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Early career ocean professionals declaration on Ocean Negative Carbon Emissions for our ocean and future

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ABSTRACT

This paper highlights the urgent need to accelerate research and action on ocean carbon sinks through human intervention, known as Global Ocean Negative Carbon Emissions (Global-ONCE) Programme, as a vital strategy in global efforts to mitigate climate change. Achieving 'net zero' by 2050 cannot rely on emission reductions alone, emphasising the necessity of complementary approaches. Global-ONCE's mission extends beyond scientific exploration. It embodies a profound commitment to protecting and restoring blue carbon ecosystems, as well as implementing ocean-based solutions that are sustainable, equitable, and inclusive. Early Career Ocean Professionals (ECOPs) are at the heart of these efforts, and their innovative approaches, technical expertise, and passion make them indispensable leaders in advancing ONCE initiatives. ECOPs bridge the gap between science and society, playing a relevant role in integrating cutting-edge research, technological advancements, and community-driven action to address climate threats. By bringing together diverse perspectives and leveraging their interdisciplinary expertise, ECOPs ensure ONCE strategies are grounded in scientific rigour and practical feasibility. Through advocacy, education, and collaboration, ECOPs not only spearhead research and innovation but also inspire collective action to safeguard our oceans. This paper amplifies the critical role of ECOPs as agents of change and calls for a unified global commitment to harness the ocean's potential for a climate-resilient future.

INTRODUCTION

Through various international conferences (e.g., the United Nations Ocean Conferences and the Integrated Marine Biosphere Research [IMBeR] IMBIZO conferences) and regional workshops (e.g., the Asia-Pacific Climate Week and the Southern Ocean Observing System symposium), the ECOP Programme has emerged as a prominent advocate for ocean conservation and climate action. ECOPs drive transformative changes and work towards a sustainable future for our oceans and planet through advocacy, innovation, and collaboration (Roman et al.,2024).

The global ocean plays a crucial role in the Earth's climate system, significantly mitigating climate change through its capacity to act as a heat and carbon sink while shaping atmospheric and biogeochemical circulation patterns (Jiao et al., 2010; Hoegh-Guldberg et al., 2023). It is essential for maintaining climate stability. However, anthropogenic impacts have progressively undermined the ocean's efficacy in performing its natural functions (Heinze et al., 2015). Thus, initiating coordinated scientific and technological action is paramount to tackling climate change. In response to this need, the Global-ONCE Programme was established in June 2022 under the United Nations Decade of Ocean Science for Sustainable Development (2021-2030). This international Programme aggregates 79 research groups from 33 countries, engaging over 1,500 dedicated participants. Global-ONCE advocates for negative carbon emission strategies and develops ecological geoengineering solutions that are scientifically sound, reasonable, and legally compliant (Liu et al.,2022). It is dedicated to advancing the harmonious coexistence between humanity and the marine ecosystem, fostering an ecologically

sustainable civilisation. In June 2025, Global-ONCE co-released the OOSC (One Ocean Science Congress) Manifesto, "Science for Ocean Action", which presents actionable scientific recommendations ahead of the Third United Nations Ocean Conference to guide global ocean stewardship and climate solutions.

AUTHOR BACKGROUND AND COLLABORATIVE EFFORTS

The author list showcases a highly diverse global representation, spanning 46 countries or regions across six continents: Asia (17), Europe (13), Africa (6), South America (4), North America (3), and Oceania (3), and encompassing contributors from 82 cities worldwide (**Fig.1**). Particularly noteworthy is the inclusion of institutions from Small Island Developing States (SIDS), often at the forefront of experiencing climate change impacts and marine ecosystem challenges. These include Fiji, Seychelles and Timor-Leste. The wide range of institutions, including universities, government agencies, research institutes, and non-governmental organisations, reflects an interdisciplinary approach to marine and coastal research. Most authors initially connected through the International Marine Early Career Network (IMECaN) (Palacios-Abrantes et al.,2025) and the ECOP Programme and later collaborated at the Ocean Decade conferences in Barcelona and Bangkok in 2024, as well as at the first UN Ocean Decade International Coastal Cities Conference in Qingdao in 2025. These shared experiences fostered our collaboration, aligning with mutual interests in ocean sustainability and youth engagement.

This paper emphasises the urgent need to focus on increasing ocean carbon sinks through human intervention as a critical component of global efforts to address climate change. The urgency is underscored by the fact that emission reductions alone will not achieve 'net zero' by 2050. We declare Global-ONCE's commitment to leveraging the underutilised capacity of our ocean to address climate threats extends beyond scientific research; it represents a dedicated pledge to take action to protect blue carbon ecosystems and implement ocean-based solutions that promote sustainability and intergenerational equity while recognising and addressing the potential environmental risks and unintended consequences of such interventions. By integrating science, innovation, and community engagement, we can proactively contribute to environmental stewardship and work towards a more sustainable and resilient future.

WE ARE IN CONSENSUS THAT

a) Reaching global climate goals, including the Paris Agreement target, is crucial for a sustainable future. While moving quickly to renewable energy sources to reduce fossil fuel inputs, ONCE can help with the remaining or residual atmospheric CO_2 left after reductions in fossil fuel use.

b)Addressing the climate crisis requires a concerted global effort. Global-ONCE is an uplifting platform where the international ocean community collaborates towards a shared goal. Special attention should be paid to knowledge transfer and capacity building in developing nations to ensure that all regions can contribute to and benefit from the ONCE strategies.

c)Optimising negative carbon emission capabilities through nature-based interventions and fostering knowledge exchange among stakeholders will ensure that ONCE projects are adapted to local socio-ecological contexts and yield long-term sustainability.

d)Prioritising the prevention of environmental and health harm by adopting proactive measures in line with the precautionary principle when faced with uncertain risks. It guides decision-making by advocating caution and thorough evaluation before implementing new technologies or interventions. Rigorous environmental assessments and in-depth research should precede any large-scale geoengineering intervention, ensuring that decisions are based on minimising uncertainty and preventing unintended ecological consequences.

e)Identifying common global and regional early warning systems, Essential Ocean Variables (EOVs), and Essential Biodiversity Variables (EBVs) as standardised references. These will be critical for monitoring, researching, and forecasting biodiversity status and ecosystem functioning trends, helping to guide the adaptive management of ONCE interventions over time.

Why are ECOPs essential?

ECOPs (including scientists, policymakers, stakeholders, non-governmental organisation professionals, school teachers, ocean enthusiasts, and community leaders) from diverse backgrounds worldwide should take action at every possible level to fully protect our ocean towards a shared vision for ocean sustainability (Satterthwaite et al., 2025). ECOPs are energetic and diverse, representing various backgrounds, cultures, and experiences. By involving ECOPs from different regions and communities, we ensure that diverse perspectives are considered, leading to more inclusive and effective practical solutions. ECOPs bring fresh insights, innovative approaches, and technical skills that are imperative for developing and implementing effective ONCE strategies that promote sustainability and equity for future generations. Most importantly, ECOPs are rising stars, as many of them are growing into leadership positions for implementing ONCE research, strategies and policies. Therefore, any climate action should be accompanied by measures that promote the inclusion of ECOPs in all ONCE initiatives.

Our call to action

We are indispensable agents of change in addressing climate change. Our leadership, energy, and passion for environmental issues drive local, regional, national, and global climate actions. The active involvement of ECOPs in grassroots movements, climate policy advocacy, and the promotion of innovation is a clear example of our ability to bring cutting-edge solutions, driving significant and long-lasting change. We believe our voices and expertise are critical in mobilising meaningful actions. Working collectively allows us to develop new ideas and pave the way to a brighter, more sustainable future.

As ECOPs, we declare our commitment to mitigating the devastating impacts of climate change on our oceans. We urge governments, policymakers, corporations, practitioners, and individuals to adopt sustainable practices, such as investing in renewable energy and supporting ocean conservation efforts through dedicated "Loss & Damage" funds. Together, we can ensure healthier and more resilient oceans that support the well-being of our planet and its inhabitants.

WHAT CAN BE DONE BY ECOPS

1.Educating Yourself and Others: Learn and share knowledge about ocean carbon sinks, negative carbon emission technologies, and extensive science programs like Global-ONCE.

2.Voicing Your Support: Advocate for policies that promote well-researched ocean-based climate solutions and actively participate in community events, including information dissemination and ocean literacy initiatives.

3.Engaging with Emerging Science: Proactively connect with innovative scientists and actively discuss ONCE technology innovations and engineering research.

4.Supporting Responsible Eco-Engineering Approaches for ONCE Practices: Champion the proposed Declaration while advocating for sustainable practices and regular monitoring to assess the long-term ecological impact of ocean-based CO_2 removal methods (Zhang et al., 2022).

5.Nurturing Future Innovators: Emphasise the importance of cultivating the next generation and encouraging their proactive involvement in developing innovative solutions.

6.Building Long-Term Vision and Adaptation: Strategies for ONCE should be integrated into broader efforts for adaptation and climate resilience.

7.Fostering Youth Leadership and Participation: Through youth-led initiatives, advocacy campaigns, and active engagement in decision-making processes, we strive to amplify our voices and catalyse meaningful actions for ONCE.

8.Empowering Coastal Communities: By empowering coastal communities with the knowledge, resources, and decision-making authority needed to address ONCE, we foster local ownership through dialogue with ancestral forms of knowledge (indigenous knowledge) and enhance the resilience of coastal ecosystems and the livelihoods of these communities.

9.Strengthening Local and International Partnerships for Impact: By forging alliances among governments, civil society organisations, the private sector, academia, enterprises, and coastal communities, we can leverage collective expertise and resources to develop innovative solutions and drive systemic change.

10.Enhancing Capacity Building in Less Developed Areas: Supporting international cooperation and knowledge sharing to highlight the importance of developed nations' commitments to sharing technology and expertise with developing countries, thereby ensuring equitable access to ocean-based solutions.

Figure 1 ONCE-ECOPs Call for Action

(BCP: Biological Carbon Pump, CCP: Carbonate Counter Pump, MCP: Microbial Carbon Pump, SCP: Solubility Carbon Pump,BCMS: BCP-CCP-MCP-SCP, N,P: Nitrogen and Phosphorus, WWTP: Wastewater Treatment Plant, OAE: Ocean Alkalinity Enhancement)

ACTION AGENDA

1.Integrating Ocean Education into Curricula: We call upon governments and educational institutions to prioritise the integration of ocean literacy and climate education into formal curricula at all levels.

2. Promoting Experiential Learning and Citizen Science: We advocate for experiential and active learning opportunities that enable young people and coastal communities to engage directly with their local marine environments.

3.Supporting Youth-Led and Community-Based/Indigenous Initiatives: We urge governments, philanthropic organisations, development banks, and businesses to invest in youth-led initiatives and community-based projects to address ONCE.

4. Strengthening International Cooperation: We can foster a global environment conducive to effective ocean conservation and climate mitigation strategies through multilateral agreements, knowledge sharing, and collective action.

5. Investing in Coastal Infrastructure and Resilience: We advocate for increased investment in coastal infrastructure and resilience strategies. This includes enhancing natural buffers, like wetlands and mangroves, restoring degraded ecosystems, and incorporating ONCE-focused strategies into coastal defence systems.

6.Promoting Sustainable Fisheries Management: We call for implementing sustainable fisheries management practices to alleviate pressure on marine ecosystems and enhance the carbon sequestration potential of marine organisms.

7. Scaling Up Renewable Energy Deployment: We advocate for the rapid and responsible deployment of renewable energy technologies and financing to reduce greenhouse gas emissions and mitigate climate change.

8.Promoting Blue Carbon Conservation: By protecting these vital carbon ecosystems, we can sequester carbon, safeguard biodiversity, and reduce the vulnerability of coastal communities and other stakeholders to climate change impacts, including sea-level rise, coastal erosion, ocean acidification, and storm surges.

9.Supporting Basic and Applied Research in Marine Carbon Dioxide Removal: We call upon governments, universities, and funding agencies to prioritise the development and long-term support for basic research that will advance our knowledge on ONCE and applied research that will transform the generated knowledge into sustainable solutions.

10. Incorporating Ocean Carbon Sink Functional Zones into Marine Spatial Planning: We advocate for leveraging Marine Spatial Planning to enhance ocean carbon sink functions by developing theories and methods for delineating natural and artificial sink functional zones, thereby supporting effective management of ocean sink enhancement.

11.Establishing Early Warning Systems: Early warning protection systems are crucial in reducing damage from climate change impacts and enabling timely evacuation, especially for SIDS. Additionally, providing locals with disaster preparedness training is essential to respond to climate change disasters effectively.

CONCLUSION

The ECOPs Declaration on Ocean Negative Carbon Emissions highlights the critical role of early career professionals and youth in addressing the urgent challenges confronting our ocean and planet. Through advocacy, innovation, and collaboration, ECOPs can drive transformative changes and help secure a sustainable future for the next generations. By recognising the importance of protecting our ocean, advocating for policy change, harnessing innovation and technology, and empowering youth leadership, we can overcome the challenges posed by anthropogenic climate change and pave the way for a brighter, more sustainable future by realising compelling ONCE.

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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