# 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 |
|---|---|---|
| Mullineaux, Lauren | Woods Hole Oceanographic Institution (WHOI) | Principal Investigator |
| Helfrich, Karl R. | Woods Hole Oceanographic Institution (WHOI) | Co-Principal Investigator |
| Wheeler, Jeanette | Woods Hole Oceanographic Institution (WHOI) | Student, Contact |
| Copley, Nancy | Woods Hole Oceanographic Institution (WHOI BCO-DMO) | BCO-DMO Data Manager |

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## 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.

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## Data Files

| File |
| --- |
| **turb_tank.csv**(Comma Separated Values (.csv), 536 bytes)<br>MD5:c33ffe8d597bc919462ed7b46d250828<br><br>Primary data file for dataset ID 561097 |

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## 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 |

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## 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. |

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## 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 |

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## 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.

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## Funding

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

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