

Separating Small-Scale Oceanic Internal Waves and Vortical Motions

*Ren-Chieh Lien¹

1. University of Washington, Seattle, WA, USA

Internal waves and vortical motions coexist in the ocean, sometimes at same temporal and spatial scales. Observations taken by 20 EM-APEX floats in the upper ocean thermocline of the summer Sargasso Sea capture the temporal and vertical variations of Ertel potential vorticity (PV) in 7–70 m vertical scale, averaged over horizontal scales of $O(4\text{--}8\text{ km})$. PV is dominated by its linear components —vertical vorticity and vortex stretching, each with rms value of $\sim 0.15 f$. In the internal wave frequency band, they are coherent and in phase, expected for linear internal waves. Packets of strong vertical vorticity and vortex stretching, $> 0.2 f$, balance each other closely such that the rms PV $\sim 0.03 f$. PV is dominant at frequencies less than $1.4 f$ and peaks at vertical wavenumber $< \sim 0.1\text{ cpm}$, our highest resolvable vertical wavenumber. PV frequency spectrum plateaus at subinertial frequencies and has a -1 spectral slope in the internal wave frequencies with a small peak at inertial frequency. The PV at near-inertial frequency is likely attributed to the differential advection of background PV by near inertial waves. Measurement errors might also contribute to PV in the internal wave frequency band. Vertical vorticity and vortex stretching are separated into linear vortical mode and internal wave components following the normal mode decomposition. The theoretical prediction of a negative correlation between vertical vorticity and vortex stretching for the linear vortical mode, i.e., reinforcing PV, is confirmed at subinertial frequencies. The Burger number of the vortical mode is ~ 0.84 , implying HKE/APE of ~ 0.7 . The vortical mode frequency and vertical wavenumber spectra are 1-2 decades less than internal wave components. A joint experiment will be conducted in Tokara Strait in the next 3 years to study Kuroshio interaction with seamounts in Tokara Strait. We will discuss the importance of separating internal lee waves and vortical motions behind the seamount on quantifying turbulence mixing and watermass transformation.

Keywords: Internal Lee Waves, Vortical Motions, Turbulence, Kuroshio, Tokara Strait