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DEEP OCEAN OBSERVING STRATEGY
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Submission to SBSTA 52 on Ocean Dialogue from the Deep Ocean Stewardship Initiative and Deep Ocean Observing Strategy

The scientific networks Deep Ocean Stewardship Initiative (DOSI) and the Deep Ocean Observing Strategy (DOOS) welcome the opportunity to introduce consideration of climate and the deep ocean for the 12th session of the Research Dialogue (RD-12) held in conjunction with Subsidiary Body for Scientific and Technological Advice (SBSTA) 52.

The Deep Ocean Stewardship Initiative (DOSI) (www.dosi-project.org) is a global network of experts which seeks to integrate science, technology, policy, law, and economics to advise on ecosystem-based management of resource use in the deep sea. DOSI representatives have participated in UNFCCC COPs 21, 22, 23, 24, and 25. The Deep Ocean Observing Strategy (DOOS) (https://deepoceanobserving.org/) is a component of the Global Ocean Observing System (GOOS). It advances and coordinates observation and exploration in the deep ocean in service of science and society. **Contact:** llevin@ucsd.edu

Introduction. Humanity's tremendous dependence on the oceans for climate regulation, food, energy, livelihoods, recreation, biomedical products, technological innovations, and cultural goods extends to the deep sea, which covers most of the ocean and almost half of the planet. Most State Exclusive Economic Zones are largely deep ocean (below 200m). The IPCC SROCC (Bindoff et al. 2019) makes clear that the deep ocean is a major repository for excess heat, carbon dioxide and contaminants. Its buffering role has consequences for the physics, chemistry and biology of the deep ocean, with effects on the functions of marine ecosystems and human well-being. The uptake of heat and carbon dioxide affects global ocean circulation, sea level rise, oxygenation, ocean acidity, and the size, distribution and abundance of life in the sea. Below we focus attention on the potential contributions of the deep ocean to climate mitigation, adaptation and resilience and its role in maintaining a healthy, productive and sustainable planet.

We support the suggestions of the *Because the Ocean Initiative* submission to the SBSTA 52 Ocean Dialogue to either organize an annual Expert Ocean Dialogue, or for COP26 to adopt a "Glasgow (Informal) Ocean Work Programme", and emphasize that this dialogue should also include the deep ocean.

We seek an Ocean Dialogue that incorporates the deep ocean into UNFCCC deliberations by addressing the following key themes:

(i) Observations and research needed to improve understanding of the deep ocean in buffering climate change and to better project future climate change on land and in the oceans, including the deep-ocean floor.
(ii) Improved understanding of how climate change did, does, and will impact deep-ocean biodiversity and ecosystem functions and the consequences for ocean sustainability.
(iii) Clarification of the contribution of deep-sea biodiversity (species, habitats, ecosystems) to climate resilience, including potential for bioinspiration in the design of solutions for adaptation and mitigation.
(iv) Integrated (multi-area, multi-sectoral, multi-jurisdictional) ocean management actions needed to sustain and conserve critical deep-ocean ecosystem services under climate change, and their reflection in Nationally Determined Contributions (NDCs).
(v) Potential for mitigation and adaptation in the deep-ocean EEZs and areas beyond national jurisdiction to contribute to climate solutions. This includes the recognition of the role and variability of the ocean as the main sink of anthropogenic carbon and heat, as well as a potential source of greenhouse gases (e.g., release of methane or nitrous oxide).
(vi) Opportunities and initiatives for development of academic-industry-government-NGO partnerships that address the ocean-biodiversity-climate nexus in the deep sea.
(vii) Institutionalizing an ocean knowledge to policy dialogue under UNFCCC that includes the deep ocean in the EEZs and the high seas.

Observations and Research needed to better project future climate change.
Major uncertainties and gaps called out in the IPCC SROCC (Bindoff et al. 2019) include the need for deep ocean (a) *temperature and salinity measurements for sea-level and closure of the energy budget, (b) oxygen and carbon measurements dense enough to measure de-oxygenation of the world ocean and track the mechanisms driving the ocean carbon cycle, and* (c) studies of the *fate of methane at the ocean floor and in overlying waters.* A discussion of how to mobilize global and regional observing programs (Deep Argo, BGC Argo, Go-SHIP, Ocean SITES, GOOS, Seabed 2030, Observatories, CalCOFI, long-term fishery-independent stock assessment etc.) to fill these gaps is needed (Levin et al., 2019). Model representation of deep ocean physical and biogeochemical processes (e.g. mixing, ocean heat uptake, oxygen minimum zones structure and trends) depends heavily on these observing programs, and are thus critical to providing robust projections of global climate change on land and at sea. The SROCC highlights that *for many deep-sea ecosystems and ecosystem components (e.g., viruses and protists) insufficient scientific understanding limits the assessments of risks to low confidence or no assessment.* The strong connectedness of shallow and deep ecosystems suggests that a research agenda for deep sea processes and biological responses (Danovaro et al. 2020), as well as ecological resilience to

climate change (e.g., within the context of the Decade for Ocean Sciences for Sustainable Development), is critical for predicting feedbacks to shallow water ecosystems and global climate dynamics.

Potential for mitigation and adaptation in the deep-ocean EEZs and areas beyond national jurisdiction to contribute to climate solutions.

As industries in the deep ocean develop (e.g., emerging deep seabed mining) or expand (fisheries, oil and gas, communication cables) they need to minimize greenhouse gas emissions. For mining, this can be done through the regulatory regimes concerned with climate change, air pollution and shipping as well as through the International Seabed Authority (Heinreich et al. 2020). Deep waters are rarely mentioned in plans of the Nationally Determined Contributions associated with the Paris Agreement, but there are many mitigation and adaptation measures that could be adopted (Table 1), for regions and activities within States' jurisdiction. For Areas Beyond National Jurisdiction (ABNJ) which comprise ~ 60% of the ocean there is no NDC. International cooperation is needed to adopt mitigation and adaptation measures that could help achieve the overall UNFCCC goals in ABNJ. UNFCCC collaboration with other UN agencies (e.g., FAO, ISA, IMO, CBD, BBNJ instrument) can be developed to promote mitigation and adaptation actions in ABNJ such as those listed in Table 1. However, an international mechanism for coordinating these activities in waters beyond national jurisdiction is needed.

Beyond particular industries or sectors, scientific research exploring the vast diversity of deep-sea biomes and their ecological function is expected to lead to design solutions to mitigate or remediate the cumulative impacts of climate and pollution in areas concentrating anthropogenic pressures. The study of novel CO_2-fixation/removal metabolisms and adaptations to toxic exposure and multiple stressors at individual and ecosystem scales in the deep sea will support innovative strategies and climate solutions, and improve model capacity to anticipate non-linear responses. Changes in the future of the ocean should be taken into account in developing future climate targets, as the ocean is the main sink for anthropogenic carbon via physical, chemical and biological processes, and thus the most powerful natural mitigation driver. Acknowledging limitations to adaptation in the deep ocean is an important factor to consider when deciding on mitigation targets, specifically when impacts are inevitable (acidification, Oxygen Minimum Zone expansion, etc.) on human timescales.

Climate consciousness can be incorporated into developing regulations for biodiversity and for deep-sea resource extraction under UNCLOS. The expected electrification of human society (e.g. expanded use of electric cars, batteries, etc.) as a consequence of a shift to more renewable energy use could further increase demand for critical minerals and potentially raise pressure for deep-seabed mining. Thus, proactive examination of the impact of climate change mitigation strategies should take into consideration new and unanticipated consequences for ocean biodiversity. The International Seabed Authority has an opportunity now, as it negotiates the rules for mining beyond national jurisdiction to (a) factor predicted and actual climate variations into its management regime so as properly to understand cumulative impacts, and to manage the predicted adverse effects on biodiversity or ecosystem services caused by mining and other activities generating significant disturbances on already changing habitat conditions in climate-real context, and (b) set restrictions on the carbon emitted during at-sea mining operations and account for the real carbon cost of the full industrial chain including transport and treatment (c) to preclude additional greenhouse gas emissions from fossil fuel extraction from ABNJ. Given that current proven fossil fuel reserves are already 4 to 7 times higher than admissible carbon emissions under a 2^{o}C target (IPCC 2014, p.63) and given that oil and gas extraction in the deep sea is a technically and economically challenging activity with past accidents proving catastrophic, the climate-resilient option is to prohibit exploration for and extraction of fossil fuels in ABJN.

Climate resilience can be built into biodiversity governance (BBNJ treaty) by (i) incorporating modeled climate projections and their effects on biological connectivity and habitability into spatial planning and design of protected areas on the high seas (ii) incorporating climate as a cumulative impact for environmental impact assessment and particularly the need to update the concept of baseline studies to account for changing background conditions based on better knowledge of the local and regional evolution of climate stressors (iii) considering climate effects on the distribution of marine genetic resources, (iv) making deep-ocean observation and modeling a key component of knowledge and technology transfer. The CBD Post2020 Global Biodiversity Framework could consider climate issues in the context of marine biodiversity and MPAs in general, and with regard to deep-ocean biodiversity in particular.

Key actions to study and discuss:

- MPA designation in the high seas and EEZ deep regions - How to improve forecasting of climate change to optimize protected area planning, including adaptation of deep-sea organisms, and particularly foundation species, to multiple stressors.
- Carbon footprint of seabed mining, bottom trawling, and other deep-sea operations from cradle to grave, and their likely impact on carbon capture.
- Deep-blue carbon inventory and ecosystem capacity to ensure / maintain the sequestration or limit release of greenhouse gasses (including methane, nitrous oxide).
- Non-linear action of deoxygenation, acidification, and N_2O production on deep-sea ecosystems and on waste toxicity.
- Enhanced and coordinated deep-ocean observing activities to improve climate modeling and enable climate-resilient decision making.
- Form an ongoing process that transfers the growing understanding of the ocean-climate-biodiversity nexus and the role of the deep ocean in particular to the policy sector and vice versa.

Contributors: Lisa Levin, Yassir Eddebbar, Natalya Gallo, Rachel Jeffries, Kjell Kuhne, Hannah Lily, Nadine Le Bris, Kirk Sato, Uta Schuchmann, Moriaki Yasuhara.

Key Resources:
Deep Ocean Stewardship Initiative (www.dosi-project.org) Policy Briefs:
dosi-project.org/wp-content/uploads/2018/05/Climate-Policy-Prief-Climate-2018.pdf
dosi-project.org/wp-content/uploads/2015/08/BBNJ-Policy-brief-climate-change.pdf
https://www.dosi-project.org/wp-content/uploads/053-DOSI-Deoxygenation-V9.pdf
https://www.dosi-project.org/wp-content/uploads/2015/08/040-DOSI-Climate-change-considerations-V4.pdf.pdf

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Table 1. Examples of major categories of mitigation and adaptation that could be applied to the deep ocean within EEZs and in areas beyond national jurisdiction.

MITIGATION	*ADAPTATION*
Marine Protected Areas *(protection and enhancement of carbon sequestration services)*	***Marine Protected Areas*** *(climate resilience, climate refugia)*
At sea ***Greenhouse Gas Emission Reduction*** *(e.g., Shipping/Maritime transport, Tourism, Fishing, Science/Monitoring, Seabed Mining)*	***Ocean Observing*** *(Improving climate models via ARGO, Deep Argo, BGC Argo, GO SHIP, Seabed 2030)*
Offshore Energy *(solar, wind… could be implemented in international waters to service infrastructure). Avoid new exploration and extraction of fossil fuels in deep water.*	***Scientific Research*** *(carbon cycling in the open ocean, ecosystem and species thresholds and response to climate variables)*
CO_2 removal via geoengineering *(subsurface CO_2 burial, alkalinity, Fe fertilization, biomass burial)*	***Data Findability, Accessibility, Interoperability, Reusability (FAIR)***
	Strategic Environmental Assessment, Environmental Impact Assessment *(consideration of/monitoring for climate variables)*
	Fishing *effort and practices adapted to climate change and preserving C services (water and seafloor)*

	Early warning and safety /hazard *(buoys and sensors)*
	Blue Economy *- industry mandated sustainable practices promoting health of the ocean (e.g, for seabed mining, offshore energy, bottom fisheries, cable industry).*
	Cross sectoral ecosystem-based management/Preservations of Ecosystems: *(i) Cold water coral and sponge habitat preservation (VMEs), (ii) Hydrothermal vent preservation (genetic potential) (iii) water column integrity.*
	Preventing species invasion *that could disrupt services*
	Preserve traditional uses of the high seas *(navigation, cultural)*