Waves and turbulence in the Southern Ocean: small-scale processes with global impacts

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Abstract

The transport of heat, carbon and other properties by the overturning circulation of the Southern Ocean plays a central role in the global climate system. Observation of high rates of turbulent dissipation above regions rough bathymetry led to the hypothesis that turbulent mixing mediated by internal waves is responsible for much of the diapycnal mixing required for the overturning circulation. Many observational studies have estimated the properties of the internal wave field and associated mixing but observations of individual lee waves that can be identified with particular bathymetric features are rare. In this paper we present the first such observations in the Southern Ocean with simultaneous estimates of energy fluxes and mixing. Measurements were obtained from two EM-APEX profiling floats deployed in the Drake Passage during the Diapycnal and Isopycnal Mixing Experiment (DIMES). The floats measured temperature, salinity and horizontal velocity on fine scales and we derived a model of the float motion that enabled the calculation of vertical water velocity from the rate of change of pressure. The observed wave had a vertical displacement over 150m and velocity fluctuations over 15 cm s-1 in all three components. The peak vertical flux of horizontal momentum of was 6 N m-2, a value that is two orders of magnitude larger than the time mean wind forcing on the Southern Ocean. Turbulent kinetic energy dissipation was estimated using fine-scale parameterisations and found to be elevated above background levels by two orders of magnitude. Comparison will be shown with measurements of lee waves in laboratory studies of stratified rotating flows conducted at the Institut de Mécanique de Grenoble.

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