Closed Oyster Mesocosm 15N Tracer (Oyster Reef N2O Emission project)

Website: https://www.bco-dmo.org/dataset/722517

Data Type: experimental

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Project

» Microbial Regulation of Greenhouse Gas N2O Emission from Intertidal Oyster Reefs (Oyster Reef N2O Emission)

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Abstract

Closed Oyster Mesocosm 15N Tracer

Table of Contents

Dataset Description

Closed Oyster Mesocosm 15N Tracer

Acquisition Description

^{15}N labeled phytoplankton was continuously pumped for three days into 30.5 cm diameter mesocosms containing 10 cm of sediment and 20 liters of overlying water. Three mesocosms contained twelve 7-cm long oysters (O1, O2, O2) and three mesocosms had no oysters and served as controls (C1,C2,C3). Mesoscosms were flow through with a 0.3 day residence time and open to the atmosphere. After phytoplankton feeding period, oysters were removed and mesocosms allowed to flush for 3 days. Tank feed water was then stopped and mesocosms sealed. Time series N_2O, $^{15}N_2$, and sediment ^{15}N were measured during the period when the mesocom was sealed until the dissolved oxygen reached 2 mgL-1. Then the mesocosms were reopened and the feed water restarted. This first incubation ID is CS1. The mesocosms functioned in flow through mode for several days (rest period) and then the incubation / measurement procedure was repeated. This second incubation period ID is CS2. After CS2, the mesocosms were reopened and put into flow through. In total there were 5 closed system incubation periods. The following 'rest periods' (hours) were established between CS1-2, 2-3, 3-4, 4-5: 49 hours, 90 hours, 110.5 hours, 138.5 hours.

Water samples for N_2O analysis were collected with a peristaltic pump through a syringe needle directly into 12 ml exetainer that had been flushed with N_2 and preserved with KOH to a pH above 12. Approximately six ml sample was collected. N_2O concentrations in the headspace were measured on a GC-ECD. Water samples for 15N2 samples were collected with a peristaltic pump through a syringe needle directly into 30 ml serum bottles that had been flushed with He and preserved with KOH to a pH above 12. Approximately eight ml sample was collected. $^{15}N_2$ was analyzed by GC - Isotope Ratio Mass Spectrometry (IRMS). Sediment ^{15}N samples were collected from the mesocoms using a 2cm diameter core. The top 3 cm was retained for analysis.

Processing Description

N_2O concentrations were calculated from N_2O calibration curve and corrected for N_2O solubility in the aqueous phase using the Bunsen coefficient. $^{15}N_2$ was normalized to air and air saturated water standards and reported in the delta notation. Sediment ^{15}N values were normalized to reference materials and reported in the delta notation.

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions

[table of contents | back to top]

Parameters

Parameter	Description	Units
Incubation	First Closed Incubation or Second Closed Incubation	unitless
Time_Hours	Incubation time per incubation	hours
O1_15N2	Oyster mecosm 1 15N enrichment of dissolved N2	permil (/mL)
O1_N2O	Oyster mecosm 1 Aqueous N2O concentration	nanomole (nM)
O1_O2	Oyster mecosm 1 dissolved oxygen	mgL-1
O1_Sed_15N	Oyster mecosm 1 15N enrichment sediment (0-3 cm)	permil (/mL)
O2_15N2	Oyster mecosm 2 15N enrichment of dissolved N2	permil (/mL)
O2_N2O	Oyster mecosm 2 Aqueous N2O concentration	nanomole (nM)
O2_O2	Oyster mecosm 2 dissolved oxygen	mgL-1
O2_Sed_15N	Oyster mecosm 2 15N enrichment sediment (0-3 cm)	permil (/mL)
O3_15N2	Oyster mecosm 3 15N enrichment of dissolved N2	permil (/mL)
O3_N2O	Oyster mecosm 3 Aqueous N2O concentration	nanomole (nM)
O3_O2	Oyster mecosm 3 dissolved oxygen	mgL-1
O3_Sed_15N	Oyster mecosm 3 15N enrichment sediment (0-3 cm)	permil (/mL)
C1_15N2	Control mecosm 1 15N enrichment of dissolved N2	permil (/mL)
C1_N2O	Control mecosm 1 Aqueous N2O concentration	nanomole (nM)
C1_O2	Control mecosm 1 dissolved oxygen	mgL-1
C1_Sed_15N	Control mecosm 1 15N enrichment sediment (0-3 cm)	permil (/mL)
C2_15N2	Control mecosm 2 15N enrichment of dissolved N2	permil (/mL)
C2_N2O	Control mecosm 2 Aqueous N2O concentration	nanomole (nM)
C2_O2	Control mecosm 2 dissolved oxygen	mgL-1
C2_Sed_15N	Control mecosm 2 15N enrichment sediment (0-3 cm)	permil (/mL)
C3_15N2	Control mecosm 3 15N enrichment of dissolved N2	permil (/mL)
C3_N2O	Control mecosm 3 Aqueous N2O concentration	nanomole (nM)
C3_O2	Control mecosm 3 dissolved oxygen	mgL-1
C3_Sed_15N	Control mecosm 3 15N enrichment sediment (0-3 cm)	permil (/mL)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Thermo Delta V IRMS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	15N2 was measured on a Thermo Delta V IRMS fitted with a Gas Bench II interface following separation from O2 and Ar on a mol sieve 5A column.
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).

Dataset-specific Instrument Name	Agilent 7890B GC with a Poropak Column
Generic Instrument Name	Gas Chromatograph
Dataset-specific Description	N2O was measured on a Agilent 7890B GC with a Poropak Column.
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	Costech Elemental Analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Sediment 15N Phyto sample was analyzed on the IRMS coupled to a Costech Elemental Analyzer.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

[table of contents | back to top]

Project Information

Microbial Regulation of Greenhouse Gas N2O Emission from Intertidal Oyster Reefs (Oyster Reef N2O Emission)

Extracted from the NSF award abstract: Oyster reefs are biogeochemical hot spots and prominent estuarine habitats that provide disproportionate ecological function. Suspension-feeding eastern oysters, Crassostrea virginica, are capable of improving water quality and diminishing eutrophication by filtering nutrients and particles from the water and depositing them in the sediments. Remineralization of these deposits may enhance sedimentary denitrification that facilitates nitrogen removal in tidal estuaries. However, the scientific underpinning of oyster reef function has been challenged in various studies. In addition, recent studies of filter feeding invertebrates reported the production of nitrous oxide (N2O), a greenhouse gas, as an end product of incomplete denitrification by gut microbes. C. virginica could be another source of N2O flux from intertidal habitats. Preliminary work indicated substantial N2O production from individual oysters. The estimated N2O production from high density oyster reefs may exceed the N2O flux measured from some estuaries. With the new discovery of N2O emission and uncertainty regarding eutrophication control, the ecological value of oyster reef restoration may become equivocal. This project will quantify N2O fluxes to understand the factors controlling N2O emission from oyster reefs. Sedimentary N processes will be examined to develop an oyster reef N model to estimate N2O emission from tidal creek estuaries relative to other N cycling processes. The PIs hypothesize that intertidal oyster reefs are a substantial source of N2O emission from estuarine ecosystems and the magnitude of emission may be linked to water quality. If substantial N2O flux from oyster reefs is validated, ecological benefits of oyster reef restoration should be reevaluated. This interdisciplinary research team includes a microbial ecologist, a biogeochemist, an ecologist and an ecosystem modeler. They will utilize stable isotope and molecular microbiological techniques to quantify oyster N2O production, elucidate microbial sources of N2O emission from oysters and sediments, and estimate seasonal variation of N2O fluxes from oyster reefs. Measurements from this study will be integrated into a coupled oyster bioenergetics-sediment biogeochemistry model to compare system level rates of N cycling on oyster reefs as a function of oyster density and water quality. Modeling results will be used to assess the relative trade-offs of oyster restoration associated with N cycling. They expect to deliver the following end products:1) estimation of annual N2O flux from oyster reefs as an additional source of greenhouse gases from estuaries, 2) a better understanding of the environmental and microbial factors influencing N2O and N2 fluxes in tidal estuaries, 3) transformative knowledge for the effect of oyster restoration on water quality enhancement and ecosystem function, 4) direct guidance for oyster restoration projects whose goals include water quality enhancement, and 5) a modeling tool for use in research and restoration planning.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1233372

[table of contents | back to top]