Turbulence microstructure profiles collected during R/V Hugh R. Sharp cruise HRS2204 from Apr to May 2022

Website: https://www.bco-dmo.org/dataset/945981
Data Type: Cruise Results
Version: 1
Version Date: 2024-12-16

Project
» Collaborative Research: The importance of particle disaggregation on biogeochemical flux predictions (Disaggregation)

Contributors	Affiliation	Role
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Abstract
These data include profiles of turbulence dissipation rate obtained from a Rockland Scientific VMP-250 deployed during a cruise on the Northeast Continental Shelf to study particle disaggregation. One cruise was completed aboard the R/V Hugh R. Sharp from 2022-04-21 through 2022-05-02 (HRS22-04), which visited a variety of stations and hydrodynamic environments associated with the Northeast Continental Shelf of the United States. Cruise stations where dissipation rate profiles were obtained ranged from Georges Bank and the Great South Channel near the Gulf of Maine, and Hudson Canyon near New York. These data were collected as part of a study to clarify the importance of hydrodynamic forces on the cohesion, aggregation, and breakup of marine particles. These data were collected by Dr. Matthew Rau (chief-sci) of the George Washington University.

Table of Contents

- Coverage
- Dataset Description
  - Methods & Sampling
  - Data Processing Description
  - Problem Description
- Related Publications
- Parameters
- Instruments
- Deployments
- Project Information
- Funding

Coverage

Location: Northeastern U.S. Continental Shelf
Spatial Extent: **N**:41.764 **E**:-67.399 **S**:39.457 **W**:-72.266
Temporal Extent: 2024-04-23 - 2024-05-01

Methods & Sampling

This cruise visited eight stations on the Northeastern U.S. Continental Shelf. Latitudes and Longitudes provided per sample in the data, but general station descriptions are below. Turbulence microstructure profiles were only obtained at stations deep enough for free-fall profiling. These stations included Station 1, 2, 3, 4, and 8.

- Station 1 - Station 3: Georges Bank near the Gulf of Maine. Approximate location was 41.7 N, 68 W. Samples acquired from 0 m to 25 m depths.
- Station 4: The Great South Channel near the Gulf of Maine. Approximate location was 41.6 N, 69 W. Samples acquired from 0 m to 150 m depths.
- Station 5: Only one CTD profile was taken before this station was aborted due to weather. No data

acquired. Station location was 40.8 N, 70.5 W.

- Station 6: Off the coast of Martha's Vineyard. Approximate location was 41.3 N, 70.5 W. Samples acquired from 0 m to 10 m depths.
- Station 7: At the mouth of the Sakonnet River near Newport, Rhode Island. Approximate location was 41.5 N, 71.2 W. Samples acquired from 0 m to 10 m depths.
- Station 8: Hudson Canyon near New York. Approximate location was 39.5 N, 72.3 W. Samples acquired from 0 m to 200 m depths.

Turbulence dissipation rate profiles were obtained following standard deployment techniques for the Rockland Scientific VMP-250 instrument. This instrument free-falls through the water column and measures shear spectra from piezo-electric probes. The instrument was deployed attached to a PID-02 free-fall winch and slightly negatively-buoyant tether to eliminate the influence of tether drag. Two shear probes (calibrated by Rockland within 2 mos of deployment) were installed on the instrument along with one temperature microstructure sensor. For deployment, the instrument was lowered into the water and held at the surface prior to release. The instrument was allowed to free-fall until close to bottom before bringing it back to the surface. the tether was manually fed out of the free-fall winch during the profile and one loop was maintained on the water surface to minimize tether drag on the instrument. Three profiles at each deployment were obtained prior to instrument recovery.

Data Processing Description

Shear profile data were processed using Rockland Scientific's Odas v4.4 Matlab library following the steps detailed in the manufacturer's TN_039_Dat_Processing_Manual_odas_v4.4d.pdf technical note. The odas library was used to convert high-frequency shear measurements from the profiler into shear spectra, to which a Nasmyth spectrum was fit to estimate dissipation rate. Data were processed using default settings except for the following:

- Stations 1, 2, and 3: Dissipation rate was strong at these stations on Georges Bank with mean values approximately 10E-6 W/kg. Based on this dissipation rate and an instrument profiling speed of 0.7 m/s , the fft_length parameter was set to 0.714 s. The diss_legnth parameter to 2.142 s (3X the fft_length) and the overlap parameter set to 1.071. Finally, the ship wake was observed in the raw shear data to impact the upper 8 m of data so the min_profile_P parameter was set to 8 dbar.
- Stations 4 and 8: Dissipation rate was weaker at these deep stations with mean values approximately 10E-9 W/kg. Based on this dissipation rate and an instrument profiling speed of 0.8 m/s , the fft_length parameter was set to 1.666 s. The diss_legnth parameter to 4.998 s (3X the fft_length) and the overlap parameter set to 2.499. Finally, the ship wake was observed in the raw shear data to impact the upper 8 m of data so the min_profile_P parameter was set to 8 dbar.

Problem Description

The time clock of the instrument would not hold its setting, likely due to a dead clock battery. UTC times and dates reported are ship-times at the beginning of deployment. Relative instrument time is also reported from the time the instrument was turned on at the beginning of the operation.

[table of contents | back to top]

Related Publications

Lueck, R., Murowinski, E., and McMillan, J. A Guide to data processing (RSI Technical Note 039). Technical report, 2018.
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Deployment_ID	Identifier of the Vertical Turbulence Profiler cast, formatted as Station#_deployment#, where deployment is incremented per station	unitless
Station	Station number	unitless
Station_Deployment	Turbulence deployment number for station	units
Station_Deployment_Profile	Profile number for each Vertical Turbulence Profiler deployment (1, 2, 3); VMP-250 completes three profiles per cast	unitless
Cruise_Deployment	Turbulence deployment id where deployment number is incremented for whole cruise	unitless
ISO_DateTime_UTC	ISO datetime when the sample was acquired in UTC	unitless
Date_UTC	UTC date on which the sample was acquired	unitless
Time_UTC	UTC time when the sample was acquired	unitless
Latitude	Ship's latitude when the sample was taken	decimal degrees
Longitude	Ship's longitude when the sample was taken	decimal degrees
t_rel	Time in seconds since the instrument was turned on	seconds
p	Pressure in dbar	dbar
T	Temperature in deg Celsius as measured by the instrument conductivity-temperature sensor	degrees Celsius
e	Dissipation rate of turbulence kinetic energy in watts/kilogram	watts per kilogram (W/kg)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	VMP-250
Generic Instrument Name	Turbulence Profiler
Dataset-specific Description	The turbulence microstructure profile used was the VMP-250 produced by Rockland Scientific, which was deployed using the free-fall PID-02 winch (AGO Environmental Electronics Ltd) and 6 mm, Dyneema core tether with a specific gravity of 1.38 g/cc.
Generic Instrument Description	A free-fall instrument that directly measures the vertical distribution of turbulent flow velocity in the water column.

[table of contents | back to top]

Deployments

HRS2204

Website	https://www.bco-dmo.org/deployment/946038
Platform	R/V Hugh R. Sharp
Start Date	2022-04-21
End Date	2022-05-02
Description	See additional cruise information in R2R: https://www.rvdata.us/search/cruise/HRS2204

[table of contents | back to top]

Project Information

Collaborative Research: The importance of particle disaggregation on biogeochemical flux predictions (Disaggregation)

Coverage: Northeast United States Continental Shelf

NSF abstract:

Particle settling is one of the major ways that material in surface waters reaches the deep ocean. Particulate matter in the open ocean consists primarily of organic material from plankton and other biological detritus, which can readily aggregate to form large flocs. A combination of physical, chemical, and biological processes transforms these flocs as they settle, redistributing material throughout the water column and potentially sequestering elements such as carbon in the deep ocean. The impact of these transformations is affected by the sinking speed of these flocs, with larger and denser particles settling faster than smaller, less-dense ones. One of the key questions facing oceanographers today is what controls particle settling speed (for example, particle size, shape, and density). There is considerable evidence that particles readily break apart as they settle, decreasing their average size and settling speed, but it is not yet understood what conditions cause these disaggregation events. This work will measure the breakup characteristics of organic settling particles both in the laboratory and at sea to quantify the importance of these breakup processes relative to particle transport. The work will be done at the Pennsylvania State University in collaboration with the University of Georgia to target the development of future marine particle disaggregation models for use by the oceanographic community.

This research will play an important role in determining the importance of disaggregation on the vertical transport of particulate matter in the ocean. The project will quantify the breakup of organic marine aggregates due to fluid forces caused by turbulence or swimming organisms. Phytoplankton will be cultured and formed into aggregates in the lab prior to disaggregation using calibrated turbulence. The size, shape, and structure of these aggregates before and after breakup will be quantified using high-speed visualization and holographic imaging. In addition to the laboratory measurements, a deployable instrument that can disrupt particles in-situ and measure their size and shape will be built and deployed in the North Atlantic during the spring bloom of phytoplankton. Detailed measurements of particle concentrations, breakup characteristics, organic content, and ambient turbulence as a function of depth in the water column will be collected. This work will represent the first study of marine aggregate breakup in-situ. Specifically, the project will clarify: (1) under what conditions disaggregation is important, (2) how strong different types of natural marine aggregates are and how their strength varies with size, composition, and morphology, and (3) how aggregate size, composition, and structure influences the distribution of its breakup mass. This project will advance the career of a doctoral student and engage numerous undergraduate researchers with the field of ocean science.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

Additional Project Output (supplement to Data Collections section below):

Model Code Description:

Adrian Burd's Research Lab. (2023). BurdLab/Dissaggregation: Disaggregation (Disaggregation). Zenodo. https://doi.org/10.5281/zenodo.8226166

Associated Github Repository: https://github.com/BurdLab/Dissaggregation/tree/Disaggregation

This is the initial release of model code for particle aggregation and disaggregation in the ocean. The referenced Github Repository contains Matlab code to calculate the evolution of the particle size distribution in a single layer of the water column. The code numerically solves the aggregation-disaggregation mass balance equations using a so-called sectional approach developed by Gelbard and Seinfeld (J. Colloid and Interface Sci., 68:363-382, 1979). The model allows for particle aggregation, disaggregation, and sinking, and also changes in aggregate size from cell growth (see SetUpCoag.m), and will form the basis of a suite of particle aggrgation/disaggregation models. All documentation is provided within the code itself. Please see Associated Github Repository link above for detailed description and files.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948283

[table of contents | back to top]