

Plymouth Marine Laboratory (PML) submission to the second meeting of the technical dialogue relating to the First Global Stocktake – Technical Assessment

ABOUT

Plymouth Marine Laboratory (PML, www.pml.ac.uk) is an independent and impartial provider of policy relevant scientific research and advice, focused on pioneering research for sustaining the global ocean, its ecosystems and resources for the benefit of society's health and prosperity.

PML's research is consistently recognised as being of national and international significance for addressing societal challenges of relevance worldwide with its experts conducting interdisciplinary science to understand complex natural systems and forecast the consequences of human actions on these systems and the impacts on society. By observing, understanding, modelling and forecasting the structure and function of marine ecosystems, PML experts have demonstrated the services these ecosystems provide society and the consequences of human actions upon them.

PML is a registered charity and works with the UK Research & Innovation (umbrella organization of the UK Research Councils) as well as UK and international governments, policy makers, environmental managers, other charities, foundations and industry to understand how the ocean works and translates that knowledge, leading to the development of solutions to address societal challenges. PML is also engaged in public understanding of science, capacity building and assistance in developing countries, and the application of science.

PML experts have been part of the IPCC Author Teams for AR4, AR5, SROCC, AR6 (WGI and WGII); advised national and international governments, intergovernmental organisations (such as Group on Earth Observations), NGOs, businesses and other stakeholders on the ocean and climate change over more than 20 years. PML has given technical and scientific evidence on ocean-climate nexus at various SBSTA's since 2006, presented at both the Rio+20 Earth Summit and the 2017 UN Ocean Conference, and enhanced the development of SDG14 e.g. through participation in the Partnership Dialogue 3 and side events and currently sit on the UN SDG 14 Informal Preparatory Working Group focusing on 'Minimizing and addressing ocean acidification, deoxygenation and ocean warming'. PML is contributing to the UN Decade of Ocean Science for Sustainable Development. PML has attended all UNFCCC COPs since 2009, participated in, organised and facilitated numerous ocean side events, including co-organisation of Oceans Action Day, the first (virtual) Ocean Pavilion and EU Ocean Day at the COPs, bringing the evidence of the latest ocean-climate science to the delegates.

GLOBAL STOCKTAKE

The first Global Stocktake (GST) provides the opportunity to include the world's ocean as a key element for nations, and the global community, in delivering the Paris Agreement and addressing the Glasgow Pact of better inclusion of the ocean in all relevant UNFCCC processes.

Why the Ocean should be included in the GST:

1. The ocean has greatly slowed the rate of climate change by its uptake of over 90% of the heat energy from global warming around 25% of the anthropogenic CO₂ and 100% of the water from melting ice. But this has come at a cost: the ocean has also warmed, acidified and lost oxygen, whilst circulation patterns are changing, and sea levels are rising. The continuation of these changes not only threatens marine



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biodiversity and ecosystems through the cumulative impacts of the stressors but also the future ability of the ocean to indirectly support all life on Earth (see table below for summary).

2. A healthy and biodiverse ocean provides food, wellbeing, cultural heritage, and support for the sustainable livelihoods of billions of people – as well as mitigation and adaptation options for climate change.
3. Rapid reduction in greenhouse gas emissions to meet the Paris Agreement will decrease impacts on the ocean and benefit its ecosystems and all of society.
4. As part of the “climate system” the ocean needs to be better integrated in UNFCCC mitigation, adaptation and financial processes, including Nationally Determined Contributions, National Adaptation Plans and the Global Stocktake.
5. Improved ocean governance and management is needed to scale up marine protection and sustainable management of both the high seas and coastal waters.
6. Sustained, global ocean observations and projections of ocean physics, chemistry and biology are essential to inform better short and long-term policy-making for the benefit of people, nature and the economy.
7. Innovative ocean finance is required to achieve a sustainable ocean economy and protect the ocean’s natural capital.

RECOMMENDATION

1. PML recommends that the UNFCCC’s Global Stocktake includes scientific measurements of the multiple ocean changes and their impact on marine ecosystems caused by anthropogenic greenhouse gas emissions. “As the majority of additional heat energy and glacial melt water cause by global warming and a large proportion of anthropogenic CO₂ enters the sea it is essential to monitor these and their combined impacts over time. This would enable the UNFCCC to check if we are on track to prevent dangerous anthropogenic interference in the whole “climate system” as outlined in Article 2 of the Convention. Measures of Global Climate Indicators would support and inform the UNFCCC, its processes and the Global Stocktake as well as offer an important avenue to potentially strengthen and measure the success of ocean mitigation and adaptation actions in the context of the overall progress made under the Paris Agreement. For example, adoption of the World Meteorological Organization’s (WMO) and Global Climate Observing System’s (GCOS) Global Climate Indicators (<https://gcos.wmo.int/en/global-climate-indicators>) in the Global Stocktake would help to support and inform the UNFCCC. Of the seven WMO Global Climate Indicators there are four that are specifically relevant to the ocean (ocean heat content, ocean acidification, sea level, and sea ice extent). Whilst atmospheric concentrations of greenhouse gases are clearly an important indicator, it is essential to monitor the whole carbon and heat cycles, including that related to the land, cryosphere and ocean.
 - a. **Adoption of the WMO Global Climate Indicators in the Global Stocktake would help to harmonise ocean actions more fully within the UNFCCC process and better track climate change in the whole climate system**
 - b. Measurements and monitoring of the cumulative impacts of these stressors on ocean ecosystems and biodiversity would increase understanding of the impacts on the goods and services (e.g. food provision, carbon sinks, coastline and infrastructure protection, livelihoods and cultural

values) they provide humankind and how these will change in the future, enabling future planning and adaptation.

Stressor	Causes	Results	Direct Effects	Impacts
Acidification Developed as a research topic in past decade	Increasing atmospheric carbon dioxide emissions	Unprecedented rapid change to ocean carbonate chemistry	Reduced calcification, growth and reproduction rates in many species	Reduced ability of the ocean to take up CO ₂ Impeded shell or skeletal growth and physiological stress in many species, including juvenile stages
	Coastal nutrient enrichment, methane hydrates and acid gases from industrial emissions may also contribute locally, increasing variability	Much of the ocean will become corrosive to shelled animals and corals, with effects already seen in the Arctic Ocean	Changes to the carbon and nitrogen composition of organic material	Change to biodiversity and ecosystems, and the goods and services they provide
			Dissolution of unprotected calcium carbonate structures in some regions	Cold and upwelling waters currently supporting key fisheries and aquaculture likely to be especially vulnerable
Warming A relatively mature study area in terms of physical changes and physiology but poorly studied at ecosystem and biogeochemical levels	Increasing greenhouse gas emissions to the atmosphere	Temperature increase, particularly in near- surface waters	Decreased carbon dioxide solubility Potential change to ocean circulation	Stress to organism physiology, including coral bleaching and uptake of contaminants Migration of species
		Less ocean mixing due to increased stratification	Increased speed of chemical and biological processes	Extensive migration of species
		Increased run-off and sea-ice melt will also contribute to stratification in Arctic waters	Reduced natural nutrient re-supply in more stratified waters	More rapid turnover of organic matter

		Increased in marine heat waves		Nutrient stress for phytoplankton, particularly in warm waters Changes to biodiversity, food webs and productivity, with potential consequences for fisheries, coastal protection and tourism
Deoxygenation Emerging issue, relatively poorly studied	Reduced oxygen solubility due to warming	Less oxygen available for respiration especially in productive regions, and in the ocean interior	Reduced growth and activity of zooplankton, fish and other oxygen-using organisms	Stress to oxygen-using organisms
	Decreased oxygen supply to the ocean interior due to less mixing	Extended areas of low and very low oxygen (dead zones)		Risk of species loss in low oxygen areas
	Nutrient rich land run-off stimulating oxygen removal locally			Impacts on reproductive success Shift to low oxygen-tolerant organisms, especially microorganisms and loss of ecosystem services in these areas
Sea Level Rise A mature research area and a long-term issue	Climate warming due to increased greenhouse gas emissions to the atmosphere	Melting of glaciers and ice sheets	Increase in the volume of water in the ocean	Flooding of coastal and island habitats
		Thermal expansion of seawater	Rise in the level of seas	Erosion of shorelines Loss of infrastructure Greater risk of impacts from storms and surges