ABSTRACT

Ahmed, Sultan. Ph.D., Purdue University, May 2013. Investigations of seasonal and episodic variability in Lake Michigan currents and temperatures. Major Professor: Cary Troy.

Currents and temperatures vary on a wide range of spatial and temporal scales within the Great Lakes. In this work, results are presented from field and numerical investigations examining both the seasonal cycle of heating and cooling, as well as the basin-scale stratified response to impulsive wind forcing. For both investigations, a primary tool employed is the numerical model SUNTANS, which has been adapted to simulate the dynamics of momentum and heat in Lake Michigan. Basin scale internal waves are the dominant response of Lake Michigan due to basin wide wind forcing. These waves manifest themselves in the form of sub-inertial Kelvin waves and super-inertial Poincaré waves. The near-inertial internal Poincaré waves were found to have three nodal points corresponding to the first and second horizontal modes, irrespective of the stratification used. Near-inertial bottom kinetic energy is seen to have roughly constant magnitude over large swathes across the basin, with higher magnitude in the shallower areas like Mid-lake Plateau, as compared with the deep northern and southern basins. The near-bottom near-inertial kinetic energy when mapped appears similar to the bottom topography map. Coastal orientation and bottom topography play an important role in the variation of upwelling between the eastern and western coasts of Lake Michigan, with the west coast upwelling being spatially widespread. Internal Kelvin waves are generated during full upwellings and cross the shallow southern shelf, and can be tracked by the tail of the warm front in the west coast upwelling and by the head of the warm front during the east coast upwelling. An atmospheric heat flux module was added to SUNTANS to simulate the seasonal cycle of Lake Michigan. Multiple years from 2003 – 2010 were simulated successfully, and the results were fairly comparable to observations.