Deep-Water Near-Bottom Turbulence in Lake Michigan: An Underwater Investigation

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Motivated by a need to characterize near-bottom deep-water turbulence for an understanding of the filtration capabilities of invasive quagga mussels, an instrument tripod was deployed in Lake Michigan for six months in 60m of water to measure current velocities, with specific interest being paid to near-bottom (0.10 to 0.95 meters above bottom) velocities during the deployment. The deployment period (September 2012-April 2013) was characterized by very little stratification and a median temperature of about 4^oC throughout the water column. A mean horizontal velocity of 3.6 cm/s with a standard deviation of 2 cm/s was also measured at 1 meter above the lake bed. In spite of the 60m depth of the measurement site, surface waves were found to influence near-bottom velocities for a significant fraction of the time, with periods between 6.5 and 12.5 seconds. Fluctuations in velocity were used to quantify turbulence through the use of turbulent kinetic energy (tke) calculations, while simple spectral analysis was used to verify tke levels and identify possible wave contamination. At distances greater than 500 z+ from the bed, turbulent kinetic energy levels follow canonical scaling with values of approximately 5 u_*^2. However, very near-bottom tke levels are greatly elevated relative to the expected values, which we speculate may be due to mussel-induced currents. These conclusions coupled with further modeling will allow for the development of mussel-influence models that will prove important to understanding the impact of these invasive species.