Time series of oxygen, nitrate, methane concentrations and methane oxidation rates of the Santa Barbara Basin deep water column from 2019-2020 (BASIN project)

Website: https://www.bco-dmo.org/dataset/872703
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2022-04-05

Project
» Collaborative Research: Chemical and microbiological studies of water-soluble alkanes in the ocean (CASA)
» Collaborative Research: Do benthic feedbacks couple sulfur, nitrogen and carbon biogeochemistry during transient deoxygenation? (BASIN)

Contributors	Affiliation	Role
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Abstract
Time series of water column parameters (oxygen, nitrate, methane concentrations and methane oxidation rates) are sampled and measured to show the changes related to methane biogeochemistry during a deoxygenation and reoxygenation event in the deep Santa Barbara water column (440-583m).

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Coverage

Spatial Extent: **N**:34.2749 **E**:-120.0252 **S**:34.2008 **W**:-120.0417
Temporal Extent: 2019-06-28 - 2020-03-19

Methods & Sampling

Methodology:

Sampling and analytical procedures:

Densities were calculated from CTD-measured parameters (Seabird SBE 19plusV2 Seacat Profiler system).

Methane concentrations were measured by headspace equilibration method, modified from Kinnaman et al., 2007.

Oxygen concentrations were measured by ODF Winkler titration method.

Nitrate concentrations were measured by flow injection analysis (FIA) using the QuikChem 8500 Series 2 (Lachat Instruments, Zellweger Analytics Inc.)

Fractional methane turnover rates were analyzed based on the 3H-labeled methane incubation protocol by Bussmann et al., 2015.

Methane oxidation rates were calculated assuming adherence to the first-order rate law, by multiplying fractional methane turnover rate and ambient methane concentration (Valentine et al., 2001).

Samples were collected from R/V Connell and R/V Atlantis.

Data Processing Description

Processing notes from researcher:

Time series maps were generated using Ocean Data View version 5.2.1-64 bit. Gridded fields were calculated using DIVA gridding algorithm, with X scale-length of 400 and Y scale-length of 350.

For the 8/13/19 and 8/26/19 trips, fractional methane turnover rate samples were discarded because of an apparent leaching problem with the closure tubing inside of the Niskin bottles used for sampling (leading to interference with rate measurements).

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Data Files

File
qianhui_qin_-_time_series_data.csv (Comma Separated Values (.csv), 97.07 KB) MD5:3723db9b82a0f36f7782f6c4e8be1e8d Primary data file for dataset ID 872703

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Related Publications

Bussmann, I., Matousu, A., Osudar, R., & Mau, S. (2015). Assessment of the radio 3 H-CH4 tracer technique to measure aerobic methane oxidation in the water column. Limnology and Oceanography: Methods, 13(6), 312–327. doi:10.1002/lom3.10027
Methods

Kinnaman, F. S., Valentine, D. L., & Tyler, S. C. (2007). Carbon and hydrogen isotope fractionation associated with the aerobic microbial oxidation of methane, ethane, propane and butane. Geochimica et Cosmochimica Acta, 71(2), 271–283. doi:10.1016/j.gca.2006.09.007
Related Research

Qin, Q., Kinnaman, F. S., Gosselin, K. M., Liu, N., Treude, T., & Valentine, D. L. (2022). Seasonality of water column methane oxidation and deoxygenation in a dynamic marine environment. Geochimica et Cosmochimica Acta, 336, 219–230. https://doi.org/10.1016/j.gca.2022.09.017
Results

Valentine, D. L., Blanton, D. C., Reeburgh, W. S., & Kastner, M. (2001). Water column methane oxidation adjacent to an area of active hydrate dissociation, Eel river Basin. Geochimica et Cosmochimica Acta, 65(16), 2633–2640. doi:10.1016/s0016-7037(01)00625-1 https://doi.org/10.1016/S0016-7037(01)00625-1

Methods

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Related Datasets

IsRelatedTo

Qin, Q., Valentine, D. L., Treude, T., Kinnaman, F. S., Gosselin, K. M., Liu, N. (2022) **Initial Methane Concentration Alteration Experiment Data of the Deep Santa Barbara Basin Water Column from October 2019 (BASIN project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-04-05 doi:10.26008/1912/bco-dmo.872652.1 [view at BCO-DMO]
Relationship Description: Time series of oxygen, nitrate, methane concentrations and methane oxidation rates of the Santa Barbara Basin deep water column. Methane oxidation rates were measured using the method confirmed by the time course experiment, and the initial methane and oxygen alteration experiments.

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Parameters

Parameter	Description	Units
sample_datetime	UTC datetime of sample collection; the date format is YYYY-MM-DDTHH:MM:SS	unitless
Latitude_degrees_north	latitude of sample collection; a positive value indicates North	decimal degrees
Longitude_degrees_east	longitude of sample collection; a negative value indicates East	decimal degrees
Station_Name	station from which samples were collected; stations are either NDRO (34.2625, -120.0313), SDRO (34.2008, -120.0417), or CalCOFI (34.2749, -120.0252 W)	unitless
Type	sampling type; presents either as CTD or bottle	unitless
Depth_m	depth at which sample was collected	m
density_kg_per_m3	density of seawater at a certain depth	kg/m3
density_stdev	standard diviation of seawater density	unitless
methane_concentration_nM	methane concentration of the sampled water	nM
methane_concentration_stdev	standard diviation of methane concentration	unitless
methane_oxidation_rate_nM_per_d	methane oxidation rate of methanotrophs of the sampled water	nM/d
methane_oxidation_rate_stdev	standard diviation of methane oxidation rates	unitless
oxygen_concentration_uM	oxygen concentration of the sampled water	uM
oxygen_concentration_stdev	standard diviation of oxygen concentration	unitless
nitrate_concentration_uM	nitrate concentration of the sampled water	uM
nitrate_concentration_stdev	standard diviation of nitrate concentration	unitless

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Instruments

Dataset-specific Instrument Name	CTD Seabird 911+ rosette with 24 10-liter Niskin bottles
Generic Instrument Name	CTD Sea-Bird 911
Dataset-specific Description	For BASIN19 trips, seawater sampling was performed using R/V Atlantis' CTD (Seabird 911+) rosette with 24 10-liter Niskin bottles. In-situ temperature was recorded by CTD and in-situ oxygen concentration was recorded by an oxygen sensor that was mounted on the rosette.
Generic Instrument Description	The Sea-Bird SBE 911 is a type of CTD instrument package. The SBE 911 includes the SBE 9 Underwater Unit and the SBE 11 Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 and SBE 11 is called a SBE 911. The SBE 9 uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 and SBE 4). The SBE 9 CTD can be configured with auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). More information from Sea-Bird Electronics.

Dataset-specific Instrument Name	Seabird SBE 19plusV2 Seacat Profiler System
Generic Instrument Name	CTD Sea-Bird SBE SEACAT 19plus
Dataset-specific Description	Seawater sampling was performed using a rosette equipped with 6 4-liter Niskin bottles, the in-situ temperatures of the water samples were recorded by the conductivity–temperature–depth recorder (CTD), a Seabird SBE 19plusV2 Seacat Profiler system attached to the rosette.
Generic Instrument Description	Self contained self powered CTD profiler. Measures conductivity, temperature and pressure in both profiling (samples at 4 scans/sec) and moored (sample rates of once every 5 seconds to once every 9 hours) mode. Available in plastic or titanium housing with depth ranges of 600m and 7000m respectively. Minature submersible pump provides water to conductivity cell.

Dataset-specific Instrument Name	6 4-liter Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Seawater sampling was performed using a rosette equipped with 6 4-liter Niskin bottles, the in-situ temperatures of the water samples were recorded by the conductivity–temperature–depth recorder (CTD), a Seabird SBE 19plusV2 Seacat Profiler system attached to the rosette.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Deployments

AT42-19

Website	https://www.bco-dmo.org/deployment/867020
Platform	R/V Atlantis
Start Date	2019-10-29
End Date	2019-11-10
Description	BASIN project cruise to study chemical processes that occur in oxygen-limited waters along the continental margins. See more information at R2R: https://www.rvdata.us/search/cruise/AT42-19

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Project Information

Collaborative Research: Chemical and microbiological studies of water-soluble alkanes in the ocean (CASA)

Coverage: Coal Oil Point, Santa Barbara, CA and Gulf of Mexico

NSF Abstract:
This research project addresses the fate of hydrocarbons that enter the ocean, using geological oil seeps as a natural scientific laboratory. The key issues of intellectual merit that will be addressed focus on the development and application of methodology to determine how the chemical properties of hydrocarbon molecules dictate whether they will be trapped in the ocean's interior or find their way to the atmosphere. The research will further follow the fate of these molecules in the ocean's interior, determining how the ocean's bacterial population responds, and the extent to which responding bacteria will degrade these molecules. The broader impacts of this research will include the training of undergraduate and graduate students in scientific research and at-sea oceanographic training, as well as the dissemination of findings to policy makers striving to understand the fate and effects of hydrocarbons in the ocean.

Hydrocarbons enter the ocean through a combination of natural seepage, anthropogenic discharge and biological production, with profound impacts on ocean biogeochemistry, ecology, and the atmosphere. This research project addresses the chemical and biological processes affecting water-soluble alkanes in the ocean, using natural seeps to study their fluxes, partitioning between ocean and atmosphere, and the bacterial response to their input. The intellectual merit of this research pertains to the behavior of highly volatile hydrocarbons, a class that is abundant in petroleum reservoirs and many crude and refined products, but is poorly understood in the ocean. Volatile hydrocarbons display distinct behaviors compared with traditional oil in that they will partition to seawater or the atmosphere depending on their molecular structure and the context by which they enter the ocean, a combination of characteristics unsuitable for traditional fate and transport models that govern our understanding of liquid oil. This research project addresses this gap in knowledge through a plan to study volatile, water-soluble hydrocarbons in the context of natural seepage, focusing on key questions about their transport and fate, and the ocean's microbial response. Two key questions include: 1) What factors control the partitioning of water-soluble alkanes between water and the atmosphere at natural seeps, and how does this affect their availability to microbes? 2) What genomic and metabolic factors enable the microbial response to the input of water-soluble alkanes and how does the microbial response vary with regional oceanographic and geologic factors such as proximity to and flux from natural seepage? The hypotheses that result from these questions will be tested through a series of oceanographic and laboratory-based experiments designed around natural oil seeps in the Pacific and in the Gulf of Mexico. The results of these studies promise to inform our understanding of the transport, fate, and effects of water-soluble alkanes in the ocean.

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.

Collaborative Research: Do benthic feedbacks couple sulfur, nitrogen and carbon biogeochemistry during transient deoxygenation? (BASIN)

Coverage: Santa Barbara Basin, California, USA

NSF Award Abstract:
This study focuses on chemical processes that occur in oxygen-limited waters along the world's continental margins. These processes are influenced by the activities of microbes and control the fate of key elements that are deposited to sediments in these areas including carbon, nitrogen and sulfur. As a result, they are key to the health and function of the ocean. The intellectual merit of this research is to study the coupled chemical and microbial processes that occur in these environments by combining robotic technology with experiments that will be conducted at the ocean floor and in the shipboard laboratory. The broader impacts of this project will provide at-sea training and educational opportunities to undergraduate and graduate students and the results will be broadly distributed to stakeholders and interested parties. Results from this research promise to identify and quantify rates for key processes that couple carbon, nitrogen and sulfur in marine environments adjacent to the continents. The project addresses an important aspect of environmental change in the ocean (i.e., decreased oxygen due to warming and nutrient enrichment) and its influence on chemical and biological cycles and ocean ecosystems.

The dynamics of oxygen minimum zones along continental margins, and their potential for future expansion, are important because of their intersection with global biogeochemical cycles and because of their far-reaching impacts on ocean ecosystems. However, the impacts of transient deoxygenation on biogeochemical cycles of carbon, nitrogen and sulfur at the sea floor are not well established and are the focus of this study. This study will test the overarching hypothesis that deoxygenation triggers a positive feedback loop between bacterial mats at the sea floor that consume hydrogen sulfide, a sulfur species that can be toxic to higher organisms, and an underlying community of bacteria that produce hydrogen sulfide. By this hypothesis, the establishment of sea floor mats, which depend on inorganic nitrogen sources to run their sulfur metabolism, accelerates nitrogen cycling in the uppermost sediment horizon following deoxygenation. The accelerated nitrogen cycling allows for upward expansion of the sulfide-producing bacteria, which in-turn provide a shallow source of sulfide as substrate to further support nitrogen cycling in the sea floor mat. The results of this study will enable understanding of the relationship between oxygen dynamics in the water column and the biogeochemical processes at the sea floor that link the transformations of carbon, nitrogen and sulfur. The results of this study promise to define the environmental conditions under which the sulfur and nitrogen cycles are coupled and subject to strong positive feedbacks at the seafloor, as well as the conditions under which they are decoupled. This study provides training in research and innovative analytical and experimental techniques to four graduate students and several undergraduates. Undergraduates will be engaged in research at two institutions, one of which has recently been designated as a Hispanic serving institution. Approximately 10 undergraduate students (20 in total) will participate in each of the two proposed oceanographic expeditions, through an established course entitled: Field Studies in Marine Biogeochemistry. This course provides an opportunity for students to develop an independent research project in advance of the expedition, to participate on the expedition, and to conduct research projects while at sea.

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-1756947
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756667
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756242
NSF Division of Ocean Sciences (NSF OCE)	OCE-1829981
NSF Division of Ocean Sciences (NSF OCE)	OCE-1830033

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