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Surface boundary layer turbulence in the Southern ocean

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Due to the remote location and harsh conditions, few direct measurements of turbulence have been collected in the Southern Ocean. This region experiences some of the strongest wind forcing of the global ocean, leading to large inertial energy input. While mixed layers are known to have a strong seasonality and reach 500m depth, the depth structure of near-surface turbulent dissipation and diffusivity have not been examined using direct measurements.

We present data collected during the Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean (DIMES) field program. In a range of wind conditions, the wave affected surface layer (WASL), where surface wave physics are actively forcing turbulence, is contained to the upper 15-20m. The lag-correlation between wind stress and turbulence shows a strong relationship up to 6 hours ($\sim$1/2 inertial period), with the winds leading the oceanic turbulent response, in the depth range between 20-50m. We find the following characterize the data: i) Profiles that have a well-defined hydrographic mixed layer show that dissipation decays in the mixed layer inversely with depth, ii) WASLs are typically 15 meters deep and 30% of mixed layer depth, iii) Subject to strong winds, the value of dissipation as a function of depth is significantly lower than predicted by theory.

Many dynamical processes are known to be missing from upper-ocean parameterizations of mixing in global models. These include surface-wave driven processes such as Langmuir turbulence, submesocale frontal processes, and nonlocal representations of mixing. Using velocity, hydrographic, and turbulence measurements, the existence of coherent structures in the boundary layer are investigated.