determined qualitatively through examining the velocity perturbation profiles and identifying coherent structures. Fig (velocity profiles) shows that along the transect, these coherent structures have markedly different vertical sizes. Therefore, calculations are repeated several times with varying integration limits, Fourier transform sizes, and segment lengths. Hanning windows are applied to reduce variance loss. Kinetic and Potential energies are estimated as follows.

$$E_{total} = \frac{1}{2}\left[\rho\big(\langle u'^2\rangle + \langle v'^2\rangle\big) + \rho N^2 \langle \eta^2 \rangle\big)\right]$$

Kinetic Energy.

1. Waterman, S., Naveira Garabato, A. & Polzin, K. Internal Waves and Turbulence in the Antarctic Circumpolar Current. *J. Phys. Oceanogr.* **43,** 259–282 (2013).

2. Meyer, A., Polzin, K. L., Sloyan, B. M. & Phillips, H. E. Internal Waves and Mixing near the Kerguelen Plateau. *J. Phys. Oceanogr.* **46,** 417–437 (2016).