Submission form for Ocean-Shot Concepts-Round 2

Response ID:41 Data

1. (untitled)

1. Ocean-Shot Contact Information: *Note - This information will be shared with the National Committee for the Ocean Decade in order to receive feedback. It will also be made publicly available if the Ocean-Shot concept is accepted into the Ocean-Shot Directory.

Primary Contact Name (First & Last) : Tristan Horner
Organization : Woods Hole Oceanographic Institution
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2. Ocean-Shot Title

Exploring Worlds within Worlds

3. Author(s): *Please list contributors to the submitted Ocean-Shot concept with first and last names in the order you wish them to be referenced for *potential* use in the Ocean-Shot Directory. Examples can be found here:

Tristan Horner

4. Ocean-Shot Directory Summary (Please provide a short introduction/description of the Ocean-Shot concept for *potential* use in the Ocean-Shot Directory, 100 word limit. Examples can be found here.):

A call to assemble a team of 'explorers' to constrain the role of microscopic marine particles in mediating critical chemical transformations in expanding oxygen-minimum zones.

5. Abstract (describe hypothesis, scientific and/or technological objective, 200 word limit):

Anoxic waters in the ocean interior host anaerobic microbes that are responsible for generating greenhouse gases such as nitrous oxide and methane. However, molecular and chemical data indicate that anaerobic microbial metabolisms may exist far outside of strictly anoxic zones. This apparent paradox is attributed to the existence of particle-associated microzones: micron-sized anoxic environments that develop during the heterotrophic oxidation of marine snow. These microscopic 'worlds within worlds' potentially expand the functionally anoxic portion of the ocean into hypoxic environments. However, the development, durability, and distribution of these microenvironments remain largely unknown. I propose a call to action Ocean Shot with a focus on recruiting 'explorers' to understand and characterize these important—but hitherto inscrutable—ecosystems. Doing so will require assembling a transdisciplinary team of scientists spanning molecular biology, geochemistry, modeling, and microfluidics with the shared goal of developing new approaches for studying microenvironments. The volume of the ocean that is hypoxic is predicted to expand over the next century, potentially also expanding the niche for particle-associated anoxic environments. The chemical consequences of expanding hypoxia cannot be fully predicted without understanding the significance of microenvironments, and the Ocean Decade represents a once-in-a-generation opportunity to focus attention on this important topic.

6. Please select the challenges (no more than 3) that are most relevant to your concept (Expanded reference below):

Challenge 2: Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity under changing environmental, social and climate conditions.
Challenge 5: Enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate and weather.
Challenge 7: Ensure a sustainable ocean observing system across all ocean basins that delivers accessible, timely, and actionable data and information to all users.

7. Describe how your Ocean-Shot addresses the selected challenges (150 word limit).

The portion of the ocean that is strictly anoxic is largely confined to coastal environments and low latitude upwelling systems. These regions currently represent the loci of the most intense nitrous oxide, methane, and hydrogen sulfide generation within

the ocean interior. However, if ubiquitous biogenic marine particles offer fertile substrates for the development of anoxic environments, then there is an urgent need to re-assess the sensitivity of the particle-associated chemical transformations to ocean deoxygenation. At present, we lack the tools to study microenvironments, let alone their significance to global biogeochemical cycles. This Ocean Shot will address these issues by bringing together scientists with knowledge outside of traditional ocean sciences, including physicists and experts in microfluidics. Thus, I believe that this Ocean Shot will address both Knowledge and Solutions Challenges as well as Essential Infrastructure Challenges posed by the Ocean Decade.

8. Vision and potential transformative impact (200 word limit):

My vision for this ocean shot is to assemble a diverse, international team of scientists interested in exploring microscopic 'worlds within worlds.' Questions include: who inhabits these worlds—are the microbes that exist within anoxic microzones distinct from those in persistent oxygen-deficient environments? How durable are these worlds—what is the lifespan of an anoxic environment within a sinking biogenic particle? What is the significance of these worlds—how much greenhouse gas production is attributable to these environments compared to the subtropical oxygen-minimum zones? Lastly, how do we model these worlds—can we develop diagnostics for predicting the abundance of these environments in relation to ongoing ocean deoxygenation? These questions cannot be answered by an individual researcher let alone a team of ocean scientists; this problem requires a truly transdisciplinary team and the Ocean Decade offers the opportunity for its assembly.

9. Realizable, with connections to existing U.S. scientific infrastructure, technology development, and public-private partnerships (150 word limit):

There is significant international interest in the role of oxygen-minimum zones in mediating many chemical transformations—from balancing the nitrogen cycle to the formation of unusual minerals. This interest has promoted development of new autonomous tools for studying microbial ecology within oxygen-poor environments, but this has yet to be extensively coupled to chemical and/or rate measurements. Such measurements will require development of new instruments and platforms that can study marine particles in situ, such as through imaging, monitoring of micro-scale chemical gradients, and monitoring of particle lifecycles. These technologies will then enable replication of the conditions within microenvironments under laboratory settings, allowing for the further development and testing of new technologies for studying particles.

10. Scientific/technological sectors engaged outside of traditional ocean sciences (100 word limit):

Three main sectors outside of conventional ocean sciences would be engaged by this Ocean Shot: microfluidics, sensor development, and optics. It is essential to engage experts in microfluidics given that the behavior of fluids differs at small scales (e.g., microdomain effects). Likewise, sensors with a high spatial resolving power will be necessary for ascertaining chemical gradients at the micron scale. Lastly, new technologies for imaging unperturbed particles in situ will be necessary to develop analogue environments in the laboratory.

11. Opportunities for international participation and collaboration (100 word limit):

This Ocean Shot is designed with international collaboration in mind. First, it requires myriad technologies to be trialed and tested, much of which can take place at the bench, rather than in the ocean. This significantly lowers the barrier to participate in this Ocean Shot given the significant costs associated with oceanographic fieldwork. Secondly, the major marine oxygen-minimum zones are globally distributed. A global view of the chemical transformations occurring within the particles found within low-oxygen environments thus requires a concerted international effort from countries in both hemispheres.

12. Develops global capacity and encourages the development of the next generation of ocean scientists (100 word limit):

This call to action will assemble a team that can identify promising approaches for characterizing particle-associated microzones and establish best practices that can be applied to study any of the globally distributed oxygen-minimum zones. Likewise, by recruiting new 'explorers,' this Ocean Shot will train scientists to be comfortable working with new technologies, across vast spatial scales, and in the expanding low-oxygen reaches of the ocean interior.

2. Thank You!

Thank You Email

Jul 01, 2021 15:34:12 Success: Email Sent to: Tristan.Horner@whoi.edu