Abstract Submitted
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Francois N. Frenkiel Award Talk: Relevance of the Thorpe length scale in stably stratified turbulence[1] BENJAMIN D. MATER, SIMON M. SCHAAD, S. KARAN VENAYAGAMOORTHY, Colorado State University — A relatively simple and objective measure of large-scale vertical overturns in turbulent oceanic flows is the Thorpe length scale, L_T. Reliance on common scaling between the Ozmidov length scale L_O (which is a measure of the size of largest eddy unaffected by buoyancy in stratified turbulence) and L_T is commonplace in the field of oceanography to infer the dissipation rate of turbulent kinetic energy ε. In this study, we use direct numerical simulations (DNS) of stably stratified turbulence to compare the Thorpe overturn length scale, L_T, with other length scales of the flow that can be constructed from large-scale quantities fundamental to shear-free, stratified turbulence. Quantities considered are the turbulent kinetic energy, k, its dissipation rate, ε, and the buoyancy frequency, N. Fundamental length scales are then the Ozmidov length scale, L_O, the isotropic large scale, $L_{k\varepsilon}$, and a kinetic energy length scale, L_{kN}. Behavior of all three fundamental scales, relative to L_T, is shown to be a function of the buoyancy strength parameter NT_L, where $T_L = k/\varepsilon$ is the turbulence time scale. When buoyancy effects are dominant (i.e., for $NT_L > 1$), $L_T$is shown to be linearly correlated with L_{kN} and not with L_O as is commonly assumed for oceanic flows. Agreement between L_O and L_T is only observed when the buoyancy and turbulence time scales are approximately equal (i.e., for the critical case when $NT_L \approx 1$). The relative lack of agreement between L_T and L_O in strongly stratified flows is likely due to anisotropy at the outer scales of the flow where the energy transfer rate differs from ε. The key finding of this work is that observable overturns in strongly stratified flows are more reflective of k than ε. In the context of oceanic observations, this implies that inference of k, rather than ε, from measurements of L_T is fundamentally correct when $NT_L \approx 1$ and most appropriate when $NT_L > 1$. Furthermore, we show that for $NT_L < 1$, L_T is linearly correlated with $L_{k\varepsilon}$, *when* mean shear is absent.

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