ICOS

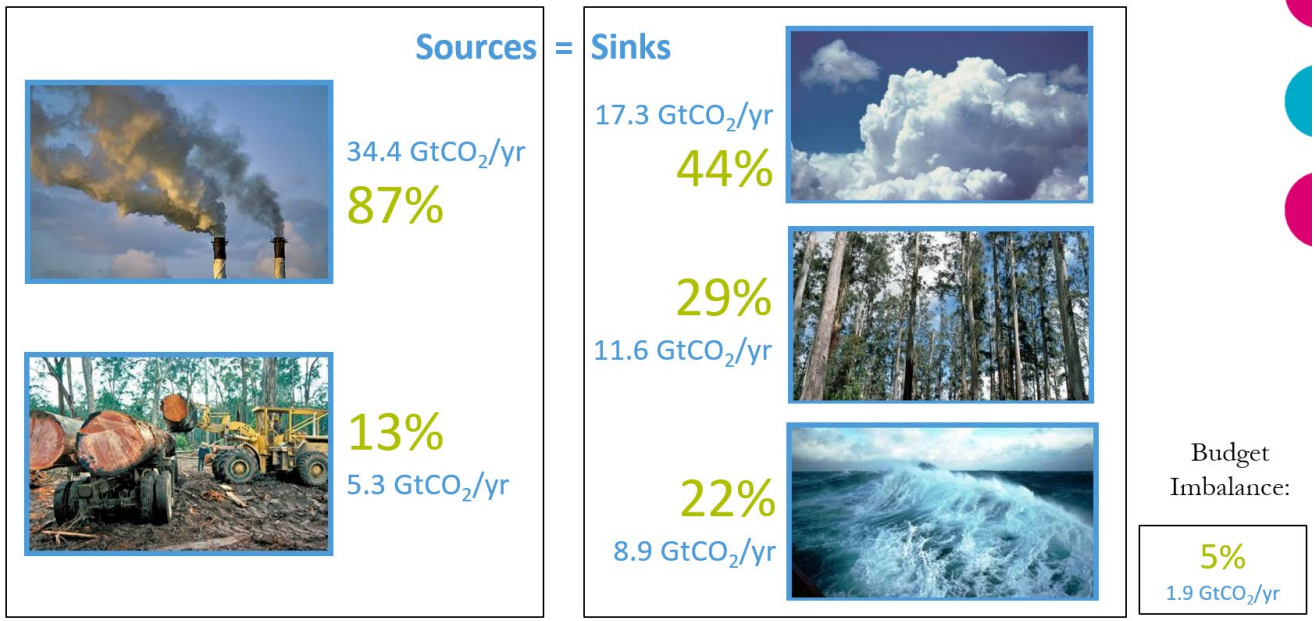
INTEGRATED CARBON OBSERVATION SYSTEM

HIGHLIGHTS FROM THE LAST 2 YEARS AND FUTURE PERSPECTIVES

Oceans MSA and OTC

Richard Sanders, Ingunn Skjelvan, Tobias Steinhoff Steve Jones, Benjamin Pfeil, Andrew Watson, Socratis Loucaides, Ute Schuster, Meike Becker, Sue Hartman

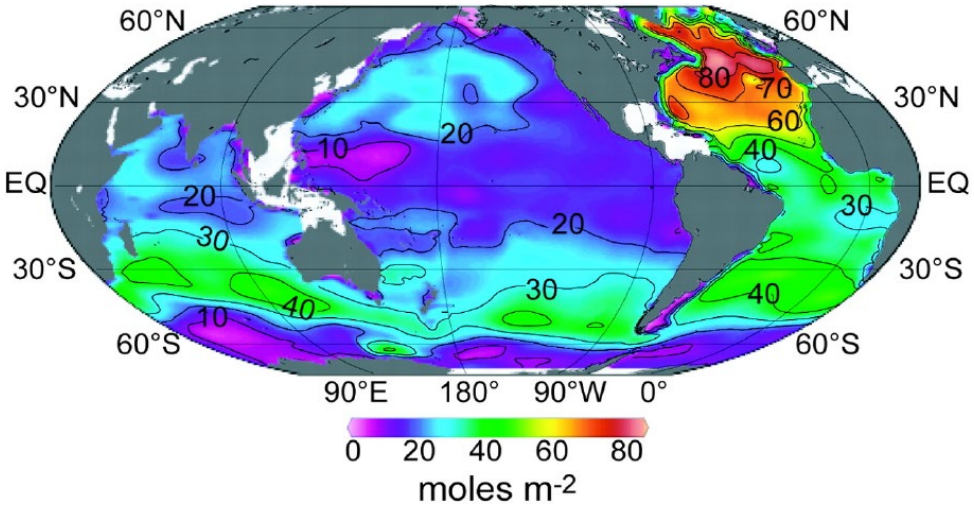
Fate of anthropogenic CO_2 emissions (2008–2017)



Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Le Quéré et al 2018; Global Carbon Budget 2018

- Future of Ocean Sink will affect timing, size and cost of mitigation and adaptation actions and future CDR (Carbon Dioxide Removal) actions.

Ocean sink is highly Variable in Space and time



The geographical distribution of ocean C anth uptake [Using CFCs to Estimate Anthropogenic CO2 Uptake in the Ocean | PMEL Ocean Tracer Program (noaa.gov)]

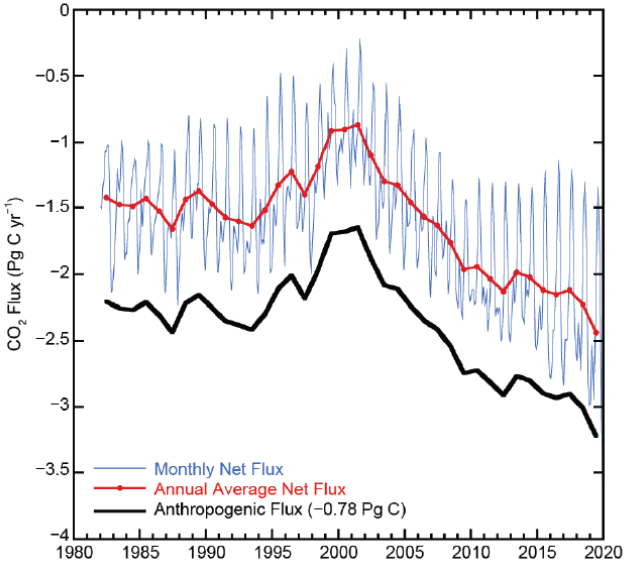


Fig. 3.26. Global annual (red line) and monthly (blue line) net CO_2 fluxes (Pg C yr^{-1}) for 1982–2019. The black line is the anthropogenic CO_2 flux that is the net flux plus the riverine component. Negative values indicate CO_2 uptake by the ocean.

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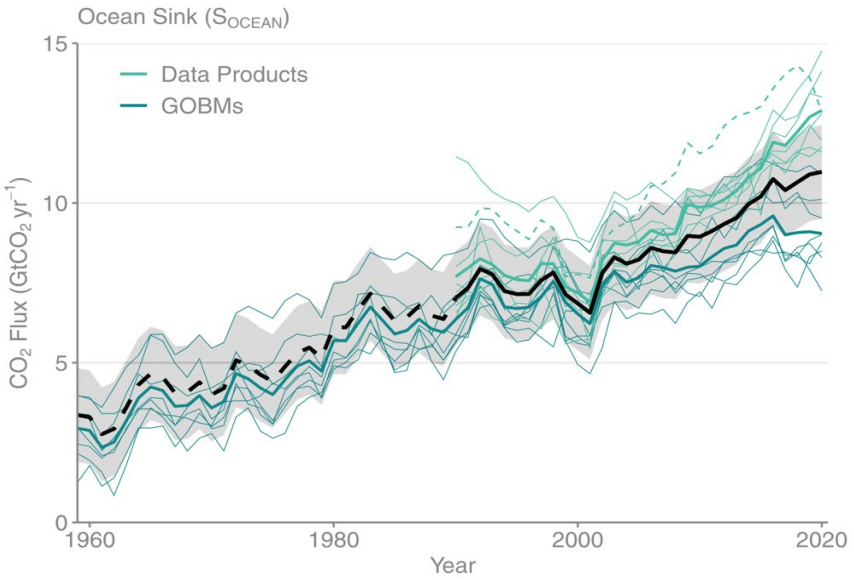
Lumpkin, R. L., Ed., 2020: Global Oceans [in "State of the Climate in 2019"]. Bull. Amer. Meteor. Soc., 101 (8), S129–S183, https://doi.org/10.1175/BAMS-D-20-0105.1.

Ocean models and data disagree



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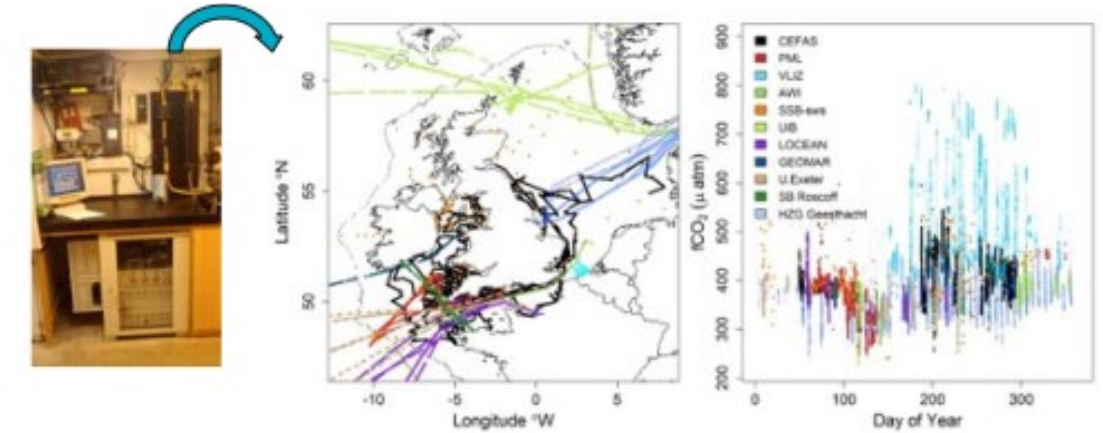
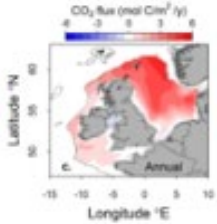
Global C project

Require system to monitor ocean C uptake and report it to decision makers in suport of climate negotiations

ICOS: Head Office, Stations across Europe, Data Centre, Calibration labs, Thematic Centres supporting stations.

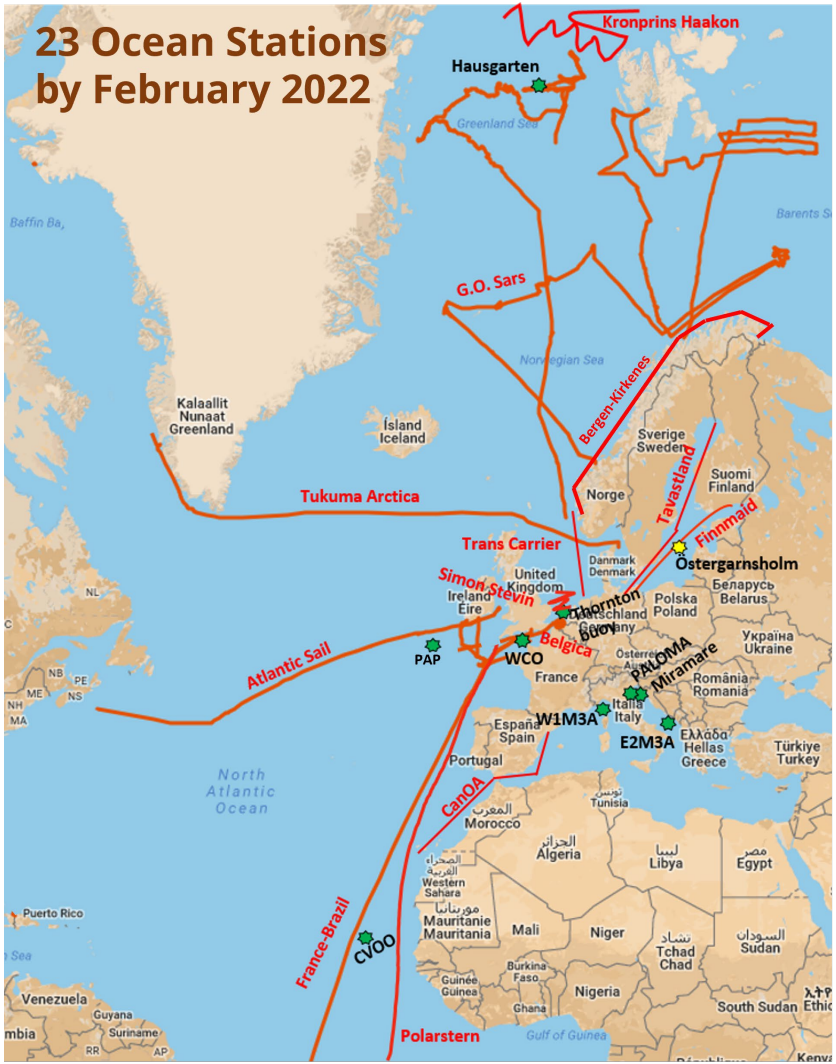


SCIENTIFIC REPORTS
nature research



Winter weather controls net influx of atmospheric CO_2 on the north-west European shelf

Vassilis Kitidis, PML, U.K..



BE-SOOP Belgica
BE-SOOP Simon Stevin
DE-SOOP Finnmaid
DE-SOOP Atlantic Sail
DE-SOOP Polarstern
ES-SOOP CanOA
FR-SOOP France-Brazil
NO-SOOP Bergen-Kirkenes
NO-SOOP G.O. Sars
NO-SOOP Kronprins Haakon
NO-SOOP Tukuma Arctica
NO-SOOP Trans Carrier
SE-SOOP Tavastland

SOOP – Ship Of Opportunity Program (13)

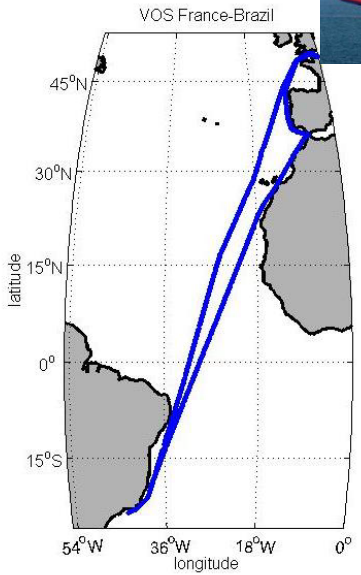
BE-FOS Thornton buoy
DE-FOS CVOO
DE-FOS Hausgarten
IT-FOS E2M3A
IT-FOS W1M3A
IT-FOS Miramare
IT-FOS PALOMA
UK-FOS PAP
UK-FOS Western Channel Obs.

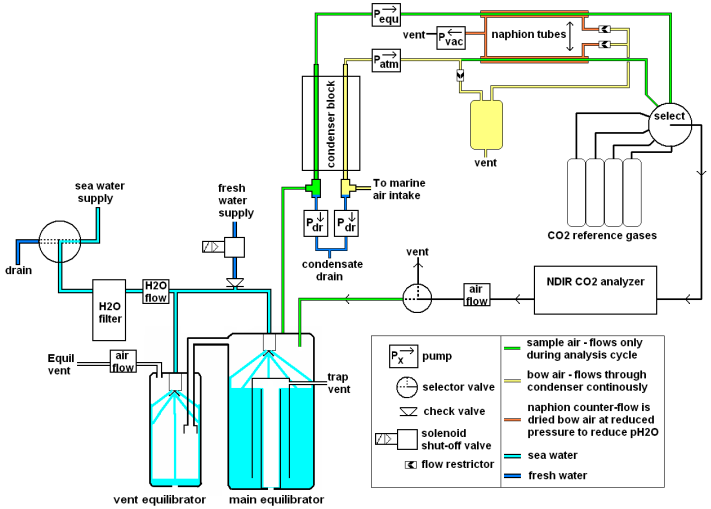
FOS – Fixed Ocean Station (9)

SE-MFT Östergarnsholm

MFT – Marine Flux Tower

SOOP (Ship Of Opportunity Program) lines

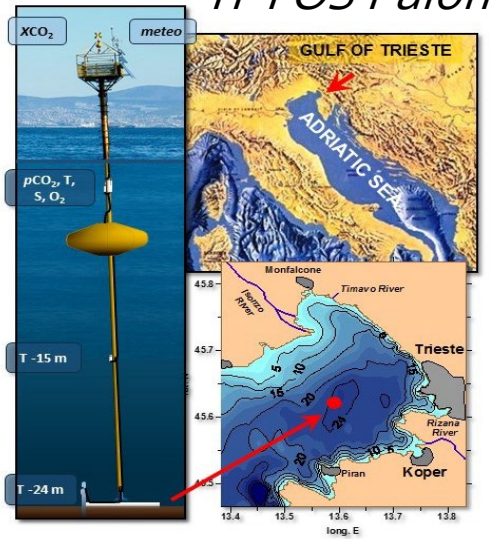




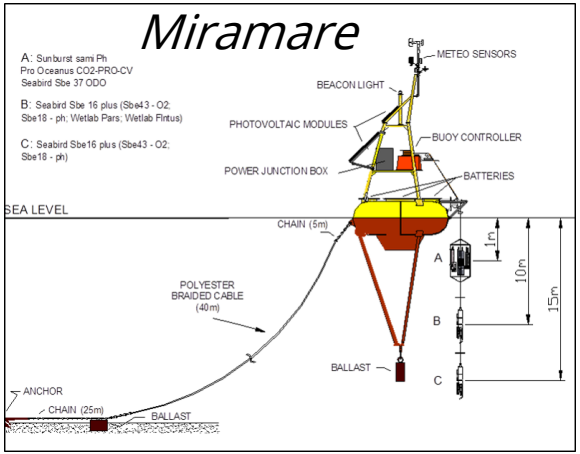
Based on SOCAT methods and requirements

FOS (Fixed Ocean Stations)

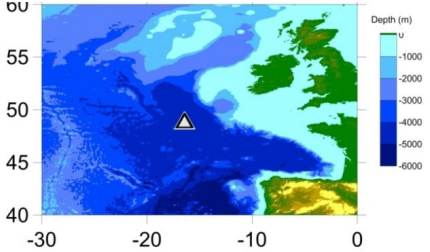
IT-FOS Paloma

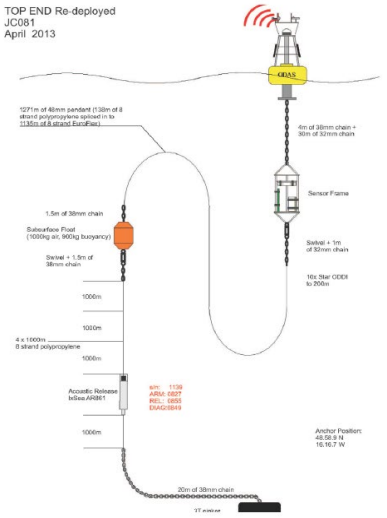


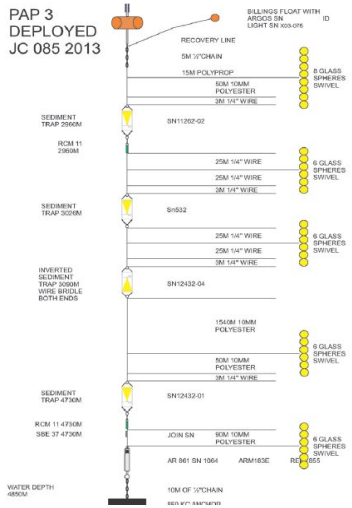
IT-FOS Miramare



UK-FOS PAP (Porcupine Abyssal Plain)







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OTC services supplied to MSA

- Labelling (Ingunn Skjelvan, NORCE)
- Training and Station Support (Tobias Steinhoff, NORCE)
- Data (Steve Jones, UiB)
- Technology (Socratis Loucaides, NOC)
- Leadership and Management (Richard Sanders, NORCE, Andy Watson & Ute Schuster, Exeter)

- Support via Station Subscriptions (roughly 10K Eu per year per station and National Govts)
- Scale is approx. 6FTE, 3 in kind.

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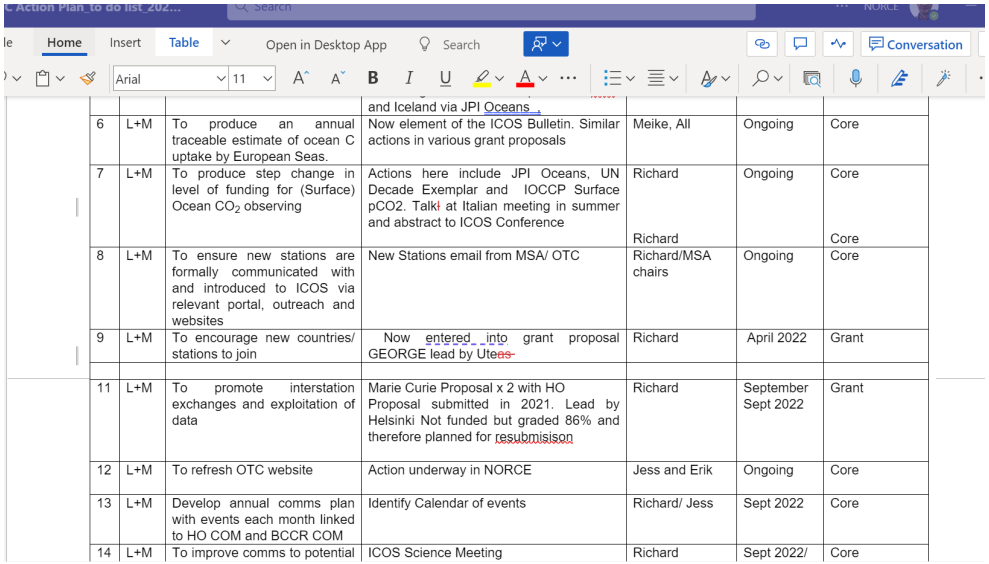
OTC Workplan

- General Work programme described in Annex II
- Annual Activity Plan broken into Core Actions and Grant Actions
- Reviewed in summer and new plans developed with MSA Chairs
- Discussion with MSA in Autumn
- Approved by GA in Autumn



			and Iceland via JPI Oceans			
6	L+M	To produce an annual traceable estimate of ocean C uptake by European Seas.	Now element of the ICOS Bulletin. Similar actions in various grant proposals	Meike, All	Ongoing	Core
7	L+M	To produce step change in level of funding for (Surface) Ocean CO_2 observing	Actions here include JPI Oceans, UN Decade Exemplar and IOCCP Surface pCO2. Talki at Italian meeting in summer and abstract to ICOS Conference	Richard Richard	Ongoing	Core Core
8	L+M	To ensure new stations are formally communicated with and introduced to ICOS via relevant portal, outreach and websites	New Stations email from MSA/ OTC	Richard/MSA chairs	Ongoing	Core
9	L+M	To encourage new countries/ stations to join	Now entered into grant proposal GEORGE lead by Utees-	Richard	April 2022	Grant
11	L+M	To promote interstation exchanges and exploitation of data	Marie Curie Proposal x 2 with HO Proposal submitted in 2021. Lead by Helsinki Not funded but graded 86% and therefore planned for resubmisison	Richard	September Sept 2022	Grant
12	L+M	To refresh OTC website	Action underway in NORCE	Jess and Erik	Ongoing	Core
13	L+M	Develop annual comms plan with events each month linked to HO COM and BCCR COM	Identify Calendar of events	Richard/ Jess	Sept 2022	Core
14	L+M	To improve comms to potential	ICOS Science Meeting	Richard	Sept 2022/	Core

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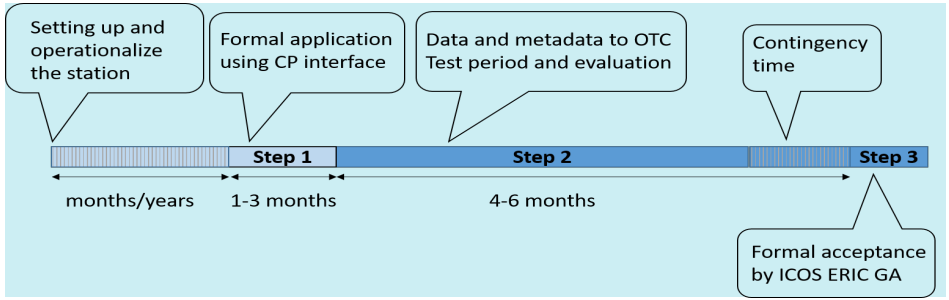
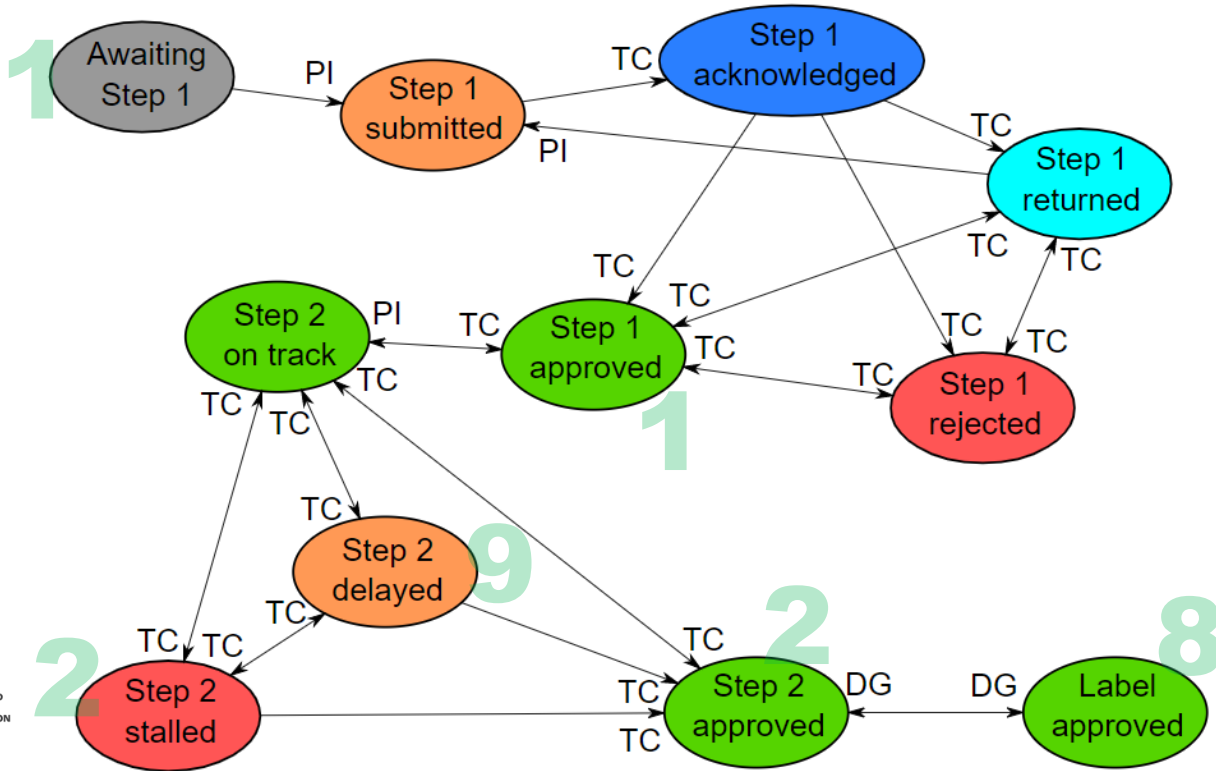
Labelling steps and sub-steps





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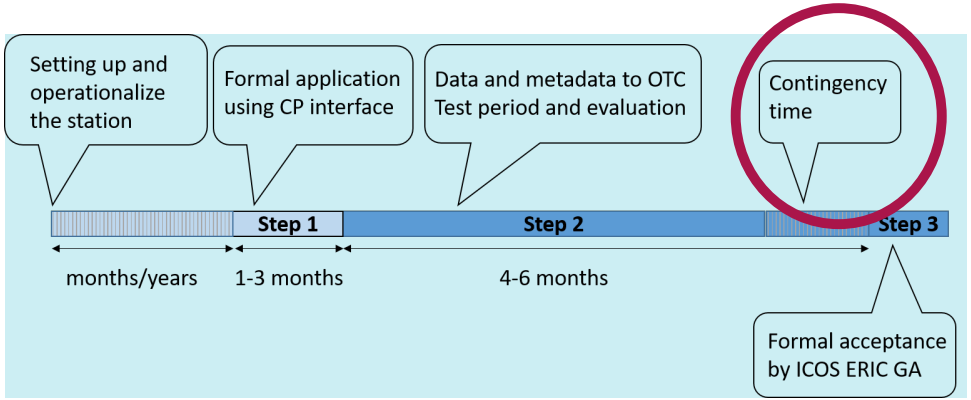
Challenges



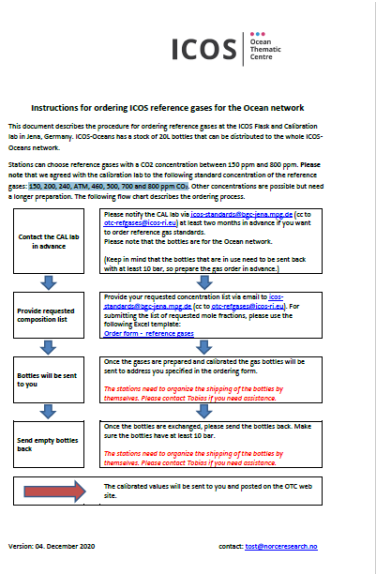
- Instrumental failure
- Failure with ship/buoy
- Cancelling of cruises
- Lack of discrete samples for FOS validation
- Lack of funding for station and/or PI
- Lack of alternative validation methods for FOS
- **Currently working on all these elements**

Support: ICOS reference gases

Reference gases are now available for ALL marine ICOS stations!

- The CAL lab purchased 60 bottles (20 L) in 2020
- We can choose out of the following cocentrations:
  150, 200, 240, ATM, 460, 500, 700 and 800 ppm CO_2

  Other concentrations are possible, but might take longer
- Ordering process:
  - OTC website -> Training and Support -> Reference gases -> Ordering instructions
  - Fill out the excel sheet and send it to CAL and Tobias



ICOS Ocean Thematic Centre

Instructions for ordering ICOS reference gases for the Ocean network

This document describes the procedure for ordering reference gases at the ICOS Flask and Calibration lab in Jena, Germany. ICOS-Oceans has a stock of 20L bottles that can be distributed to the whole ICOS-Oceans network.

Stations can choose reference gases with a CO2 concentration between 150 ppm and 800 ppm. Please note that we agreed with the calibration lab to the following standard concentration of the reference gases: 150, 200, 240, ATM, 460, 500, 700 and 800 ppm CO_2. Other concentrations are possible but need a longer preparation. The following flow chart describes the ordering process.

Contact the CAL lab in advance
Please notify the CAL lab via icos-standards@bgc-jena.mpg.de (cc to otc-refgases@icos-ri.eu) at least two months in advance if you want to order reference gas standards.
Please note that the bottles are for the Ocean network.
[Keep in mind that the bottles that are in use need to be sent back with at least 10 bar, so prepare the gas order in advance.]

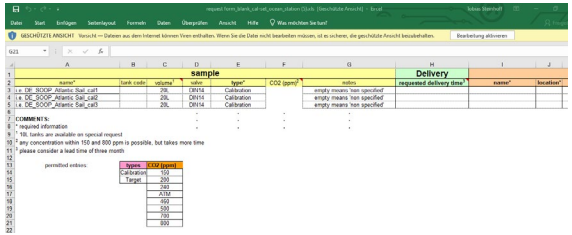
Provide requested composition list
Provide your requested concentration list via email to icos-standards@bgc-jena.mpg.de (cc to otc-refgases@icos-ri.eu). For submitting the list of requested mole fractions, please use the following Excel template:
Order form - reference gases

Bottles will be sent to you
Once the gases are prepared and calibrated the gas bottles will be sent to address you specified in the ordering form.
The stations need to organize the shipping of the bottles by themselves. Please contact Tobias if you need assistance.

Send empty bottles back
Once the bottles are exchanged, please send the bottles back. Make sure the bottles have at least 10 bar.
The stations need to organize the shipping of the bottles by themselves. Please contact Tobias if you need assistance.

The calibrated values will be sent to you and posted on the OTC web site.

Version: 04. December 2020 contact: test@norceresearch.no



1st ICOS OTC pCO_2 instrument inter-comparison exercise

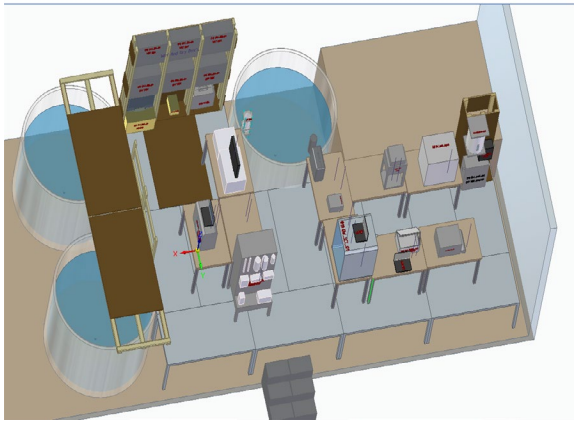
28 June - 09 July 2021

Ostend/Belgium

Tobias Steinhoff, **Thanos Gkritzalis**, Dariia Atamanchuk , Melissa Chierici, **Emma Dölger**, Emil Jeansson, **Steve Jones**, **Vlad Macovei**, Claire Mourgues, Craig Neill, Ute Schuster, Maciej Telszewski, **Hannelore Theetaert**, **Silke Verbrugge**

IC2021 at a glance

Flanders Marine Institute (VLIZ), Belgium
Marine Station Ostende



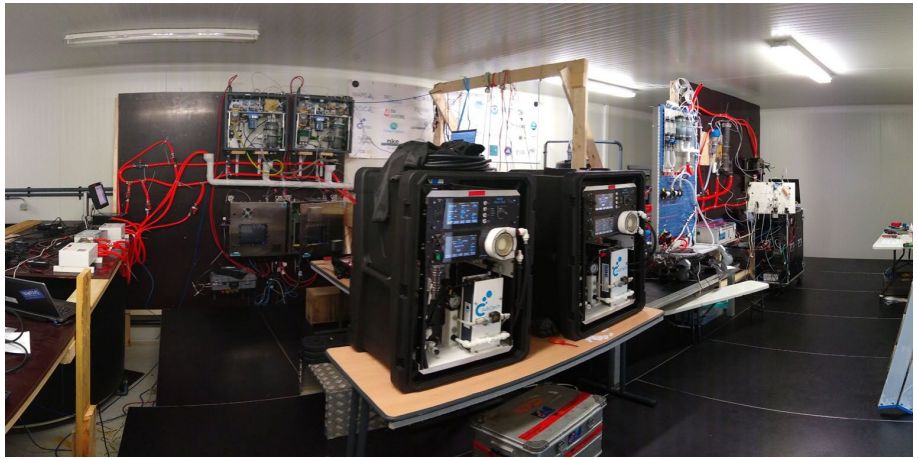
- Focus on surface applications
- Using a 5 m³ tank with natural sea water (North Sea) with heat exchanger
- Submersible pump that fed all flow-through instruments
- Allowing time for changes and/or adjustments
- Different pCO_2 levels, different temperatures (water/air)
- Defining groups around each instrument type
- Defining conditions for a successful deployment
  "Quick Start Guide"
- Use CO2 stds from ICOS CAL traceable to WMO scale (0-800 ppm)
- QuinCe data processing

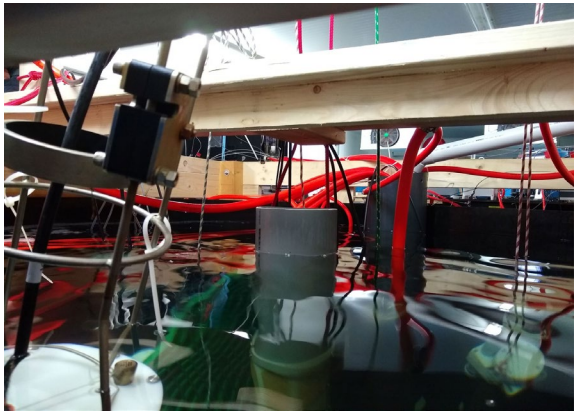
Underway (UW)	Surface (BUOY)	Submersible (SUB)
13 (8)	7 (6)	9 (4)

IC2021 – Take home message from preliminary results

- **Nearly 50% of the instruments agree within ±5 µatm (already)!**
- **The majority were instruments with calibration gases.**

- Finalizing week: 30. May – 03. June
- Draft ready: after summer break





Data. Development of Quince Tool for Data processing and submisison

- Complete data flow in place - email, NRT, Auto QC, manual QC, data check, publication
  - Currently used by all labelled underway stations except two
  - First FOS stations coming on line soon
- NRT sent to CP (until 2021 to CMEMS)
  L2 sent to CP
  Annual collections per station with DOI
  SOCAT submission is manual (no service on the SOCAT end) - will be working to make that as streamlined as possible

ICOS Carbon Portal

Copernicus Europe's eyes on Earth

Copernicus Marine Service

Providing products and services for all marine applications

Home | About & contacts | Observations | Data & Services | Science & impact | Resources | News & events | Log out | My Carbon Portal Account

View data cart 1 item

SD1030_NRT_20191017

Copy preview chart URL

Remove from cart

CO2 partial pressure (air) | CO2 partial pressure (water), SST

time instant, UTC	2020-07-17 17:11
latitude	
longitude	
practical salinity [psu]	
water temperature [°C]	
CO2 fugacity (water), SST [µatm]	
CO2 fugacity (air) [µatm]	
CO2 partial pressure (water), SST [µatm]	
CO2 partial pressure (air) [µatm]	
Data points in bounding box	5,727
Data points shown in map	3,913

CO2 partial pressure (air) — CO2 partial pressure (air) [µatm] — CO2 partial pressure (water), SST [µatm]

CO2 partial pressure (water), SST

CO2 partial pressure (air) [µatm]

CO2 partial pressure (water), SST [µatm]

2019-10-31 2019-11-30 2019-12-31 2020-01-31 2020-02-29 2020-03-31 2020-04-30 2020-05-31 2020-06-30

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International Actions

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 Fontenoy - 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

WMO International Greenhouse Gas Monitoring Symposium

START DATE
30 January 2023

END DATE
01 February 2023

LOCATION
Geneva, WMO HQ

WMO INTERNATIONAL GREENHOUSE GAS MONITORING SYMPOSIUM
30 January–1 February 2023

WMO is developing a concept for a sustained, internationally coordinated routine **Greenhouse Gas Monitoring Infrastructure** in consultation with a broad group of stakeholders from both scientific, operational, and policy-setting entities. This builds on WMO's experience with the Global Atmosphere Watch and the Integrated Global Greenhouse Gas Information System, and it incorporates some of the operational practices and globally coordinated and agreed methods used in its World Weather Watch.

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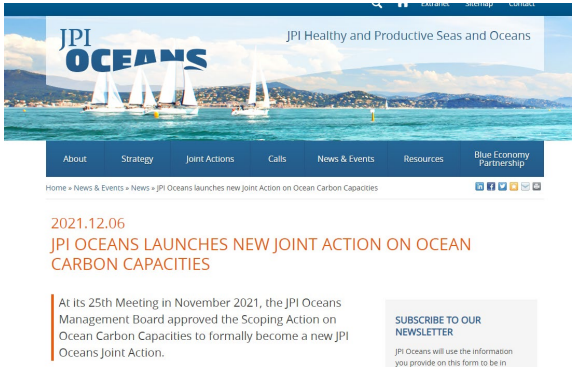

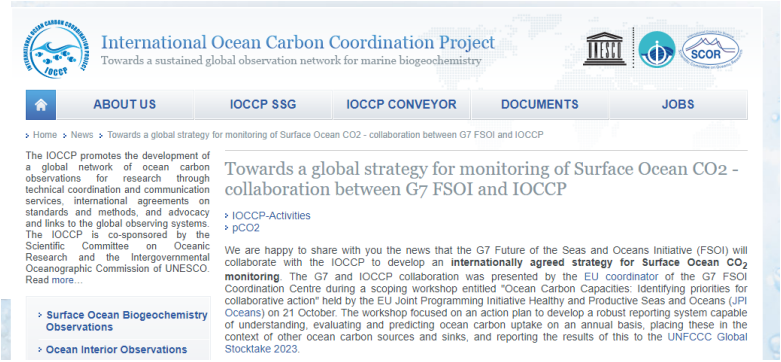

Training and Station Support (paused during Covid)

ICOS OTC/IOCCP sensor training workshop

- 2022

SOLAS summer school

- summer 2022 (online)
- summer 2023 Cabo Verde (in person)

ICOS summer school

- May 2023

Station Visits will be continued after summer 2022

Future Workplan

- Core role is to support stations to deliver base of value chain
  - Training
  - Standard Supply
  - Labelling
  - Advocacy
  - Software Provision and support
  - Assistance with SOCAT
- Extra activities, to improve value chain
  - Better tools, better data mgt, better network design etc etc
  - Submit Grants to cover these (Currently have four grants funded to cover international support, exploitation of the network, links to nearshore zone and GOSHIP)
  - Support Station funding applications (domestic and EU) with writing effort

(From Guidi et al., (2020) Big Data in Marine Science. Alexander, B., Heymans, J. J., Muñiz Piniella, A., Kellett, P., Coopman, J. [Eds.] Future Science Brief 6 of the European Marine Board, Ostend, Belgium. ISSN: 2593-5232. ISBN: 9789492043931. DOI: 10.5281/zenodo.375579).

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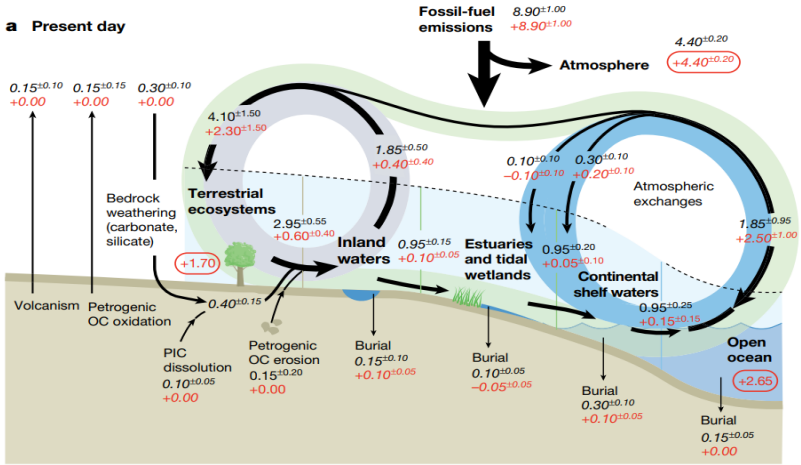
Future Challenges

- Working with ARGO (soon if not already most of the calculated pCO_2 values wil come from Argo, however these values are calculated based on sensors that require calibrating and which are prone to drift)
- Working with GOSHIP Hydrography programme
- Making ICOS services more widely accessible, Ferrybox, Jerico, Danubius etc etc.
- Maintaining the network financially (and the other components of the Value Chain)
- Citizen Science (yachts etc) and their possible role in remote areas



Key processes involved in coastal C cycling (Regnier et al., Nature, 2022 *Nature* **volume 603**, pages401–410 (2022)). The contemporary global carbon budget (numbers in black, period 2005–2014) and its anthropogenic perturbation (numbers in red).

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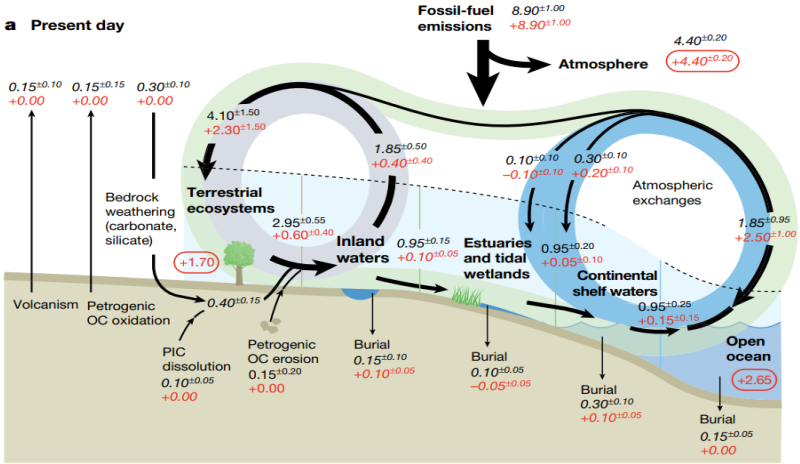
Future Challenges

- Defining and supporting the end state of ICOS Oceans Network
  - all pCO_2 observations in Europe,
  - one in each country,
  - one in each ocean area,
  - enough to estimate Ocean CO_2 uptake alone
  - enough to measure Ocean CO_2 uptake in concert with other tools,
  - reference network
- Carbon Dioxide removal
- The Coastal Zone (often a source to the atmosphere, highly drynamic, potentially controllable by humans)



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