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Computational Modelling of Boundary Shear in a Closed Basin on Multiple Scales

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Wind-induced motions in temperature stratified lakes span length scales from kilometres to the dissipation length scale. Dissipation occurs in an intermittent manner and at various locations in the water column. However, dissipation in the bottom boundary layer (BBL) is believed to dominate. Motivated by field measurements in Lake Simcoe, Ontario, Canada, a mid-sized lake with two dominant bays and a moderately complex bottom bathymetry we present computational modelling efforts on two different scales. The first considers the entire basin, treated by the MITgcm in its hydrostatic configuration. The dynamics of an internal seiche are followed for several wave periods. The geographic distribution of bottom shear is dominated by the region in which the thermocline intersects the lake bottom and one of the two bays that dominate the lake shape. The detailed mechanisms responsible for the increased near bottom shear are explored by a more detailed two-dimensional slice model using a pseudo-spectral method. These result indicate that the temporal asymmetry observed in the field is well described by non hydrostatic seiche dynamics, with greatly increased mixing due to shear instability during the downslope moving portion of the seiche period.