Francois N. Frenkiel Award Talk: Relevance of the Thorpe length scale in stably stratified turbulence\textsuperscript{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 $\varepsilon$. 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, $\varepsilon$, 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 $\varepsilon$. The key finding of this work is that observable overturns in strongly stratified flows are more reflective of $k$ than $\varepsilon$. In the context of oceanic observations, this implies that inference of $k$, rather than $\varepsilon$, 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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