Velocity fields from turbulence tanks, with analysis performed to describe its turbulence characteristics analyzed at University of California - Berkeley (DiatomTrajectories project)

Website: https://www.bco-dmo.org/dataset/564816
Data Type: experimental
Version: 2015-07-31

Project
» Trajectories and spatial distributions of diatoms at dissipation scales of turbulence (DiatomTrajectories)

Contributors	Affiliation	Role
Karp-Boss, Lee	University of Maine	Principal Investigator
Variano, Evan	University of California-Berkeley (UC Berkeley)	Principal Investigator, Contact
Jumars, Peter	University of Maine (U Maine DMC)	Co-Principal Investigator
Copley, Nancy	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

This dataset is available as a large.zip file (1.8 GB compressed; 3.5 GB uncompressed) available for Download (WARNING: LARGE FILE). Each folder represents a different experiment. In the folders are:

1) A series of txt files, each of which describes 1 independent sample of a 3D velocity vector field measured in an x-y plane in the turbulence tank. The data is 5-column tab-delimited data:
Column 1 is x-location of velocity measurement (in mm, and defined relative to origin at the tank's geometric center)
Column 2 is y-location (in mm)
Column 3 is x-component of velocity vector (in m/s)
Column 4 and 5 are y- and z-components of velocity vector, respectively (in m/s)

2) A *.mat file, including the same data as above, but arranged into an LxMxN matrix, in which L is x-location, M is y-location, and N is number of independent samples. Velocity components are called UU,VV, and WW. The x- and y- values are called xvals and yvals. This file is constructed from the *.txt files using the *.m file found in the root directory "view_and_organize_vectors_from_Darling.m"

3) Eight *.png figures that summarize the turbulent features of velocity fields.

4) A *.dat file giving some key statistics describing the turbulent features of velocity fields. This file is constructed from the *.mat files using the *.m file found in the root directory "analyze_vectors_from_Darling.m"

Methods & Sampling

The txt files are output from the DaVis 8 software program, using Stereoscopic PIV (particle image velocimetry) mode. This software computes the velocity vectors (given in the txt files) from digital video captured in a fluid flow The full DaVis 8 steroscopic PIV process is described in the documentation provided by LaVision GMBH. Key processing parameters are recorded in the file “notes.txt” in the root directory.

Data Processing Description

All processing to this data is explained in the two commented *.m-files in the root directory.

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Data Files

File
PIV_files.csv(Comma Separated Values (.csv), 139 bytes) MD5:78640ff45e0c0e590fe33d09503b1fb2 Primary data file for dataset ID 564816

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Parameters

Parameter	Description	Units
filename	link to file download	unitless

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Instruments

Dataset-specific Instrument Name	PIV camera
Generic Instrument Name	Camera
Dataset-specific Description	Cameras: Two LaVision Imager Intense camera Resolution: 1376 x 1040 px Lenses: Nikon AF Micro Nikkor 60 mm 1:2.8 D 532 nm bandpass filters
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	PIV laser
Generic Instrument Name	Laser
Dataset-specific Description	New Wave Research Nd:YAG Solo II 15 Hz; Wavelength 532 nm
Generic Instrument Description	A device that generates an intense beam of coherent monochromatic light (or other electromagnetic radiation) by stimulated emission of photons from excited atoms or molecules.

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Deployments

Variano_lab

Website	https://www.bco-dmo.org/deployment/564836
Platform	UC_Berkeley
Start Date	2013-09-01
End Date	2016-08-31

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Project Information

Trajectories and spatial distributions of diatoms at dissipation scales of turbulence (DiatomTrajectories)

Coverage: Laboratory in Orono, Maine

Description from NSF award abstract:
Turbulence is ubiquitous and important in the upper mixed layer where phytoplankton reside. On scales relevant to individual cells and colonies, dissipating turbulence erodes molecular diffusive boundary layers around cells and affects probabilities of encounter critical for processes such as predator-prey interactions and aggregation. Superimposed on ambient fluid motion are local motions of cells due to tumbling and sinking. How these motions interact with ambient turbulence is not well understood, particularly for the morphologically diverse, non-motile diatoms that dominate primary productivity. Recent studies show that still-water sinking velocities of particles and turbulent diffusive motions of fluids cannot simply be added together to solve for particle motions; for negatively and nearly neutrally buoyant particles, high turbulence intensity produces several times faster sinking and rising velocities than seen in still water. Atmospheric studies of water droplets in clouds have focused on inertial mechanisms of acceleration, but the review in this proposal suggests that--in the parameter space defined by the particle characteristics of diatoms--shape may be much more important than inertia in determining plankton-turbulence interactions. The investigators propose to study effects of turbulence on settling trajectories and resultant spatial distributions of diatoms. Employing a novel volumetric particle imager, they will obtain 3D Lagrangian trajectories of individual cells and chains of selected strains of diatoms under controlled turbulence. By targeting species of different morphologies and mechanical properties as well as cultures at different growth stages, new insights will be gained on how physical, morphological and physiological properties affect sinking speeds and trajectories of non-motile phytoplankton.

Sinking is an important life strategy of phytoplankton, and its interaction with ambient flows holds significant implications for the residence time of phytoplankton in the mixed layer and ultimately for phytoplankton productivity in the photic zone and fluxes of elements to the deeper ocean. This study challenges common views on mechanisms that cause phytoplankton sinking in the ocean and offers a mechanistic dissection of departures in turbulent sinking from Stokes settling. By targeting species of varied morphologies and mechanical properties, as well as cultures at different growth stages, new insights will be gained into how physical, morphological and physiological properties interact to determine sinking speeds and trajectories of non-motile phytoplankton, particularly in and near the vortices that dominate turbulent flows. Results from this study will also advance understanding of underlying spatial distributions of phytoplankton in the poorly resolved decimeter to millimeter domain, with abundant implications for the foraging fields of grazers and formation of particle aggregates.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1334788
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