

Concentrations of acrylate and dimethylsulphoniopropionate from the surface of coral reefs sampled in Moorea, French Polynesia in April 2018

Website: <https://www.bco-dmo.org/dataset/879142>

Data Type: Other Field Results, experimental

Version: 1

Version Date: 2022-08-31

Project

» [Photolysis and Photoproduction of Acrylate in Seawater and their Impact on the Marine Organosulfur Cycle](#)
(Impact Acrylate in Seawater)

Program

» [United States Surface Ocean Lower Atmosphere Study](#) (U.S. SOLAS)

Contributors	Affiliation	Role
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Abstract

Shallow-water coral reefs hold large quantities of acrylate and its precursor dimethylsulfonylpropionate (DMSP). The main sources of acrylate in coral reefs are from the coral algal symbionts in the family Symbiodiniaceae and from the photolysis of dissolved organic matter. Heterotrophic consumption is the main loss for these compounds, albeit these processes are poorly characterized. This dataset contains acrylate, DMSP, and dimethylsulfoxide (DMSO) concentrations in dissolved and unfiltered seawater samples that were collected from near-surface seawater in a Mo'orea coral reef, French Polynesia, and the offshore open Pacific Ocean. The coral reef and Pacific Ocean stations were located offshore from the UC Berkeley Gump Research Station. Samples were collected from April 6 to April 24, 2018. Details of the sampling and experimental procedures for this dataset are reported in Xue et al. (2022).

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Coverage

Spatial Extent: N:-17.4552 E:-149.831 S:-17.4823 W:-149.841

Temporal Extent: 2018-04-06 - 2018-04-24

Methods & Sampling

Study area: The main field study was conducted in a coral reef offshore from the Richard Gump South Pacific Research Station located next to Cook's Bay on the northern shore of Mo'orea, French Polynesia. Research was conducted by small boat in a shallow-water coral reef and offshore Pacific Ocean. See Figure 1 in Xue et al. 2022 (under review) for the geographic locations of French Polynesia, the island of Mo'orea, and the schematic description of the reef structure and the reef-ocean transect sampling locations.

Sample collection and storage: Water samples were collected from the near sea surface using precleaned polypropylene bottles from repeated sampling trips to six hydrographic stations along a reef-ocean transect. To collect samples for dissolved concentrations, the unfiltered samples were gravity filtered through a precombusted GF/F filter into precleaned 20 milliliter (mL) scintillation vials following the procedure of small-volume drip filtration (Kiene and Slezak 2006). Paired with each dissolved sample, another set of samples was also collected for the measurement of total concentrations by transferring 15 mL of unfiltered seawater into 20 milliliter (mL) scintillation vials. All samples were microwaved to boiling and allowed to cool to room temperature followed by bubbling using high-purity nitrogen and acidification with 150 microliters of Ultrex-grade HCl. Each sample was collected in duplicate and was stored at room temperature in the dark until analyses were conducted in the home laboratory in Syracuse, New York.

Acrylate and organosulfur quantification: Acrylate concentrations were determined using a pre-column derivatization HPLC method (Xue and Kieber 2021). For derivatization, 300 microliter (μL) thiosalicylic acid (20 mM) reagent was added into a 5 mL precleaned borosilicate vial containing 3 mL of a standard or seawater sample. The pH in each vial was adjusted to 4.0. Then each vial was tightly screw-capped and incubated at 90 degrees Celsius in a water bath for 6 hours. After cooling to room temperature, each derivatized sample was filtered using a 0.2 μm Nylon syringe filter followed by injection of 1 mL sample into a Shimadzu reverse-phase HPLC with UV absorbance detection at 257 nanometers (nm). To measure concentrations of DMSP and DMSO, both compounds were first converted to DMS. To convert DMSP or DMSO to DMS, 200 μL 5 M NaOH or 20% TiCl_3 was added to 1 mL of a standard or seawater sample in a precleaned borosilicate serum vial, which was immediately capped and sealed followed by incubation. Incubation for DMSP was overnight at room temperature, while incubation for DMSO was at 55 degrees C for 1 hour. The produced DMS was analyzed using a cryogenic purge-and-trap system and a Shimadzu GC-14A with a flame photometric detector (Kinsey et al., 2016).

Chlorophyll a (Chl a): 250 ml of seawater was filtered through a 25 millimeter (mm) diameter GF/C glass fiber filter that was subsequently stored frozen. The fluorescence of the extracts was measured with a calibrated Turner designs fluorometer

Notes: Concentrations (column C-H) in dissolved or unfiltered (total) samples are given in units of nanomole/L with subscripts d and t indicating dissolved and total concentrations, respectively.

Data Processing Description

This dataset used Microsoft Excel, SigmaPlot version 11.0 for analyses.

BCO-DMO processing description:

- Converted dates to YYYY-MM-DD format
- Adjusted field/parameter names to comply with BCO-DMO naming conventions
- Added a conventional header with dataset name, PI names, version date
- Added latitude/longitude values based on IDs in 'Sampling_site' column

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Data Files

File
transect.csv (Comma Separated Values (.csv), 4.75 KB) MD5:9772a6872048edc0bd25f11b4b834bf6
Primary data file for dataset ID 879142

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Related Publications

Kiene, R. P., & Slezak, D. (2006). Low dissolved DMSP concentrations in seawater revealed by small-volume gravity filtration and dialysis sampling. *Limnology and Oceanography: Methods*, 4(4), 80-95.

doi:[10.4319/lom.2006.4.80](https://doi.org/10.4319/lom.2006.4.80)

Methods

Kinsey, J. D., Kieber, D. J., & Neale, P. J. (2016). Effects of iron limitation and UV radiation on *Phaeocystis antarctica* growth and dimethylsulfoniopropionate, dimethylsulfoxide and acrylate concentrations.

Environmental Chemistry, 13(2), 195. <https://doi.org/10.1071/en14275> <https://doi.org/10.1071/EN14275>

Methods

Xue, L., & Kieber, D. J. (2021). Photochemical Production and Photolysis of Acrylate in Seawater. *Environmental Science & Technology*, 55(10), 7135-7144. <https://doi.org/10.1021/acs.est.1c00327>

Results

Xue, L., Kieber, D. J., Masdeu-Navarro, M., Cabrera-Brufau, M., Rodríguez-Ros, P., Gardner, S. G., Marrasé, C., & Simó, R. (2022). Concentrations, sources, and biological consumption of acrylate and DMSP in the tropical Pacific and coral reef ecosystem in Mo'orea, French Polynesia. *Frontiers in Marine Science*, 9.

<https://doi.org/10.3389/fmars.2022.911522>

Results

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Related Datasets

IsRelatedTo

Xue, L., Kieber, D. J. (2022) **Biological turnover of acrylate and dimethylsulphoniopropionate from coral reefs sampled in Moorea, French Polynesia in April 2018**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-09-01 doi:10.26008/1912/bco-dmo.879158.1 [[view at BCO-DMO](#)]

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Parameters

Parameter	Description	Units
Sampling_date	Date of sampling in format YYYY-MM-DD	unitless
Sampling_site	Sampling site (CH, nearshore outflow channel; BR=back reef; CO=ocean crest; CR=reef crest; OO=open ocean; SO=shelf ocean)	unitless
Latitude	Latitude of sampling location (South is negative)	decimal degrees
Longitude	Longitude of sampling location (West is negative)	decimal degrees
Temperature	Temperature of water at sampling site	degrees Celsius

Chl_a	Concentration of Chlorophyll a	micrograms per liter ($\mu\text{g/L}$)
Acrylate_d_rep1	Dissolved Acrylate concentration for first replicate	nanomolar (nM)
Acrylate_d_rep2	Dissolved Acrylate concentration for second replicate	nanomolar (nM)
Acrylate_d_avg	Average value for Dissolved Acrylate	nanomolar (nM)
Acrylate_d_std_dev	Standard deviation of Dissolved Acrylate values	nanomolar (nM)
Acrylate_t_rep1	Total Acrylate concentration for first replicate	nanomolar (nM)
Acrylate_t_rep2	Total Acrylate concentration for second replicate	nanomolar (nM)
Acrylate_t_avg	Average value for Total Acrylate	nanomolar (nM)
Acrylate_t_std_dev	Standard deviation of Total Acrylate values	nanomolar (nM)
DMSP_d_rep1	Dissolved DMSP concentration for first replicate	nanomolar (nM)
DMSP_d_rep2	Dissolved DMSP concentration for second replicate	nanomolar (nM)
DMSP_d_avg	Average value for Dissolved DMSP	nanomolar (nM)
DMSP_d_std_dev	Standard deviation of Dissolved DMSP values	nanomolar (nM)
DMSP_t_rep1	Total DMSP concentration for first replicate	nanomolar (nM)
DMSP_t_rep2	Total DMSP concentration for second replicate	nanomolar (nM)
DMSP_t_avg	Average value for Total DMSP	nanomolar (nM)
DMSP_t_std_dev	Standard deviation of Total DMSP values	nanomolar (nM)
DMSO_d_rep1	Dissolved DMSO concentration for first replicate	nanomolar (nM)
DMSO_d_rep2	Dissolved DMSO concentration for second replicate	nanomolar (nM)
DMSO_d_avg	Average value for Dissolved DMSO	nanomolar (nM)
DMSO_d_std_dev	Standard deviation of Dissolved DMSO values	nanomolar (nM)
DMSO_t_rep1	Total DMSO concentration for first replicate	nanomolar (nM)
DMSO_t_rep2	Total DMSO concentration for second replicate	nanomolar (nM)
DMSO_t_avg	Average value for Total DMSO	nanomolar (nM)
DMSO_t_std_dev	Standard deviation of Total DMSO values	nanomolar (nM)

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Instruments

Dataset-specific Instrument Name	Shimadzu FPD-14 flame photometric detector
Generic Instrument Name	flame photometric detector
Dataset-specific Description	DMS was analyzed using a cryogenic purge-and-trap system and a Shimadzu GC-14A with FPD-14 flame photometric detector
Generic Instrument Description	The determination of sulfur or phosphorus containing compounds is the job of the flame photometric detector (FPD). This device uses the chemiluminescent reactions of these compounds in a hydrogen/air flame as a source of analytical information that is relatively specific for substances containing these two kinds of atoms. The emitting species for sulfur compounds is excited S ₂ . The lambda max for emission of excited S ₂ is approximately 394 nm. The emitter for phosphorus compounds in the flame is excited HPO (lambda max = doublet 510-526 nm). In order to selectively detect one or the other family of compounds as it elutes from the GC column, an interference filter is used between the flame and the photomultiplier tube (PMT) to isolate the appropriate emission band. The drawback here being that the filter must be exchanged between chromatographic runs if the other family of compounds is to be detected.

Dataset-specific Instrument Name	Shimadzu GC-14A
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	DMS was analyzed using a cryogenic purge-and-trap system and a Shimadzu GC-14A with a flame photometric detector.
Generic Instrument Description	Instrument separating gases, volatile substances, or substances dissolved in a volatile solvent by transporting an inert gas through a column packed with a sorbent to a detector for assay. (from SeaDataNet, BODC)

Dataset-specific Instrument Name	Shimadzu Prominence
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Shimadzu Prominence high performance liquid chromatography (HPLC) system with a model SPD-20A/V UV-Vis absorbance detector set at 257 nm.
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

Dataset-specific Instrument Name	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	Sea-surface water samples were collected in Niskin bottles during cruises in the Pacific Ocean, Atlantic Ocean, and the Gulf of Mexico
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.

Dataset-specific Instrument Name	Turner Designs TD-700 fluorometer
Generic Instrument Name	Turner Designs 700 Laboratory Fluorometer
Dataset-specific Description	The fluorescence of the extracts was measured with a calibrated Turner designs fluorometer
Generic Instrument Description	The TD-700 Laboratory Fluorometer is a benchtop fluorometer designed to detect fluorescence over the UV to red range. The instrument can measure concentrations of a variety of compounds, including chlorophyll-a and fluorescent dyes, and is thus suitable for a range of applications, including chlorophyll, water quality monitoring and fluorescent tracer studies. Data can be output as concentrations or raw fluorescence measurements.

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Project Information

Photolysis and Photoproduction of Acrylate in Seawater and their Impact on the Marine Organosulfur Cycle (Impact Acrylate in Seawater)

Website: <https://mooreareefresearch.wordpress.com/>

Coverage: Gump Research Station on the island of Mo'orea in French Polynesia (17.50 °S, 149.833 °W), State University of New York, College of Environmental Science and Forestry (43.034° N, 76.137° W)

NSF Award Abstract:

This project would investigate the marine chemistry of the compound acrylate. Acrylate is a mostly overlooked by-product of a very well-studied process through which a compound known as DMSP (dimethylsulfoniopropionate), a compound produced by phytoplankton, is converted to the gas dimethylsulfide (known as DMS). This process is an important part of understanding the marine cycling of sulfur, and DMS plays a role in cloud formation and climate. Thus, these aspects of the conversion of DMSP to DMS have received considerable attention. On the other hand, very little is known about acrylate concentrations, fluxes, or impacts in the oceans, even though it is produced during the conversion of DMSP to DMS. Acrylate concentrations and fluxes should at times be substantial, especially in shallow-water coral reefs or during blooms of DMSP-rich phytoplankton that are common throughout the world's oceans and often harmful or toxic. It is likely that acrylate is a reactive form of marine organic matter that significantly impacts the carbon cycle and ecology of the upper ocean. This project will foster research and educational opportunities for undergraduates and one graduate student through several avenues including field work with international collaborators, attendance at national and local meetings, mentoring, preparing for and delivering college-level lectures, and presentations made to the general public at forums such as Syracuse's Milton J. Rubenstein Museum of Science. Results will be disseminated through peer-reviewed publications, media communications, web-based data bases, and presentations at scientific meetings, public forums and in the classroom.

A three-year project is proposed to study the effect of sunlight on the formation and loss of acrylate in seawater, to model these processes in the water column, and to determine if photoproduction and photolysis are important pathways in the marine acrylate cycle in a shallow-water coral reef. Four objectives are planned to carry out this research: (1) synthesize radiocarbon-labeled DMSP as a source of radiocarbon-labeled acrylate for photolysis and uptake studies; (2) conduct laboratory experiments using a solar simulator to study the photolysis and photoproduction of acrylate in water and seawater under varying conditions (e.g., pH, temperature, oxygen concentration); (3) determine temperature and wavelength-dependent quantum yields for acrylate photolysis and acrylate photoproduction in seawater using a monochromatic irradiation system; and (4) conduct a field study at the Richard Gump Research Station to determine rates of photolysis, photoproduction and microbial consumption of acrylate in a shallow-water coral reef.

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Program Information

United States Surface Ocean Lower Atmosphere Study (U.S. SOLAS)

Website: <http://www.us-solas.org/>

Coverage: Global

The Surface Ocean Lower Atmosphere Study (SOLAS) program is designed to enable researchers from different disciplines to interact and investigate the multitude of processes and interactions between the coupled ocean and atmosphere.

Oceanographers and atmospheric scientists are working together to improve understanding of the fate, transport, and feedbacks of climate relevant compounds, and also weather and hazards that are affected by processes at the surface ocean.

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Physical, chemical, and biological research near the ocean-atmosphere interface must be performed in synergy

to extend our current knowledge to adequately understand and forecast changes on short and long time frames and over local and global spatial scales.

The findings obtained from SOLAS are used to improve knowledge at process scale that will lead to better quantification of fluxes of climate relevant compounds such as CO₂, sulfur and nitrogen compounds, hydrocarbons and halocarbons, as well as dust, energy and momentum. This activity facilitates a fundamental understanding to assist the societal needs for climate change, environmental health, weather prediction, and national security.

The US SOLAS program is a component of the International SOLAS program where collaborations are forged with investigators around the world to examine SOLAS issues ubiquitous to the world's oceans and atmosphere.

[Â» International SOLAS Web site](#)

Science Implementation Strategy Reports

[US-SOLAS](#) (4 MB PDF file)

[Other SOLAS reports](#) are available for download from the US SOLAS Web site

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1756907

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