

Carbon isotopes (^{13}C and ^{14}C) and concentrations of dissolved methane (CH_4) in surface waters sampled in June 2019 at the Coal Oil Point seep field of the Santa Barbara Basin

Website: <https://www.bco-dmo.org/dataset/823720>

Data Type: Cruise Results

Version: 1

Version Date: 2020-09-10

Project

» [Constraining Global Coastal Ocean Methane Emissions to the Atmosphere](#) (Coastal Methane Emissions)

Contributors	Affiliation	Role
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Abstract

Carbon isotopes (^{13}C and ^{14}C) and concentrations of dissolved methane (CH_4) in surface waters sampled in June 2019 at the Coal Oil Point seep field of the Santa Barbara Basin.

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Coverage

Spatial Extent: N:34.42 E:-119.607 S:34.333 W:-120.015

Temporal Extent: 2019-06-17 - 2019-06-19

Methods & Sampling

Samples were collected from the small boat R/V Connell, operated by UCSB. Gases dissolved in seawater were extracted following the procedures outlined in Sparrow and Kessler (2017) and Joung et al (2019). As detailed in these prior publications, surface waters (~ 1 m below sea surface) were pumped through a suction hose with a discharge pump and were passed through multiple filters for removing particles. This water was then continuously passed through a gas-permeable membrane to vacuum extract the dissolved gases in the seawater.

Following these at-sea sample collection procedures, the extracted gas samples were purified and analyzed following vacuum line procedures previously detailed in Sparrow and Kessler (2017).

Please see the Sparrow and Kessler (2017) for detailed descriptions and validation tests for these procedures.

Dissolved methane concentration measurements were conducted using a headspace equilibration technique previously described in Weinstein et al. (2016) and Leonte et al (2017).

Data Processing Description

BCO-DMO Processing:

- modified parameter names;
- converted date and time (local) into ISO 8601 UTC format.

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Data Files

File
methane_radiocarbon.csv (Comma Separated Values (.csv), 1.66 KB) MD5:9c43d720b20b8644c7d3eff770f5aaea Primary data file for dataset ID 823720

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Related Publications

Joung, D., Leonte, M., & Kessler, J. D. (2019). Methane Sources in the Waters of Lake Michigan and Lake Superior as Revealed by Natural Radiocarbon Measurements. *Geophysical Research Letters*, 46(10), 5436–5444. doi:10.1029/2019gl082531 <https://doi.org/10.1029/2019GL082531>

Methods

Leonte, M., Kessler, J. D., Kellermann, M. Y., Arrington, E. C., Valentine, D. L., & Sylva, S. P. (2017). Rapid rates of aerobic methane oxidation at the feather edge of gas hydrate stability in the waters of Hudson Canyon, US Atlantic Margin. *Geochimica et Cosmochimica Acta*, 204, 375–387. doi:[10.1016/j.gca.2017.01.009](https://doi.org/10.1016/j.gca.2017.01.009)

Methods

Sparrow, K. J., & Kessler, J. D. (2017). Efficient collection and preparation of methane from low concentration waters for natural abundance radiocarbon analysis. *Limnology and Oceanography: Methods*, 15(7), 601–617. doi:[10.1002/lom3.10184](https://doi.org/10.1002/lom3.10184)

Methods

Sparrow, K. J., Kessler, J. D., Southon, J. R., Garcia-Tigreros, F., Schreiner, K. M., Ruppel, C. D., Miller, J. B., Lehman, S. J., & Xu, X. (2018). Limited contribution of ancient methane to surface waters of the U.S. Beaufort Sea shelf. *Science Advances*, 4(1), eaao4842. <https://doi.org/10.1126/sciadv.aao4842>

General

Weinstein, A., Navarrete, L., Ruppel, C., Weber, T. C., Leonte, M., Kellermann, M. Y., Arrington, E. C., Valentine, D. L., Scranton, M. I., & Kessler, J. D. (2016). Determining the flux of methane into Hudson Canyon at the edge of methane clathrate hydrate stability. *Geochemistry, Geophysics, Geosystems*, 17(10), 3882–3892. <https://doi.org/10.1002/2016gc006421>

<https://doi.org/10.1002/2016gc006421>

Methods

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Related Datasets

IsRelatedTo

Kessler, J. D., Joung, D. (2021) **Radiocarbon in methane from waters of the US Atlantic and Pacific margins as collected on R/V Hugh Sharp cruise HRS1713 and R/V Rachel Carson cruise RC0026 in 2017 and 2019**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-09-27 doi:10.26008/1912/bco-dmo.861576.1 [[view at BCO-DMO](#)]

Parameters

Parameter	Description	Units
STATION	Station ID	unitless
LAT	Latitude	decimal degrees North
LONG	Longitude	decimal degrees East
DATE	Date local (PDT); format: MM/DD/YYYY	unitless
TIME	Time local (PDT); format: hh:mm	unitless
ISO_DateTime_UTC	Date and time (UTC) formatted to ISO 8601 standard: YYYY-MM-DDThh:mmZ	unitless
StnDep	Depth of the water column at that station	meters (m)
SamDep	Water Depth where sample was collected	meters (m)
FW	Volume of water filtered	liters (L)
GC_CH4	Dissolved CH4 concentrations measured by GC-FID	nanomolar (nM)
GC_CH4_stdev	Standard deviation of GC_CH4	nanomolar (nM)
Licor	Extracted Gas concentrations measured by Licor	parts per million (ppm)
d13C	13C in CH4 by AMS	per mil (‰)
d13C_stdev	Standard deviation of d13C	per mil (‰)
C14_CH4	14C in CH4 by AMS	percent modern
C14_CH4_stdev	Standard deviation of C14_CH4	percent modern
D14C	14C in CH4 by AMS	per mil (‰)
D14C_stdev	Standard deviation of D14C	per mil (‰)

Instruments

Dataset-specific Instrument Name	Accelerator Mass Spectrometer
Generic Instrument Name	Accelerator Mass Spectrometer
Dataset-specific Description	¹⁴ C and ¹³ C were measured by Accelerator Mass Spectrometer (AMS) and Isotope Ratio Mass Spectrometer (IRMS), respectively, at the Keck-Carbon Cycle AMS facility at UC Irvine.
Generic Instrument Description	<p>An AMS measures "long-lived radionuclides that occur naturally in our environment. AMS uses a particle accelerator in conjunction with ion sources, large magnets, and detectors to separate out interferences and count single atoms in the presence of 1x10¹⁵ (a thousand million million) stable atoms, measuring the mass-to-charge ratio of the products of sample molecule disassociation, atom ionization and ion acceleration." AMS permits ultra low-level measurement of compound concentrations and isotope ratios that traditional alpha-spectrometry cannot provide. More from Purdue University:</p> <p>http://www.physics.purdue.edu/primelab/introduction/ams.html</p>

Dataset-specific Instrument Name	Agilent 6850
Generic Instrument Name	Agilent 6850 networked gas chromatograph
Dataset-specific Description	A gas chromatograph with a flame ionization detector (Agilent 6850) was used for the GC analyses.
Generic Instrument Description	<p>A single channel, networked, gas chromatograph that separates and analyses compounds into separate components and can be used for chemical, petrochemical and petroleum analyses. The sample is introduced into the injector and then vaporised in the instrument. A chemically inert gas (e.g. helium and nitrogen) carries the vaporised solute into the column that is maintained in a temperature controlled oven. As the solute elutes from the column, it enters the heated detector. An electronic signal is generated upon interaction of the solute with the detector. The Agilent 6850 has a similar performance to the Agilent 6890N GC, but is half as wide. The local interface provides run control and status information and the instrument comes network-ready with a built-in LAN communications interface. There is a choice of detectors available, the Flame Ionization Detector (FID), Thermal Conductivity Detector (TCD) or Mass Selective Detector (MSD). There is an option of split/splitless or packed inlets, a variety of automated sample introduction systems and products available for headspace analysis. This model is no longer in production.</p>

Dataset-specific Instrument Name	Isotope Ratio Mass Spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	¹⁴ C and ¹³ C were measured by Accelerator Mass Spectrometer (AMS) and Isotope Ratio Mass Spectrometer (IRMS), respectively, at the Keck-Carbon Cycle AMS facility at UC Irvine.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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Project Information

Constraining Global Coastal Ocean Methane Emissions to the Atmosphere (Coastal Methane Emissions)

Coverage: US Pacific Margin, US Atlantic Margin, Gulf of Mexico, Arctic Ocean

NSF Award Abstract:

This project will determine global methane emissions from coastal marine environments, one of the most uncertain natural sources of methane to the atmosphere. Methane is a greenhouse gas whose impact on future climate warming will depend on emissions from both human sources and the changing natural environment. It is therefore critical to understand the baseline emission rates of natural methane sources to the atmosphere as well as their sensitivity to change. While the open ocean environment is thought to emit only minor amounts of methane to the atmosphere, concentrations and emission rates of methane increase substantially approaching coastlines. Coastal ocean methane emissions are potentially significant at the global scale but remain highly uncertain due to a lack of observations that accurately capture coastal distributions. Furthermore, the source of methane emitted from coastal surface waters is not well known, limiting our ability to predict how emissions will change in the future. This project will determine the source and global emission rate of methane from the coastal ocean to the atmosphere, and establish a framework to predict future emission rates in a warming climate. In addition to these scientific and societal impacts, this project will have strong educational impacts as it will provide undergraduate students the opportunity to experience the entire scientific process from idea conception to publication of the final results. A sequence of classes has been established by the PI at the University of Rochester to guide students through this process from an ocean science perspective. This project will serve as the focus for the next iteration of the class sequence, and participating students will be vital contributors to the research. When conducted previously, this educational outreach has empowered undergraduates to pursue their own scientific interests and has led to significant numbers of students pursuing graduate careers in the ocean sciences. This project will also support a Ph.D. student in a truly unique experience whereby she/he will have the opportunity to conduct meaningful research in both sea-going measurement as well as modeling laboratories, and thus integrate into two often disparate communities.

This project will be accomplished through a unique and equal combination of observational and statistical modeling work, leveraging methodologies that are well established in the PI and co-PI's laboratories to make rapid progress over the 2.5-year duration of the project. In total, surface methane concentrations in four coastal regions "spanning three different ocean basins and subtropical to subpolar latitude ranges" will be measured using an ultra-fast vacuum extraction method, yielding coastal data coverage that is unparalleled in previous datasets. Additionally, the radiocarbon content of surface methane will be measured to fingerprint its provenance between fossil and microbial sources, and biogeochemical data including chlorophyll, nutrient, and dissolved oxygen concentrations will be collected. Initial cruise data (year 1) will be used to train Artificial Neural Network models to predict surface methane supersaturation as a function of biogeochemical variables, and later cruises (year 2) will allow for independent model validation in regions that were not used for training.

Having established the fidelity with which this model can generalize between coastal environments, it will be applied to extrapolate maps of methane supersaturation and estimate regional and global scale coastal methane emissions while quantifying their uncertainty. Overall, this work will close these gaps in our knowledge of the natural methane budget, yielding the most robust estimates to date of coastal ocean emissions and a new understanding of the mechanisms that sustain them.

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-1851402

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