



Ocean negative carbon emissions: A new UN Decade program

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The Paris Agreement sets the target to limit increases in mean global temperature to well below 2°C, preferably to 1.5°C, compared with preindustrial levels. Carbon neutrality is the preferred route to reach this target.¹ This requires primarily a reduction of CO₂ emissions to the atmosphere but also an increase of carbon sinks or negative emissions (absorption of atmospheric CO₂). The ocean is the largest active carbon pool on Earth, acting as the key regulator to global climate change, and thus has great potential for carbon negative emission.^{2,3} Recent research demonstrates that the ocean has already absorbed approximately 28% of anthropogenic CO₂ since the Industrial Revolution,^{4,5} which indicates that ocean negative carbon emissions could potentially have an important role in achieving the 1.5°C or 2.0°C goal. Given the urgency and seriousness of the ongoing climate change, it is therefore imperative to explore the potential of enhancing ocean carbon sinks.

The Global Ocean Negative Carbon Emissions (Global-ONCE) Program (logo shown in Figure 1) was approved by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Scientific

and Cultural Organization (UNESCO) in the framework of the United Nations' call for Decade Actions of Ocean Science for Sustainable Development and the United Nations Decade Initiative Plan. The Global ONCE UN decade program starts officially from the World Oceans Day, 8 June 2022, and will last for 10 years. Global ONCE has five leading partner organizations: the North Pacific Marine Science Organization (PICES), the International Council for the Exploration of the Sea (ICES), the Surface Ocean-Lower Atmosphere Study (SOLAS), the Integrated Marine Biosphere Research (IMBeR) network, and the World Climate Research Program (WCRP China). Global ONCE partners also include UNESCO-IOC and the European programs, Ocean-based Negative Emission Technologies (Ocean NETS); Quantifying and Deploying Responsible Negative Emissions (NEGEM); Super Bio-Accelerated Mineral weathering (BAM), a new climate risk hedging reactor technology; and Geoengineering and Negative Emissions Pathways in Europe (GENIE). Global ONCE will collaborate actively with relevant UN Decade programs, including the Global Ecosystem for

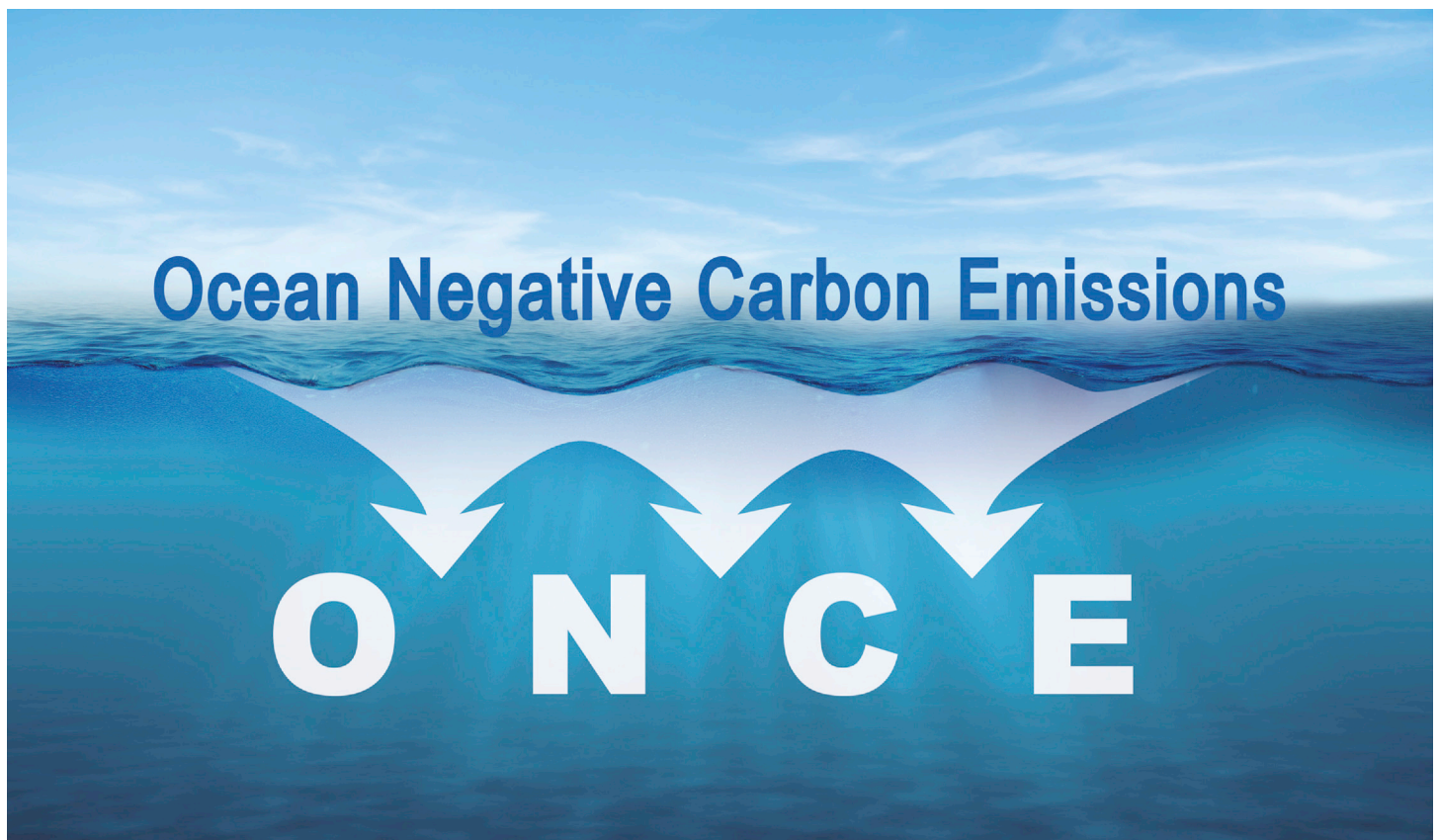


Figure 1. The logo of the Global ONCE UN Decade program The three connected arrows indicate the integration of ocean carbon sequestration mechanisms, including microbial carbon pump (MCP), biological pump (BP), and carbonate counter pump (CCP).

Ocean Solutions (GEOS), Ocean Acidification Research for Sustainability (OARS), and Sustainability of Marine Ecosystems through global knowledge Networks (SMARTNET) in the future.

The objectives of Global ONCE are to provide the data, knowledge, opportunities, and practices to enable society to evaluate mitigation approaches to climate change. These include the establishment of a network of instrumented marine monitoring stations and research facilities to evaluate such approaches; formulation of decision rules for initiation and evaluation of these approaches; facilitation of co-designed interdisciplinary collaborative research on key carbon transformation processes; development of technical and personnel capacity; and enhancement of knowledge exchange between scientists, policymakers, industries, and societies. The Global ONCE approaches cover the spectrum from nature-based interventions to optimize carbon sequestration capability along with biodiversity preservation and restoration to chemical and engineering technologies to enhance ocean carbon uptake.

At this stage, there are several technical frameworks for enhancing ocean carbon sequestration artificially, such as seaweed cultivations, ocean alkalinity enhancement, nutrient fertilization, artificial upwelling, and recovery of marine ecosystems. Global ONCE addresses the fifth Ocean Decade Challenge: to enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate and build resilience to the effects of climate change across all geographies and at all scales.

So far, 36 international institutions have committed to joining Global ONCE and working toward the above objectives. Targeted activities include creating an international network of ONCE-related facilities; co-producing best-practice manuals; connecting partner-organized summer schools and training workshops for early career researchers; making training materials accessible in multiple languages and formats; raising public awareness through collaboration with museums, aquaria, and science festivals; and providing evidence-based advice to the Inter-

governmental Panel on Climate Change (IPCC) and Conference of Parties (COP) meetings of the UN Framework Convention on Climate Change.

The National Natural Science Foundation of China (NSFC) Basic Science Center for Marine Carbon Pumps and Biogeochemical Processes has also been launched in China to study key scientific issues of ocean carbon sequestration and provide better service and theoretical support to the Global ONCE program. Meanwhile, the UNESCO and IOC approved the Global ONCE side event to the United Nations Ocean Conference, which was held from 27 June to 1 July 2022 in Lisbon, Portugal. The theme of this virtual side event was to expand science- and innovation-based ocean negative carbon emission approaches in the framework of the United Nations Sustainable Development Goals, and was held virtually on 30 June 2022.

A team of international scientists is leading Global ONCE and implementing it through careful co-design and development of ONCE technologies. The aim is to develop ONCE protocols and standards for carbon mitigation in the future. For further information, see <https://www.global-once.org>.

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DECLARATION OF INTERESTS

The authors declare no competing interests.