Assessment of small scale anisotropy in stably stratified turbulent flows

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Abstract. We have analyzed small scale turbulent structures and statistics in stably stratified flows using direct numerical simulations for the assessment of widely used Kolmogorov's hypothesis of small scale isotropy. Direct measurement of the small scale turbulent quantities such as the rate of dissipation of turbulent kinetic energy ϵ and the rate of dissipation of temperature variance χ requires nine mean square velocity gradients and three mean square scalar gradients respectively. Oceanographers measure dissipation quantities from just one gradient component for both ϵ and χ by invoking Kolmogorov's small scale isotropy hypothesis. According to this hypothesis in a high Reynolds number flow, the directional information of large scales are lost during the transfer of energy from large to small scales and the statistics of small scales are universally isotropic (independent of coordinate orientations). Though the use of the isotropic assumption at small scales in oceanic flows is both tempting and necessary due to practical limitations of instruments used for measurements, such an assumption is likely to result in an over- or under estimation of small scale turbulent quantities such as ϵ and χ for two main reasons. First, turbulence in oceanic flows is often intermittent and the Reynolds number is not always sufficiently high enough to justify isotropy at small scales. Second, oceanic flows are strongly influenced by stable vertical stratification (density variation) and thus, large scale anisotropy is likely to be coupled to small scales introducing significant departure from isotropy. In this study we have revisited the small scale isotropy assumption in stably stratified flows and provide an estimation of separation of small scale isotropy –anisotropy based on the turbulent Froude number.