Abstract View

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Observations of Interaction between the Internal Wavefield and Low-Frequency Flows in the North Atlantic

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ABSTRACT

A total of four moorings from POLYMODE array I and II were analyzed in an investigation of the interaction of wavefields and mean flow. In particular, evidence for internal wave-mean flow interaction was sought by searching for time correlations between the vertically acting Reynolds stress of the wavefield (estimated using the temperature and velocity records), and the mean shear. No significant stress-shear correlations were found at the less energetic moorings ($\bar{u} \lesssim 10$ cm s^{-1}), indicating that the magnitude of the eddy viscosity was under 200 cm^2 s^{-1}, with the sign of the energy transfer uncertain. This is considerably below the O(4500 cm^2 s^{-1}) predicted by Müller (1976). An extensive error analysis indicates that the large wave stress predicted by the theory should have been observable clearly under the conditions of measurement. At moorings typified by a higher mean velocity ($\bar{u} \approx 25$ cm s^{-1}), statistically significant stress-shear correlations were found, and the wavefield energy level was observed to modulate with the strength of the mean shear. The observations were consistent with generation of short ($\sim$ 1 km horizontal wavelength) internal waves by the mean shear near the thermocline, resulting in an effective eddy viscosity of $\sim$ 100 cm^2 s^{-1}.

Theoretical computations indicate that the wavefield "basic state" may not be independent of the mean flow as assumed by Müller (1976) but can actually be modified by large-scale vertical shear and still remain in equilibrium. In that case, the wavefield does not exchange momentum with a large-scale vertical shear flow and, excepting critical-layer effects, a small vertical eddy viscosity is to be expected. Using the Garrett-Munk (1975) model internal wave spectrum, estimates were made of the maximum momentum flux (stress) expected to be lost to critical-layer absorption. This stress was found to increase almost linearly with the velocity difference across the shear zone,

corresponding to a vertical eddy viscosity of $-100\ cm^2\ s^{-1}$. Stresses indicative of this effect were not observed in the data.

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