Preview of Award 1131834 - Annual Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
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Project Title:	Reconstructing Glacial Nitrogen and Carbon Cycling Using Isotopes
PD/PI Name:	Andreas Schmittner-Boesch, Principal Investigator Alan C Mix, Co-Principal Investigator
Submitting Official (if other than PD\PI):	Andreas Schmittner-Boesch Principal Investigator
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Andreas Schmittner-Boesch

Accomplishments

*** What are the major goals of the project?**

Here we propose to use a three-dimensional model of both nitrogen and carbon isotopes, incorporated in a global circulation and biogeochemical model, in order to better understand the glacial nitrogen cycle and its impact on atmospheric CO2. The cycling of oxygen, nitrogen and carbon depends strongly on the largescale ocean circulation. Reproducing the glacial circulation pattern will therefore be an important aspect of the project. Carbon isotopes will provide constraints on ocean circulation and the biological pump.

We will test three specific null-hypotheses:
H1: The bio-available nitrogen inventory of the ocean during the Last Glacial Maximum (LGM) was not larger than during the Late Holocene (LH).
H2: Changes in iron supply did not increase the efficiency of nitrate consumption by phytoplankton in polar oceans during glacial periods.
H3: Changes in the nitrogen cycle (H1 & H2) did not contribute significantly to glacialinterglacial variations of atmospheric CO2 concentrations.

Specific goals were:

yr 1) Model improvement (Including the iron cycle), calibration; building LH databases of d15N, d13C and D14C measurements.

yr 2) LGM simulations and databases

yr 3) Analysis, hypotheses tests

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Model development work has proceeded by (1) merging the nitrogen and carbon isotope models into one consistent model version and (2) by including iron cycling (this was carried out by our colleagues in Kiel).

Data synthesis work has proceeded by completing the NICOPP project and organizing a workshop that will update LGM carbon isotopes in December. Mix (and his graduate student Summer Praetorius, who is not funded by this project) have assembled Pacific d13C data, D14C data from Chile, Baja, Oregon, and Alaska. We have also compiled and cleaned the d13C data set from CDIAC (GLODAP and CARINA), which contains 17,989 measurements since the 1990s.

A project web site has been created at http://people.oregonstate.edu/~schmita2/Projects/LGM/index.html.

Specific Objectives: Since the project is delayed by about one year due to the leaving of Chris Somes and the training of the new graduate student Juan Muglia we continued to work on model improvements and calibration as well as understanding isotope distributions in the modern ocean.

Significant Results: Nitrogen cycle and isotopes: The new study by Somes et al. (in review) provides new estimates of global nitrogen fluxes for the pre-industrial ocean using the nitrogen isotope model and the Late Holocene data set assembled by NICOPP. We estimate nitrogen fixation, water column denitrification, and benthic denitrification to be between 195-350 (225), 65-80 (76), and 130-270 (149) TgN/yr, respectively, with the best esimate in parenthesis. This paper also emphasizes and quantifies uncertainties for these estimates due to nutrient utlilization during water column denitrification and the fractionation factor for benthic denitrification.

Carbon isotopes: The new study by Schmittner et al. (in review) provide new insights on how biological fractionation and air sea gas exchange affect the preindustrial and modern distributions of carbon isotopes in the ocean. We quantify, for the first time, the effects of air-sea gas exchange on biologically created gradients in d13C and the temperature dependent fractionation during air-sea gas exchange separately. We find they are both about equally important.

Key outcomes or
Other achievements:

*** What opportunities for training and professional development has the project provided?**

Graduate student Juan Muglia took all required courses for his PhD this year and will take the qualifying exam next week.

*** How have the results been disseminated to communities of interest?**

Resuts from NICOPP have been published in Nature Geoscience this year and a press release has been published at OSU, which has been noted by some media.

*** What do you plan to do during the next reporting period to accomplish the goals?**

We plan to start LGM simulations, finalize data synthesis for the LGM, and start data model comparison and analysis.

Presumably we will start with a model version without prognostic iron and repeat the simulations with prognostic iron once a working iron model version is available.

Products

Journals

Robinson, R. S. et al. (2012). A review of nitrogen isotopic alteration in marine sediments. *Paleoceanography*. 27 PA4203.

Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1029/2012PA002321

Galbraith, E. D. Kienast, M. and the NICOPP working group (2013). The acceleration of oceanic denitrification during deglacial warming. *Nature Geoscienes*. 0 1-6.

Status = PUBLISHED; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.1038/ngeo1832

A. Schmittner, N. Gruber, A. C. Mix, R. M. Key, A. Tagliabue, and T. K. Westberry (2013). Biology and air–sea gas exchange controls on the distribution of carbon isotope ratios (δ13C) in the ocean. *Biogeosciences Discussion*. 10 8415-8466.

Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/bgd-10-8415-2013

Somes, C. J., Oschlies, A., and Schmittner, A (2013). Isotopic constraints on the pre-industrial oceanic nitrogen budget. *Biogeosciences Discuss.*. 10 3121-3175.

Status = UNDER_REVIEW; Acknowledgment of Federal Support = No ; Peer Reviewed = Yes ; DOI: 10.5194/bgd-10-3121-2013

Books

Book Chapters

Thesis/Dissertations

Conference Papers and Presentations

Other Publications

Technologies or Techniques

Nothing to report.

Patents

Nothing to report.

Inventions

Nothing to report.

Licenses

Nothing to report.

Websites

Title: Reconstructing Glacial Nitrogen and Carbon Cycling Using Isotopes

URL: http://people.oregonstate.edu/~schmita2/Projects/LGM/index.html

Description: Project website.

Other Products
Nothing to report.

Participants

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Andreas Schmittner-Boesch	PD/PI	3
Alan C Mix	Co PD/PI	1

What other organizations have been involved as partners?

Name	Location
McGill University	Montreal, Canada
University of Kiel	Kiel, Germany

Have other collaborators or contacts been involved? N

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The new synthesis of d13C data from the modern ocean has been requested by, and shared with, a number of scientists. The papers on the nitrogen and carbon isotopes (Somes et al. in review; Schmittner et al. in review) deepen our understanding of the nitrogen and carbon cycles in the modern ocean.

What is the impact on other disciplines?

Our work on the nitrogen isotope modeling is used and cited by biologists and ecologists who use nitrogen isotopes measured in animals but don't know the d15N of the nitrate in the specific region of the ocean where they're working.

What is the impact on the development of human resources?

Juan Muglia is trained as an oceanographer. Chris Somes has finished his PhD in Kiel and is now continuing his studies of nitrogen isotopes there as a postdoctoral scientist.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?
Nothing to report.

Changes

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.