

Tank measurements characterizing turbulence for larvae experiments conducted at Woods Hole Oceanographic Institution in 2011 (Larvae in turbulence project)

Website: <https://www.bco-dmo.org/dataset/561097>

Data Type: experimental

Version: 2015-06-08

Project

» [Larval Response to Turbulence During Dispersal and Settlement](#) (Larvae in turbulence)

Contributors	Affiliation	Role
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Table of Contents

- [Dataset Description](#)
 - [Data Processing Description](#)
- [Data Files](#)
- [Parameters](#)
- [Instruments](#)
- [Deployments](#)
- [Project Information](#)
- [Funding](#)

Dataset Description

Data taken measuring grid-stirred tank turbulence under a range of forcing frequencies at amplitude 5 cm. Tank is described in Wheeler et al. (2013). Turbulence properties calculated from velocity vectors estimated from PIV analysis (an analogous PIV analysis described in Wheeler et al. 2013). Measurements were made by K. Helfrich in Summer 2009.

Relevant References:

Wheeler J.D., Helfrich K.R., Anderson E.J., McGann B., Staats P., Wargula A.E., Wilt K., Mullineaux L.S. (2013) Upward swimming of competent oyster larvae *Crassostrea virginica* persists in highly turbulent flow as detected by PIV flow subtraction. *Mar Ecol Prog Ser* 488, 171-185.

Wheeler J.D., Helfrich K.R., Anderson E.J., Mullineaux L.S. (2015) Isolating the hydrodynamic triggers of the dive response in eastern oyster larvae. *Limnol Oceanogr*, (doi:10.1002/lno.10098)

Data Processing Description

PIV velocity vectors have been used to compute root mean square velocities, integral length scales (as per Tennekes and Lumley 1972), energy dissipation rates (as per Doron et al. 2001), and Kolmogorov length scales.

[[table of contents](#) | [back to top](#)]

Data Files

File
turb_tank.csv (Comma Separated Values (.csv), 536 bytes) MD5:c33ffe8d597bc919462ed7b46d250828
Primary data file for dataset ID 561097

[[table of contents](#) | [back to top](#)]

Parameters

Parameter	Description	Units
dial_num	tank turbulence dial setting	unitless
freq	oscillation frequency of double grid at amplitude 5 cm	Hz
energy_dissipation	energy dissipation rate; estimated using equation from Doron et al. 2001	cm ² /s ³
vel_Urms	horizontal root mean square velocity	cm/s
vel_Wrms	vertical root mean square velocity	cm/s
Kolmog_len	Kolmogorov length scale of turbulent flow; using a kinematic viscosity of 0.01 cm ² /s	cm
integral_x	horizontal integral length scale; estimated using Tennekes and Lumley	cm
integral_z	vertical integral length scale; estimated using Tennekes and Lumley	cm

[[table of contents](#) | [back to top](#)]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Camera
Dataset-specific Description	high-speed monochrome camera (Photron Fastcam SA3) and a pulsed near-infrared laser (Oxford Lasers, Firefly 300 W, 1000 Hz, 808 nm) for particle image velocimetry (PIV) analysis
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

[[table of contents](#) | [back to top](#)]

Deployments

lab_Mullineaux_2011

Website	https://www.bco-dmo.org/deployment/561100
Platform	WHOI
Start Date	2011-06-01
End Date	2012-08-31
Description	Larval oysters in turbulence experiments

[[table of contents](#) | [back to top](#)]

Project Information

Larval Response to Turbulence During Dispersal and Settlement (Larvae in turbulence)

Coverage: Laboratory studies at Woods Hole Oceanographic Institution

Description from NSF award abstract:

The planktonic larval stage of benthic marine invertebrates provides a mechanism for exchange of individuals between remote populations. Dispersal is affected by swimming behaviors, particularly those that alter the larva's vertical position in the water. Larvae of some species change their vertical positions in response to turbulence by ceasing to swim and sinking downward (diving). By doing so, they can alter their horizontal transport in currents and increase their supply to the seafloor. The main objectives of this study are to investigate behavioral responses of oyster (*Crassostrea virginica*) larvae to turbulence in the water column and at the seafloor, and to determine how these behaviors affect settlement. The investigators hypothesize that diving behavior enhances settlement into suitable habitat, even where mean bed shear stress is high. They expect that once larvae approach the bottom, they can take advantage of temporal and spatial refuges (such as turbulent lulls in the lee of roughness elements) to settle in otherwise harsh conditions. Investigating larval responses to turbulence is a challenge because it requires simultaneous measurement of time-variant flows and larval behaviors. The investigators will modify a conventional particle image velocimetry (PIV) approach so it can be used to track larval motions and fluid velocities simultaneously. PIV provides information on flow kinematics (e.g., rotation and strain rate) in the immediate vicinity of a larva, as well as bulk dissipation rates and measures of Taylor and integral length scales that likely influence larval acceleration. When these measurements are coupled with a larval trajectory, they provide a history of the fluid environment a larva experiences, and can be used to determine what characteristic of turbulence triggers the diving behavior. They also make it possible to calculate the bottom shear stress an individual larva experiences when it encounters the bottom and attempts to settle. The investigators will examine turbulence effects on larval behaviors in the water column using a grid-stirred tank. They will use a racetrack flume to test the hypothesis that larval settlement success depends on the frequency of lulls of sufficient duration for larval attachment.

Laboratory experiments will provide a mechanistic understanding of larval behavior that can be used in general theoretical models exploring how behavior influences dispersal and population connectivity. The quantified swimming responses of oysters are critical input for coupled bio-physical models of dispersal in the field. An understanding of larval behavior contributes to our ability to predict the effects of natural and anthropogenic perturbations (some of which are linked to global climate change) on benthic communities in coastal ecosystems where turbulence and habitat suitability vary spatially. This information is critical for informed decision making on shellfish management and design of marine reserves. The technique developed for simultaneous PIV and larval tracking will open new questions in larval ecology and be broadly applicable to studies of plankton interactions with turbulence.

[[table of contents](#) | [back to top](#)]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0850419

[[table of contents](#) | [back to top](#)]