# Processed CTD data with thermodynamic calculations from R/V Atlantic Explorer cruise AE2207 to the Bermuda Atlantic Time Series (BATS) station in April 2022

**Website**: https://www.bco-dmo.org/dataset/877100
**Data Type**: Cruise Results
**Version**: 1
**Version Date**: 2022-07-21

**Project**
» Collaborative Research: Inferring Cellular Lysis and Regeneration of Organic Matter by Marine Viruses (InVirT)

| Contributors | Affiliation | Role |
|---|---|---|
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**Abstract**
This dataset includes CTD data from R/V Atlantic Explorer cruise AE2207 to the Bermuda Atlantic Time Series (BATS) station in April 2022. The CTD data were processed, binned, and smoothed, and derived variables from thermodynamic calculations were generated.

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## Coverage

**Spatial Extent**: **N**:31.66367 **E**:-64.16483 **S**:31.0265 **W**:-64.59317
**Temporal Extent**: 2022-04-22 - 2022-04-25

### Methods & Sampling

CTD packages with Niskin rosettes were deployed to 300 meters with the exception of two deep casts: C01 to 2000 meters (where PAR sensor was removed) and C13 to 1000 meters. All deployments began with a 4-5 minute soak at 15m to initialize the pumps and stabilize instrument readings. Casts are identified by two-digit ids preceded by a C, so that C01 is the first cast and C10 is the tenth cast etc.

### Data Processing Description

**Data Processing:**
Data were converted from .hex files to .cnv files using SeaSave on default parameters. Then, each file was read using the seabird python library (https://github.com/castelao/seabird), and cast latitude, longitude, and deployment time were retrieved. For further calculations, pressure, temperature (primary sensor), conductivity (primary sensor), oxygen (primary sensor), beam attenuation, ECO chlorophyll fluorescence, PAR, corrected PAR, and instrument time were retained. Due to a choppy sea state, data from the upper 5 db were trimmed as the measurements were noisy. Then, all scans from the first 4.5 minutes of the cast were removed as these data were associated with the initializing soak at 15m before profiling. Finally, the upcast was removed to retain the downcast.

Using the python implementation of the Gibbs SeaWater oceanographic toolbox from TEOS-10 (https://www.teos-10.org/pubs/gsw/html/gsw_front_page.html), the following thermodynamic calculations were conducted. A corrected depth (height relative to sea surface, meaning a negative number) was calculated from the pressure and latitude. Then, potential salinity was calculated using conductivity, temperature, and pressure. Absolute salinity was calculated from potential salinity, and conservative temperature was calculated from absolute salinity, temperature, and pressure. Density in terms of sigma-theta was calculated using absolute salinity and conservative temperature. Then, oxygen solubility was calculated using the GSW oxygen solubility function with absolute salinity, conservative temperature, pressure, latitude, and longitude. Oxygen saturation was estimated for each scan using the primary oxygen sensor and the derived oxygen solubility. The outputs for the transformed data for each retained scan are contained in the file [first file]. Then, to remove additional instrument noise and standardize profiles across casts, data were smoothed and interpolated to every 0.5 dbar of pressure with a Nadaraya-Watson kernel estimator using a bandwidth of 5 meters. Using the smoothed and binned outputs, the mixed layer depth was calculated using the criterion of an increase in sigma-theta above 0.125 from 10dbar. Then, the DCM depth was calculated by identifying the depth corresponding to the highest chlorophyll fluorescence below the mixed layer depth. The derived mixed layer and dcm depths, as well as the smoothed and 0.5 dbar binned values for the above mentioned variables are included in the file [file 2].

**BCO-DMO Processing:**
- replaced "NA" with "nd" to indicate "no data";
- converted date/time field to ISO8601 format;
- removed the "id" field (identical to "cast").

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## Data Files

| File | |
|---|---|
| **AE2207_ctd_processed.csv** | (Comma Separated Values (.csv), 2.43 MB) MD5:47c9e1ea904d8e679346e862f9120e1c |
| Primary data file for dataset ID 877100 | |

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## Related Datasets

### IsDerivedFrom

Muratore, D., Wilhelm, S. W., Sullivan, M., Weitz, J. (2022) **CTD data from R/V Atlantic Explorer cruise AE2207 to the Bermuda Atlantic Time Series (BATS) station in April 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-07-14
doi:10.26008/1912/bco-dmo.877011.1 [view at BCO-DMO]
*Relationship Description: To generate the processed CTD dataset, the unprocessed data were binned and smoothed, and derived variables from thermodynamic calculations were generated.*

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## Parameters

| Parameter | Description | Units |
|---|---|---|
| cast | Identifier for individual cast | unitless |
| ISO_DateTime_UTC | CTD deployment date and time in UTC; format is ISO8601: YYYY-MM-DDThh:mm:ssZ | unitless |
| lat | Latitude at time of deployment | degrees North |
| lon | Longitude at time of deployment | degrees East |
| pressure | Pressure | decibars (dbar) |
| corrected_depth | Height relative to sea surface | meters (m) |
| par_value | PAR | microEinsteins per squre centimeter per second (uE/cm^2s) |
| par_relative | Corrected irradiance (same as cpar in 'Unprocessed' CTD dataset) | percent (%) |
| temp | Temperature | degrees Celsius |
| absolute_salinity | Derived absolute salinity | grams per kilogram (g/kg) |
| density | Derived sigma-theta from reference depth of 0 | kilograms per cubic meter (kg/m^3) |
| fluor | Wet Labs ECO Chlorophyll Fluorescence | milligrams per cubic meter (mg/m^3) |
| beam | Wet Labs C-Star Beam Attenuation | reciprocal meters (1/m) |
| oxygen | Oxygen concentration | micromoles per kilogram (umol/kg) |
| oxy_sol | Derived oxygen solubility | micromoles per kilogram (umol/kg) |
| oxy_sat | Derived oxygen saturation | percent (%) |
| mld | Mixed layer depth using a change in sigma-theta from 10dbar of 0.125 | meters (m) |

| | | |
|---|---|---|
| dcm | Deep chlorophyll maximum depth | meters (m) |

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## Instruments

| | |
|---|---|
| **Dataset-specific Instrument Name** | Altimeter (Valeport) - VA500 |
| **Generic Instrument Name** | Altimeter |
| **Generic Instrument Description** | An instrument that measures height above a fixed surface. The data can be used to map ocean-surface topography and generate gridded surface height fields. |

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|---|---|
| **Dataset-specific Instrument Name** | Licor PAR sensor (Biospherical Instruments) QSP-2300 |
| **Generic Instrument Name** | Biospherical PAR sensor |
| **Generic Instrument Description** | An irradiance sensor designed to measure Photosynthetically Active Radiation (PAR), manufactured by Biospherical Instruments Inc. |

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|---|---|
| **Dataset-specific Instrument Name** | CTD unit (Seabird) SBE 9+ |
| **Generic Instrument Name** | CTD Sea-Bird |
| **Generic Instrument Description** | A Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics. This instrument designation is used when specific make and model are not known or when a more specific term is not available in the BCO-DMO vocabulary. Refer to the dataset-specific metadata for more information about the specific CTD used. More information from: http://www.seabird.com/ |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Fluorometer (Chelsea) Aquatracka |
| **Generic Instrument Name** | CTD-fluorometer |
| **Generic Instrument Description** | A CTD-fluorometer is an instrument package designed to measure hydrographic information (pressure, temperature and conductivity) and chlorophyll fluorescence. |

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|---|---|
| **Dataset-specific Instrument Name** | Fluorometer (Wet Labs) ECO-FLRTD |
| **Generic Instrument Name** | CTD-fluorometer |
| **Generic Instrument Description** | A CTD-fluorometer is an instrument package designed to measure hydrographic information (pressure, temperature and conductivity) and chlorophyll fluorescence. |

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|---|---|
| **Dataset-specific Instrument Name** | Oxygen sensors (Seabird) SBE 43 |
| **Generic Instrument Name** | Sea-Bird SBE 43 Dissolved Oxygen Sensor |
| **Generic Instrument Description** | The Sea-Bird SBE 43 dissolved oxygen sensor is a redesign of the Clark polarographic membrane type of dissolved oxygen sensors. more information from Sea-Bird Electronics |

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|---|---|
| **Dataset-specific Instrument Name** | Conductivity sensor (Seabird) SBE 4C |
| **Generic Instrument Name** | Sea-Bird SBE-4 Conductivity Sensor |
| **Generic Instrument Description** | The Sea-Bird SBE-4 conductivity sensor is a modular, self-contained instrument that measures conductivity from 0 to 7 Siemens/meter. The sensors (Version 2; S/N 2000 and higher) have electrically isolated power circuits and optically coupled outputs to eliminate any possibility of noise and corrosion caused by ground loops. The sensing element is a cylindrical, flow-through, borosilicate glass cell with three internal platinum electrodes. Because the outer electrodes are connected together, electric fields are confined inside the cell, making the measured resistance (and instrument calibration) independent of calibration bath size or proximity to protective cages or other objects. |

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|---|---|
| **Dataset-specific Instrument Name** | Transmissometer (Wet Labs) C-Star |
| **Generic Instrument Name** | Transmissometer |
| **Generic Instrument Description** | A transmissometer measures the beam attenuation coefficient of the lightsource over the instrument's path-length. This instrument designation is used when specific manufacturer, make and model are not known. |

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|---|---|
| **Dataset-specific Instrument Name** | Reversing Thermometer (Seabird) SBE 35RT |
| **Generic Instrument Name** | Water Temperature Sensor |
| **Generic Instrument Description** | General term for an instrument that measures the temperature of the water with which it is in contact (thermometer). |

| | |
|---|---|
| **Dataset-specific Instrument Name** | Temperature profiler (Seabird) SBE 3F (and 3+ secondary unit) |
| **Generic Instrument Name** | Water Temperature Sensor |
| **Generic Instrument Description** | General term for an instrument that measures the temperature of the water with which it is in contact (thermometer). |

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## Deployments

**AE2207**

| | |
|---|---|
| **Website** | https://www.bco-dmo.org/deployment/873946 |
| **Platform** | R/V Atlantic Explorer |
| **Start Date** | 2022-04-22 |
| **End Date** | 2022-04-27 |
| **Description** | See additional cruise information at the Rolling Deck to Repository (R2R): https://www.rvdata.us/search/cruise/AE2207 |

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## Project Information

**Collaborative Research: Inferring Cellular Lysis and Regeneration of Organic Matter by Marine Viruses (InVirT)**

**Coverage**: Bermuda Atlantic Time Series

*NSF Award Abstract:*
Viral infections of marine microbes can transform the fate of microbial populations that fuel global ocean biogeochemical cycles. For example, viral infections of microbes lead to the release of carbon and nutrients back into the environment. This regeneration of carbon and nutrients stimulates the activity of other microbes and diverts carbon and nutrients from larger organisms in marine food webs. Because virus-microbe infections are relatively specific, it is critical to identify those pairs of viruses and microbes that may disproportionally contribute to the turnover of carbon and nutrients in the ocean. This project will develop quantitative approaches and tools to quantify which viruses infect which microbes and to use these data to quantify how viral infections of microbes collectively shape nutrient and carbon cycles in the North Atlantic Ocean. The project will analyze virus-microbe interactions in mesocosms at the Bigelow Laboratory for Ocean Sciences in mid-coast Maine and during open ocean expeditions to the Bermuda Atlantic Time-Series Study (BATS) site. An interdisciplinary team will leverage recent advances in molecular biology, computational biology, and mathematical modeling to identify virus-host partners and their impact on the movement of elements through marine systems. This project will support three graduate students, six undergraduate students and one postdoctoral researcher in an interdisciplinary context. Research advances will be translated into reproducible software methods to be disseminated via the community cyberinfrastructure platform iVirus, with additional training materials presented as part of a viral methods and informatics workshop held at The Ohio State University. The translation of discoveries to the public will be furthered by the involvement of journalism undergraduate students at the University of Tennessee-Knoxville.

This project builds upon advances in the molecular toolkit of viromics to develop an integrated approach to characterize lineage-specific rates of infection, lysis, and nutrient release induced by marine viruses in open ocean ecosystems. It will combine theory, in vitro experiments, and in situ sampling to (i) extend a robust inference method for estimating virus-microbe cross-infection networks from time-series data; (ii) establish and characterize in-vitro protocols for inferring cross-infectivity in complex communities using culture-independent methods; (iii) estimate lineage-specific rates of lysis and regeneration of nutrients in marine systems, including applications to coastal and open ocean ecosystems. Project aims focus on quantifying the extent to which virus-induced lysis and regeneration of carbon and nutrients is heterogeneously distributed across microbial populations. To do so, the project will incorporate time series measurements of abundance information (via metagenomes) and activity information (via metatranscriptomes). In so doing, it will advance efforts to understand community-scale interactions rather than those amongst a single virus-host pair. Theoretical methods and in vitro protocols will directly infer lineage-specific infection, lysis, and nutrient release rates in coastal- and open-ocean ecosystems in the North Atlantic Ocean. Results will be used to identify key links that disproportionately influence bulk nutrient release. A novel PCR-based approach will augment and validate the core inference approach. Overall, the project aims to enhance our understanding of how viruses contribute to marine ecosystem function.

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.

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## Funding


| Funding Source | Award |
| --- | --- |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1829636 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1829640 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1829641 |


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