OCEAN OBSERVATORIES INITIATIVE

OOI Deep Ocean Observing Workshop

27-29 August 2018 Seattle, WA

WORKSHOP REPORT

Workshop Goal and Format

The Ocean Observatories Initiative (OOI) Deep Ocean Observing Workshop provided an interdisciplinary forum to develop deep-ocean science questions and identify societal needs that could be addressed using the existing OOI infrastructure. The goal of this workshop was to expand the deep-ocean user community and direct it toward developing realistic proposals and hypotheses to carry forward deep-ocean observations on the OOI Cabled Array and in the broader NE Pacific. The workshop also aimed to examine the feasibility of developing a Deep Ocean Observing Strategy (DOOS) demonstration project, using the OOI and other regional assets, that could serve as a template for future observing activities. To do so, the workshop brought together researchers with interest or expertise in deep ocean observation, including early career and experienced deep-ocean observing scientists from multiple disciplines, OOI scientists, NSF program managers, the DOOS Steering Committee, and other stakeholders. It provided an opportunity for participants to gather detailed information about OOI infrastructure and data availability and discuss existing and prospective Essential Ocean Variables (EOVs) that are or can be measured by OOI and other nearby deep-water observatories. Particular attention was paid to the capabilities and utility of the OOI Cabled Array as well as the OOI Endurance and Papa Arrays, also in the NE Pacific. Additionally, participants addressed DOOS goals and opportunities to leverage other regional ocean observing assets (e.g., the US Integrated Ocean Observing System – Northwest Association of Networked Ocean Observing Systems, Oceans Network Canada).

The workshop comprised three main features: informational presentations about NE Pacific assets, DOOS science questions, DOOS demonstration project concepts, and EOVs relevant to the deep ocean; lightning talks by the participants about their individual research pursuits; and small working groups. Given the project development goal of the workshop, much of the workshop was devoted to small working groups in order to solidify what these proposals and hypotheses might be. At the beginning of the workshop, science questions for each of the four working groups were selected by participants, using the multi-disciplinary DOOS Science Questions and OOI Science Themes as a foundation. Participants then divided themselves into the working groups based on their interests.

During working group sessions, groups were tasked with (1) solidifying their deep-ocean science questions into potentially actionable hypotheses and projects; (2) determining whether the questions could be explored fully using OOI assets or other existing regional data and infrastructure; (3) determining what additional instruments or infrastructure would need to be added to answer these questions. The breakout group work resulted in framing four topics—operational products, the connection of vents and seeps to ocean processes, cross-shelf exchange, and benthopelagic coupling—discussed in greater detail below.

Thematic areas

Operational Products

One aspiration of this workshop was to promote the use of already available data; the group interested in operational products saw an opportunity to leverage the near-real-time data of the Endurance Array and other NE Pacific observatories to help local managers, fishermen, and the public by creating alerts and hazard warnings.

The overarching goal was to examine how observatory data can inform societal decisions, i.e., how streams of data can be translated into actual management decisions and influence policy over the long term. The group discussed several key areas of need including hypoxia, event response, tsunamis, fisheries, and whales. Of these, they decided to focus their efforts toward developing a system for hypoxic event response. These episodes of low dissolved oxygen can be difficult to predict especially regarding specific areas affected. More accurate local-scale predictions are needed so that devastating impacts on local fisheries, such as Dungeness crab, could be mitigated.

The operational products group proposed a cycle for developing and using such an alert system: Validation and Reanalysis (Historical Analysis, Episodic Review), Monitoring System (Seasonal Forecasts, Real-time), Alert System (Threshold trigger, Communications), and Event Response (Stakeholder decisions, In-situ data collection). Additionally, they identified usable data from the Endurance Array including gliders, desired technological enhancements such as hydrophones and real-time oxygen measurements, social science and computer expertise needed, and management connections that would enable creation of a system for hypoxia alerts. This process could be extended to other desired alerts in future.

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The Connection of Vents and Seeps to Ocean Processes

The Cabled Array on the OOI includes the most well-instrumented volcano in the ocean, with real-time connectivity via its fiber-optic cable. Ocean Networks Canada (ONC) has instrumented a vent at Endeavor. The Hydrate Ridge methane seep (OOI) and Barkley Canyon methane seep (ONC) also represent a unique set of instrumented sites in close proximity. The vents and seeps group was interested in how these data could be used to explore cross-disciplinary processes from below the seafloor to the sea surface.

The group developed several key potential science questions to take advantage of this access: How is venting and seepage connected to ocean processes (e.g., nutrient fluxes, carbon fluxes, mixing, plankton, fish)? And what is the link between subseafloor processes and biological processes up to high trophic levels ('from mantle to megafauna')? What is the connectivity between NE Pacific vent and seep communities and how do they collectively interact with regional ocean processes?

This group introduced a variety of concrete proposals to answer these questions; some reflect proposals already in process and others are plans for future work. With these projects, they expect to demonstrate approaches to examine vent and seep communities with assets in the NE Pacific that can be extrapolated globally and plan to revisit Ridge program documentation and associated questions. A better understanding of the vent and seep communities will improve prediction of seismicity and eruption, characterization of potential mining areas (massive sulfides and gas hydrates), and impacts on fish habitats relevant to fisheries and marine protected areas.

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Synoptic Assessment of Cross Shelf Exchange

There is a lack of understanding of transport processes across the shelf, both from the inner shelf to offshore, and vice versa. Similarly, vertical mixing, particularly in areas of large bathymetric changes, and horizontal advection down the coast are not well resolved. Without an understanding of these transport processes, it is also not possible to resolve biological and biogeochemical drivers of these productive ecosystems.

The relationship between the deep-ocean and the cross-shelf exchange has important societal and modeling implications; most visible today is the impact and activity of "the warm blob." There is a need to better understand the source and depth of high CO_2, nutrient rich, low-oxygen waters. Additional measurements in canyons to better understand their role in the exchange are also required (using economical Lagrangian tracers). This focus on mechanism of the exchange will help inform what may be learned from real-time forecasting from the shelf.

Specifically, this group was interested in how natural and anthropogenic variations in climate connected to the global overturning circulation and its variability. This includes linkages with variations in deep and bottom water formation rates and water properties, circulation and deep-ocean mixing, geothermal heating, and impacts on deep-sea ecology. As well as the degree of and mechanisms for influence of the deep ocean on cross-shelf processes and implications of changes in source water properties.

To understand the above-mentioned phenomena, a study would be required to perform ongoing and intensive data analysis, develop an understanding of associated biological processes, and incorporate velocity, oxygen, temperature, and salinity measurements. As such, associated projects would require easily-automated access to data, the use of existing OOI resources such as gliders, bio-acoustics, bio-optics, and moorings in both the Endurance Array Washington and Oregon Lines. In addition, efforts would require calibration/ground-truthing analysis, uncertainty estimates, event-based response capability, observation of associated biological community structures.

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Benthopelagic Coupling

Benthopelagic coupling is a key concept in understanding processes and fluxes, such as the carbon cycle, throughout the water column. As we seek to gain a better understanding of the global carbon budget in the context of increasing atmospheric carbon dioxide, it is important to quantify the movement of carbon between the deep sea and surface waters via upward transfer through biota and downward sinking and mixing into the sediment.

This group first outlined the general pathways believed to be of varying import in benthopelagic coupling and chose projects focused on aspects of those pathways that would begin tackling the larger question. Specifically, they focused on how changing oceans alter horizontal and vertical flux (of carbon and related constituents) to and from the deep ocean, and how physics (internal waves and eddies as transport), biology (particle attenuation, biological pump, migratory species), and biogeochemistry (nutrients and DOC/DIC) contribute and respond to change.

This question addresses three DOOS science questions on global change effects on the carbon pump, the deep ocean pelagic ecology, and the sea floor biota and their functions. The three sub-topics include passive flux, active flux, and

fate at the seafloor in the benthic boundary layer. The benthopelagic coupling group identified the Endurance Array as the best option for beginning this study and plans to develop a core set of instrumentation that can be added to other OOI nodes or nearby observatories to better answer the science question.

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Conclusions

The OOI Deep Ocean Workshop brought together diverse stakeholders, facilitating projects that can help answer fundamental questions about the deep ocean as well as use observatory data for hazard alerts and resource management strategies. Each working group assessed availability and utility of in-place assets as well as resource needs to answer their questions. At the end of the workshop, groups discussed the level of engagement of each participant and how they would continue momentum on their project(s) and proposal development. In some cases, this involves informal gatherings at existing meetings that group members were planning to attend, while other groups will rely on virtual platforms, such as Slack, in order to stay connected.

Participants expressed interest in incorporating OOI data into their existing and future work, as well as maintaining the collaborations formed at the workshop. The workshop highlighted that within the deep ocean observing community, the OOI can provide a critical resource in helping to ask questions at scales and across disciplines in ways not previously available. Observatory data can enable new advances, whether they be near-real-time hypoxia alerts, benthopelagic coupling from seafloor to the air-sea interface, across- and along-shelf transport, or microbes to megafauna connections from the subseafloor through the water column.

Individuals interested in learning more about or potentially collaborating with these groups should contact group points of contact. For more general information about deep ocean observing contact: info@deepoceanobserving.org. For assistance with the OOI, please contact the OOI Help Desk: help@oceanobservatories.org.

Other Resources:

https://oceanobservatories.org/
http://deepoceanobserving.org/
http://www.oceannetworks.ca/
http://www.nanoos.org/
https://ioos.noaa.gov/