



Declaration on Operationalising the Surface Ocean Carbon Value Chain

We, the 100+ ocean experts and stakeholders specialising in surface ocean carbon measurements and quantification of ocean carbon uptake, representing Europe, Australia, Asia, North America, South America and Africa, assembled at the Flanders Marine Institute (VLIZ) in Oostende, Belgium and online (6-9 November 2023) to assess the status of the multi-component community effort capable of measuring, storing, synthesising and mapping of the surface ocean carbon information, call for concerted international and intergovernmental efforts to create a robust, resilient and sustainable surface ocean carbon observing system. We envisage and expect that such a system, the so-called surface ocean carbon value chain, will meet the ever-increasing demands for ocean carbon data and information needed to inform national and intergovernmental policies on climate change and mitigation efforts, with the Paris Agreement being the most pressing commitment.

Climate change is the most fundamental acute issue facing humanity, with the accumulation of carbon dioxide (CO₂), a potent Greenhouse Gas (GHG), in the atmosphere being a primary cause of this change. Urgent, deep and sustained emission reductions are needed to peak and reduce emissions, to reach net zero by 2050, as agreed by the 196 Parties to the Paris Agreement. The concentrations of GHGs in the atmosphere are regulated by both emissions and uptake by the land and ocean. The Global Carbon Budget reports that in the last decade the ocean alone takes up about 26% of the CO₂ emitted to the atmosphere every year, thus limiting greater climate change. However, ocean CO₂ uptake varies significantly in time and space and a large number of high-quality continuous measurements is needed to monitor and predict the ever-changing scales and patterns of the air-sea interactions and to monitor and predict any adverse impacts of this uptake such as ocean acidification.

The United Nations Framework Convention on Climate Change (UNFCCC) mandates action upon the Global Climate Observing System Implementation Plan (GCOS IP), which in turn details the need to routinely monitor the ocean carbon uptake as essential for understanding the global climate change impacts and its future projections in support of climate policy making (e.g. GCOS IP 2022 Action B8). The global ocean carbon research community has a long-lasting recognition of the importance of measuring key ocean carbon Essential Climate Variables (ECVs) in support of the GCOS IP, coordinated under the Global Ocean Observing System (GOOS).

Over the past three decades, this community of experts and stakeholders has developed a multi-component system capable of measuring, storing, synthesising and mapping ocean-related carbon parameters, enabling their use in the annual Global Carbon Budget, model projections, and inversion systems. The observational element,

which provides data from merchant and research vessels, moorings as well as sailing boats and uncrewed surface vehicles, is referred to as SOCONET (the Surface Ocean CO₂ Observing Network). SOCONET delivers data to the community-driven data quality control and synthesis element known as SOCAT (the Surface Ocean CO₂ Atlas). SOCAT, in turn, is used for global mapping that fills observational gaps via machine learning approaches and other statistical methods involving satellite-borne information and is undertaken by individual investigators loosely coordinated through SOCOM (the Surface Ocean pCO₂ Mapping Intercomparison). These activities together are referred to as the surface ocean carbon value chain and form an ocean contribution to the state of the Global Carbon Budget, including an estimate of the ocean carbon uptake, which is reported annually to UNFCCC by the Global Carbon Project (GCP) and through the WMO State of the Climate Report.

Despite the long-standing success in delivering critical information, the surface ocean carbon value chain is configured as a loose affiliation of observing and data synthesis elements that lack formal integration and operates on unstable, short-term research-based funding streams. In addition, sub-optimal support for coordination activities translates to limited formal presence of the elements of the surface ocean carbon value chain as part of GOOS, which in turn slows down GOOS' efforts to deliver the essential information needed. In recent years, recognition of the fundamental value of accurate, systematic and robust ocean carbon information has increased significantly across managerial and policy-making scales, and as a result demands for data products continue to increase. A need to supply routine air-sea CO₂ flux data to the World Meteorological Organization's Global Greenhouse Gas Watch (GGGW), the need to integrate new technology and to broaden the scope to include coordination of nitrous oxide (N₂O) observations, will potentially overwhelm an already acutely stressed system, and therefore we find it timely to review the operating model of the surface ocean carbon value chain.



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OUR COLLECTIVE AMBITION, founded in the GCOS IP, is to completely transform our ability to deliver an integrated global ocean carbon monitoring system, helping countries to better understand and manage the causes of climate change in a timely and efficient manner. In recognition of this ambition, over 100 experts and stakeholders representing Europe, Australia, Asia, North America, South America and Africa gathered in Oostende, Belgium and together committed to:

- ✓ Formalise the structures of SOCONET to create a robust and resilient GOOS network bringing together surface ocean CO₂ observing efforts
- ✓ Develop a clear pathway to securing a robust, resilient and scalable SOCAT data management system for the long term
- ✓ Support and quantitatively underpin the efforts above with observing system experiments using SOCOM methods, satellite observations and models to optimise the current observing design

WE REQUEST that all national and regional funding agencies and structures, global and regional intergovernmental agencies, space agencies and groupings, as well as global and regional coordination bodies take note of this commitment and work with the scientific community to realise this ambition via the following actions:

- ✓ Stabilise support for existing high accuracy data collection elements of SOCONET via dedicated, long-term sustainable funding mechanisms and internationally agreed rules to measure within country's Exclusive Economic Zones (EEZ)
- ✓ Support a SOCONET coordination structure via dedicated, long-term sustainable funding mechanisms
- ✓ Equip all oceanographic research vessels with high quality surface ocean carbon observing instruments and support their operation
- ✓ Coordinate the use of emerging autonomous surface technologies and sailing boats to obtain data from remote, traditionally hard to reach places such as the Southern Ocean
- ✓ Develop funding mechanisms to support SOCAT as the data platform for quality-controlled surface ocean data
- ✓ Support a dedicated surface ocean GHG observing system design activity with regular evaluation and refinement of the design
- ✓ Support innovation in surface ocean air-sea CO₂ flux mapping techniques (SOCOM) and routine releases of ocean CO₂ flux products
- ✓ Support development, innovation and availability of relevant satellite-borne data products, to stabilise support of annual carbon assessments
- ✓ Address lack of capacity in the surface ocean carbon value chain through training and new career opportunities as well as incentives for contributing to the global network
- ✓ Develop a review process to ensure that we innovate and develop the surface ocean carbon value chain in response to new information, science challenges, technological innovations and changes in the global carbon cycle

Glossary:

COP: Conference of the Parties; **GCP:** Global Carbon Project; **GHG:** Greenhouse Gas; **GCOS:** Global Climate Observing System; **GOOS:** Global Ocean Observing System; **SOCAT:** Surface Ocean CO₂ Atlas; **SOCONET:** Surface Ocean CO₂ Observing Network; **SOCOM:** Surface Ocean pCO₂ Mapping Intercomparison; **UNFCCC:** United Nations Framework Convention on Climate Change; **WMO GGGW:** World Meteorological Organization Global Greenhouse Gas Watch