Samples collected from the Monterey Bay Times Series from May 2014 to February 2016. These data include CTD, nutrient, chlorophyll a and phaeopigment concentration data.

Website: https://www.bco-dmo.org/dataset/774848
Data Type: Cruise Results
Version: 1
Version Date: 2019-08-07

Project
» Differential contributions of archaeal ammonia oxidizer ecotypes in relation to their changing environment (Contributions of AOA Ecotypes)

Contributors	Affiliation	Role
Francis, Christopher	Stanford University	Principal Investigator
Chavez, Francisco	Monterey Bay Aquarium Research Institute (MBARI)	Co-Principal Investigator
Soenen, Karen	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Samples collected from the Monterey Bay Times Series from May 2014 to February 2016. These data include CTD, nutrient, chlorophyll a and phaeopigment concentration data.

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Coverage

Spatial Extent: **N**:36.7663 **E**:-122.0058 **S**:36.6893 **W**:-122.3988
Temporal Extent: 2014-05-05 - 2016-02-03

Dataset Description

Samples collected from the Monterey Bay Time Series from May 2014 to February 2016. These data include CTD, nutrient, chlorophyll a and paeopigment concentration data.

These data were published in Tolar *et al.,* submitted (Table S1)

Methods & Sampling

The water column in Monterey Bay (coastal California, USA) was sampled near-monthly from May 2014-February 2016 at stations M1 (36.747 ºN, 122.022 ºW) and M2 (36.697 ºN, 122.378 ºW), on board the RV *Western Flyer* or RV *Rachel Carson* using a CTD Rosette sampler (Sea-Bird Scientific, Bellevue, WA). For each hydrocast, the CTD collected data on conductivity, temperature, depth, dissolved oxygen (DO), total CO2, and

transmissivity (turbidity). Additional samples were collected from 11-12 depths from the cast (0, 5, 10, 20, 30, 40, 60, 80, 100, 150, 200 m; 500 m included for 2015-2016) to measure nutrients (ammonia, nitrite, nitrate, silicate, phosphate), chlorophyll *a* and phaeopigment concentrations. These were processed using established methods as part of the Monterey Bay Time Series (http://www3.mbari.org/bog/Projects/CentralCal/summary/ts_methods_and_materials.htm**;** Pennington and Chavez 2000). Light penetration depth (LPD; 0.1-50 % of surface light) was estimated by secchi disk.

Approximately 1 L sample seawater was filtered using a peristaltic pump onto duplicate filters – 10 µm polycarbonate (PCTE, Sterlitech; pre-filter), 0.2 µm GVWP (Millipore; final filter) – for molecular analysis from 6-10 depths per site per month (0-500 m depth). Samples were immediately frozen on liquid N2 and stored at -80°C upon return to laboratory until processing.

DNA was co-extracted with RNA using previously described methods (Smith et al. 2014a), with slight modification – both 0.1 and 0.5 mm sterile glass beads (BioSpec) were used for bead beating on the FastPrep (Thermo) and fresh -mercaptoethanol was added to Lysis/Binding buffer (10 µL per mL) immediately before extraction. Concentration of DNA was measured using a Qubit fluorometer (Invitrogen). Gene abundance was determined using published methods for total archaeal *amoA* (Francis et al. 2005), water column group A (WCA) and water column group B (WCB) *amoA* (Beman et al. 2008); modified to TaqMan assay, (Mosier and Francis 2011), and two archaeal *nirK* groups (AnirKa and AnirKb; Lund et al. 2012).

Water samples were collected from 6-10 depths for nitrification rate measurements using 15NH4Cl as a tracer. Sample seawater was spiked with 15NH4Cl, and placed in ship-board seawater flow-through incubators for 24 h. Incubations were carried out in the dark or at estimated in situ light using stainless steel tubes with pre-drilled evenly spaced and sized holes (Pennington and Chavez 2000; Smith et al. 2014). At the end of incubations, samples were filtered (0.2 µm) and frozen at -20 ºC. δ15N values were measured from NOx in each sample, converted to N2O via the bacterial denitrification assay (Sigman et al. 2001) using a ThermoFinnigan Gas Bench and PreCon trace gas concentration system interfaced with the Delta VPLUS isotope-ratio mass spectrometer (Bremen, Germany) at the UC Davis Stable Isotope Facility.

Data Processing Description

BCO-DMO processing notes:

- Units (%) removed from column Light_Penetration_Depth
- Adjusted column header names

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Data Files

File
cruise.csv (Comma Separated Values (.csv), 63.09 KB) MD5:c833fa61333eeeef61f657a55e05ba47 Primary data file for dataset ID 774848

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Related Publications

Beman, J. M., Popp, B. N., & Francis, C. A. (2008). Molecular and biogeochemical evidence for ammonia oxidation by marine Crenarchaeota in the Gulf of California. The ISME Journal, 2(4), 429–441. doi:10.1038/ismej.2007.118
Methods

Francis, C. A., Roberts, K. J., Beman, J. M., Santoro, A. E., & Oakley, B. B. (2005). Ubiquity and diversity of ammonia-oxidizing archaea in water columns and sediments of the ocean. Proceedings of the National Academy of Sciences, 102(41), 14683–14688. doi:10.1073/pnas.0506625102
Methods

Lund, M. B., Smith, J. M., & Francis, C. A. (2012). Diversity, abundance and expression of nitrite reductase (nirK)-like genes in marine thaumarchaea. The ISME Journal, 6(10), 1966–1977. doi:10.1038/ismej.2012.40
Methods

Mosier, A. C., & Francis, C. A. (2011). Determining the Distribution of Marine and Coastal Ammonia-Oxidizing Archaea and Bacteria Using a Quantitative Approach. Methods in Enzymology, 205–221. doi:10.1016/b978-0-12-381294-0.00009-2 https://doi.org/10.1016/B978-0-12-381294-0.00009-2
Methods

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Smith, J. M., Casciotti, K. L., Chavez, F. P., & Francis, C. A. (2014). Differential contributions of archaeal ammonia oxidizer ecotypes to nitrification in coastal surface waters. The ISME Journal, 8(8), 1704–1714. doi:10.1038/ismej.2014.11
Methods

Timothy Pennington, J., & Chavez, F. P. (2000). Seasonal fluctuations of temperature, salinity, nitrate, chlorophyll and primary production at station H3/M1 over 1989–1996 in Monterey Bay, California. Deep Sea Research Part II: Topical Studies in Oceanography, 47(5-6), 947–973. doi:10.1016/s0967-0645(99)00132-0 https://doi.org/10.1016/S0967-0645(99)00132-0
Methods

Tolar, B. B., Reji, L., Smith, J. M., Blum, M., Pennington, J. T., Chavez, F. P., & Francis, C. A. (2020). Time series assessment of Thaumarchaeota ecotypes in Monterey Bay reveals the importance of water column position in predicting distribution–environment relationships. Limnology and Oceanography, 65(9), 2041–2055. Portico. https://doi.org/10.1002/lno.11436
Results

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Parameters

Parameter	Description	Units
Cruise	Cruise identifier	unitless
Date	Date (Pacific Standard Time, PST) of sampling: YYYY-MM-DD	unitless
Station	Station name (M1 or M2)	unitless
Month_Day	Month and day of sampling - MMM_DD	unitless
Year	Year of sampling - YYYY	unitless
Latitude	Latitude - south is negative	decimal degrees
Longitude	Longitude - west is negative	decimal degrees
Depth	Water depth sampled (BCTD)	meter (m)
Temperature	Water temperature (BCTD)	degrees Celcius (°C)
Salinity	Water salinity (BCTD)	psu
Density	Water density (T) - calculated	unitless
Pressure	Water pressure (BCTD)	decibar (dbar)
Light_Penetration_Depth	LPD estimated	percentage (%)
Nit_rate_insitu	Nitrification Rate - in situ light incubation	nanomoles per day (nM/d)
Nit_rate_dark	Nitrification Rate - dark incubation	nanomoles per day (nM/d)
Chlorophyll	chlorophyll concentration	milligram per cubic meter (mg/m3)
Phaeopigments	phaeopigment concentration	milligram per cubic meter (mg/m3)
Chlorophyll_a	depth-integrated chlorophyll	milligram per square meter (mg/m2)
Fluorescence	chlorophyll fluorescence (BCTD)	volts
PO4	phosphate concentration	micromole (uM)
SiO4	silicate concentration	micromole (uM)
NO3	nitrate concentration	micromole (uM)
NO2	nitrite concentration	micromole (uM)
NH4	ammonia concentration	micromole (uM)
Total_CO2	total carbon dioxide	millimoles per liter (mmol/L)
Oxygen	dissolved oxygen	millimoles per liter (mmol/L)
Transmissivity	optical clarity (BCTD)	percentage (%)
amoA_qPCR	archaeal amoA gene abundance	copies per liter (copies/L)
WCA_qPCR	Water column A amoA gene abundance	copies per liter (copies/L)
WCB_qPCR	Water column B amoA gene abundance (bdl=below detection limit)	copies per liter (copies/L)
nirKa_qPCR	archaeal nirK group A gene abundance	copies per liter (copies/L)
nirKb_qPCR	archaeal nirK group B gene abundance	copies per liter (copies/L)

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Instruments

Dataset-specific Instrument Name	CTD Rosette sampler (Sea-Bird Scientific, Bellevue, WA)
Generic Instrument Name	CTD Sea-Bird
Generic Instrument Description	Conductivity, Temperature, Depth (CTD) sensor package from SeaBird Electronics, no specific unit identified. This instrument designation is used when specific make and model are not known. See also other SeaBird instruments listed under CTD. More information from Sea-Bird Electronics.

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Deployments

12514

Website	https://www.bco-dmo.org/deployment/788987
Platform	R/V Rachel Carson
Start Date	2014-05-05

17014

Website	https://www.bco-dmo.org/deployment/788990
Platform	R/V Rachel Carson
Start Date	2015-06-19

19114

Website	https://www.bco-dmo.org/deployment/788993
Platform	R/V Rachel Carson
Start Date	2014-07-10

22414

Website	https://www.bco-dmo.org/deployment/788997
Platform	R/V Fulmar
Start Date	2014-08-14

28014

Website	https://www.bco-dmo.org/deployment/789000
Platform	R/V Rachel Carson
Start Date	2014-10-07

30214

Website	https://www.bco-dmo.org/deployment/789003
Platform	R/V Rachel Carson
Start Date	2014-10-29

32414

Website	https://www.bco-dmo.org/deployment/789006
Platform	R/V Rachel Carson
Start Date	2014-11-20

15515

Website	https://www.bco-dmo.org/deployment/789009
Platform	R/V Rachel Carson
Start Date	2015-06-04

13115

Website	https://www.bco-dmo.org/deployment/789012
Platform	R/V Rachel Carson
Start Date	2015-05-11

12015

Website	https://www.bco-dmo.org/deployment/789015
Platform	R/V Rachel Carson
Start Date	2015-04-30

18815

Website	https://www.bco-dmo.org/deployment/789018
Platform	R/V Rachel Carson
Start Date	2015-07-07

21515

Website	https://www.bco-dmo.org/deployment/789021
Platform	R/V Rachel Carson
Start Date	2015-08-03

23715

Website	https://www.bco-dmo.org/deployment/789024
Platform	R/V Rachel Carson
Start Date	2015-08-25

26515

Website	https://www.bco-dmo.org/deployment/789027
Platform	R/V Western Flyer
Start Date	2015-09-22

29915

Website	https://www.bco-dmo.org/deployment/789030
Platform	R/V Rachel Carson
Start Date	2015-10-26

32315

Website	https://www.bco-dmo.org/deployment/789033
Platform	R/V Rachel Carson
Start Date	2015-11-19

34915

Website	https://www.bco-dmo.org/deployment/789036
Platform	R/V Rachel Carson
Start Date	2015-12-15

03416

Website	https://www.bco-dmo.org/deployment/789039
Platform	R/V Rachel Carson
Start Date	2016-02-03

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Project Information

Differential contributions of archaeal ammonia oxidizer ecotypes in relation to their changing environment (Contributions of AOA Ecotypes)

Coverage: Monterey Bay

Description from NSF award abstract:
Because the first and rate-limiting step of nitrification, ammonia oxidation, was long believed to be restricted to a few groups within the domain Bacteria, the discovery of ammonia-oxidizing archaea (AOA) - members of one of the most abundant microbial groups on the planet (now known as the Thaumarchaeota) - has seriously challenged our understanding of the microbial ecology and biogeochemistry of the nitrogen cycle. AOA are now believed to be responsible for the majority of nitrification in the sea, and occur in the marine water column as two taxonomically distinct groups, namely the Water Column Group A (WCA) and B (WCB) ecotypes. An open question in marine biogeochemistry is whether the taxonomic definition of WCA and WCB and their observed distributions correspond to distinct ecological and biogeochemical niches. To fill this critical knowledge gap, this project will examine linkages between patterns of ecotype-specific archaeal ammonia monooxygenase (amoA) gene abundance and expression and 15N-based nitrification rates across multiple

depths (0-500m) and two stations within the Monterey Bay Time Series (MBTS). Acquiring quantitative expressional and biogeochemical activity data from a wide array of water column samples from the MBTS, bimonthly over the course of two years, will yield valuable new insights into how archaeal ammonia oxidation and AOA ecotype dynamics are influenced by changes in ocean conditions.

The discovery of AOA has served to refocus attention on nitrification in the ocean; however, there are still an alarmingly low number of direct measurements of oceanic ammonia oxidation rates. This paucity of data has made it difficult to accurately quantify the degree to which nitrification supports primary production in the global ocean. One major goal of this project is to ascertain whether a quantitative relationship between the abundance of AOA genes and transcripts and instantaneous rates of nitrification exists for the coastal ocean. Prior collaboration indicated a strong correlation between 15N-based nitrification rates and archaeal amoA gene copies in surface waters of northern Monterey Bay. This study will acquire a more holistic understanding of this relationship by performing these measurements as part of the MBTS, not only at depths in the euphotic zone - where the biogeochemical importance of nitrification is hotly debated - but also within disphotic and aphotic waters of the mesopelagic. By conducting this research as part of the 23 year MBTS, the resultant dataset will be incorporated into a larger oceanographic framework. These efforts will also directly connect to a goal of the MBTS to determine spatiotemporal patterns in new and regenerated primary production by providing new quantitative insights into processes responsible for regenerated nitrogen production in the photic zone. Additionally, the extensive collections of microbial sequence and biogeochemical data generated through this study will provide a valuable resource to the scientific community and, ultimately, help reveal new information about the ecology and factors regulating nitrification in the ocean, greatly advancing our ability to model its role in N and C cycles under present and future conditions.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1357024

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