Asymmetry and Imbalance in a Quasi-Geostrophic Parameter Regime
- or -
Mesoscale Eddy - Internal Wave Coupling as an Oceanic Analogue of Radiative Damping

Kurt Polzin
Woods Hole Oceanographic Institution
kpolzin@whoi.edu

The standard dynamical paradigm for oceanic dynamics is to consider the stratified interior as an ideal fluid and place all dissipative processes in either the bottom boundary layer or associate them with eddy/mixed layer interactions. This conceptual framework is consistent with an absence of mean interior potential vorticity gradients. On the other hand, background potential vorticity gradients are clearly documented in hydrographic data, e.g. [1]. Moreover, current meter data [2] also document the presence of downgradient eddy fluxes of potential vorticity. Thus we arrive at an essential conundrum: what is the frictional or diabatic process that permits the material modification of potential vorticity within the stratified oceanic interior associated with the downgradient fluxes? It is clear that diabatic processes are far too weak. A case will be made here that a coupling between mesoscale eddies and the internal wavefield acts as a frictional process.

The case to be presented will focus on the interpretation of observations. These include: (i) Vertical profiles of horizontal velocity obtained with a free-falling instrument using a electric field sensing technique obtained as part of the Mid-Ocean Dynamics Experiment (MODE)[3,4]. These data were originally interpreted as being representative of the background internal wavefield with an excess of downward energy propagation associated with atmospheric generation. The data are interpreted here as an example of internal wave capture[5] in a mesoscale strain field. (ii) Current meter array data obtained as part of the POLYMODE Local Dynamics Experiment (LDE). [6] found correlations between internal wave momentum fluxes (stresses) and eddy rate of strain estimates that they interpreted in terms of a horizontal viscosity $\nu_h = 200 - 400$ m^2 s^{-1}. A revised estimate of this horizontal viscosity ($\nu_h = 50$ m^2 s^{-1}) and a vertical viscosity ($\nu_v = 3 \times 10^{-3}$ m^2 s^{-1}) estimate will be presented. (iii) Finally, an attempt will be made to relate such a coupling coefficients to recent satellite altimetry based estimates of mesoscale eddy kinetic energy cascades[7].

[1] Robbins, Price, Owens and Jenkins, 2000: The importance of lateral diffusion for the ventilation of the lower thermocline in the Subtropical North Atlantic. *J. Phys. Oceanogr.*, **30**, 67–89.
[2] Brown, Owens and Bryden, 1986: Eddy-potential vorticity fluxes in the Gulf Stream Recirculation. *J. Phys. Oceanogr.*, **16**, 523–531.
[3] Sanford, 1975: Observations of the vertical structure of internal waves. *J. Geophys. Res.*, **80**, 3861–3871.
[4] Leaman, 1976. Observations on the vertical polarization and energy flux of near-inertial waves. *J. Phys. Oceonogr.*, **6**, 894–908.
[5] Bühler and McIntyre, 2005. Wave capture and wave-vortex duality. *J. Fluid Mech.*, **534**, 67–95.
[6] Brown and Owens, 1981: Observations of the horizontal interactions between the internal wave field and the mesoscale flow. *J. Phys. Oceanogr.*, **11**, 1474-1480.
[7] Scott and Wang, 2005: Direct evidence of an oceanic inverse kinetic energy cascade from satellite altimetry. *J. Phys. Oceanogr.*, **35**, 1650–1666.