

CBIOS

Changing Biotic-Sediment Interactions in the Ocean Seabed

Rapidly Changing Biotic-Sediment Interactions in the Ocean Seabed – Biogeochemical
Consequences in the 21st Century

1. Summary/Abstract

The activities of macrobenthos (animals > 500 μm living in or on sediments) significantly alter organic carbon (OC) storage and cycling within the seafloor. However, the lack of validated conceptual models and paucity of integrated datasets limit accurate and appropriately scaled predictions of benthic community response to global warming, acidification, and deoxygenation, and subsequent alterations in carbon cycling. We propose a working group (WG) to coordinate internationally among research disciplines, spanning climate science, organic geochemistry, paleoecology, benthic ecology, and evolutionary genetics. This WG, *Changing Biotic-Sediment Interactions in the Ocean Seabed (CBIOS)*, will enhance understanding of global benthic-sediment dynamics. We will review current science on biotic-sediment interactions to develop a conceptual model(s) informed by paleo records of global change and contemporary benthic community functional traits, evaluate non-carbon ecosystem services that changing biotic-sediment interactions may alter, and develop an open-access database that supports cross-disciplinary investigations into altered macrobenthos communities, OC cycling and carbon sequestration. CBIOS products will include three annual WG meetings, a training workshop hosted by the University of the West Indies in collaboration with SpeSeas (Trinidad and Tobago), a new conceptual model, an open-access CBIOS dataset, and a perspectives article synthesizing working group findings. This WG will include several members from, and will build on, a previously SCOR-sponsored workshop on benthic systems.¹

2. Scientific Background and Rationale

2.1 Importance

Documented poleward shifts of many benthic taxa in response to climate warming and potential changes in vertical exchange of materials (including living biota) due to changes in climate-related water-column productivity has sparked growing interest in how these shifts interactively influence biogeochemical processing. Such global changes in species distribution influence the geochemical properties of sediments, and their role as global carbon sources and sinks.² Ocean sediments represent Earth's largest interactive landscape for OC storage. An estimated 16% of the global seabed lies on continental shelves and margins which, along with other contiguous nearshore regions, account for ca. 75% of total ocean carbon burial. Several reviews have discussed marine megafaunal effects on carbon processes, but do not detail the specific influence of benthic metazoans on biogeochemical processes.³ For example, while much attention has been directed towards understanding the role of vegetation in blue carbon habitats, the influence of metazoans has been largely ignored.

CBIOS will explore direct effects of carbon consumption/uptake by macrobenthos, indirect effects via grazing on microbes, modification of the environment (i.e., bioturbation, including particle reworking, solute exchange during bio-irrigation and burrowing, and biodeposition), and linkages with phylogenetic diversity of carbon-processing pathways. We will consider linkages with environmental heterogeneity to both the distribution of macrobenthos and to changes in biogeochemical cycling, noting direct ties to nitrogen and phosphorus cycling. We will also scale up this relationship to evaluate its regional and global significance, which is particularly timely given that state-of-the-art Earth System Models (ESMs), such as those used for the IPCC AR5 report⁴, still rely on rudimentary sediment models⁵ (e.g., Hülse et al., 2018 for

a recent overview) and none consider the potential effects of benthic ecosystem changes on coupled biogeochemical cycles and the climate system. Due to differences in shallow (photic) habitats and deep-sea environments, CBIOS will calibrate our model(s) for each of these environments.

These changes will likely include poleward shifts in species, reshuffling of community compositions (taxonomic and functional groups), and alteration of biomass/body size distributions, mortality, and behavioral/physiological adaptations. Informed environmental and management decisions, the development of mitigation strategies, and prediction of the global capacity to cycle carbon all require understanding the role natural communities play in sedimentary OC accumulation and long-term C sequestration (burial). This working group will explore biogeochemical pathways and associated organismal change in low- and high-carbon deposition/burial (hot spots) spanning across oxic and anoxic regions. These regions range from shallow (intertidal) to deep waters and span latitudinal gradients and we predict they will respond differently to climate-related changes in ocean ecosystems.

Past climate shifts have resulted in many large-scale redistributions and extinctions of marine organisms. We will therefore use the fossil record of marine macrobenthic fauna to better understand how to predict adaptive responses or extinctions of different taxa. Similarly, we will synthesize the current literature that explores adaptive phenotypic and genotypic variation and change in macrobenthos across different latitudes and water depths, and incorporate them into the CBIOS conceptual model(s). Understanding carbon cycle-climate feedbacks across terrestrial and marine pelagic ecosystems has motivated major research efforts over the past two decades, in part to improve predictions from ESMs. CBIOS will examine how changes in the attributes and distribution of macrobenthic fauna could impact biogeochemical cycling in ocean sediments, and how these impacts may result in additional positive or negative feedbacks in the coupled ocean-atmosphere system. More specifically we will work within the following core topics: 1) *Carbon Dynamics, Marine Benthos, and a Changing Marine Climate*; 2) *Long-Term Evolution of Marine Benthos and Impacts on Sediment Chemistry*; and 3) *Modeling “Transient” Carbon Cycling in a Rapidly Warming Climate*.

2.2 Challenges

Ultimately, integrating the (generally poleward) redistribution of benthos and associated impacts on carbon cycling via changes in sediment oxygenation across a spectrum of global carbon (i.e., from high OC deposition/burial hotspots to low OC supply zones in the deep-ocean) and climatic (i.e., latitudinal gradients in temperature across a species range) gradients presents a major challenge that will be addressed by CBIOS. The WG also seeks to address glaring gaps in knowledge on the global carbon budget as it relates to ocean sediments, diagenetic models, benthic-pelagic coupling in ocean biogeochemical models and, ultimately, ESMs. In particular, we plan to identify knowledge gaps (e.g. regional gaps) that require more data collection. While we have some understanding of changes in microbial carbon cycling and changes in benthos because of global warming, the integrated response is largely unknown. Additionally, CBIOS will examine one of the complicating factors when considering poleward redistribution of a particular species, which is the changing nature of shallow water deposits latitudinally resulting from increased dominance of relict (glacial) deposits in the < 200 m depth range towards the

poles. We will also address the complicating factors of changing sea levels, their impact on intertidal sedimentary habitats, and how inundation of shallow sediments affects carbon deposition/burial.

2.3 Justification for SCOR working group

A subset of our proposed members are currently developing a *Nature Reviews* article that will synthesize the current state of the science on animal-sediment interactions in the face of global change. The review article will provide a foundation for the proposed WG and identify knowledge gaps that CBIOS will address. The scope of past and future animal-sediment interactions is a topic that lies within SCOR's mission, was identified as a key gap in a previously funded SCOR workshop¹, and is not being addressed by any current SCOR-sponsored large-scale research projects. The lack of conceptual models and integrated datasets limits current research on benthic-sediment interactions - a need our proposed WG will address. The development of an international open-source database will unite disparate research groups and address a need recognized by previous WGs⁶ by allowing the ocean research community to better access data regarding past changes in benthic communities composition/function to predict future benthic community changes and alterations in C cycling. In addition to addressing current knowledge gaps, the proposed WG will also promote capacity building in the ocean sciences by supporting early career scientists and underrepresented groups, promoting a training workshop led by early career scientists, and encouraging international collaboration with members spanning a diversity of backgrounds, career stages, and institutions.

3. Terms of Reference

1. To evaluate the state of the science of animal-sediment interactions, their response to a changing climate, subsequent alterations in metazoan community composition and function, and the consequences for carbon cycling.
2. To create a conceptual model(s) that integrates ancient ocean macrobenthic fauna and their adaptive response to past climate change with modern benthic communities to predict future alterations in animal-sediment interactions, their effects on carbon cycling, and how Earth System Models, such as those used by the IPCC, can best incorporate this information.
3. To assess the mechanisms by which climate change impacts on animal-sediment interactions may alter non-carbon ecosystem services.
4. To develop an open-access database that integrates paleo records (using museum databases) with modern benthic community data, including information on phenotypic and genotypic variation within and among species, to support cross-disciplinary investigations into animal-sediment interactions and to identify knowledge gaps for future studies.
5. To foster international collaborations across transdisciplinary research groups and promote capacity building in the ocean sciences through the involvement of early-career scientists from a diversity of countries, backgrounds and institutions.

4. Working Plan

CBIOS will develop a series of meetings to achieve the goals described in the WG's terms of reference (ToR), with products including a conceptual model, a perspectives article, an open-source database, and model outputs under climate scenarios for use in climate assessments (IPCC). Prior to WG initiation, a subset of members will attend a workshop hosted by Utah State University (application submitted for Summer 2019), and WG members will apply for an OCB workshop at WHOI (application to be submitted December 2019).

The main work plan activities are:

(1) Creation of a conceptual model describing past, current, and future changes to benthic-sediment interactions

We will develop a conceptual model that will inform database and model development. As needed, working sub-groups will be developed for specific research areas. The conceptual model will incorporate the following:

(a) review of current spatial patterns of global sediment carbon sequestration and stocks. We will summarize recent estimates of the amount of carbon stored in the continental margin and deep ocean sediments (hadal zone and abyssal plains) and polar, temperate, and tropical marine sediments, and how those link to extant animals and their activities.

(b) examine mechanisms linking adaptive responses to the distributions of marine benthos, underpinned by both inter- and intra-specific diversity.^{7,8} We will explore how evolutionary innovations established novel burrow architectures and feeding guilds, and how the emergence of bioturbation acted as a major player on geobiologic feedbacks and geochemical cycles and how this can inform carbon cycling models.

(c) consider the influence of continental margin type (e.g., passive or active, seasonal or aseasonal) on benthic community composition via different input rates, timing, and types of sediment and organic matter, and how these gradients, from natural and human drivers, create critical zones that influence productivity, distribution, phenotypic plasticity, and/or evolution that offer an opportunity to advance our understanding of seafloor carbon cycling.⁹

(d) predict the effect of projected changes to climate variables at the seafloor (T, O₂, pH, and aragonite saturation) and to particulate organic carbon (POC) flux, sources of uncertainty, time of signal emergence, and the expected nature of metazoan faunal responses with respect to carbon dynamics.

(e) assess the impacts of redistribution and general poleward expansion of benthos on carbon cycling via changes in sediment oxygenation across a spectrum of global carbon (i.e., from coastal hotspots to low C supply zones in the deep-ocean) and climactic (i.e., latitudinal gradients in temperature across a species range) gradients.

(2) Development of an open-access CBIOS database that will incorporate paleoenvironmental and modern data

The conceptual model developed in Activity 1 (ToR #2) *will identify current critical gaps* in knowledge on the global carbon budget as it relates to ocean sediments, diagenetic models, benthic-pelagic coupling in ocean biogeochemical models and, ultimately, ESMs. To address these gaps, *we will develop a database* to compile the necessary data to understand how the redistribution of benthos may impact carbon cycling via changes in sediment oxygenation across a spectrum of global carbon (i.e., from coastal hotspots to low C supply zones in the deep-ocean) and climatic (i.e., latitudinal gradients in temperature across a species range) gradients.

(3) Development of a perspective article(s) on the fate of benthic-sediment interactions

As mentioned previously, a subset of the CBIOS group is writing an article for *Nature Reviews* which will provide a foundation for the SCOR WG. The SCOR WG will work from this document to *develop a perspective article* for a high-impact journal that challenges the evolutionary, ecological, and marine science communities with questions that go beyond those covered in the *Nature Review* on the following core topics: (1) Carbon Dynamics, Marine Benthos, and a Changing Marine Climate; (2) Long-Term Evolution of Marine Benthos and Impacts on Sediment Chemistry; and (3) Modeling “Transient” Carbon Cycling in a Rapidly Warming Climate. This perspective article will synthesize the findings of the WG and highlight future research needs.

Year 1:

First WG Meeting, Conceptual Model and CBIOS Database

At the first CBIOS meeting, members and attendees will discuss the structure and implementation of CBIOS, agree on rules and norms for collaborative work, develop the conceptual model (ToR #1-3), and begin the open-access database plan (ToR #4). Working sub-groups will be created to discuss areas of need within the different aspects of CBIOS to develop the conceptual model. These sub-groups will also identify the type of data needed to understand how marine benthos respond to changing climatic gradients with the ultimate goal of incorporating them into regional biogeochemical cycles in ESMs.

This first meeting will coincide with the 2020 Ocean Sciences Meeting in San Diego, CA to maximize attendance and visibility of the CBIOS working group. If selected, an additional meeting would gather any WG members attending the Summer 2020 Ocean Carbon and Biogeochemistry (OCB) workshop.

Year 2:

Second WG Meeting, Training Workshop, Finalize Conceptual Model

At the second WG meeting, each sub-group will present their portions of the conceptual model, and members will integrate each component and finalize the conceptual model developed in Year 1 (ToR #2). Development of the open-access database will continue, and final decisions regarding database development (i.e., data accessibility, usage, long-term hosting and

maintenance) will be agreed upon (ToR #4). This WG meeting will coincide with the 2021 Aquatic Sciences Meeting in Palma de Mallorca, Spain.

In addition to the second WG meeting, early career scientists will organize a training workshop hosted by the University of the West Indies, in collaboration with SpeSeas (Trinidad and Tobago), with mentorship from more established researchers (ToR #5). This workshop will cover benthic-sediment interactions and global change, data standardization and database implementation.

Year 3:

Third WG meeting, Finalize CBIOS Database, Perspectives Article

The third workshop will draft the perspectives article that synthesizes the findings of the WG, highlights remaining knowledge gaps, and outlines a way forward for future research in the field of benthic-sediment interactions (ToR #1, 3). Additional development of the database will be included as needed (ToR #4). This WG workshop will coincide with the 2022 Ocean Sciences Meeting in Honolulu, Hawaii.

5. Deliverables

We will develop a conceptual model (Year 1-2; ToR #2) to describe past animal-sediment interactions, and their response to past global change, to assess how the modern response of benthos compares to previous global change, and to lay a framework for future predictions of altered benthic-sediment interactions.

After developing the conceptual model, we will generate an open-access database (Year 2; ToR #4) to incorporate paleo-environmental data and modern data on benthos distribution, functional guilds, phenotypic and genotypic data, as well as organic geochemical data relating to OC and other elemental cycling. The database will conform to Biological and Chemical Oceanography Data Management Office (BCO-DMO) best management practices. We will investigate BCO-DMO or OBIS (Ocean Biogeographic Information System) as a potential host for the database. All data and associated metadata will be organized, validated for QA/QC, and made available according to the data management practices described by BCO-DMO and OBIS.

The WG will produce a perspective article to evaluate the ramifications of changes in zoogeochemistry of ocean seafloor in response to global change/mass migration and/or adaptive change (phenotypic/genotypic) (Year 3; ToR #1, 3). This perspective article will address questions such as: *what are implications of changing biotic-sediment interactions for carbon cycling and ESMs?* These specific deliverables will be developed through SCOR WG meetings, which will be further leveraged by an OCB workshop to be held at WHOI and a training workshop to enhance capacity building for our international partners (Year 2; ToR #5).

6. Capacity Building

The database and conceptual model produced by the S WG will promote the synthesis and preservation of data and concepts related to benthic-sediment interactions. The long-term storage and open-access nature of the CBIOS database will promote international collaborations,

standardized data collection, and increase data accessibility for the ocean science research community. The CBIOS database will be accessible according to the data management practices described by OBIS, BCO-DMO, the Intergovernmental Oceanographic Commission (IOC) Ocean Data and Information System (ODIS) or equivalent data management center.

CBIOS will promote open-access documentation whenever possible. This WG is a transdisciplinary group that can go beyond “business-as-usual” to look at interconnections and bio-geo-chemical processes over multiple spatial and temporal scales to highlight underlying mechanisms driving sediment-benthos processes. Moreover, the WG will promote systems-thinking and connect multiple highly technical disciplines at multiple scales of research.

The proposed WG members (full and associate) come from a diversity of institutions and countries, as well as a variety of career stages, which will promote capacity building within the ocean sciences. To further build capacity for ocean sciences, CBIOS will develop a training workshop on benthic-sediment interactions and global change hosted by the University of the West Indies, in collaboration with SpeSeas (Trinidad and Tobago). The training workshop will be organized by early-career scientists with advice from more established WG members. Early career scientists, post-doctoral research associates, and graduate students will be encouraged to attend the training workshop. We will promote further capacity building by seeking collaborations and funding with other national and international groups, including the U.S. Ocean Carbon and Biogeochemistry program, to support meeting costs.

7. Working Group Composition

The proposed WG is comprised of world-renowned scientists that represent a diverse range of career stages, institutions, and countries.

7.1 Full members

Name	Gender	Place of work	Expertise relevant to proposal
Thomas S. Bianchi (co-chair)	Male	Professor, Department of Geological Sciences, University of Florida, Gainesville, FL, USA	Global carbon cycling, chemical biomarkers, benthic biogeochemistry
Luis Buatois	Male	Professor, Department of Geological Sciences, University of Saskatchewan, Canada	Animal-substrate interactions through geologic time
Judith Gobin	Female	Senior Lecturer, Department of Life Sciences, The University of The West Indies, St. Augustine, Trinidad and Tobago	Marine benthos in soft sediments, rocky shores, deep-sea environments and climate change impacts across these

			habitats (and over time)
Agnes Karlsson	Female	Assistant Professor, Dept. of Ecology, Environment, and Plant Sciences, Stockholm University, Stockholm, Sweden	Integrating stress responses at sub-cellular level with higher biological levels, benthos-based indicators of ecological status
Lisa A. Levin	Female	Professor Center for Marine Biodiversity and Conservation Scripps Institution of Oceanography, UC San Diego, USA	Benthic community structure and function, global climate projections to the seafloor, and carbon cycling
Jack J. Middelburg	Male	Professor, Earth Sciences, Utrecht University, The Netherlands	Inorganic and organic geochemistry, benthic ecology, and earth system science
Pierre Regnier	Male	Professor, Université Libre de Bruxelles, Brussels, Belgium	Biogeochemistry with model-data fusion approaches and advanced statistical methods
Natasha Karenyi	Female	Lecturer, Dept. of Biological Sciences, University of Cape Town, Republic of South Africa	Marine biodiversity, ecosystem classification, benthic ecology
Paul V.R. Snelgrove (co-chair)	Male	Professor, Dept. of Ocean Sciences and Biology Department, Memorial University of Newfoundland, Canada	Marine biodiversity, food quality, and ecosystem functioning
Hong Zhou	Female	Professor, Dept. of Environmental Ecology College of Marine Life Sciences, Ocean University of China	Modern benthic community data collection including phenotypic and genotypic variation

7.2 Associate members

Name	Gender	Place of work	Expertise relevant to proposal
Diva Amon	Female	Visiting Curie Fellow, Natural History Museum, UK ; Director, SpeSeas, Trinidad and Tobago	Deep sea biology, human impacts on the deep sea, caribbean, and chemosynthetic environments
Sandra Arndt	Female	Professor, Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Brussels, Belgium	Biogeochemistry, diagenesis, land-ocean interactions, paleoclimate
Trisha Atwood	Female	Assistant Professor, Watershed Sciences, Utah State University USA	Response of aquatic ecosystems to global change; effects of disturbance on aquatic biogeochemistry, including carbon cycling and storage
Erik Kristensen	Male	Professor, Dept. of Biology, Southern University of Denmark, Odense, Denmark	Biodiversity, biogeochemistry, bioturbation, benthic fauna
Alf Norkko	Male	Professor, Tvärminne Zoological Station, University of Helsinki, Helsinki, Finland	Ecology of seafloor habitats; environmental mediation of biodiversity and ecosystem function
Deena Pillay	Male	Lecturer, Department of Zoology University of Cape Town Rondebosch, Republic of South Africa	Bioturbation, benthic ecology, ecosystem engineers, anthropogenic effects on estuarine systems.
Candida Savage	Female	Assistant Professor, Dept. of Marine Science, University of Otago, Dunedin, New Zealand	Marine ecology, nutrient cycling, systems ecology, and paleoecology

Erik E. Sotka	Male	Professor, College of Charleston, Department of Biology, Grice Marine Laboratory, SC, USA	Marine and molecular ecology, evolutionary ecology
Ryan Stanley	Male	Research Scientist, Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, Nova Scotia, Canada	Cryptic intraspecific diversity associated with climatic variation
Simon Thrush	Male	Professor, The University of Auckland, Inst. Of Marine Science, Auckland, New Zealand	Organism-sediment interactions; effects of disturbance on populations, communities and recovery processes

8. Working Group Contributions

Dr. Thomas S. Bianchi has studied biogeochemical cycling in marine sediments, more specifically sources and decay dynamics of sedimentary organic matter, and hotspots of carbon burial in the coastal ocean for over 30 years.

Dr. Luis Buatois focuses on animal-substrate interactions through geologic time. He characterizes secular changes in types of bioturbation in different environmental settings as a result of the interplay of evolutionary radiations and mass extinctions. The long-term goal of his research program is to understand the role bioturbation may have played in macroevolution and evolutionary paleoecology.

Dr. Judith Gobin brings a wealth of marine benthic ecological experience to the team and especially from the SIDs perspective. Her expertise covers soft sediments, rocky shores as well as deep-sea environments and her understanding of climate change impacts across these habitats (and over time), is of great importance to her geographic study area of the Caribbean territory.

Dr. Natasha Karenyi is a benthic ecologist with a particular interest in developing a conceptual framework for the ecology of subtidal sediment ecosystems. She has a focus on marine biodiversity and ecosystem classification research.

Dr. Agnes Karlson studies biodiversity and ecosystem functioning as well as adaptive capacity of individuals and populations to environmental changes in the species-poor system of the Baltic Sea, which is also the fastest warming sea area in the world. She is particularly interested in how to interpret stable isotope data in archived samples of consumers from e.g. long-term monitoring.

Dr. Lisa A. Levin will contribute expertise on the effects of climate change, particularly oxygen loss and ocean acidification, on benthic community structure and function. She brings experience with infaunal lifestyles, bioturbation, global climate projections to the seafloor and

assessments of their consequences for carbon cycling and the climate. She has participated in the IPCC AR 5 as contributing author, in the IPCC Special Report on Oceans and Cryosphere, served on the Ocean Carbon Biogeochemistry Program steering committee, and serves as co-lead of the Deep Ocean Observing Strategy and Deep-Ocean Stewardship Initiative.

Dr. Jack J. Middelburg is a biogeochemist with expertise in inorganic and organic geochemistry, benthic ecology, stable isotopes and earth system science, including paleoceanography.

Dr. Pierre Regnier is leading the research group ‘Biogeochemistry & Modeling of the Earth System’ at the Université Libre de Bruxelles. His research focuses on the biogeochemistry of carbon and nutrients in terrestrial, freshwater and marine ecosystems including the seafloor, global greenhouse gas (CO₂, N₂O, CH₄) cycling, geomicrobiology, and modeling of land-ocean interactions. He combines model-data fusion approaches and advanced statistical methods, as well as reactive-transport and Earth system modeling.

Dr. Paul V.R. Snelgrove brings 30 years of research experience in seafloor ecosystems and has published widely on questions relating to marine biodiversity, food quality, and ecosystem functioning.

Dr. Hong Zhou studies modern benthic community data collection from Chinese continental shelf and coastal habitats, including information on phenotypic and genotypic variation within and among species (e.g. Chinese polychaetes and other macrobenthic invertebrates, Chinese free-living marine nematodes in Barcode of Life Data System).

9. Relationship to other international programs and SCOR Working groups

CBIOS strongly relates to current and past SCOR WGs, as well as other international programs. Specifically, the objectives and scope of CBIOS will complement current SCOR WGs such as **Changing Ocean Biological Systems (COBS; SCOR WG#149)**, which is investigating the effects of oceanic conditions on marine organisms and ecosystems. CBIOS also builds off of past working groups, such as **WG#62: Carbon Budget of the Ocean**; and **WG#76: Ecology of the Deep Sea Floor**, and other large-scale research projects that have been co-sponsored by SCOR, such as the **Global Ocean Ecosystem Dynamics (GLOBEC)** which focused on the impacts of climate change on marine ecosystems and fisheries. Additionally, CBIOS complements the work conducted by **SCOR WG#128 Natural and Human-Induced Hypoxia and Consequences for Coastal Areas**, and two members of WG#128 are proposed members of CBIOS. This WG would also build on the foundation provided by the SCOR-sponsored workshop on benthic systems and several participants in that workshop are proposed as members of this group. CBIOS further complements these current and previously supported SCOR programs by investigating the impacts of climate change on benthic community dynamics and carbon cycling. Members of CBIOS have also been involved in a Pegasus/ Future Earth/ NCEAS workshop to advance the Global Ocean Observing System (GOOS).

CBIOS is currently seeking support from Utah State University to fund a workshop on marine animal-sediment interactions in Summer/Fall 2019 and will also seek support from

Ocean Carbon and Biogeochemistry (OCB), by applying for a Summer 2020 workshop (deadline December 2019) to be held at Woods Hole, MA.



April 15, 2019

Dear Dr. Thomas Bianchi and SCOR Working Group Proposal Review Committee:

I am writing on behalf of the Ocean Carbon & Biogeochemistry (OCB) Project Office to express our great interest in the proposed SCOR Working Group “*CBIOS (Changing Biotic-Sediment Interactions in the Ocean Seabed) - Rapidly Changing Biotic-Sediment Interactions in the Ocean Seabed – Biogeochemical Consequences in the 21st Century.*” OCB is a network of scientists who work across disciplines to understand the ocean’s role in the global carbon cycle and the response of marine ecosystems and biogeochemical cycles to environmental change. The proposed working group is highly relevant to the scientific goals of OCB and would help characterize and quantify processes involved in carbon transformation by the macrobenthos, which remains a key unknown in the ocean carbon cycle and has important implications for ocean carbon uptake and sequestration. Furthermore, earth system models currently lack the necessary information to effectively parameterize processes mediated by the macrobenthos, which limits our predictive understanding of how biogeographic and compositional shifts in these communities will impact global marine biogeochemical cycles.

As part of this activity, I understand that the investigators plan to submit an activity proposal on the macrobenthos to the next OCB solicitation, which will be of great interest to the OCB Scientific Steering Committee. The proposed working group, along with an associated OCB activity represent an important opportunity to build and strengthen this community of researchers and build awareness in the broader OCB community about the role of the macrobenthos and associated sedimentary processes in the ocean carbon budget.

We look forward to hearing more about this activity and are hopeful for a positive outcome.

Sincerely yours,

A handwritten signature in black ink that reads 'Heather M. Benway'.

Heather Benway
Executive Officer, OCB Project Office

10. Key References

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11. Appendix - 5 publications for full members

Thomas S. Bianchi

- Bianchi, T.S., Blair, N., Burdige, D., Eglinton, T.I., Galy, V. (2018) Centers of organic carbon burial at the land-ocean interface. *Org. Geochem.* 115: 138-155.
- Shields, M.R., Bianchi, T.S., Mohrig, D., Hutchings, J.A., Kenney, W.F., Kolker, A.S., Curtis, J.H., 2017. Carbon storage in the Mississippi River delta enhanced by environmental engineering. *Nat. Geosci.* 10, 846–851. <https://doi.org/10.1038/ngeo3044>.
- Smith, R.W., Bianchi, T.S., Allison, M.A., Savage, C., Galy, V. (2015) The Role of Fjords as Major Oceanic Sites of Marine Organic Carbon Burial. *Nat. Geosci.* 8: 450–453.
- Bauer, J.E., Cai, W.J., Raymond, P., Bianchi, T.S., Hopkinson, C.S., Regnier, P. (2013) The Coastal Ocean as a Key Dynamic Interface in the Global Carbon Cycle. *Nature* 504 (7478): 61-70.
- Bianchi, T.S., Allison, M.A. (2009) Large-river delta-front estuaries as natural “recorders” of global environmental change. *Proc. Nat. Acad. Sci.* 106 (20): 8085-8092.

Luis Buatois

- Buatois, L.A., Almond, J., Mángano, M.G., Jensen, S., Germs, G.J. (2018) Sediment

- disturbance by Ediacaran bulldozers and the roots of the Cambrian explosion. *Nat. Sci. Reports* 8: 4514.
- Buatois, L.A., Mángano, M.G. (2018) The other biodiversity record: Innovations in animal-substrate interactions through geologic time. *GSA Today* 28:4-10.
- Mángano, M.G., Buatois, L.A. (Eds.) (2016) The trace-fossil record of major evolutionary events. Volume 1: Precambrian and Paleozoic. *Topics Geobiol.* 39. Springer, 358 pp.
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Judith Gobin

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