Investigation of Lee Waves in the Southern Ocean

Manish S. Devana

# **Introduction**

# **Methods**

This study utilizes a 100 km towyo transect over a region of complex topography by the Shag Rocks islands.

## Linear Wave Theory & Diagnostic Equations

Linear internal wave theory allows for construction of polarization relations which are critical to understanding internal waves in observations. Eq. 1 relates the ratio of internal wave kinetic and potential energies to the frequency.

(1)

This observed frequency has been Doppler shifted by the mean flow and must therefore by modified by Eq. 2 to obtain an intrinsic frequency.

(2)

U is the mean flow and represents the wavenumber vector. The intrinsic frequency can be utilized, along with the local buoyancy frequency, to estimate the horizontal wavenumber with Eq. 3:

(3)

where *m* is the vertical wavenumber, estimated from observations (see following section). For ray tracing, the horizontal wavenumber must be decomposed into its meridional and zonal components *k* and *l*.

## Internal Wave Parametrizations

This section details the use of the diagnostic equations shown above for estimating observed wave properties, following much of the methodology used by Waterman et al. 2013. Integrated variance spectra of velocity and density anomalies are used for estimation internal wave energies. For each quantity of interest, the anomaly component is estimated by subtracting a sliding 2nd order polynomial fit to each vertical profile, where the polynomial fit represents the mean value (Eq. 4):

(4)

where *X* represents an observed quantity of interest, is the mean value, and is the quantity anomaly. The sliding polynomial fit was constructed by fitting to overlapping 100 dB segments which increase in size by 8 dB every 8 dB. The polynomial fits are combined and linearly regressed back into single vertical profiles which can subtracted from observed profiles. The resulting anomaly profiles are binned into half overlapping 1500 dB bins. Bin size was chosen to fully capture the clearly observable wave features in *figure velocity anomalies.* The power spectral density is then calculated in each bin using Welch’s method and Hanning windowing to reduce loss of variance. Finally, spectral power is integrated between target vertical wavelengths corresponding to the vertical size of velocity anomaly features. Rather than use constant integration limits, they are adjusted for each bin to properly capture the wave features. Kinetic energy is estimated using Eq. 5, where denotes integrated variance spectra. Potential energy is estimated from isopycnal displacements (Eq. 6), where Γ is neutral density. Neutral densities are calculated using the CSIRO neutral density code. is calculated by differencing Γ over 400 dB windows.

# **Results**

# **Discussion**