A communication and coordination service for marine biogeochemistry

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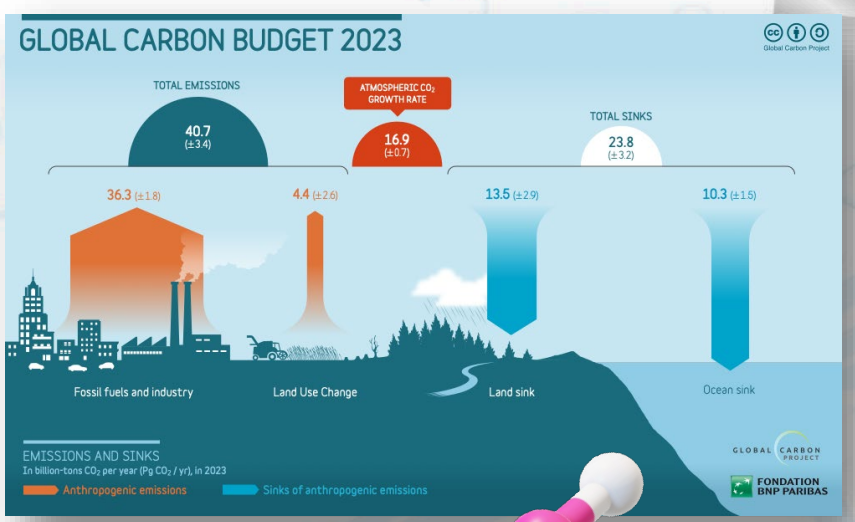
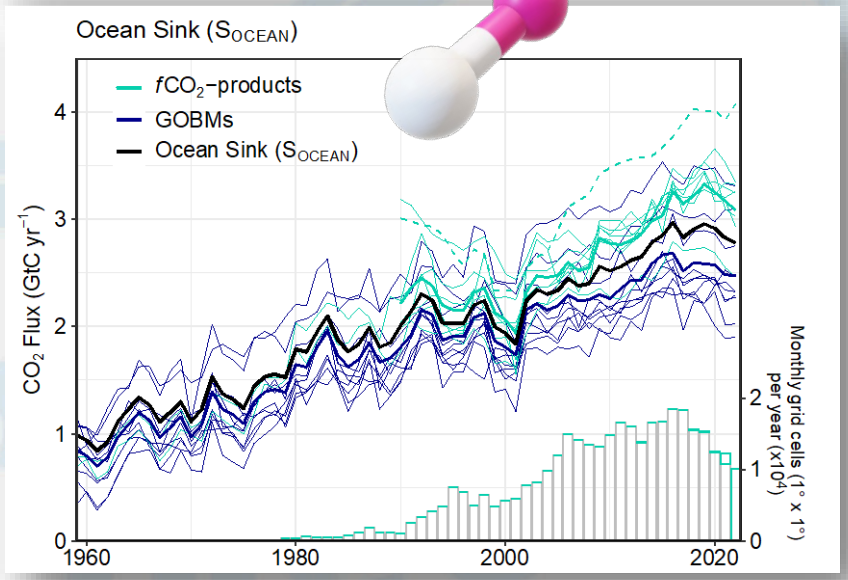
Strong emphasis on ocean carbon requires consolidation and smart coordination

Our core ambition in the past 12 months and for the next 12-24 months is to:

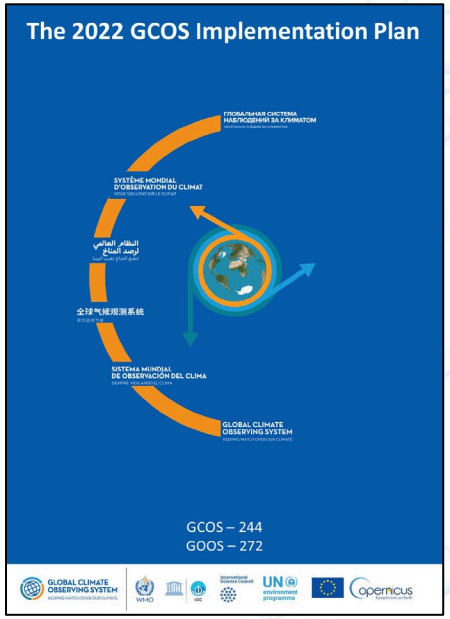
- Continue playing a leading role in development of a GOOS **Carbon Plan;**
- Continue engagement with WMO around the Global Greenhouse Gas Watch **(G3W) and its Implementation Plan;**
- Respond to requests related to GCOS IP 2026 related to marine biogeochemistry observations;
- Formalise structures and strategies for **SOCONET** to create a robust and resilient GOOS network bringing together ocean CO_2 observing efforts;
- Develop a clear pathway to securing a robust, resilient and scalable **SOCAT** data management system for the long term;
- Collaborate with WMO's JET-EOSDE around a proposal to develop an **Ocean BGC Cycles Application Area.**

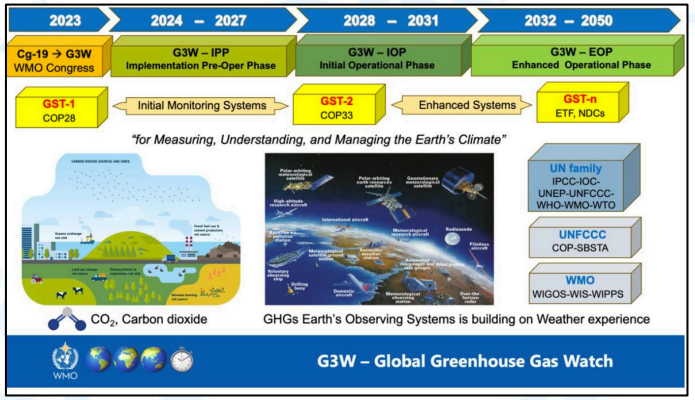


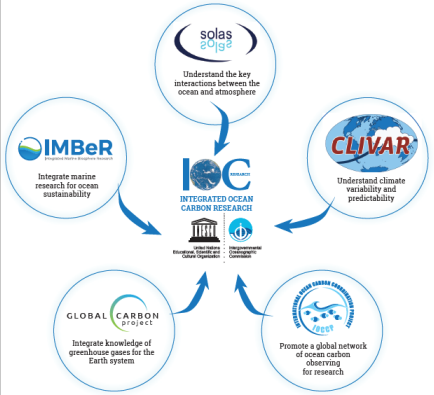


All that is a lot for the not many champions in the community to take on, therefore prioritizing, consolidation where possible and limiting engagement in other tasks will be key to our success.

Develop a coherent Carbon and Nitrous Oxide Plan in response to intergovernmental and community mandates







GCOS IP 2022

Collects and documents the data needs for monitoring the climate system and for assessing the impacts of climate variability and change. Submitted every 5 years to the United Nations Framework Convention (UNFCCC) and is recognized by the Conference of the Parties (COP).

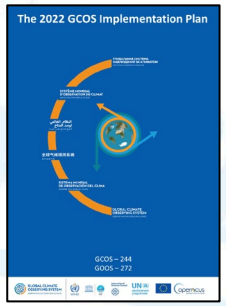
GGGW IP 2024

GGGW provides an integrated, operational framework in relation to GHG monitoring, striving to reduce the uncertainty in assessing the efficacy of climate action. Approved by WMO Congress and recognized by SBSTA59 at COP28. IP Requested by WMO Congress to allow Member States to facilitate actions required in 2024-2027

IOC IOCR WG 2021

The IOC-R addresses key issues in ocean carbon research through a combined strategy of investigative and observational goals around changing ocean carbon sink and impact that increasing CO2 levels have on ocean ecosystems. Reports to SBSTA and IOC Member States.

Ongoing and planned activities including assessment of budgetary and personnel needs



Action B8: Coordinate observations and data product development for ocean CO_2 and N_2O	
Activities	1. Develop a strategy and implementation plan to operationalize the data production and delivery of surface ocean CO_2 information. 2. Coordinate the existing nitrous oxide (N_2O) ocean observations into a harmonised network.

Action D2: Ensure Global Climate Data Centres exist for all in situ observations of ECVs	
Activities	1. Identify ECVs for which adequate global centres do not exist or are insufficiently supported and facilitate and support the creation or improvement of global data centres for these ECVs. 2. Promote regional data centres, their interoperability, where possible, synchronisation of their data holdings, and the provision of data in their archives to global data centres.

Action F5: Develop an Integrated Operational Global GHG Monitoring System	
Activities	The overall aim here is to develop an integrated operational global greenhouse gas monitoring infrastructure. The first steps are: 1. Design and start to implement a comprehensive global set of surface-based observations of CO_2, CH_4 and N_2O concentrations routinely exchanged in near-real time suitable for monitoring GHG fluxes.

Financial O8: Ocean network design

Developing, running and expanding the surface ocean GHG observing system will require a coordinator (1 FTE) in IOCCP linked to GOOS and a technical coordinator (1 FTE) for SOCONET at OceanOPS.

National Ocean Research Agencies, Environmental and Climate Ministries, Academic Institutions, and National Meteorological Services need to take the financial commitment to run the sustained observing systems. Current committed funding for surface ocean GHG observations is approximately 8.1 M$ per year distributed across several nations. Estimates of near-term costs associated with support of existing and new observations, including initiating expansion to data-poor regions in the near-term, is approximately an additional 29 M$ per year distributed across all nations. This includes 9.2 M$ per year in capital investment for instrument updates, maintenance, and new instrumentation on existing platforms in addition to 25 FTE of new technical staff distributed across supporting nations to build capacity to fully operate new and existing measurements and quality control the data. Those investments are the highest priority in order to sustain critical observing infrastructure. Investment in research and development of approximately 4 M$ per year is needed to advance new techniques and GHG instruments, including support of early career researchers to grow the ocean GHG community. New autonomous surface ocean CO_2 platforms currently contributing data to SOCAT could be expanded to data-poor regions that OSEs have identified as major contributors to uncertainty in ocean CO_2 flux. An investment of 8 M$ per year in those measurements would make near-term progress and be adapted and deployed to other regions as OSEs assess observing impact.

Financial O9: Gridded Air-Sea CO_2 flux

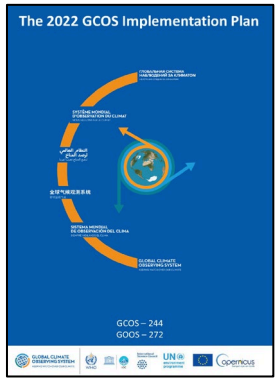
The effort to run SOCAT has been estimated as 3 FTEs to develop and maintain software systems, support and troubleshoot the submission process, coordinate the annual release and to coordinate SOCAT of which approximately 1 FTE is committed. Innovating and developing SOCAT further will add another 2 FTE costs. Therefore, an extra 4 FTEs are needed.

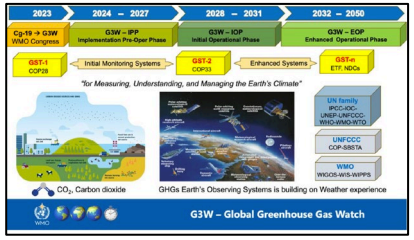
MEMENTO also requires full time support (1 FTE) for database updates and maintenance, including for possible shared or leveraged infrastructure with SOCAT.

The SOCOM mapping exercise needs to be supported via National Ocean Research Agencies, Environmental and Climate Ministries, Academic Institutions, National Meteorological Services. Estimated costs to sustain efforts and conduct research to test optimal observing design is approximately 8 M$ per year across all nations.

WMO/IOC recommend that each National Ocean Research Agency or equivalent support a national contribution to this action that is consistent with and proportional to weather observing and forecasting contributions to address national needs and global assessments.

GOOS Ocean Carbon and Nitrous Oxide Plan - structure





- **Executive Summary**
  - "This document will outline GOOS'es goals related to ocean carbon and nitrous oxide observing and describe the timeline for delivery of these goals through coordination, communication and implementation efforts over the next 3-5 years."
- **Introduction**
  - Motivation based on justification for the mandate documents
  - Motivation based on relevant elements of GOOS'es vision, mission and strategy
  - Description of usefulness of implementation of the Plan in supporting stakeholders (scientific community across GOOS elements, national and international efforts, funders of the ocean carbon observing system, others….)
- **Strategic approach**
  - Mandates
    - GCOS IP 2022
    - WMO G3W Implementation Plan 2024
    - IOC Integrated Ocean Carbon Research Report 2021
    - Other….?
  - Capacities and priorities across GOOS elements in the context of the mandates
    - Panels
    - OceanOPS
    - OCG
    - Networks
    - GRA's?
    - ETOOFS?
    - Partners: IODE, others?
  - Partnerships for implementation
  - Description of elements of mandates which are beyond GOOS'es capacity
- **Goals**
  - 4-5 Goals
    - 3-4 Objectives per goal
    - Each objective needs to have a clear description of action with timeline, named responsible GOOS element, measure of success
- **Conclusion and Next Steps**

Goals

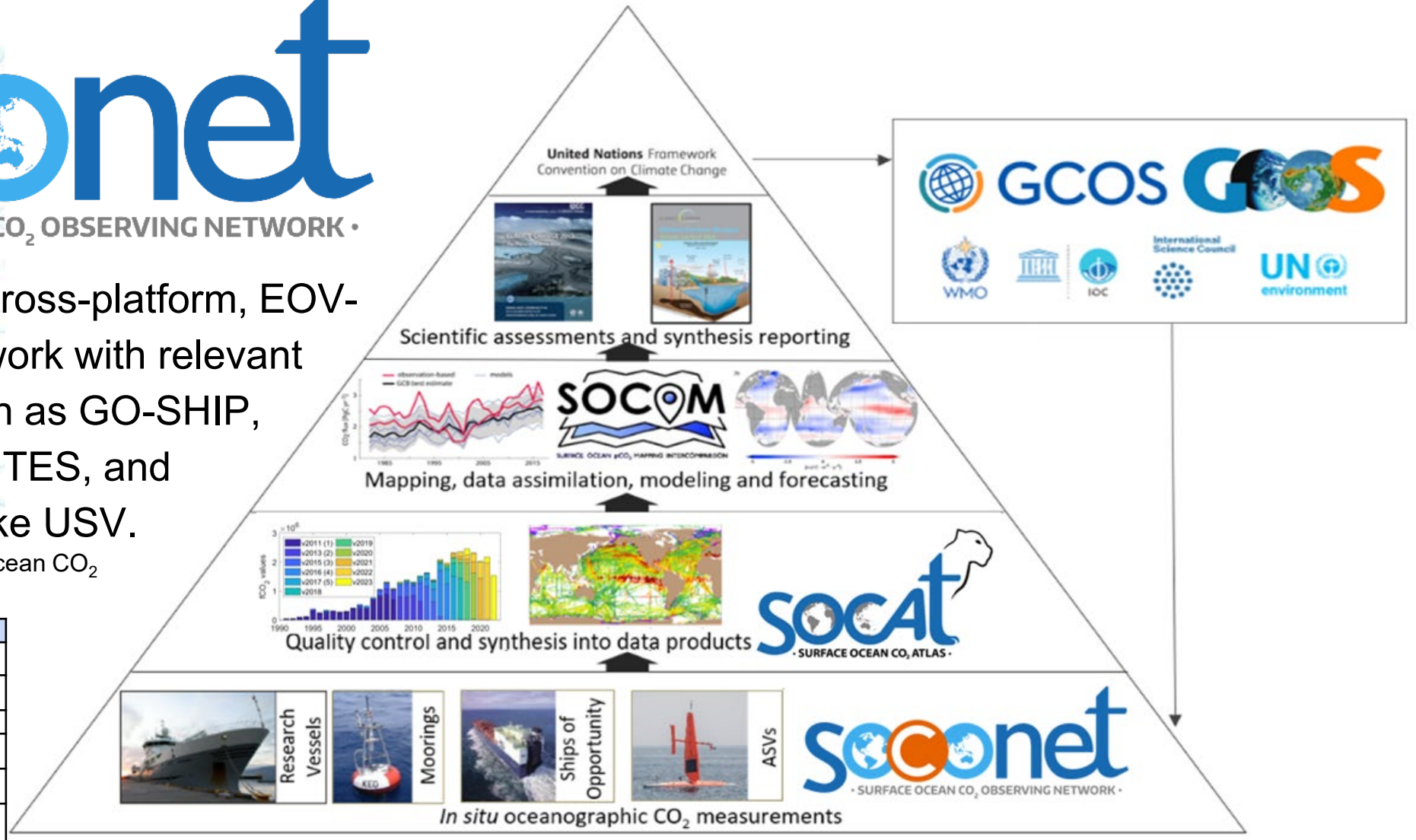
Work around each goal focuses on gap analysis and development of 3-4 most pressing delivery objectives.

- Goal 1: Fill ocean carbon and nitrous oxide observational gaps
  - Synthesis of observing system design efforts (partnership?)
  - Critical domain gaps (e.g., ocean surface, coastal ocean, interface/exchange with seafloor)
  - Critical regional sampling gaps (e.g., Polar, Tropical Pacific, Indian Ocean, etc.)
  - Critical temporal sampling gaps (e.g., observations during winter)
  - Critical parameters gaps (e.g., co-located sampling, more holistic set of parameters on existing platforms)
  - Critical innovation and technological gaps (sensors, platforms)
- Goal 2: Provide useful climate information for modeling/forecasting, product development, mitigation, adaptation
  - Ocean carbon data management
    - Per network?
    - Per application? (e.g., ocean acidification, mCDR)
  - Existing and new data synthesis products
    - Per network (SOCAT, GLODAP, SPOTS)?
    - Per application (e.g., fluxes, storage)
    - More holistic?
  - Gaps filling efforts (e.g., Machine Learning)
- Goal 3: Sustain funding for observations and data management
  - Identification of infrastructural and personnel needs based on filling the gaps described in Goals 1 and 2
  - Identification of public and private stakeholders benefiting from filling those gaps
  - Identification of mechanisms allowing the stakeholders to invest in filling these gaps
- Goal 4: Develop optimal support structure for ocean carbon coordination efforts within GOOS
  - Existing structure
  - Specific coordination needs (within GOOS, across the community involved in delivering the GOOS Carbon Plan
  - Optimal structure

Formalized surface ocean CO2 observing network -

SOCONET is a thematic, cross-platform, EOV-based* network, that will work with relevant GOOS OCG networks such as GO-SHIP, Argo, SOOP, and OceanSITES, and potential future networks like USV.

* direct measurements of surface ocean CO_2



OCG Network Attributes	SOCONET alignment
Global in scale	Global coverage with ships, moorings, uncrewed surface vehicles (USVs)
Observes one or more EOVs/ECVs	Inorganic Carbon
Observations are sustained	Back to 1990
Community of Practice	Build off Workshops on Surface Ocean pCO_2 Observations, incl creating a Steering Cmte
Maintains network missions/targets	To be included in SOCONET Implementation Plan
Delivers data that are free, open and available in timely manner	Continued submission through the established SOCAT data system and NODCs
Ensures metadata quality and delivery	Metadata are delivered to SOCAT and NODCs, and will be augmented, if needed, for OceanOPS metadata requirements
Develops Standards and Best Practices	Standards and best practices will be collated and updated in SOCONET Implementation Plan
Undertakes capacity development	Some currently, but more needed to elevate quality and provide assistance to under-resourced groups to entrain additional platforms into the network

Modified from Guidi et al. (2020)

Global network formed by consolidating 3 decades of efforts of around 20 groups

Global Observing Network for
Reference Surface Water pCO_2 Observations
Kick-off Meeting

Time: Sunday, 11 February 2018, 8:30 – 17:30
Location: Portland, Oregon, USA
Venue: Residence Inn Portland Downtown / Convention Center,
1710 NE Multnomah Street, 97232 Portland, Oregon, USA

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

frontiers in Marine Science

REVIEW
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A Surface Ocean CO_2 Reference Network, SOCONET and Associated Marine Boundary Layer CO_2 Measurements

Rik Wanninkhof[1], Penelope A. Pickers[2], Abdirahman M. Omar[3], Adrienne Sutton[4], Akihiko Murata[5], Are Olsen[6], Britton B. Stephens[7], Bronte Tilbrook[8], David Munro[9], Denis Pierrot[10], Gregor Rehder[11], J. Magdalena Santana-Casiano[12], Jens D. Müller[11], Joaquin Trinanes[13], Kathy Tedesco[14], Kevin O'Brien[15], Kim Currie[16], Leticia Barbero[10], Maciej Telszewski[17], Mario Hoppema[18], Masao Ishii[19], Melchor González-Dávila[12],*

Initial objectives and current focus

Initial Objectives (1-5 years):

- Community of practice **- formalizing structures**
- **Near-real-time platform tracking** and annual metrics on data quality/quantity
    - Network provides resources towards OceanOPS platform tracking
    - Respond to near-real-time data delivery needs (e.g., G3W)
- Develop **SOPs** and continue intercomparison exercises
- Mutual aid, exchange and assistance for technical issues in **operations**
- Support for **capacity building** focused on elevating quality and entraining additional platforms into the network
- **Provide coordination** to the community on new platforms, instruments, sensors, and protocols
    - e.g., **N_2O and CH_4**

Current focus (2024):

- Formal integration of SOCONET into the GOOS OCG – achieved in May 2024
- Formalize and convene SOCONET Steering Committee
    - Interim SC is currently writing grants, taking stock of SOCONET observing assets, developing requirements for SOCONET reference measurements and more.
- Develop SOCONET Implementation Plan, including network mission, targets, and design.
- Pilot on platform tracking through OceanOPS - NOAA assets
- IOCCP includes a Nitrous Oxide Expert on its SSG to coordinate inclusion of this variable into SOCONET.

International Council for Science
SCOR
Scientific Committee on Oceanic Research

INTERNATIONAL OCEAN CARBON COORDINATION PROJECT
IOCCP

The Global Ocean Observing System
GOOS
Biogeochemistry Panel

UNESCO
United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

A communication and coordination service for marine biogeochemistry

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Thank You!

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