CTD and underwater mass spectrometer data acquired in 2016 aboard the RV/Endeavor (cruise EN575) in the the subtropical Atlantic using a Triaxus tow vehicle.

Website: https://www.bco-dmo.org/dataset/843222
Data Type: Cruise Results
Version: 1
Version Date: 2021-03-03

Project
» Collaborative Research: Inventories of Primary Productivity by In-situ Mass Spectrometry in the Upper Ocean (ZIPP)

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Abstract
CTD and underwater mass spectrometer data acquired in 2016 aboard the RV/Endeavor (cruise EN575) in the the subtropical Atlantic using a Triaxus tow vehicle.

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Coverage

Spatial Extent: **N**:39.8138 **E**:-71.4505 **S**:27.61 **W**:-76.8814
Temporal Extent: 2016-03-04 - 2016-03-11

Acquisition Description

Data collected from Pt. Everglades, Florida to Narragansett Bay, Rhode Island, crossing Gulf Stream and

several mesoscale eddies between 28 and 40 N. The SWIMS instrument uses a quadrupole mass analyzer to measure in-situ gas concentration. Ion currents were calibrated using an in-situ calibration technique and a Recurrent Neural Network to remove bias introduced by pressure and temperature changes on the membrane inlet.

In this application we towed the mass-spectrometer through water depths from 0 to 150 m aboard a Triaxus tow vehicle, corresponding to region where sunlight penetrates the surface ocean. The SWIMS was used to measure oxygen, argon, carbon dioxide, and nitrogen in seawater.

Processing Description

Data from Triaxus CTD and SWIMS was merged in real time.

Post-processing includes:

- Introduction of a 21 second lag between CTD and SWIMS data, because SWIMS measurements pass through inlet tubing with 21 second travel time.
- Wild_edit Seabird-like removal of values that fall outside 5 standard deviations of the mean.
- Linear interpolation across data gaps.
- SWIMS ion current has been corrected to remove the effects of hydrostatic pressure and temperature on the membrane permeation rate. Details of the method can be found at https://doi.org/10.3389/feart.2020.537028.
- Calibration is carried out in-situ, using a known reference standard of equilibrated seawater, pumped from a gas-tight foil bag.

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Parameters

Parameter	Description	Units
ISO_DateTime_UTC	DateTime of sample in UTC time zone and ISO format (yyy-mm-ddThh:mm:ss)	unitless
Latitude	Latitude of sampling location, west is negative	decimal degrees
Longitude	Longitude of sampling location, south is negative	decimal degrees
Pressure	Pressure at depth	decibels (db)
Depth	Sample depth	meters (m)
Temperature	In situ temperature	degrees Celsius (°C)
Salinity	In situ salinity	PSU
Oxygen	In situ dissolved oxygen from MicroCAT CTD	umol/kg
Fluorescence_CDOM	In situ fluorescence	milligrams per cubic meter (mg/m3)
Beam_Transmission	In situ light transmission	percentage (%)
PAR	In situ photosynthetically active radiation	unitless
N2	In situ dissolved Nitrogen from SWIMS	umol/kg
O2	In situ dissolved oxygen from SWIMS	umol/kg
Argon	In situ dissolved Argon from SWIMS	umol/kg
CO2	In situ dissolved Carbon Dioxide from SWIMS	umol/kg

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Instruments

Dataset-specific Instrument Name	SBE 37
Generic Instrument Name	CTD Sea-Bird MicroCAT 37
Dataset-specific Description	Triaxus tow vehicle from U. Of Minnesota, Duluth, equipped with SBE 37, SBE43, and Wetlabs ECOpuck.
Generic Instrument Description	The Sea-Bird MicroCAT CTD unit is a high-accuracy conductivity and temperature recorder based on the Sea-Bird SBE 37 MicroCAT series of products. It can be configured with optional pressure sensor, internal batteries, memory, built-in Inductive Modem, integral Pump, and/or SBE-43 Integrated Dissolved Oxygen sensor. Constructed of titanium and other non-corroding materials for long life with minimal maintenance, the MicroCAT is designed for long duration on moorings. In a typical mooring, a modem module housed in the buoy communicates with underwater instruments and is interfaced to a computer or data logger via serial port. The computer or data logger is programmed to poll each instrument on the mooring for its data, and send the data to a telemetry transmitter (satellite link, cell phone, RF modem, etc.). The MicroCAT saves data in memory for upload after recovery, providing a data backup if real-time telemetry is interrupted.

Dataset-specific Instrument Name	SBE43
Generic Instrument Name	Sea-Bird SBE 43 Dissolved Oxygen Sensor
Dataset-specific Description	Triaxus tow vehicle from U. Of Minnesota, Duluth, equipped with SBE 37, SBE43, and Wetlabs ECOpuck.
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

Dataset-specific Instrument Name	Triaxus Tow Vehicle
Generic Instrument Name	towed undulating vehicle
Dataset-specific Description	Triaxus tow vehicle from U. Of Minnesota, Duluth
Generic Instrument Description	A towed undulating vehicle is a generic class of instruments. See the data set specific information for a detailed description. These are often prototype instrument packages designed to make very specific measurements.

Dataset-specific Instrument Name	SWIMS
Generic Instrument Name	Membrane Inlet Mass Spectrometer
Dataset-specific Description	SWIMS: Submersible Wet Inlet Mass Spectrometer is a membrane inlet mass spectrometer that is submersible to 2000 m and samples every 2 seconds for pre-chosen masses.
Generic Instrument Description	Membrane-introduction mass spectrometry (MIMS) is a method of introducing analytes into the mass spectrometer's vacuum chamber via a semipermeable membrane.

Dataset-specific Instrument Name	Wetlabs ECOpuck
Generic Instrument Name	Wet Labs ECO Puck
Dataset-specific Description	Triaxus tow vehicle from U. Of Minnesota, Duluth, equipped with SBE 37, SBE43, and Wetlabs ECOpuck.
Generic Instrument Description	The Puck is a miniature version of the ECO series of sensors, specifically designed for use in AUVs, profiling floats, and Slocum gliders with a dry science bay. This compact optical sensor is available in combinations of backscattering and fluorescence measurements. Manufacturer's website: https://www.seabird.com/auv-rov-sensors/eco-puck/family?productCategoryI...

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Deployments

EN575

Website	https://www.bco-dmo.org/deployment/829303
Platform	R/V Endeavor
Start Date	2016-03-03
End Date	2016-03-11

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Project Information

Collaborative Research: Inventories of Primary Productivity by In-situ Mass Spectrometry in the Upper Ocean (ZIPP)

Coverage: Subtropical North Atlantic from Florida to Rhode Island, from 25N to 41 N, west of 70 W

NSF Award Abstract:

Production of organic matter from carbon dioxide (specifically by photosynthetic organisms) and respiration of organic matter back to carbon dioxide (by a wide variety of organisms, including photosynthesizers) are very nearly in balance over much of the ocean -- but not quite. In some regions remote from land, more carbon is produced through photosynthesis than is respired back to carbon dioxide; in others, just the opposite is true. Figuring out which is exceedingly important because in regions where photosynthesis exceeds respiration, there is a net production of food for marine life as well as a net removal of carbon dioxide (a powerful greenhouse gas) from the atmosphere. Conversely, oceanic regions where respiration exceeds photosynthesis are zones of net food consumption and release of carbon dioxide to the atmosphere. In practice, the problem is that the differences, one way or the other, are so small that it is difficult to distinguish between the measurements themselves and noise (that is, scatter) in the data. Resolution of this problem requires new technology that can make the necessary measurements with very high precision in the ocean itself rather than in a bottle of sampled seawater. In this project, the investigators will attempt to do just that using a sophisticated instrument normally found only in an analytical laboratory -- a mass spectrometer, a device capable of making ultra-high-precision measurements of changes in the amount of dissolved oxygen, carbon dioxide, and other substances associated with photosynthesis and respiration in the marine water column. The investigators will support graduate students to participate as integral members of the research team. There will also be public educational outreach to secondary school students offering them the opportunity to engage with the project to gain first-hand experience seeing how the basic sciences can be used to solve oceanographic problems.

In this project, a team of investigators will evaluate one facet of these methodological concerns using in-situ mass spectrometry to better constrain net community production (NCP). The UMIMS is a fast-response Underwater Membrane Inlet Mass Spectrometer that can be deployed in autonomous and remotely-operated vehicles. In this application, UMIMS will be deployed aboard a SeaSoar tow vehicle to make high resolution vertical sections of the excess dissolved oxygen (O2) over argon (Ar) budget, a promising measure of NCP in the surface ocean. Profiles with the UMIMS can provide the capacity to resolve processes throughout the mixed-layer and euphotic zone that affect the NCP budget. In the near term, the team will utilize the capabilities of the UMIMS to make accurate and simultaneous mixed layer profiles of O2 and Ar and compare measurements of NCP from the UMIMS with measurements from the conventional shipboard O2/Ar budget from underway seawater. These comparisons will be used to determine the limitations of both methods and the degree to which they can resolve the ambient physical processes leading to non-stationary exchange. In the long term, the researchers expect to make the technological and methodological advances necessary to deploy the UMIMS on Lagrangian floats and sea gliders. As such, this project is expected to make a significant step toward measuring near-continuous time and space series observations of the oceanic metabolic balance and the biological pump, similar to the way Argo

floats measure temperature and salinity today.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1429940

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