November Newsletter

Achievements

New ICOS Ocean publications can be found at the bottom of this newsletter. Please send us more with a brief piece of text describing the main results - it's great to see ICOS Oceans data being published.

Congratulations to Andrew Watson from the University of Exeter, UK who has published a paper in Nature Communications.

Congratulations to Richard Lampitt (National Oceanography Centre) who has been awarded the EGUs Fridiof Nansen medal for ocean sciences. He has been an influential figure in the EU and global marine observing world for many years now and is known to us as the former lead PI of the PAP site, a key ICOS and EMSO station.

Upcoming Events

12th ICOS General Assembly meeting to be held virtually on 17-18th November 2020

1st ICOS OTC pCO_2 instrument inter-comparison workshop will be held between 28. June - 11. July 2021. The weblink can be found here

WMO has organised a number of preparatory workshops prior to the WMO Data Conference, 16-19 November 2020.

SOOP (12 lines)	
Belgica (BE)	BE-SOOP-Belgica
Simon Stevin (BE)	BE-SOOP-Simon-Stevin
Finnmaid (DE)	DE-SOOP-Finnmaid
Atlantic Sail (DE)	DE-SOOP-Atlantic Sail
Polarstern (DE)	DE-SOOP-Polarstern
France-Brazil (FR)	FR-SOOP-France-Brazil
G.O. Sars (NO)	NO-SOOP-G.O.Sars
Kronprins Haakon (NO)	NO-SOOP-Kronprins Haakon
Tukuma Arctica (NO)	NO-SOOP-Tukuma Arctica
Trans Carrier (NO)	NO-SOOP-Trans Carrier
Tavastland (SE)	SE-SOOP-Tavastland
UK Caribbean (UK)	UK-SOOP-UK-Caribbean
FOS (9 stations)	
Thornton Buoy (BE)	BE-FOS-Thornton buoy
CVOO (DE)	DE-FOS-CVOO
Hausgarten (DE)	DE-FOS-Hausgarten
E2M3A (IT)	IT-FOS-E2M3A
W1M3A (IT)	IT-FOS-W1M3A
Miramare (IT)	IT-FOS-Miramare
PALOMA (IT)	IT-FOS-PALOMA
PAP (UK)	UK-FOS-PAP
WCO (UK)	UK-FOS-Western Channel Obs.
MFT (1 tower)	
Östergarnsholm (SE)	SE-MFT-Östergarnsholm

Figure 1. Map of the ICOS oceans station network.

Welcome to the quarterly newsletter from the ICOS Ocean Thematic Centre. Never has the importance of quantifying ocean C uptake been more important. Our mission is to support the 20+ ICOS ocean stations (Figure 1) to deliver the data we need to better quantify the oceans role in carbon cycling.

Updates to the work programme

This year has obviously turned out very differently from the way we planned it, and many activities have been postponed/ cancelled/ modified in response! Here is a quick update on activities in the OTC. As a reminder we divide our activities into 5 work-streams: leadership and management, labelling, data, technology and training and station support

Leadership: Our major effort this year has been on developing the IOCOS concept. Other important activities have included working on a Marie Curie ITN application, writing letters of support, responding to consultations and preparing for the ICOS evaluation. This part also coordinates the station ringarounds which we conduct quarterly to hear about your problems, get feedback on our performance and tailor our activities. The data we get from these is proving invaluable in helping to make the IOCOS case for a different funding model.

Other News

Website Updates

Check out our website for a statement describing the external partnerships we'd like to build to deliver our work programme. This is key in the context of the EU Green Deal and Horizons Europe calls which we expect to use to support the development of the station network.

Find out about the new OTC initiative, IOCOS (Integrated Ocean Carbon Observations System) here:

IOCOS website: https://www.iocos.org

IOCOS twitter: #ocean_carbon

We are looking for amateur photographers to take photos of our ocean stations, please contact either Jess Thorn or Richard Sanders for more information.

Other News

ICOS is planning a Marie Curie Training network. Full details will be communicated from the Chairs of the MSA, Sue and Thanos, and we hope that we can support a range of projects from the OTC.

We are putting together a scoping document for the UN Decade of Ocean Sciences. Please contact us for more information.

We save all information and files onto the ICOS Nextcloud Fileshare at: https://fileshare.icos-cp.eu/s/xMXc5fJPXqLLcaA

Labelling: The labelling work stream lead by Ingunn Skjelvan works with stations on a 1:1 basis to help you demonstrate that your data streams are consistent with the major accolade of being an ICOS station. In the last year we have helped many stations along their labelling journey with several achieving the status of being labelled this year, no mean feat in a pandemic. As part of this general effort to help stations improve and validate data quality Ingunn has also been leading on the OTC/ ICOS strategic partnership with Saildrone.

Data: Our data work-stream, led by Benjamin Pfeil provides software to manage your data, assists you with uploads to the CP and SOCAT as well as keeping a watching brief on how the carbon data management world is evolving. One major target of the whole community which the data group is helping to bring to reality is the provision of near real time data from ship to shore. This both safeguards your data in case of a failure somewhere and allows problems to be spotted early.

Technology: Our technology work-stream lead by Socratis Loucaides has had a busy year, working up and publishing data from deployments of OA sensor systems and surface vessel mounted pCO2 systems in Belize and standalone carbonate system sensors deployed to full ocean depth. We welcome future collaborations from the MSA to use these new technologies now their success has been demonstrated. The other major achievement has been to formally adopt the design and prototype manufacture of a calibration system for membrane sensor based pCO2 systems as a core part of the OTC forward plan.

Training and Station support: This area, led by Tobias Steinhoff is undergoing some exciting transformations. Our planned pCO2 intercomparison (more information here) has had to be postponed to next summer from this year but we have taken to opportunity of this space to thoroughly review our training portfolio. We now plan actions to link ICOS to the outside world (IOCCP, SOLAS) on a regular basis and a regular training programme delivered internally associated with MSA meetings. In parallel we have devoted time to getting the gas bottle calibration programme up and running and to establishing the membrane sensor support action plan which links together actions from across the OTC in labelling, data, technology and station support. If you would like to get involved then we are always looking for help!

Our plans for next year are obviously quite fluid, given the COVID situation but we see major actions around IOCOS linked to the UN Decade and the COP, we hope to work with new stations on labelling and data uploads and to seek funding for the membrane sensor calibration systems. The inter-calibration is looking like a fixed date, even if we have to run it in a COVID secure manner and we are excited to see the gas bottle standards rolling out across the network.

We hope to welcome Spain formally into the ICOS network. Spain has a vast ocean area and a proud tradition of making really high-quality ocean carbon measurements which deliver great science outputs so we look forward to learning a lot from their PIs and stations about how they have achieved their success! On this note: if you know a country that isn't in ICOS where you think the ocean CO2 community would like and could benefit from our services or a station in your or another ICOS member

country in the same boat then do get in touch with them and us. We are always keen to roll out the benefits of OTC membership to as many people as possible. Our station fee of a little under 10KE gives you access to calibration standards, data management, the latest technology and a great training and station certification programme. We think it's a great deal and hope you do too.

The ICOS evaluation has just finished. The formal report will be issued in late November but in summary, was a very positive experience. The Chair of the External Evaluation Board commented " The implementation of ICOS has been an outstanding success and is well underway to becoming fully operational. Remarkable achievement given the complexity of the challenge".

In summary: "The ICOS RI evaluated by an external board. After an extensive document search, reading and surveys, the board heard people both inside and outside of ICOS. At the end of the meeting, the board gave its first feedback on how well ICOS carries out its management, operations and data production, and how well ICOS fulfils its role in the global GHG information system. The initial feedback was highly positive. The board considered both the operations and the finances well managed. However, the board remarked that we would need to create a plan to ensure the long-term financial sustainability of the station operations – a complicated issue which the Head Office and the Thematic Centres are working on to improve. The board also said people in ICOS community are rather engaged, while there is of course variation. The ecosystem, ocean and atmosphere domains are rather integrated, but that could be improved, as could internal communications.

The board found that ICOS data are widely used and cited in scientific publications, including high-impact journals as well as in models, and that the RI also actively promotes the use of data through various means. However, the board stated that improving the tracking of the data usage and also stakeholder work need to continue.

The General Assembly of ICOS initiated the Evaluation process a year ago. The ICOS Statutes say the RI must be evaluated every five years. The final evaluation report will be presented to the General Assembly in January 2021".

Cruise preparation for DY116

Scientist and engineers at NOC are continuing to prepare for the planned cruise on Discovery to the PAP-SO in November. Here, Dr Andy Gates, Dr Sue Hartman, Dr Anita Flohr, Jon Campbell and Corinne Pebody are working with fluorometers and CO2 sensors of the type to be recovered at sea on DY116. Nick Rundle and other technicians at NMF have introduced, refined and shared practices of working with common instruments in a socially distanced way. This asset recovery cruise, supported by CLASS enables us to make safe our equipment and data which has been measuring and withstanding the weather and waves at the PAP-SO for the last 18 months.

Data from the last 30 years is available at BODC and contributes to our shared science with our EMSO, ICOS and iFADO partners.

The ATL2MED Saildrone Mission

The ATL2MED mission is a joint effort between 14 partners in Europe and USA where two unmanned surface vehicles (saildrones) sailed from the Atlantic Ocean to the Mediterranean Sea and on their way were involved in numerous experiments, from eddy studies in the Canary Current upwelling system, via mesoscale studied off the

Balearic Islands with help of a tagged sea turtle, detection of CO2 emission near the volcanic Aeolian Islands, inter-comparison with gliders, and validation of fixed ocean stations in the Mediterranean and Atlantic. The saildrones were deployed off the Canary Islands in October 2019, and nine months later, in July 2020, they headed for key in Trieste. When the mission started, no one had heard about Covid-19. After the pandemic hit Europe in January 2020, some of the planned research cruises were cancelled, but in spite of this, the two saildrones continued their journey which were very fortunate for the experiment. During such a long experiment, it is almost expected to meet some challenges, and this was the case also for ATL2MED. The two saildrones experienced heavy biofouling, which required some extra key visits for removal. Also, some sensor drift and malfunction were experienced during the mission. At present, the saildrone data are being QCed and this is also the case for the data from the fixed ocean stations, gliders, and ship. All carbon data from the saildrone have been processed using the online tool QuinCe and been made available at the ICOS Carbon Portal by the OTC data management group. Later this fall or early next year, further data processing and comparison will be performed. The ATL2MED mission has shown the large potential for unmanned surface vehicles equipped with appropriate instruments. Such vehicles are robust supplements for validating fixed ocean stations, they are cost effective with respect to man power and ship time, and they are promising tools when observing system like Argo floats, gliders, ships, etc. are to be integrated.

The MOSAiC expedition.

Now that the project, MOSAiC, has finished, the Polarstern will support other expeditions in both Antarctic and Arctic as it has been doing for more than 35 years. During all of these expeditions the pCO2 system on board Polarstern will continue to take measurements for ICOS.

Despite disruptions due to the COVID-19 crisis, the station on board the Polarstern recently passed a demanding quality control programme and has now received the ICOS label for standardised greenhouse gas measurements. In September 2019, scientists took a major step in fundamentally understanding the Arctic region and how it is affected by global warming when they started the year-round research project MOSAiC. Dr. Mario Hoppema is one of the scientists contributing to this mission, the largest polar expedition in history. He analyses the partial pressure of carbon dioxide measurements monitored on board of the German research vessel for ICOS.

Image of Polarstern courtesy of https://www.icos-cp.eu/event/953

Meet a station

We would like to offer a very warm welcome to the new station, M/S Tavastland.

pCO2 measurements on M/S Tavastland: SMHI and the Finnish Environmental Institute, SYKE, installed a ferrybox on M/S Tavastland in 2009. M/S Tavastland is a roro cargo vessel that travels from Lubeck in Germany to Oulu and Kemi, in the very north of Finland and this route back and forth takes about a week.

The ferrybox measures salinity, temperature, oxygen, chlorophyll fluorescence, turbidity, phycocyanin fluorescence and CDOM-fluorescence and have also two automated water samplers that can be used to collect reference samples. During 2010 a pCO2 system from General Oceanic was purchased and installed next to the ferrybox.

The data from the ferrybox is transmitted to SMHI by satellite using ftp-protocol every hour. The pCO2 data is not yet transferred in near real time but work is ongoing to make it possible in the near future. The CO2 data is gathered during the service occasions in Lubeck or through Team Viewer. The raw CO2 data is recalculated with the in situ values for salinity and temperature from the ferrybox.

After years of problems with the system and sporadic data collection, it was finally fully operational in the fall of 2017 due to supportive efforts by the BONUS INTEGRAL project, and has been measuring continuously since. With support of members within BONUS INTEGRAL, the station is now an official marine station within ICOS.

The station PI is Anna Willstrand Wranne, who also runs the station as research engineer together with Dr Kristin Andreasson.

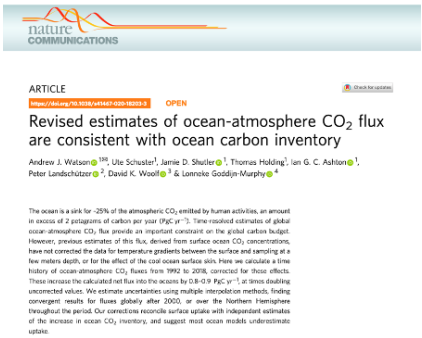
The 4th ICOS Science Conference was a great success, with 1040 registered participants from across the globe and over 200 oral and poster presentations. Just in cased you missed it, you can watch the highlights, now available on YouTube here.

OTC publicity materials: We have an OTC flyer that outlines who we are what services we can offer. Perfect for distributing at meetings and conferences. You can access it here on the OTC website. We launched it at the OTC downhill at Ocean Sciences in San Diego and got great feedback.

IOCOS (Integrated Ocean Carbon Observation System). We are well aware that one of the major issues the stations face is secure funding: it's tough enough delivering world class climate relevant data on secure funding, much harder in an uncertain funding climate. We have taken the decision to launch a major initiative with our stakeholders to transform the funding situation for stations away from piecemeal ad-hoc station funding into an operational phase. IOCOS is led by the OTC with input from the GCP, IOCCP, GCP and others. The aim is to have a unified voice and a communications strategy plan in place, to allow us to speak to external stakeholders and funding agencies about the importance of ocean observations and the work you all do, and to express the urgent need for sustainable, long term funding. For more information about this initiative, please visit our new website here.

Recent Papers

This is a short non comprehensive overview of recent ICOS-Oceans relevant papers. We always like to hear about new research that uses ICOS station data so if you'd like to use this forum to publicise your work then please get in touch!


nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-020-18203-3 OPEN

Revised estimates of ocean-atmosphere CO_2 flux are consistent with ocean carbon inventory

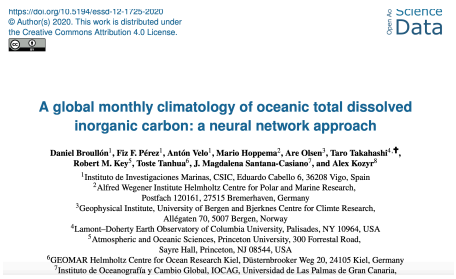
Andrew J. Watson[1✉], Ute Schuster[1], Jamie D. Shutler[1], Thomas Holding[1], Ian G. C. Ashton[1], Peter Landschützer[2], David K. Woolf[3] & Lonneke Goddijn-Murphy[4]

The ocean is a sink for ~25% of the atmospheric CO_2 emitted by human activities, an amount in excess of 2 petagrams of carbon per year (PgC yr^{-1}). Time-resolved estimates of global ocean-atmosphere CO_2 flux provide an important constraint on the global carbon budget. However, previous estimates of this flux, derived from surface ocean CO_2 concentrations, have not corrected the data for temperature gradients between the surface and sampling at a few meters depth, or for the effect of the cool ocean surface skin. Here we calculate a time history of ocean-atmosphere CO_2 fluxes from 1992 to 2018, corrected for these effects. These increase the calculated net flux into the oceans by 0.8–0.9 PgC yr^{-1}, at times doubling uncorrected values. We estimate uncertainties using multiple interpolation methods, finding convergent results for fluxes globally after 2000, or over the Northern Hemisphere throughout the period. Our corrections reconcile surface uptake with independent estimates of the increase in ocean CO_2 inventory, and suggest most ocean models underestimate uptake.

"Revised estimates of ocean-atmosphere CO2 flux are consistent with ocean carbon inventory" by Professor. Watson (andrew.watson@exeter.ac.uk) published in Nature Communications.

Ocean carbon uptake widely underestimated.
The world's oceans soak up more carbon than most scientific models suggest, according to new research published in Nature Communications last month. Previous estimates of the movement of carbon between the atmosphere and oceans, know as 'flux', have not accounted for temperature differences at the water's surface and few metres below. The new study includes this, and finds significantly higher net flux of carbon into the oceans.

The full article can be read here


https://doi.org/10.5194/essd-12-1725-2020

Open Access Science Data

A global monthly climatology of oceanic total dissolved inorganic carbon: a neural network approach

Daniel Broullón[1], Fiz F. Pérez[1], Antón Velo[1], Mario Hoppema[2], Are Olsen[3], Taro Takahashi[4,†], Robert M. Key[5], Toste Tanhua[6], J. Magdalena Santana-Casiano[7], and Alex Kozyr[8]

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A recent paper was published by COPERNICUS publications (August 2020), citing ICOS and co authored by 2 ICOS OTC PI's, "**A global monthly climatology of oceanic total dissolved inorganic carbon: a neural network approach**".

Researchers presented a tool for computing TCO2 in the global ocean. In comparison to previous methods, the uncertainties in such computations were reduced. Including two updated datasets containing thousands of measurements of in- organic carbon variables across the ocean in the training of the neural network, they were able to capture a wide range of variability of TCO2. The low errors obtained in independent subsets at time series stations are further evidence of the potential of the network in computing TCO2. Their global monthly climatology, created with a neural network, is the first that covers the oceans from the surface to the abyss at such temporal resolution. In addition to the accuracy of the network, the low uncertainty of the climatology in different regions and its usefulness in creating climatologies of other seawater CO2 chemistry variables (i.e. pCO2) show its robustness. Their research presents the global climatology of TCO2 to the scientific community to complement the recently designed climatology of AT by Broullón et al. (2019) for its use in the initialisation and evaluation of models or any other analysis related to the carbon cycle.

To read the full publication you can find it here: https://essd.copernicus.org/articles/12/1725/2020/essd-12-1725-2020.pdf

Other publications citing ICOS:

Global Carbon Budget 2019, Friedlingstein, P. et al. Earth Syst. Sci. Data, 11, 1783–1838, https://doi.org/10.5194/essd-11-1783-2019, 2019. The full article can be found here.

Basin-scale estimate of the sea-air CO_2 flux during the 2010 warm event in the tropical North Atlantic. Lefèvre N., D. Veleda, P. Tyaquiçã, C. Perruche, D. Diverrès, J. S.P. Ibánhez (2019). J. Geophys. Res.-Biogeosciences. 124, doi:10.1029/2018JG004840

The ICOS monitoring of fCO2 in the Atlantic enables us to detect anomalous inter-annual event such as the warm event of 2010. To read the full article click here.

The next issue of the newsletter will be published in April 2021. Things we plan to cover include a report from the ICOS evaluation and our initial thoughts on how to evolve the OTC services in response to it and a report from the OTC data workshop being conducted in November 2020. However, we are looking for articles from the community. Have you been on a cruise, published a paper, hosted a station exchange or started a new programme that you could tell us about? Or would you like to write a profile of your station?
Please send text and images directly to Jess Thorn or Richard Sanders.