CTD data and particulate organic carbon, particulate organic nitrogen, and adenosine triphosphate from Niskin bottle samples collected along the coastal ocean off Virginia Beach into the Chesapeake Bay aboard RV Fay Slover on April 1, 2024

Website: https://www.bco-dmo.org/dataset/994268
Data Type: Cruise Results
Version: 1
Version Date: 2026-03-10

Project
» Adenosine triphosphate as a master variable for biomass in the oceanographic context (ATP biomass indicator)

Contributors	Affiliation	Role
Bochdansky, Alexander Boris	Old Dominion University (ODU)	Principal Investigator
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Abstract
CTD data and Niskin bottle samples were collected and analyzed for particulate organic carbon (POC), particulate organic nitrogen (PON), and adenosine triphosphate. Samples were taken at five stations and six depths during a one-day transect from the coastal ocean off Virginia Beach into the Chesapeake Bay on April 1, 2024 conducted on R/V Fay Slover.

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Coverage

Location: Coastal North Atlantic and Chesapeake Bay entrance
Spatial Extent: **N**:36.97415 **E**:-75.59008333 **S**:36.96506667 **W**:-76.12536667
Temporal Extent: 2024-04-01

Methods & Sampling

Seawater was collected on the research vessel Fay Slover using 5-liter (L) Niskin bottles along a gradient from the open ocean near the Chesapeake light tower into the Chesapeake Bay. Conductivity, temperature, and depth were measured using a Seabird SBE 32 CTD equipped with a Wetlabs fluorometer and a Wetlabs transmissometer (650 nanometers (nm)).

Field collection of ATP
Using biological oxygen demand (BOD) bottles, samples of 150 - 300 milliliters (mL) (depending on station)

were taken from the Niskin bottles at five stations and six depths along the transect. Water was filtered through 25-millimeter (mm) GF/F filters using large capacity filter funnels at a vacuum of 200 millibars (mbar). Once filtered, and without keeping the filters running dry for more than a few seconds, the filters were quickly transferred into 1.5 mL cryovials filled with 1 mL of a solution of benzalkonium chloride (1% w/w fin. conc.) with phosphoric acid (5% w/w fin. conc.) in a 25 millimolar (mM) Tricine buffer (PBAC, Bochdansky et al. 2021). The filters were extracted in PBAC for 20 to 30 minutes before the cryovials (including the filters) were frozen and kept at -80 degrees Celsius (°C) before analysis. The location and methods were similar to those published in Bochdansky et al. 2024.

Laboratory analysis of ATP
Ten microliters (µL) of each sample (in triplicates) were transferred to 6 mL pony scintillation vials (Research Products International), and received 3 mL of ultrapure water, and 50 µL of CellTiter-Glo 2.0 (Promega Corporation). Internal standards were used by spiking a fourth vial with 50 µL of samples with 50 µL of 0.0164 micromolar (µM) ATP standard. Using internal standards instead of separate calibration curves corrects for matrix effects that change the luminescence signal caused by the presence of ions, acids, and organic material (Bochdansky et al., 2021). Luminescence was analyzed in a PerkinElmer liquid scintillation counter model Tricarb 3110 TR with a single photon counting protocol of 1 minute each. ATP was calculated using equation 2 in Bochdansky et al. (2021).

Particulate organic carbon and nitrogen
Between 250 and 500 mL of seawater (less in the inshore and more in the offshore stations) was filtered onto pre-combusted (450°C, 4 hours) GF/F filters. The filters were stored frozen (-20°C) and later dried at 50°C for approximately 24 hours, then acidified under concentrated HCl fumes in a desiccator, redried for another 24 hours at 50°C and then capped and stored in a desiccator. Filters were rolled in a tin wrap and pressed into pellets to be analyzed in a CHN analyzer (ODU Department of Chemistry Water Quality Laboratory).

Data Processing Description

ATP samples were analyzed in technical triplicates (three values for each sample) and then averaged. POC and PON values reflect single samples.

BCO-DMO Curation Notes

- Imported original file "CTD & Niskin bottle data COMBINED NaN 1Apr2024.csv" into the BCO-DMO system.
- Marked "NaN" as a missing data identifier (missing data are empty/blank in the final CSV file).
- Renamed fields to comply with BCO-DMO naming conventions.
- Created date-time fields (local and UTC) in ISO 8601 format.
- Saved the final file as "994268_v1_april_2024_slover_ctd_niskin.csv".

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Data Files

File	
994268_v1_april_2024_slover_ctd_niskin.csv	(Comma Separated Values (.csv), 19.27 KB) MD5:ee1d1ef16f1fd28f77a2c9e6d69dbf00
Primary data file for dataset ID 994268, version 1	

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Related Publications

Bochdansky, A. B., Beecher, A. A., Calderon, J. R., Stouffer, A. N., & Washington, N. N. (2024). A comparison of adenosine triphosphate with other metrics of microbial biomass in a gradient from the North Atlantic to the Chesapeake Bay. Frontiers in Marine Science, 11. https://doi.org/10.3389/fmars.2024.1288812

Methods

Bochdansky, A. B., Stouffer, A. N., & Washington, N. N. (2021). Adenosine triphosphate (ATP) as a metric of microbial biomass in aquatic systems: new simplified protocols, laboratory validation, and a reflection on data from the literature. Limnology and Oceanography: Methods, 19(2), 115–131. doi:10.1002/lom3.10409
Methods

Fumenia, A., Loisel, H., Moutin, T., Adams, J. C., Agogué, H., Aluwihare, L. I., Arrigo, K. R., Babin, M., Baetge, N., Balch, W. M., Bates, N. R., Björkman, K. M., Bochdansky, A. B., Bonnet, S., Bozec, Y., Cattaneo, R., Cauvin, A., Chaves, J. E., Church, M. J., . . . Wegley Kelly, L. (2026). Global compilation of in situ particulate organic carbon, nitrogen, and phosphorus measurements in coastal and open ocean waters. Nature Scientific Data (in review).
IsReferencedBy

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Related Datasets

IsRelatedTo

Fumenia, Alain, Loisel, Hubert, Moutin, Thierry, Adams, Jamee C., Agogué, Hélène, Aluwihare, Lihini I. , Arrigo, Kevin R., Babin, Marcel , Baetge, Nicholas , Balch, William M., Bates, Nicholas R., Bjorkman, Karin , Bochdansky, Alexander B. , Bonnet, Sophie , Bozec, Yann , Cattaneo, Raffaela , Cauvin, Arnaud , Chaves, Joaquin , Church, Matthew J., … Wegley Kelly, Linda . (2026). *In situ dataset of particulate organic carbon, nitrogen, and phosphorus in coastal and open ocean waters* (Version 1) [Dataset]. SEANOE. https://doi.org/10.17882/113424

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Parameters

Parameter	Description	Units
Station	Station number	unitless
Depth	Measurement/collection depth	meters
Lon	Longitude	degrees and minutes
Longitude	Longitude	decimal degrees
Lat	Latitude	degrees and minutes
Latitude	Latitude	decimal degrees
Time	Time of day (Eastern Daylight Time (EDT))	unitless
Date	Date of collection	unitless

ISO_DateTime_EDT	Date and time (EDT) in ISO 8601 format	unitless
ISO_DateTime_UTC	Date and time (UTC) in ISO 8601 format	unitless
Julian_Days	Julian day of 2024	decimal days
Attenuance	Beam attenuation	m-1
Conductivity	Conductivity	Siemens m-1
Sigma_theta	Sigma theta	sigma-theta
Salinity	Salinity	practical salinity unit
Potential_Temperature	Potential temperature	degrees Celsius
Transmission	Beam transmission (650 nm)	percent (%)
Fluorescence	Chlorophyll fluorescence	relative fluorescence units
Attenuance_voltage	Beam attenuation	instrument voltage
Depth2	Measurement/collection depth. Duplicate of the "Depth" column provided to improve readability/usability with the columns that follow.	meters
Volume_filtered_POC_PON	Volume filtered for POC and PON	milliliters
POC_mg_L	Particulate Organic Carbon	milligrams per liter (mg L-1)
PON	Particulate Organic Nitrogen	milligrams per liter (mg L-1)
C_N_ratio	Mass ratio of POC/PON	unitless (ratio)
ATP_nM	Adenosine triphosphate	nanomolar (nM)
ATP_SD	ATP standard deviation of technical triplicates	nanomolar (nM)

ATP_mg_L	ATP	milligrams per liter (mg L-1)
Biomass_Carbon	ATP multiplied by 250 to convert to carbon units	milligrams per liter (mg L-1)
Percent_Biomass	% biomass of POC	percent (%)
POC_uM	POC in micromolar	micromolar (uM)
Biomass_POC	ATP converted to carbon by multiplication with 250 and expressed as micromolar	micromolar (uM)

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Instruments

Dataset-specific Instrument Name	CHN analyzer
Generic Instrument Name	CHN Elemental Analyzer
Dataset-specific Description	Filters were rolled in a tin wrap and pressed into pellets to be analyzed in a CHN analyzer (ODU Department of Chemistry Water Quality Laboratory).
Generic Instrument Description	A CHN Elemental Analyzer is used for the determination of carbon, hydrogen, and nitrogen content in organic and other types of materials, including solids, liquids, volatile, and viscous samples.

Dataset-specific Instrument Name	Wetlabs fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	Conductivity, temperature, and depth were measured using a Seabird SBE 32 CTD equipped with a Wetlabs fluorometer and a Wetlabs transmissometer (650 nm).
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	Seabird SBE32 CTD rosette
Generic Instrument Name	Seabird SBE 32 Carousel Water Sampler
Dataset-specific Description	Conductivity, temperature, and depth were measured using a Seabird SBE 32 CTD equipped with a Wetlabs fluorometer and a Wetlabs transmissometer (650 nm).
Generic Instrument Description	The SBE 32 is a Carousel Water Sampler. With an accessory Deck Unit, the Carousel provides water sampling and real-time CTD data acquisition with any Sea-Bird profiling CTD (requires electro-mechanical cable and slip-ring equipped winch). With an accessory underwater unit, the Carousel can operate autonomously with a Sea-Bird Scientific profiling CTD and can be programmed to close bottles at selected depths, allowing deployment using non-electrical wire or line. The Carousel is available in two models: • Full-size SBE 32 for a 12 or 24-position system (36-position custom). • Compact SBE 32C for a 12-position sampler with bottles up to 8 liters, for use with limited vertical clearance.

Dataset-specific Instrument Name	Wetlabs C-Star transmissometer (650 nm)
Generic Instrument Name	WET Labs {Sea-Bird WETLabs} C-Star transmissometer
Dataset-specific Description	Conductivity, temperature, and depth were measured using a Seabird SBE 32 CTD equipped with a Wetlabs fluorometer and a Wetlabs transmissometer (650 nm).
Generic Instrument Description	The C-Star transmissometer has a novel monolithic housing with a highly integrated opto-electronic design to provide a low cost, compact solution for underwater measurements of beam transmittance. The C-Star is capable of free space measurements or flow-through sampling when used with a pump and optical flow tubes. The sensor can be used in profiling, moored, or underway applications. Available with a 6000 m depth rating. More information on Sea-Bird website: https://www.seabird.com/products/c-star-transmissometer

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Project Information

Adenosine triphosphate as a master variable for biomass in the oceanographic context (ATP biomass indicator)

Coverage: Global

NSF Award Abstract:
In the ocean, most living organisms are microbes that are too small to be seen by the naked eye. Despite their small size, microbes play an important role in processes that govern marine ecosystems and food webs. For example, microbes affect the concentrations of nutrients and gases in the water and the atmosphere, thereby exerting a significant impact on the climate globally. Consequently, it is important to know how many microbes there are in any given environment because there is a direct causal connection between living mass and overall biological activity. Determining how “alive” any volume of water is, however, is a difficult task. The gold standard is to count microbial cells under the microscope. This method is extremely time consuming when done well and needs to be performed separately on many different types of microbial cells. In addition, standard microscopic techniques do not reveal whether the cells were alive when they were collected. In contrast, a chemical method based on the amount of adenosine triphosphate (ATP) offers distinct advantages.

Notably, ATP is relatively easy to measure, and the method can be widely used because all living cells contain ATP in similar concentrations. This study tests and applies an improved method of ATP analysis to generate data at very high resolution in space and time. One PhD student and six undergraduate students will receive research training and the project fosters international research collaborations with European scientists. This research provides deeper insights into the distribution of live matter in different regions and depths of the world's oceans.

Decades ago, adenosine triphosphate (ATP) was proposed as a universal biomass indicator. However, its application in the field of oceanography has been limited due to misconceptions regarding cellular ATP concentration. Recent evidence suggests that ATP functions as a hydrotrope requiring homeostatically controlled ATP levels much higher than those solely needed for energy metabolism. ATP occurs in surprisingly stable concentrations in cytoplasm across a wide range of microbes thus representing live cytoplasm volume. This project examines in detail the usefulness of particulate ATP (PATP) as a biomass marker over a large section of the North Atlantic Ocean with special emphasis on mesopelagic and deep-sea environments where chlorophyll is a poor indicator of biomass or associated biological processes. The project uses field collections of marine snow and ambient water in combination with particle cameras to examine the microscale heterogeny of biomass in the water column. Laboratory studies determine factors that may influence the recovery of PATP through filtration and extraction protocols and determine to what extent ATP concentrations potentially deviate from the typical cytoplasm concentration during phosphorus limitation. The improved PATP-biomass method offers numerous operational advantages, especially the fact that it can be employed at high spatial and temporal resolution. Once validated, the PATP biomass method could be widely adopted as a key variable for biomass in routine oceanographic surveys. This project supports graduate and undergraduate students from diverse backgrounds to contribute to laboratory and field research. Public outreach efforts include tours and presentations for middle and high-school students, as well as the general public.

This project is funded by the Chemical Oceanography and Biological Oceanography Programs in the Division of Ocean Sciences.

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-2319114

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