Velocity observations from a mooring at Station AT55 in Lake Michigan from 2019-05-13 to 2019-06-05

Website: https://www.bco-dmo.org/dataset/856544
Data Type: Other Field Results
Version: 1
Version Date: 2021-08-17

Project
» Collaborative Research: Regulation of plankton and nutrient dynamics by hydrodynamics and profundal filter feeders (Filter Feeders Physics and Phosphorus)

Contributors	Affiliation	Role
Troy, Cary	Purdue University	Principal Investigator, Contact
Bootsma, Harvey	University of Wisconsin (UW-Milwaukee)	Co-Principal Investigator
Cannon, David	Purdue University	Co-Principal Investigator
Liao, Qian	University of Wisconsin (UW-Milwaukee)	Co-Principal Investigator
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
A fixed mooring was established to measure water column velocities in Lake Michigan near Milwaukee, WI, during 2019 from May 13 – June 5, 2019 at a 55m depth site. The mooring involved a small tripod, upon which an ADCPs (Nortek Signature 500) was mounted to measure water column velocities between 152cm and 4852cm above the bed.

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Coverage

Spatial Extent: **Lat**:43.069916666667 **Lon**:-87.753216666667
Temporal Extent: 2019-05-13 - 2019-06-05

Dataset Description

A fixed mooring was established to measure water column velocities in Lake Michigan near Milwaukee (12 km northeast of Milwaukee Harbor), WI, during 2019 from May 13 – June 5, 2019 at a 55m depth site. Site coordinates: 43° 4.195’ N, 87° 45.193’W.

The mooring involved a small tripod, upon which an ADCPs (Nortek Signature 500) was mounted to measure water column velocities between 152cm and 4852cm above the bed.

Methods & Sampling

ADCPs were used to sample current velocities at 2 Hz, with the Nortek Signature 500 (152cm - 4852cm above bed, 1m bin size) measuring continuously.

Data Processing Description

Data were successfully downloaded from instruments. No problems were detected with the measurements.

All velocity data was averaged over 10 minutes of sampling before being interpolated onto a common time vector. Individual instrument accuracies, ranges, and resolutions are included in the attached file (ADCP_METADATA_052019.xlsx).

All data were quality controlled according to manufacturer recommendations and measurements with poor amplitudes and correlations were removed before averaging.

BCO-DMO processing notes:

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Data Files

File
adcp_2019_rework.csv (Comma Separated Values (.csv), 8.93 MB) MD5:141a9333f1057b71ce5e97d7d732341c Primary data file for dataset ID 856544

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Supplemental Files

File
ADCP Metadata filename: ADCP_METADATA_052019.xlsx (Octet Stream, 42.80 KB) MD5:151009c62d2d7555254a3b103b5b4066 Additional description of the sampling procedure of the 2019 ADCP data acquired in Lake Michigan.

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Parameters

Parameter	Description	Units
ISO_DateTime_UTC	Time of sample in ISO format, UTC timezone	unitless
Latitude	Latitude of sampling location	decimal degrees
Longitude	Longitude of sampling location	decimal degrees

N_152cm	North component of average water column velocities measured at 152 cm above the bed. Measurements are defined positive (+) when velocities are moving toward the north	m/s
N_252cm	North component of average water column velocities measured at 252 cm above the bed. Measurements are defined positive (+) when velocities are moving toward the north	m/s
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Instruments

Dataset-specific Instrument Name	Nortek Signature 500
Generic Instrument Name	Acoustic Doppler Current Profiler
Dataset-specific Description	Nortek Signature 500
Generic Instrument Description	The ADCP measures water currents with sound, using a principle of sound waves called the Doppler effect. A sound wave has a higher frequency, or pitch, when it moves to you than when it moves away. You hear the Doppler effect in action when a car speeds past with a characteristic building of sound that fades when the car passes. The ADCP works by transmitting "pings" of sound at a constant frequency into the water. (The pings are so highly pitched that humans and even dolphins can't hear them.) As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument. Due to the Doppler effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return. Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to bounce back and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings. (More from WHOI instruments listing).

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Project Information

Collaborative Research: Regulation of plankton and nutrient dynamics by hydrodynamics and profundal filter feeders (Filter Feeders Physics and Phosphorus)

Coverage: Lake Michigan

Overview:
While benthic filter feeders are known to influence plankton and nutrient dynamics in shallow marine and freshwater systems, their role is generally considered to be minor in large, deep systems. However, recent evidence indicates that profundal quagga mussels (Dreissena rostriformis bugensis) have dramatically altered energy flow and nutrient cycling in the Laurentian Great Lakes and other larges aquatic systems, so that conventional nutrient-plankton paradigms no longer apply. Observed rates of phosphorus grazing by profundal quagga mussels in Lake Michigan exceed the passive settling rates by nearly an order of magnitude, even under stably stratified conditions. We hypothesize that the apparently enhanced particle deliver rate to the lake bottom results from high filtration capacity combined with vertical mixing processes that advect phytoplankton from the euphotic zone to the near-bottom layer. However, the role of hydrodynamics is unclear, because these processes are poorly characterized both within the hypolimnion as a whole and within the near-bottom layer. In addition, the implications for phytoplankton and nutrient dynamics are unclear, as mussels are also important nutrient recyclers. In the proposed interdisciplinary research project, state-of-the-art instruments and analytical tools will be deployed in Lake Michigan to quantify these critical dynamic processes, including boundary layer turbulence, mussel grazing, excretion and egestion, and benthic fluxes of carbon and phosphorus. Empirical data will be used to calibrate a 3D hydrodynamic-biogeochemical model to test our hypotheses.

Intellectual Merit:
This collaborative biophysical project is structured around two primary questions: 1) What role do profundal dreissenid mussels play in large lake carbon and nutrient cycles? 2) How are mussel grazing and the fate of

nutrients recycled by mussels modulated by hydrodynamics at scales ranging from mm (benthic boundary layer) to meters (entire water column)? The project will improve the ability to model nutrient and carbon dynamics in coastal and lacustrine waters where benthic filter-feeders are a significant portion of the biota. By so doing, it will address the overarching question of how plankton and nutrient dynamics in large, deep lakes with abundant profundal filter feeders differ from the conventional paradigm described by previous models. Additionally, the project will quantify and characterize boundary layer turbulence for benthic boundary layers in large, deep lakes, including near-bed turbulence produced by benthic filter feeders.

Broader Impacts:
The project will provide new insight into the impacts of invasive dreissenid mussels, which are now threatening many large lakes and reservoirs across the United States. Dreissenid mussels appear to be responsible for a number of major changes that have occurred in the Great Lakes, including declines of pelagic plankton populations, declines in fish populations, and, ironically, nuisance algal blooms in the nearshore zone. As a result, conventional management models no longer apply, and managers are uncertain about appropriate nutrient loading targets and fish stocking levels. The data and models resulting from this project will help to guide those decisions. Additionally, the project will provide insight to bottom boundary layer physics, with applicability to other large lakes, atidal coastal seas, and the deep ocean. The project will leverage the collaboration and promote interdisciplinary education for undergraduate and graduate students from two universities (UW-Milwaukee and Purdue). The project will support 3 Ph.D. students and provide structured research experiences to undergraduates through a summer research program. The project will also promote education of future aquatic scientists by hosting a Biophysical Coupling Workshop for graduate students who participate in the annual IAGLR conferences, and the workshop lectures will be published for general access through ASLO e-Lectures and on an open-access project website.

Background publications are available at:
http://onlinelibrary.wiley.com/doi/10.1002/2014JC010506/full
http://link.springer.com/article/10.1007/s00348-012-1265-9
http://aslo.net/lomethods/free/2009/0169.pdf
http://www.sciencedirect.com/science/article/pii/S0380133015001458

Note: This is an NSF Collaborative Research Project.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1658390

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