



# ICOS

● ● ●  
INTEGRATED  
CARBON  
OBSERVATION  
SYSTEM

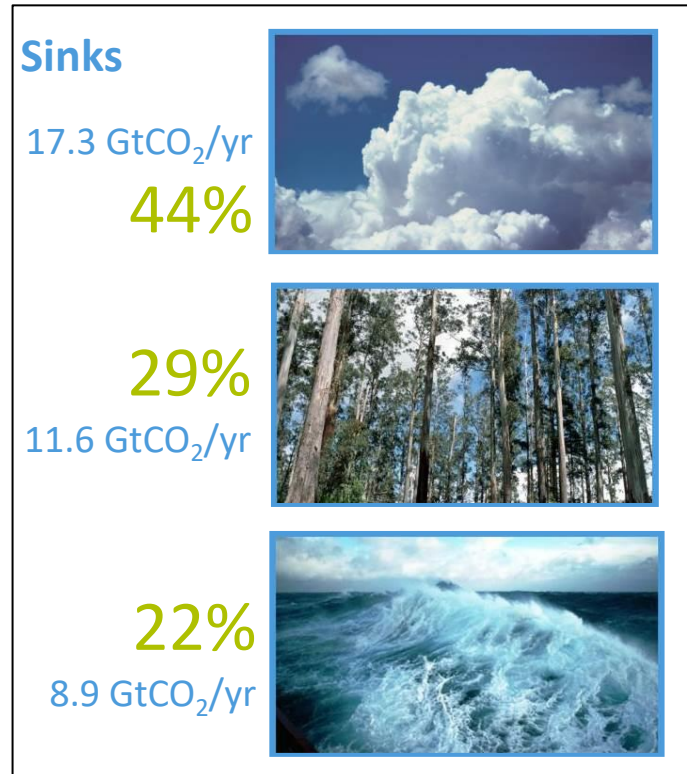
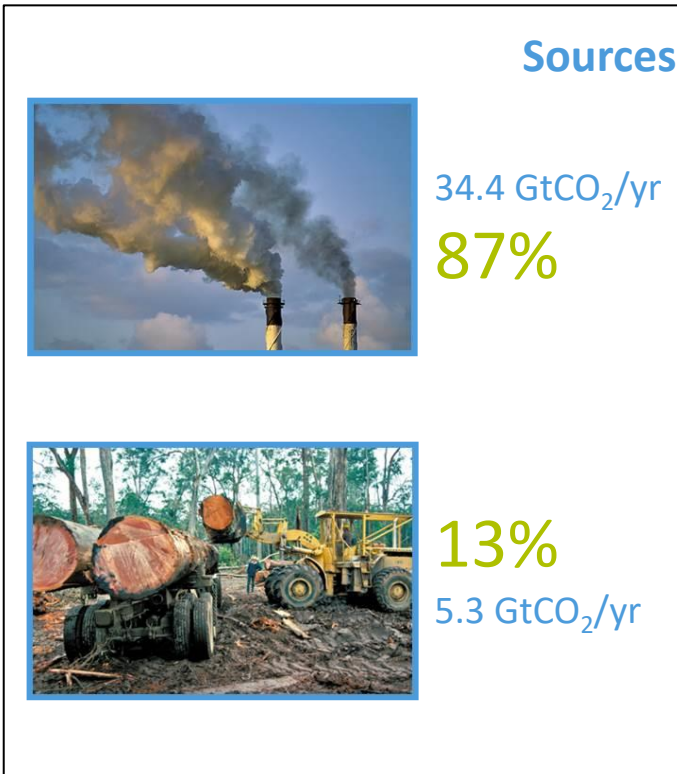
THE OCEAN CARBON OBSERVING SYSTEM, ITS CURRENT STATUS, CHALLENGES AND NEEDS

Richard Sanders ICOS Ocean Thematic Centre  
Bergen, Norway

# Contents

- The need for an ocean observing system
- Current Status
- Future Plans

# Fate of anthropogenic CO<sub>2</sub> emissions (2008–2017)



Budget Imbalance:  
**5%**  
1.9 GtCO<sub>2</sub>/yr

# Future of Ocean C Sink

- Will regulate cost, timing and timing of emission reductions, NETs.
- Uncertain
- Poorly Measured
- Ocean Carbon Value Chain
  - Fragile
  - Voluntary
  - Critical Single point

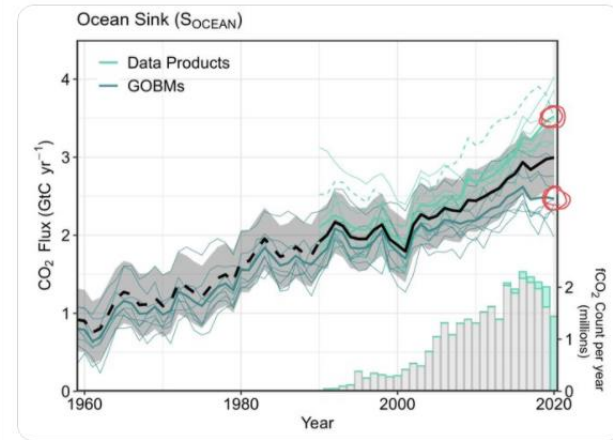


David Ho  
@\_david\_ho\_

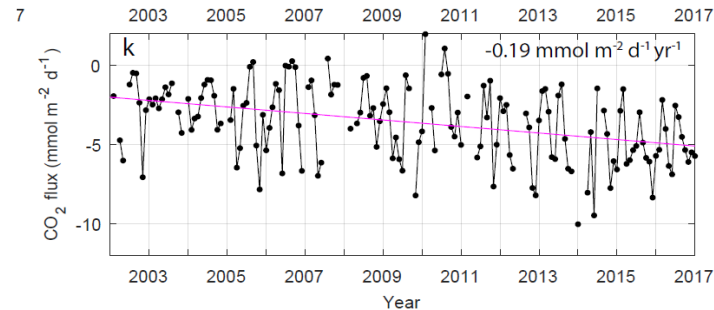
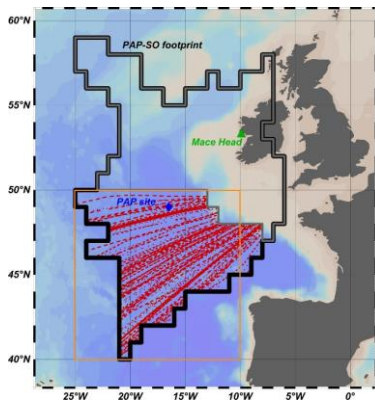
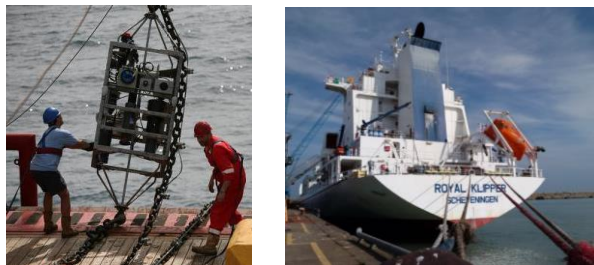
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This figure from the just published 2021 Global Carbon Budget (@gcarbonproject) showing the significant discrepancy between data and model based methods to estimate the ocean carbon sink is going to give me nightmares for a while. We've got work to do.

[bit.ly/3CJakU9](https://bit.ly/3CJakU9)

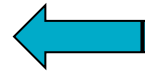
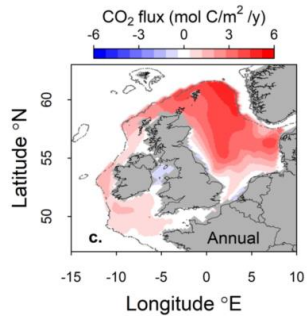
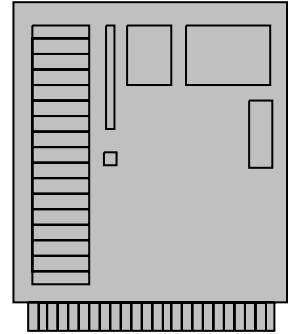
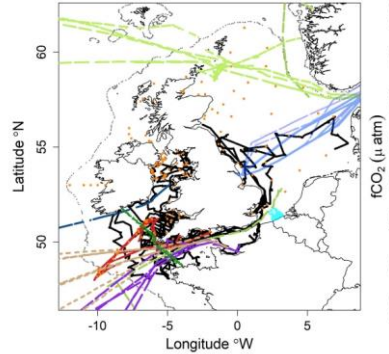


# We have the tools to do the job



- Macovei et al, (2020) Progress in Oceanography.
- Local Strengthening of sink in NE Atlantic over last 2 decades
- Ship no longer operating, what is happening now?

# We have the tools to do the job



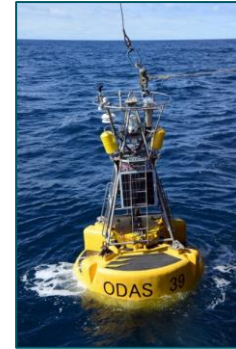
SCIENTIFIC  
REPORTS  
nature research



- Definitive study of N Sea published in 2020
- 2015 net atmospheric influx was  $26.2 \pm 4.7 \text{ Tg C y}^{-1}$
- What is happening now?

# Ocean Thematic Centre

- **Leadership, outreach and administration** 'Helping the ICOS Ocean Observing Community deliver the data we need to quantify the oceans role in planetary C Cycling' (Richard Sanders, Jess Thorn, Andrew Watson)
- **Labelling** 'Helping stations to document that they make the highest quality measurements consistent with international best practice' (Ingunn Skjelvan)
- **Data** 'Building and sustaining the data pathway between ship and policy maker' (Benjamin Pfeil)
- **Training** 'Helping the community of stations to deliver the highest quality data' (Tobias Steinhoff)
- **Technology** 'Exposing stations to next generation technologies which will allow them to make better, cheaper, faster, less power intensive observations, often on new platforms' (Socratis Loucaides)



# Optimal Network probably contains a blend of platforms

EGU21-11442

<https://doi.org/10.5194/egusphere-egu21-11442>

EGU General Assembly 2021

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- Inclusion of Argo and Moorings key
- Inherent assumption that SOCAT will stay the same

## Observation System Simulation Experiments for surface ocean pCO<sub>2</sub> reconstructions in the Atlantic Ocean

Anna Denvil-Sommer<sup>1</sup>, Marion Gehlen<sup>2</sup>, and Mathieu Vrac<sup>2</sup>

<sup>1</sup>University of East Anglia, Norwich, UK ([anna.sommer.lab@gmail.com](mailto:anna.sommer.lab@gmail.com))

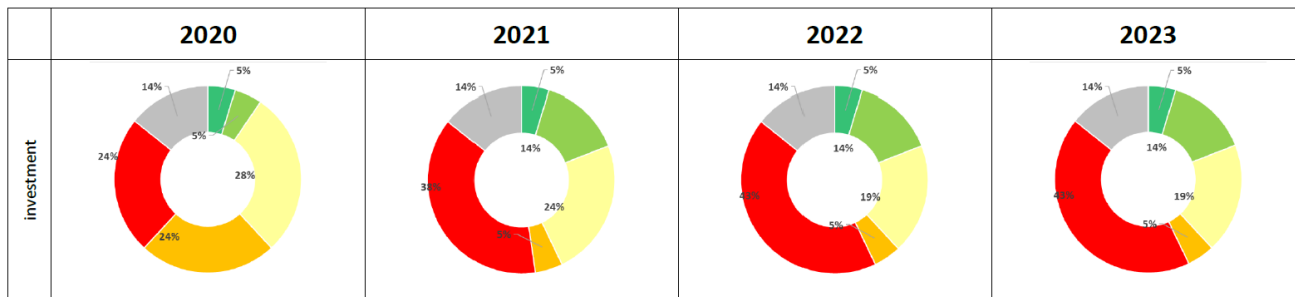
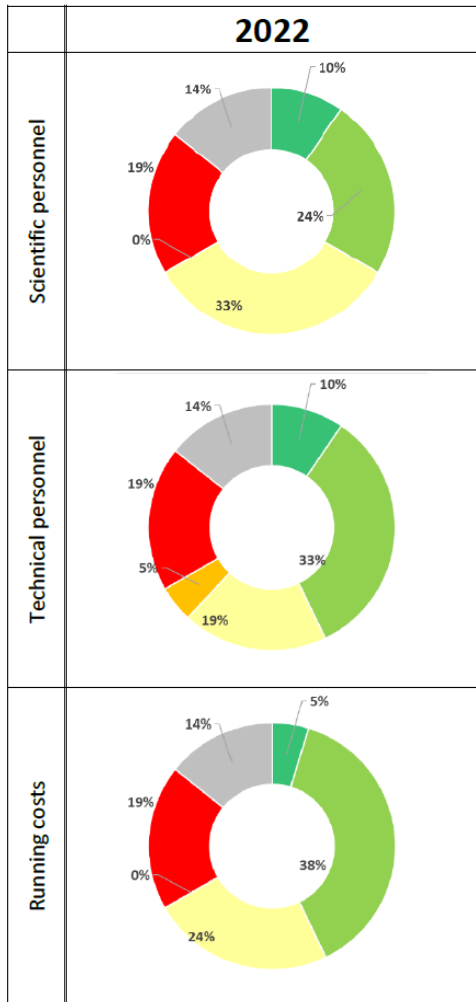
<sup>2</sup>CNRS, Laboratoire des Sciences du Climat et de l'Environnement, Gif Sur Yvette, France

physical-biogeochemical global ocean model with a 0.25° nominal spatial resolution. The aim of this work was to find an optimal spatial distribution of observations to supplement the widely used Surface Ocean CO<sub>2</sub> Atlas (SOCAT) and to improve the accuracy of ocean surface pCO<sub>2</sub> reconstructions. OSSEs showed that the additional data from mooring stations and an improved



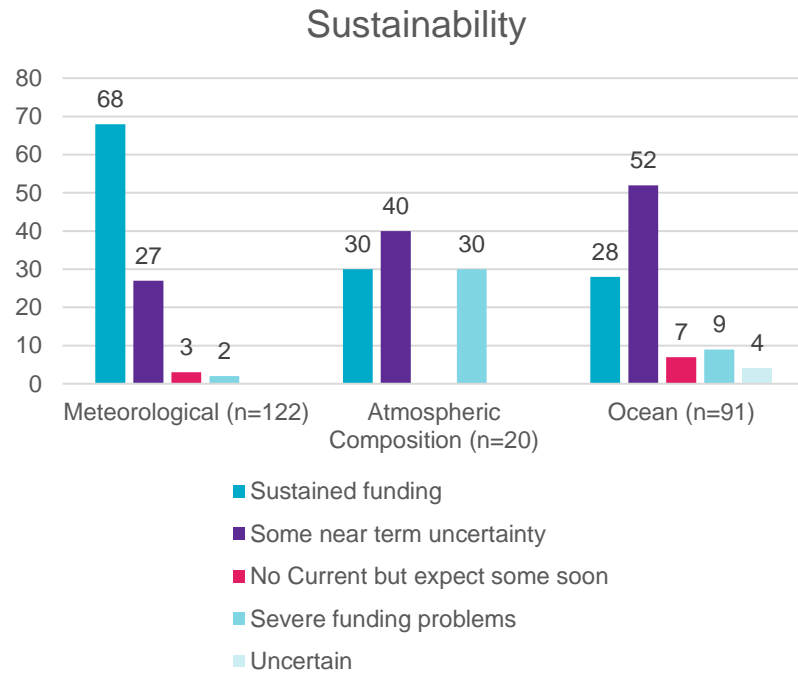
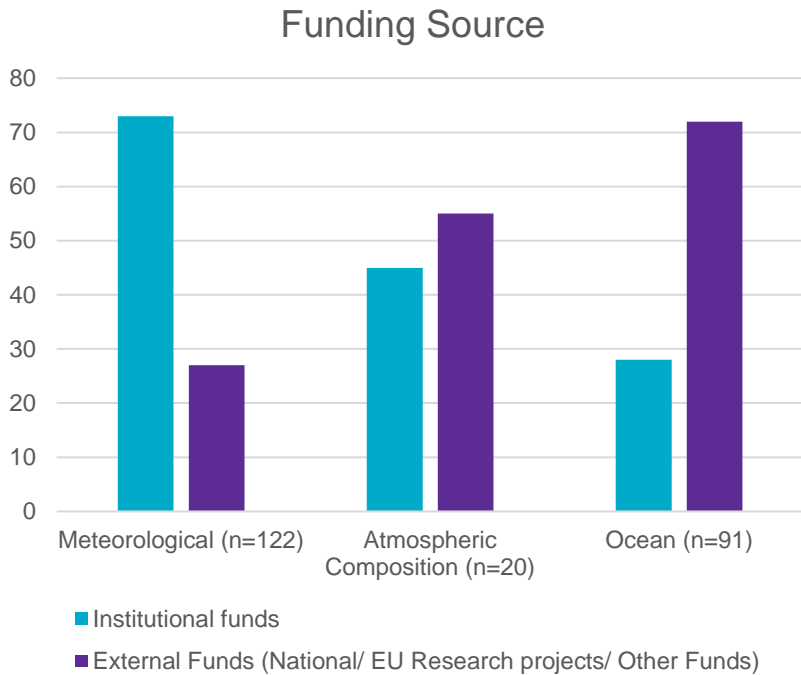
# ICOS Survey of Funding Sustainability of Stations 2020-2023

5	4	3	2	1	
No funding	Funding questionable	Basic/not sustainable funding	Sufficient funding available	Secured/sustainable funding	No response



- From this year around 75% of stations do not have enough investment going into them.
- In 2 years time, around half the stations will have inadequate running costs and people
- These are the basic data we use to quantify the (changing?) role of the ocean in the global C cycle.

# Funding sustainability of the environmental in situ observing networks in Europe



# Propose IOCOS



INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION  
COMMISSION Océanographique Intergouvernementale  
COMISIÓN OCEANOGRÁFICA INTERGUBERNAMENTAL  
МЕЖПРАВИТЕЛЬСТВЕННАЯ ОКЕАНОГРАФИЧЕСКАЯ КОМИССИЯ  
اللجنة الدولية الحكومية لعلوم المحيطات  
政府间海洋学委员会

UNESCO - 7 Place de Fontenay - 75352 Paris Cedex 07 SP, France  
<http://ioc.unesco.org> - contact phone: +33 (0)1 45 68 03 18  
E-mail: [v.ryabinin@unesco.org](mailto:v.ryabinin@unesco.org)

Ref. : IOC/VR/21.373/JB/AC/cn

7 October 2021

Dear Mr Sanders,

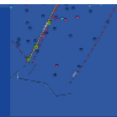
It is with great pleasure that I am writing to inform you of the endorsement of your Decade Action entitled "Integrated Ocean Carbon Observing System, ID 123" as a project forming part of the UN Decade of Ocean Science for Sustainable Development 2021-2030.

Please accept my sincere congratulations for this achievement. Let me also thank you for your engagement and commitment to the Ocean Decade vision of the science we need for the ocean we want.



## Ocean Observing Co-Design

by The Global Ocean Observing System



# Transforming our ocean observing system assessment and design process

Supporting the Decade of Ocean Science  
for Sustainable Development

**Ocean Observing Co-Design will build a system co-designed with scientific experts in observations and forecasts, and with key user stakeholders.**

**It will provide fit-for-purpose ocean observing, supplying the information required to manage the ocean we need for the future we want.**

Decade of Ocean Science

# ICOS



# Supportive International Context

- NOAA Statement
- G7 Statements
- UN Decade
- Canadian NACO
- IOCR
  
- G7 FSOI- IOCCP
- JPI Oceans



## NOAA's Role at COP26



*NOAA is committed to helping the world respond to climate change through its mission of delivering climate science, service, and stewardship.*

### Science

**Advancing the state of the science for sea-level rise.** Collaborating with several U.S. agencies, NOAA will publish updated sea-level rise and extreme coastal water projections for every U.S. state and territory, filling gaps for rural and underserved regions. This data is key for advancing how we plan for coastal resilience, infrastructure and emergencies.

**Enhancing the World Ocean Database.** NOAA will develop and deploy a new tool within the World Ocean Database to help ocean data users easily discover and access immense volumes of globally distributed ocean information. Partnering with the International Oceanographic Commission, this investment will increase timely, high quality input for climate forecast models, as well as seasonal and longer time-scale monitoring.

**Opening a Pacific Islands ocean acidification training center.** NOAA and the U.S. Department of State are partnering with the South Pacific Community, the University of the South Pacific, and The Ocean Foundation to launch a new training center in Fiji to expand capacity for ocean acidification monitoring and research across the Pacific Islands. Understanding how ocean acidification affects local coral reefs and fisheries will enable better protection for the ecosystems, livelihoods, and economies they support.

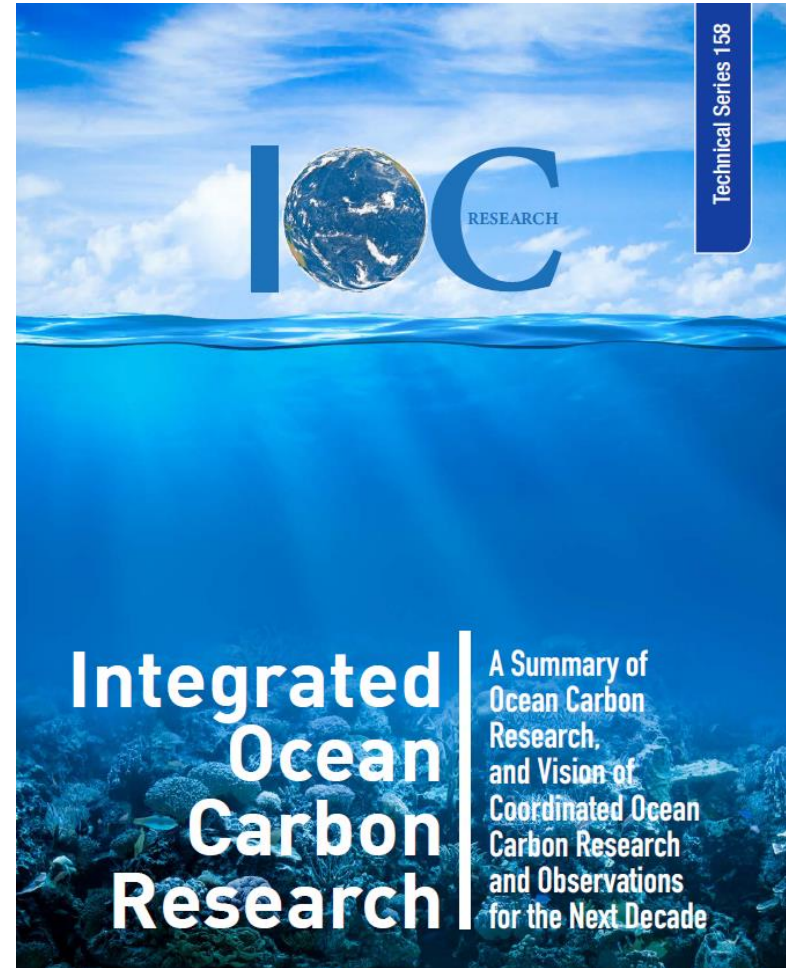
**Launching the NOAA Blue Carbon Inventory.** In partnership with the U.S. Department of State, NOAA will provide technical support to countries to incorporate coastal blue carbon into their National Greenhouse Gas Inventories (NGGI). NOAA will focus on 3-5 geographically-diverse countries, amplifying the impact of this investment through regional partnerships, interagency collaboration, and activities such as the development of guidebooks, workshops and training materials. This metric is an important way countries track progress towards achieving their climate ambitions.

**Establishing a globally operational Surface Ocean CO<sub>2</sub> Reference Network.** The network will integrate established and proposed national and regional surface ocean carbon dioxide (CO<sub>2</sub>) research and monitoring efforts into a global framework, enabling countries to track changes in global ocean uptake of CO<sub>2</sub> over time. Through international engagement, NOAA will facilitate the development of the global network and produce high-value products, such as observation-based annual updates of ocean carbon uptake and changes in ocean acidification, that are critical for decision making about ocean-based mitigation options and marine ecosystem health.

[www.climate.gov/COP26](http://www.climate.gov/COP26)

# IOCR

- Will the ocean uptake of anthropogenic CO<sub>2</sub> continue as primarily an abiotic process?
- What is the (changing) role of biology in the ocean carbon cycle?
- What are the exchanges of carbon between the land-ocean-ice continuum and how are they evolving over time?
- How are humans altering the ocean carbon cycle and resulting feedbacks?

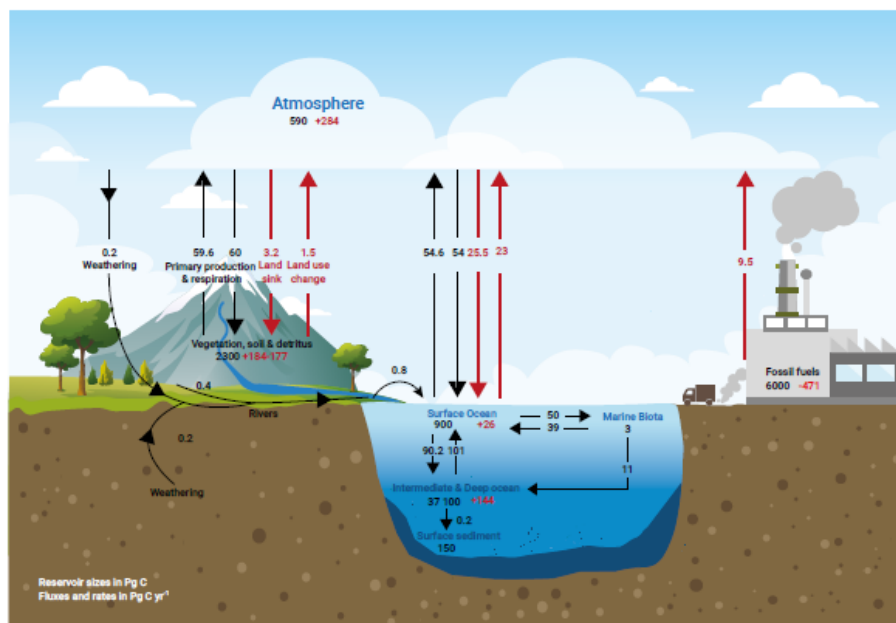


**b. Enhance and coordinate the existing suite of carbon observing and synthesis projects (R. Sanders, S. K. Lauvset, U. Schuster, D. C. E. Bakker)**

Two different *in situ* approaches are currently used to quantify surface ocean carbon uptake and interior ocean transport and storage. Surface ocean observations of  $p\text{CO}_2$  and associated parameters are combined with remote sensing, reanalysis information, and statistical models (mapping methods) to evaluate the ocean uptake of atmospheric  $\text{CO}_2$  across the sea surface at relatively high spatial (100 km) and

**e. New technologies to enhance autonomous observations and analyses (J. D. Shutler, A. J. Watson)**

Implementing the IOC-R research agenda will rely heavily on recent observational and analytical advances. In particular, remote sensing, autonomous platforms and vehicles, and artificial intelligence approaches offer the opportunity to study and solve pressing research questions regarding the workings and perturbations of the ocean carbon cycle.



**Figure 2** Inventories of major carbon reservoirs and transport between the reservoirs of the global carbon cycle, estimated for the decade of 2010-2020. Black arrows and numbers indicate the natural carbon cycle and reservoirs, while red arrows and numbers indicate anthropogenic perturbations. The figure is adapted from Sarmiento and Gruber (2002)<sup>3</sup>, with the permission of the American Institute of Physics, updated to the decade of 2009-2018 using values from Friedlingstein et al. (2019)<sup>6</sup>. Changes in natural fluxes between the ocean and atmosphere are based on a downward revision of the global gas average transfer velocity<sup>7</sup>. Uncertainties in values range from 10-50%.

# G7 Action



## G7 2030 Nature Compact

(3E) **Supporting the UN Decade of Ocean Science for Sustainable Development:** endorsing the G7 Ocean Decade Navigation Plan to drive developments in transformational ocean science to protect and further our sustainable relationship with the ocean. As part of this work we will convene scientific and policy experts to discuss the carbon absorption function of the ocean, furthering targeted and effective ocean action.



- Scoping Paper v2, June 2021-

***A Surface Ocean CO<sub>2</sub> Monitoring Network: Facilitating the development of an internationally-agreed observing strategy and coordination structure for GOOS.***

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*In partnership with the GOOS Biogeochemistry Panel and other international and G7 Member ocean carbon programmes, catalyse and facilitate the development of an internationally-agreed strategy for monitoring surface ocean CO<sub>2</sub> globally, and build on existing observing programmes, data management structures, and coordination bodies to create a global surface monitoring CO<sub>2</sub> network capable of responding to the needs of global and regional policy drivers including the UNFCCC Global Stocktake 2023.*

*Action Areas 1, 3, and 4.*

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# Canadian NACO

SECTIONS Q SEARCH

THE HILL TIMES

Tuesday, December 14, 2021 | Latest Paper

News Opinion Foreign Policy Politics Policy Legislation Lobbying Hill Climbers Election

## GLOBAL

### How Canada can fix the single greatest miscalculation in climate policy

By ANYA WAITE OCTOBER 20, 2021

A Canadian-led North Atlantic Ocean Carbon Observatory could be Canada's most important contribution to the fight against climate change.



Former Bank of Canada governor Mark Carney, pictured in 2012. Mr. Carney warned earlier this month that any calculation of global carbon dioxide emissions must take into account changes in the ocean. *The Hill Times* photograph by Andrew Meade

LEADER

### Warming oceans may absorb less carbon and that could impact climate goals: scientist

By Sarah Sewell The Canadian Press  
Mon, Nov. 8, 2021 43 mins read  
Article was updated Nov. 09, 2021



ST. JOHNS, N.L. — Warming oceans may be absorbing less carbon dioxide than they used to, and scientists say that could have serious ramifications for climate targets.

More research is desperately needed on how climate change is impacting the ability of the world's oceans to absorb greenhouse gas emissions, says Anya Waite, scientific director and chief executive officer of the Ocean Frontier Institute, a research partnership between Dalhousie University in Nova Scotia, Memorial University in Newfoundland and Labrador, and the University of Prince Edward Island.

"Climate targets actually haven't been taking into account the ocean, and we urgently need to take the ocean into account or we won't be able to reach climate targets," Waite said in a recent interview from the United Nations climate change conference in Glasgow, Scotland.

"In fact, the targets themselves may be wrong."

Oceans that are no longer able to absorb carbon may become carbon emitters, she said.





Home » News & Events » News » JPI Oceans launches new Joint Action on Ocean Carbon Capacities



2021.12.06

## JPI OCEANS LAUNCHES NEW JOINT ACTION ON OCEAN CARBON CAPACITIES

At its 25th Meeting in November 2021, the JPI Oceans Management Board approved the Scoping Action on Ocean Carbon Capacities to formally become a new JPI Oceans Joint Action.

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## International Ocean Carbon Coordination Project

Towards a sustained global observation network for marine biogeochemistry



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DOCUMENTS

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» Home » News » Towards a global strategy for monitoring of Surface Ocean CO<sub>2</sub> - collaboration between G7 FSOI and IOCCP

The IOCCP promotes the development of a global network of ocean carbon observations for research through technical coordination and communication services, international agreements on standards and methods, and advocacy and links to the global observing systems. The IOCCP is co-sponsored by the Scientific Committee on Oceanic Research and the Intergovernmental Oceanographic Commission of UNESCO. Read more...

» [Surface Ocean Biogeochemistry Observations](#)

» [Ocean Interior Observations](#)

### Towards a global strategy for monitoring of Surface Ocean CO<sub>2</sub> - collaboration between G7 FSOI and IOCCP

» [IOCCP-Activities](#)  
» [pCO<sub>2</sub>](#)

We are happy to share with you the news that the G7 Future of the Seas and Oceans Initiative (FSOI) will collaborate with the IOCCP to develop an **internationally agreed strategy for Surface Ocean CO<sub>2</sub> monitoring**. The G7 and IOCCP collaboration was presented by the EU coordinator of the G7 FSOI Coordination Centre during a scoping workshop entitled "Ocean Carbon Capacities: Identifying priorities for collaborative action" held by the EU Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans) on 21 October. The workshop focused on an action plan to develop a robust reporting system capable of understanding, evaluating and predicting ocean carbon uptake on an annual basis, placing these in the context of other ocean carbon sources and sinks, and reporting the results of this to the UNFCCC Global Stocktake 2023.

ICOS

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SYSTEM

### **Phase 1: Strategy Development** (mid-2021 to mid-2022)

Develop a G7 FSOI Task Team with partners to address Tasks 1 – 3 through an international workshop (virtual or mixed) and through regular writing team meetings to draft and circulate for extensive international review a strategy for a global surface CO<sub>2</sub> monitoring network, including a phased implementation plan (roadmap) and budget requirements.

#### **Deliverables:**

Workshop report of the Strategy Development meeting.

Draft strategy, phased-implementation plan, and roadmap for the development of a sustained global surface ocean CO<sub>2</sub> monitoring network.

### **Phase 2: Establishment of the Global Network and Implementation agreements** (mid-2022 to early-2023)

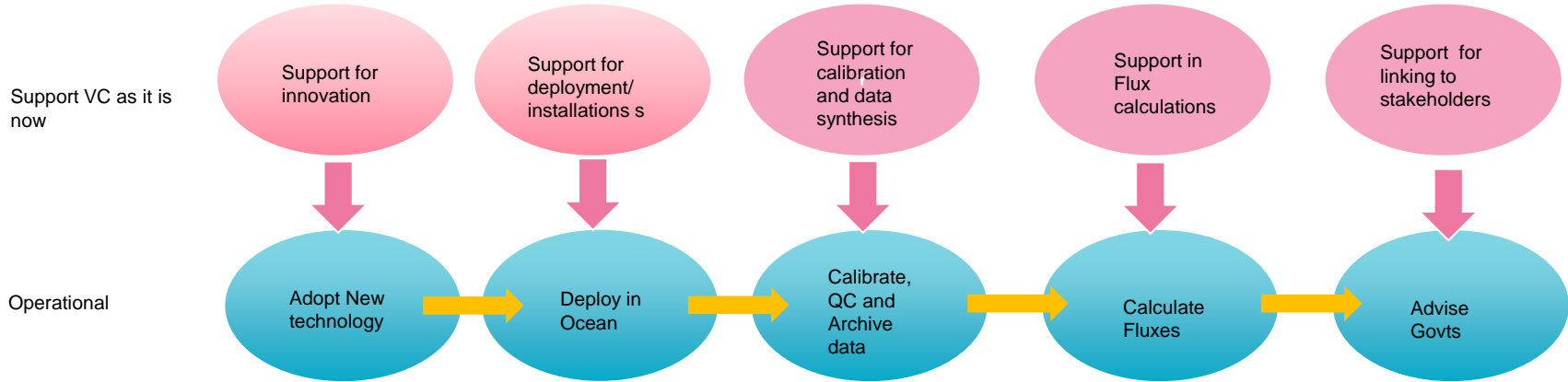
Using the Draft strategy and roadmap developed by the Task Team in Phase 1, host a stakeholders forum and global workshop for government agencies and ministries (G7 FSOI and GOOS) to address Task 4; namely, identify existing national programmes that are elements of the global surface ocean CO<sub>2</sub> monitoring network, identify critical gaps in the observing system (including global coordination structures and data management activities), and reach agreements on priorities for coordinated investment to establish the global network.

# Acceptance step/ Ambition for Value Chain

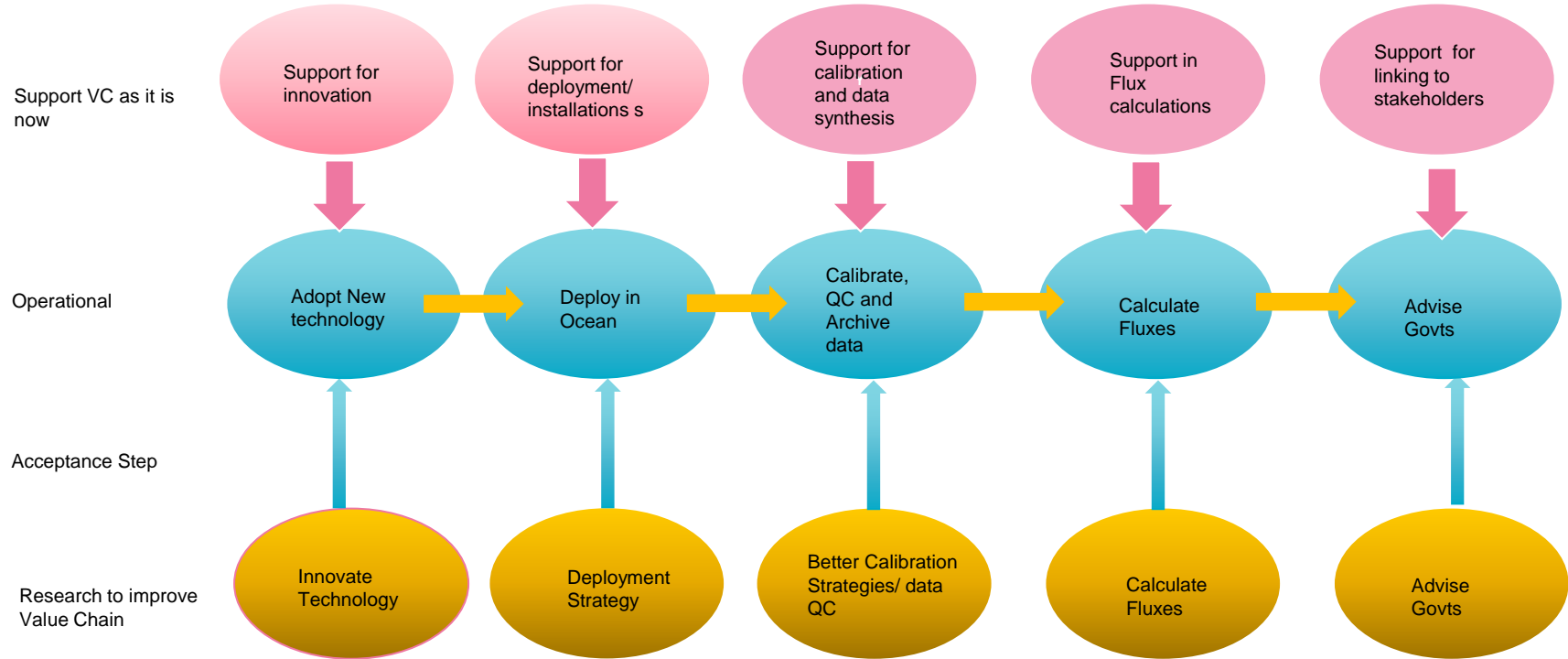
Operational



# Ambition for Value Chain?



# Ambition for Value Chain?



Research to improve Value Chain

New Sensors, new platforms

How Many sensors? What platforms? Where

New QC methods (AI etc) Intercomparison Strategies

New algorithms, more AI, new theory

Better links to other components of global C cycle,

# Summary

- Ocean C cycle is key part of global C cycle
- It is not stable and its response to net zero is uncertain
- Our current systems to measure it are multiplatform and work
- However they are poorly funded and fragile
- There is a massive international impetus to improve things via a value chain approach



