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Velocity Profiling, Turbulence, and Chlorophyll Concentrations in the Bottom Boundary Layer of Lake Michigan near Muskegon, Michigan

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ABSTRACT

The characterization of water flow and turbulence near lake beds is important for modelling environmental and ecological effects throughout a lake. In Lake Michigan, where invasive filter-feeding Quagga mussels dominate the lake bed, turbulence plays an important role in determining how much of chlorophyll is mixed down to the Quagga Mussels. Deep in Lake Michigan (44m) near Muskegon, MI, a large tripod was deployed, attached with an Acoustic Doppler Velocimeter, a fluorometer to measure chlorophyll concentrations, and a temperature sensor. Measurements were recorded from late May until early August by sampling velocities every hour in ten-minute bursts at 4 Hz, and sampling temperature and concentration approximately every minute, continuously. Several important turbulent parameters were calculated using the data collected. Chlorophyll data from the site showed that the water column here displayed a Concentration Boundary Layer (CBL), in which the chlorophyll concentration increases as distance from the lake floor increases. The median speed (U = 2.85cm/s) and Turbulent Kinetic Energy (TKE = 2.1×10^{-5} m^2/s^2) were also calculated. All of these results have previously had very little documentation in such deep waters. The observation of a CBL shows that the invasive Quagga Mussels are able to drastically alter chlorophyll concentrations near the lake floor, an important result for future modeling efforts. The quantification of turbulence parameters will be useful in further studies to find causation between various turbulence levels and concentrations.

KEYWORDS

Turbulence, Lake Michigan, Quagga Mussels, Environmental Fluid Mechanics, Bottom Boundary Layer, BBL, Concentration Boundary Layer, CBL,