Sediment Resuspension and Transport in Lake Michigan

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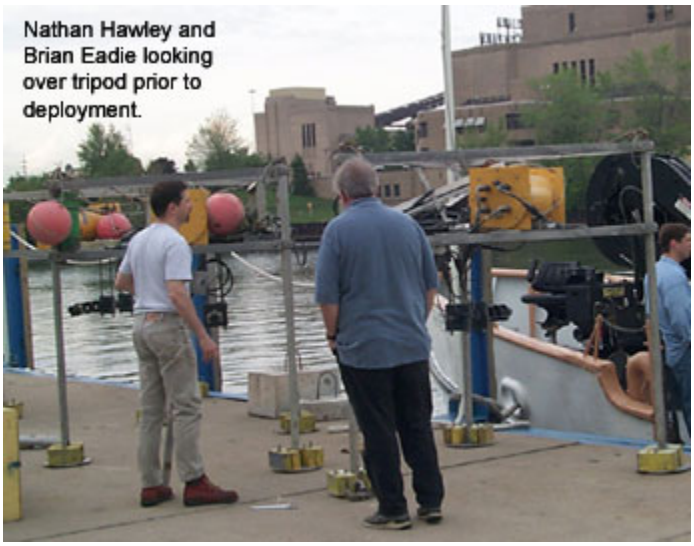
This project is now complete

The research in this task consists of field measurements designed to establish the conditions necessary for the resuspension of fine-grained bottom sediments in Lake Michigan and to assess the relative importance of local resuspension versus advective processes in the deeper parts of the lake.



Background

The processes responsible for the transport, deposition, and resuspension of solids are of considerable importance in both the Great Lakes and in the coastal ocean in general, since this material can significantly affect both biological productivity and the cycling of pollutants. Although long-term patterns of sediment deposition and movement in the Great Lakes have been deduced from the distribution of radionuclide tracers, the temporal resolution of these studies is about 30 years. The response of the lake bed to individual events is not well-understood and the processes responsible for the maintenance of the Benthic Nepheloid Layer (BNL), which is found in many ocean basins and all of the Great Lakes are also not well known. Further, the physical properties of the particles in the BNL are not well known. Whatever its origin, the BNL appears to be important in the cross shelf transport of chemical substances.

Extending our understanding of these processes, and properly representing them in models, requires detailed and long-term measurements of currents, particulate concentration, and sediment properties both within the bottom boundary layer (BBL) and the water column as a whole. Acquiring such measurements and using these to guide model development are the long-term goals of this project.

Description

Three instrumented moorings (in water depths of 28, 58, and 100 m) were deployed in 1994 and 1995 at three locations near Muskegon, Michigan. The time series records of water temperature, current velocity, and water transparency collected at these stations have been the subject of analysis for the past several years. The fall and winter data has been published.

A bottom-resting flume was deployed at about 15 sites in Lake Michigan in order to experimentally determine the bottom velocity required to erode the lake bed. Analysis of the flume data was completed and a report was submitted to the EPA. The flume was successfully deployed a total of 26 times at 13 different locations in Lake Michigan. Unfortunately, the flume could not generate sufficient velocity to erode sediment at these sites other than a very thin surface layer. This material was eroded at very low (less than 5 cm s-1) velocities. Due to the high variability in the measured current speeds, it was not possible to analyze the data quantitatively.

2003 Accomplishments

Efforts this year were directed at completing analysis of the data collected during the summer of 1995. A technical memo describing all of the data was released, and a manuscript focusing on the processes responsible for maintaining the benthic nepheloid layer was submitted to the Journal of Geophysical Research. The manuscript describes the use of wavelets to identify intervals during the deployments when changes in the thickness of the benthic nepheloid layer occurred with the same periodicity as changes in other water parameters (temperature and current velocity), and uses the wavelet cross correlation to determine the phase angle between changes in water turbidity and current direction. Although a direct causal connection could not be established, the data strongly suggest that short period internal waves are responsible for maintaining the benthic nepheloid layer. These internal waves appear to be generated by the propagation of inertial waves up the lake slope during upwellings, when the predominantly along shelf currents are temporarily suppressed.

The summer data was the last data collected during this project to be analyzed (previous manuscript analyzed data collected during the fall and winter), so the project is now completed. Results from this project will be used as guides for data analysis in the project Origin and maintenance of the benthic nepheloid layer.

Products

Publications

Hawley, N., 2004, The response of the benthic nepheloid layer to near-inertial internal waves in southern Lake Michigan, *Journal of Geophysical Research*, 109, C04007, doi:10.1029/2003JC002128.

Hawley, N. *Observations of the intermediate and benthic nepheloid layers in southern Lake Michigan during the summer of 1995. NOAA Technical Memorandum GLERL-124*. NOAA, Great Lakes Environmental Research Laboratory, Ann Arbor, MI, 30 pp. (2003).

Hawley, N. and Lee, C.-H., 1999. Sediment resuspension and transport in Lake Michigan during the unstratified period. *Sedimentology* 46, 791-805.

Lee, C.-H., and N. Hawley, 1998. The response of suspended particulate material to upwelling and downwelling events in southern Lake Michigan, *Journal of Sedimentary Research*, 68, 819-831.

Presentations

Hawley, N., 1999. *Observations of changes in suspended sediment concentrations in Lake Michigan during the summer of 1995; what's happening when 'nothing' is happening?* American Geophysical Union spring meeting, Boston MA.

Hawley, N., and Lee, C.-H., 1998. *Sediment resuspension and transport in southern Lake Michigan,* Ocean Sciences meeting, San Diego, CA.

Lee, C.H., and Hawley, N., 1996. *Offshore sediment transport by downwelling in Lake Michigan*, American Geophysical Union spring meeting, Baltimore, MD.

Hawley, N., 1996. *Sediment resuspension in southern Lake Michigan during the unstratified period*, Ocean Sciences meeting, San Diego, CA.

Hawley, N., 1996. *The response of the benthic nepheloid layer to internal waves in southern Lake Michigan*, American Geophysical Union fall meeting, San Francisco, CA.