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Turbulent properties of oceanic near-surface stable boundary layers subject to wind, fresh water, and thermal forcing.

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The near-surface oceanic boundary layer is generally regarded as convectively unstable due to the effects of wind, evaporation, and cooling. However, stable conditions also occur often, when rain or low-winds and diurnal warming provide buoyancy to a thin surface layer. These conditions are prevalent in the tropical and subtropical latitude bands, and are underrepresented in model simulations.

Here, we evaluate cases of oceanic stable boundary layers and their turbulent processes using a combination of measurements and process modeling. We focus on the temperature, salinity and density changes with depth from the surface to the upper thermocline, subject to the influence of turbulent processes causing mixing. The stabilizing effects of freshwater from rain as contrasted to conditions of high solar radiation and low winds will be shown, with observations providing surprising new insights into upper ocean mixing in these regimes. Previous observations of freshwater lenses have demonstrated a maximum of dissipation near the bottom of the stable layer; our observations provide a first demonstration of a similar maximum near the bottom of the solar heating-induced stable layer and a fresh-water induced barrier layer. Examples are drawn from recent studies in the tropical Atlantic and Indian oceans, where ocean gliders equipped with microstructure sensors were used to measure high resolution hydrographic properties and turbulence levels. The limitations of current mixing models will be demonstrated. Our findings suggest that parameterizations of near-surface mixing rates during stable stratification and low-wind conditions require considerable revision, in the direction of larger diffusivities.