

Assessment of finescale parameterizations of deep ocean mixing in the presence of geostrophic current shear : Results of microstructure measurements in the Antarctic Circumpolar Current Region

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The Southern Ocean is thought to be one of globally significant mixing hotspots. In this study, we carry out simultaneous measurements of microscale turbulence and finescale shear/strain in the south of Australia to assess the validity of the existing finescale parameterizations of deep ocean mixing in the Antarctic Circumpolar Current (ACC) region where geostrophic shear flows coexist with the background internal wave field.

It is found that turbulent dissipation rates and the derived diapycnal diffusivities are overall small but the internal wave field is more energetic than the Garrett-Munk (GM) wave field. Finescale shear/strain ratio (R_ω) well exceeds the GM value in the deep layer south of Southern ACC Front, suggesting that the local internal wave spectra are significantly biased to lower frequencies. Through the comparison of the turbulent dissipation rates directly measured with those inferred from finescale parameterizations, we find that the Gregg-Henyey-Polzin (GHP) and Ijichi-Hibiya (IH) parameterizations, both of which take into account the spectral distortion in terms of R_ω , can well predict the turbulent dissipation rates at many observed locations, whereas the shear-based parameterization (the strain-based parameterization) tends to overestimate (underestimate) the directly measured turbulent dissipation rates. However, at the observed locations where the vertical shear associated with the geostrophic current is enhanced, both the GHP and IH parameterizations tend to overestimate the turbulent dissipation rates by up to a factor of ~ 3 . The most likely causes of the overestimates are (i) spatial anisotropy of the internal wave field and (ii) distortion of the vertical wavenumber spectrum, which are both caused by large-amplitude monochromatic near-inertial waves and lee waves.

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