

# ICOS



**INTEGRATED  
CARBON  
OBSERVATION  
SYSTEM**

## ICOS RI Annual Report 2018 Approved by ICOS General Assembly

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## Foreword from Director General

*"ICOS is young, just becoming fully operational and already it is outdated."* This provocative statement of a colleague described our challenge in the year 2018 in a perhaps in a too drastic but mayhap at least partly right way. We are working in a very fast developing scientific and political landscape which permanently throws new challenges on the table. Thus, we have been running two crucial activities in parallel during the year 2018: We made further steps towards becoming fully operational, and we have reflected the work done so far and developed stepwise a strategy for the next decade and beyond, as well as translated it into a more concrete action plan for the next five years.

The strategic re-thinking of ICOS was a laborious and partly controversial process, however, definitely worth the efforts. The vision of ICOS is much clearer now and – more important – there is a consensus about it and the ways how to reach it. This has definitely strengthened the ICOS community and is enabling us to tackle the challenges coming. The drought in major parts of Europe and the Fridays for Future movement of the youth have brought climate change back to the top level of the political agenda. This message was also coming from the ICOS Science Conference in Prague: The clear stepwise generation of knowledge from standardised systematic observation via science and assessment towards political action is an indispensable column for climate mitigation and adaptation, and ICOS has a role to play there.

Thus, we have again worked hard to become further operational: more stations were labelled and the first official ICOS data sets were published and well received, with downloads increasing significantly. This is the result of the hard work done in the National Networks, the Central Facilities and the Carbon Portal. I want to thank the whole ICOS community for these efforts.

On top of that, ICOS community has initiated an integrated scientific study on the 2018 European drought, to show the value of long-term observations in atmosphere, ecosystems and oceans. This has already resulted in a well-received session at the European Geosciences Union conference in April 2019, and will be visible in a special issue with ca 20 scientific publications.

The good progress has already made ICOS an important partner in international cooperation. ICOS is cooperating with international organisations such as World Meteorological Organisation (WMO) and Group on Earth Observation (GEO); aiming at building up an integrated, global carbon and greenhouse gas observation system whose European in-situ pillar ICOS would be. In supporting this development, we are closely cooperating with other European institutions (e.g. COPERNICUS) and partnering research infrastructures in other continents.

Finally, ICOS has significantly ramped up its communication. It has always been a challenge to communicate about a distributed research infrastructure. Visiting 12 stations with a famous nature photographer who has more than a million followers at Instagram and producing the #ICOScapes photo exhibition and related movies was the perfect solution for that challenge. We have now an impressive tool to communicate about ICOS and disseminate its results.

Coming back to the statement in the beginning of this foreword, my answer is: "ICOS is by far not outdated! What we set up 10 years ago is proving to be right, gives the right information and we are young and agile to accept more challenges."

*Werner Kutsch*  
Director General

## 2018 Highlights of ICOS Research Infrastructure

- Standardisation and labelling of the sites progressed. During 2018, a total of 25 new stations received the ICOS label. The station labelling is an integrated process for final implementation of ICOS standards and compliance check for the stations, and it was the main activity of National Networks and Thematic Centres.
- The 3<sup>rd</sup> ICOS (biannual) Science Conference 2018 gathered over 300 scientists and other stakeholders to the Czech University of Life Sciences, in the Czech Republic. During the conference, #ICOScapes Photo Exhibition presented gorgeous photographs of ICOS stations and activities for the audience.
- ICOS Long-Term Strategy was developed throughout the year, and was approved in November 2018 by the General Assembly. The drafting of the ICOS 5-year plan for 2020-2024 was started.
- First release of ICOS final high-quality dataset was generated and published through ICOS Carbon Portal. Carbon Portal also established a connection to Datacite and accomplished minting of DOIs, together with data citation integration.
- ICOS Atmospheric Thematic Centre changed facilities to a more modern building, and replaced the previous data server with a new powerful set of data servers. The new system architecture speeds up the processing of the data and allows quicker and even better maintenance operations.
- ICOS Ecosystem Thematic Centre released its Upkeep APP, having the first version now operational. Processing methodology to be applied to produce the first Level2 data was developed as well.
- ICOS Ocean Thematic Centre provided data for the Global Carbon Budget 2018, and Surface Ocean CO<sub>2</sub> Atlas (SOCAT) Version 6. On the administrative side, the negotiations for the United Kingdom to join Norway in hosting the Centre lasted the duration of the year, but were successfully concluded in early 2019.
- Calibration laboratories successfully tested the flask sampler and the flask sampling strategy.
- ICOS ERIC coordinated H2020 RINGO and ENVRIplus projects and the RI as a whole participated in several others. From these projects, a majority of resources is going to Central Facilities and National Networks. ICOS ERIC Head Office supported Central Facilities in drafting new H2020 project proposals, such as successfully received ENVRI-FAIR and EuroGEOSS.
- ICOS collaborated with a number of international organisations, such as UNFCCC, GEO, WMO and many others. ICOS also participated in a process of drafting a Memorandum of Understanding with e.g. Chinese Ecosystem Research Network (CERN), NEON in the United States, TERN in Australia, SAEON in South Africa etc.

## Introduction

ICOS ERIC as a legal entity coordinates the operations of ICOS RI, distributes information from ICOS RI to user communities and establishes integrated data and analysis from its GHG observation systems. ICOS ERIC provides effective access to coherent and precise data to facilitate research into multi-scale analysis of GHG emissions, sinks and their driving forces by making available measurement protocols long-term data and data products. The statutory seat of ICOS ERIC is in Helsinki, Finland. ICOS ERIC has governance bodies such as General Assembly (GA), Director General (DG), ICOS Research Infrastructure Committee (RI Com), Scientific Advisory Board (SAB), and Ethical Advisory Board (EAB).

ICOS ERIC General Assembly is the decision-making body of ICOS RI and acts as a high-level council for Member and Observer representatives. General Assembly discusses and approves strategic issues as well as any legal, governance of financial issues, approves the official ICOS stations into the network and location of the facilities.

Director General is responsible for implementing the decisions adopted by the General Assembly and is the legal representative of the ICOS ERIC. The Director General carries out the day-to-day management of the ICOS ERIC and is responsible for managing staff and activities of the Head Office and the Carbon Portal in accordance with the ICOS ERIC budget. The Head Office supports the work of all ICOS ERIC governance bodies and day-to-day operations of the Central Facilities. The Carbon Portal (CP) is the one stop for all ICOS data and is part of ICOS ERIC. It is led by the CP Director who is employed by the ERIC. All other personnel are employed by either Lund University in Sweden, the main host and location of the CP, or Wageningen University in The Netherlands.

## Director General and Head Office

### Highlights

- The 3<sup>rd</sup> ICOS Science Conference 2018 gathered 300 scientists to Prague, Czech University of Life Sciences to share latest research results and hear top presentations.
- The #ICOScapes photo campaign was finalised during 2018. It reached hundreds of thousands of people through Instagram during the year. The campaign culminated at a physical exhibition during the Science Conference, presenting beautiful photos of ICOS stations and activities.
- The 2018 General Assemblies approved the ICOS Long-Term Strategy, and gave feedback on the 5-Year-Action Plan. The regular ICOS ERIC & RI annual plans and reports were also approved, as were the membership contributions.
- ICOS conducted an Identity study to support the community engagement and long-term strategy of ICOS, as well as an Impact Assessment Study. The latter gained much interest within ESFRI, European Commission, and the European RI community.
- ICOS ERIC has participated and coordinating the H2020 RINGO and ENVRIplus projects as well as supported Central Facilities in engaging and drafting H2020 project proposals, such as ENVRI-FAIR and EuroGEOSS.
- The international collaboration fostered by ICOS with a number of international organisations beyond Europe including the Chinese Ecosystem Research Network (CERN), NEON in the United States, TERN in Australia, SAEON in South Africa etc.

## Administrative and financial management of ICOS ERIC and ICOS RI

This chapter describes the administrative and financial management of the ICOS ERIC and ICOS RI. The resources required for these tasks due to the financial and administrative complexity of the distributed research infrastructure, the number of Horizon 2020 projects the ERIC and the Central Facilities are involved in, and the requirements arising from the European Commission and from the legislation of the host countries have finally been implemented in the Head Office Unit on Administration.

### *Human resource administration of ICOS ERIC*

ICOS ERIC employed altogether 17 persons during the year 2018, most of them with fixed-term contracts due to the nature of the work (projects) and the financial constraints.

The following permanent and temporary personnel was employed by ICOS ERIC by the end of the 2018:

- Director General (Werner Kutsch)
- Director of Carbon Portal (Alex Vermeulen)
- Head of Unit I 'Administration' (Anne Malm, February 2018)
- Head of Unit II 'Operations' (Eija Juurola)
- Head of Unit III 'Communications' (Katri Ahlgren)
- Scientific Integration and Liaison Officer, Unit II (Jouni Heiskanen)
- Officer, Operations, Unit II (Evi-Carita Riikonen)
- Officer, Operations, RINGO, Unit II (Janne-Markus Rintala)
- Officer, Operations (Station Network Development), Unit II (Syed Ashraf Alam, October 2018). Before that he worked as an external trainee since May 2018.
- Communications Assistant, Unit III (Mari Keski-Nisula)
- International Cooperation Officer (RISCAPE, SEACRIFOG), DG Unit (Emmanuel Salmon)
- Officer, Communications (ENVRIplus), Unit III (Magdalena Brus)
- Assistant, DG Unit (Inka Hellä)
- Assistant, Unit I (Shawnie Kruskopf)
- EU-project Administration Assistant, Unit I (Leysan Karimova, February 2018)
- ENVRIplus Director (Ari Asmi, May 2018)
- Officer, ENVRIplus, DG Unit (Daniela Franz, August 2018)

In addition, Pirjo Kontkanen continued as a legal counsellor of ICOS ERIC. External HR specialist Nelli Matikainen consulted in different HR-processes and carried out day-to-day HR-matters until February 2018, when a new Head of Administration started in the position (the previous having been resigned at the end of 2017).

Head Office supports the professional training and development of its personnel. In 2018, staff members continued their participation in e.g. the EMMRI eMBA program (Executive Masters on Research Infrastructure Management) provided by the University of Milan-Bicocca and the UNITAR training for 'Core Diplomatic Training'. Staff members also participated in 'RI Train Staff Exchange', arranged within the scope of ENVRI Plus project, by Institute of Molecular Genetics (Czech node of Euro-bioimaging), and 'Public Affairs Management and Practice post-graduate diploma', provided by University of Chester. Several staff members also participated the in-depth course of 'Global Biogeochemical Cycles' by the Faculty of Physics, University of Helsinki.

The new EU General Data Protection Regulation (GDPR) came into force in May 2018. It required a number of revisions in the practicalities of ICOS ERIC. To make sure that ICOS ERIC fulfils the requirements, BA student in Law Antti Jukka was hired for three months at the Head Office. His task was to go through all processes of ICOS ERIC regarding handling of personal data, and to provide training for the personnel. He also created GDPR-handbook, which is available for the whole RI with the related materials in document management system Alfresco.

### ***Financial Management of the ICOS ERIC***

In the scope of the financial management, a main focus area during the year was to improve the financial reporting, as indicated in the feedback given by the auditors. The Head Office also started to follow cash flow, and estimate the flow of money for a longer period. The pre-payment received from the Academy of Finland was paid back at the end of the year.

The first five-year period for the funding from the Finnish Academy closed in December 2018. It was decided that the Finnish Academy will open a one-year funding period to allow ICOS ERIC to harmonise the Academy funding periods with the ICOS Five-Year-periods. Consequently, ICOS ERIC submitted a proposal for 2019 funding to Academy in June 2018.

ICOS ERIC is coordinating two EU-projects, RINGO and ENVRIplus. The management of the EU-projects was also central during the year, given the five periodic reports being submitted to the EU Commission.

The ICOS Financial Committee supported the financial management of ICOS ERIC and ICOS RI. This five-member committee consists of either General Assembly delegates or nominated experts. These members are Marc de Jong (Chair), Salah Dib, Gelsomina Pappalardo, Sirpa Nummila and Sara Moa. The committee had two virtual meetings during the year. The first meeting in 2019 was decided to have a face-to-face meeting to focus more on the second version of five-year Action and Financial plan as well as rewriting internal Financial Rules.

### ***Support to the contract management, procurement and coordination of the service providers for the Head Office***

The first invoice to Joint Research Centre (JRC) was sent after delivering the service. ICOS ERIC Procurement Rules were approved in May 2018 by the General Assembly. This document was published with some other financial documents on ICOS webpages.

The Head Office has supported the OTC for contract negotiations as the UK host institutions prepared to join in the OTC and share the tasks.

### ***General Assembly***

General Assembly had two face-to-face meetings in 2018. The two-day spring meeting of General Assembly was held in Bergen, Norway on 30-31 May 2018. RI Committee representatives as well as SAB Chair participated in the information day preceding the decisive meeting on 4 May. During the day, the Head Office representatives and Central Facility directors presented the status of the research infrastructure. The main focus of the day was on the ICOS long-term strategy and the 5-year action plan. In the decisive meeting, e.g. the Annual Report 2017, and the ICOS RI Implementation Plan 2018-2019 were approved and the Progress Report 2015-2017 was presented. Ten new stations received the ICOS label in the meeting.

The autumn General Assembly was held in Offenbach, Germany on 30 November 2018. In the meeting, the long-term strategy of ICOS, ICOS ERIC and RI plans for 2019, and membership contributions were approved. The status of the station labelling was discussed, and 15 new stations received the ICOS label. The General Assembly delegates of United Kingdom and Norway presented the plan how the OTC activities will be performed when UK joins in the OTC.

### ***Scientific Advisory Board and Ethical Advisory Board***

ICOS Scientific Advisory Board (SAB) has operational since 2016. For the term May 2016- May 2019, the members of ICOS of SAB are Anna Michalak (Chair), Beverly Law (Vice-Chair), James Butler, Marcus Reichstein and Rik Wanninkhof.

SAB provided its second report to the General Assembly in spring 2018. The report gave feedback and recommendations on further development of the ICOS Long-Term Strategy. The SAB had a physical meeting on 29 November 2018, where the strategy and the draft of the ICOS 5-Year Action Plan were discussed thoroughly.

The Ethical Advisory Board (EAB), nominated in November 2016, consists of three members for the first two-year term: Silvia Peppoloni, Meri Vannas and Per Sandin. EAB had no meeting in 2018.

## **Support for the operations and development of the RI (Task 2)**

### ***Coordination and support for the Central Facilities, RI Committee, MSAs, National Networks, and SAB***

Station labelling was the major activity concerning the whole RI. The Head Office supported the Central Facilities (CFs) in the process by communicating with the CFs and station PIs and steering the formal approval process. The Head Office also supported MSAs and Thematic Centres in identifying and solving issues that arise from the complexity of applying unified standards for heterogeneous station network.

Developing the Long-Term Strategy and the Five-Year Plan involved all bodies of the RI during the year 2018. The Director General facilitated this process with support from the Head Office by drafting the documents and acquiring input from GA, SAB, RI Com and National Networks, and by making this an iterative process to guarantee the whole RI buy-in for the topics elaborated in these documents. This included separate face-to-face meetings and teleconferences between all the actors. Additionally, Head Office visited the Central Facilities and held teleconferences when seen necessary.

RI Committee held two face-to-face meetings, on 13-15 March 2018 in Heidelberg, Germany and on 3-5 October in Todi, Italy. The specific focus in these meetings were the discussions on the ICOS vision and mission, long term strategy and 5-year planning. Updates and follow-up on station labelling process in the three domains is a regular topic in the meetings. Furthermore, RI Committee met virtually in monthly videoconferences. Extraordinary meetings were arranged when seen necessary. RI Committee participated in preparation for the General Assembly meetings, attended the discussion day event on 30 May 2018, as well as the SAB meeting on 29 November 2018.

In 2018, members of RI Committee were:

HO Eija Juurola, substitute Katri Ahlgren

CAL Ingeborg Levin, substitute Armin Jordan

ETC Dario Papale, substitute Bert Gielen

ATC Leonard Rivier, substitute Michel Ramonet

CP Alex Vermeulen, substitute Harry Lankreijer

OTC Truls Johannessen (until June 2018), Benjamin Pfeil (from June 2018), no substitute

MSA Atmosphere Huilin Chen, substitute Martin Steinbacher

MSA Ecosystem Corinna Rebmann, substitute; Mathias Herbst (until 17 April 2018); Janne Rinne (from 17 April 2018)

MSA ocean, Tobias Steinhoff, substitute Thanos Gkritzalis

ICOS ERIC supported financially the MSA activities and participated in all meetings organised in the three domains. The meetings are important events for following the progress of ICOS RI as well as scientific and technical developments in the ICOS scientific community.

### *Supporting the development of the RI*

Concrete actions for the development of the RI were done in many levels. The Head Office supported Central Facilities in engaging and drafting project proposals, such as ENVRI FAIR and EuroGEOSS. Several internal processes were either improved or drafted to answer specific cases, such as how to proceed when voluntary observation ship needs to be changed, how to proceed when new development need emerges in different parts of the RI. Information flows between ICOS bodies were improved e.g. related to sharing information on ICOS engagement with other networks.

Some development needs were identified, such as clear descriptions of processes related to managing different parts of the RI, or system for monitoring the performance of the RI. The Head Office started processing these issues. The most important strategic developments are being described in the next chapter.

## **Strategic developments**

The most important strategic developments of the year were the long-term strategy of ICOS and the five-year plan for the next period. Two other important processes were carried out as well, both feeding in to the strategy and the five-year plan. One of them deals with the monitoring of the performance of ICOS and the other with the community and how it perceives the infrastructure.

### *Developing the Long-Term Strategy and the Five-Year-Action-Plan for 2020-2024 for ICOS RI*

Several mutually supportive actions to facilitate the ICOS strategic planning were taken already in 2017.

The RI Committee started defining the most important topics to include in the strategy in their dedicated two-day meeting February in 2018. A first draft was produced shortly after that, and after thorough review, the strategy was discussed both in the information day of the General

Assembly and in the decisive meeting in May 2018. Based on that feedback, a new version was created, and sent for comments for the entire RI, including the National Networks, for several months. A next version was compiled for RI Com discussion in September, and after their review, a fourth version was provided for the GA meeting in November 2018: the meeting approved the ICOS Long-Term Strategy with final edits to be done based on the SAB feedback given in the November General Assembly.

The drafting of the 5-Year-Action Plan of ICOS RI was started in spring 2018, and continued in parallel with the strategy work, as decided by the General Assembly in May 2018. The first version of the plan was discussed in the RI Committee in September 2018, and a draft was presented for feedback for the autumn General Assembly in the same year. Developing the plan continued throughout the following months and resulted in a detailed version provided to the spring GA 2019.

### ***Analysing the impacts of the RI and studying the identity of the community***

Conducting an Impact Analysis of ICOS was started at the end of 2017 and was carried out in the first part of 2018. The analysis consisted of four steps: defining a framework for describing the impact of environmental research infrastructures in general to science, society and economy; developing a set of key impact indicators to show the RI's impact; describing the current impact of ICOS RI; and developing a strategy to improve it. The report was printed and the results disseminated in several events as described in the chapters about International Cooperation and Communications.

An ICOS Identity Study was performed in 2018 to establish an idea how the internal ICOS members perceive the infrastructure, to facilitate community engagement and further development of the RI. It explored how the internal members see ICOS' purpose, what motivates them to be part of ICOS and what they expect from ICOS in the future. The study shows that ICOS RI has several types of perceived purposes (both scientific and societal) and roles that vary not only across the domains, but are observed from several different viewpoints from inside the domain-wise communities as well, highlighting the mosaic-like characteristics of the ICOS community. Overall, ICOS RI is seen as something the respondents felt they could identify with (personally, professionally or societally). ICOS was also perceived as a competent, yet a very complex structure. Overall, it is believed that ICOS will have gained societal and scientific visibility, operability and geographical coverage in the next 3-5 years. The members are keen to develop both their own skills and the collaboration across domains.

### ***Engaging new countries and development of Pan-European network***

Head Office was actively in contact with new potential Member countries. The participation of potential new countries in ICOS activities was supported by the RINGO project, where nine countries that are planning to join in ICOS ERIC are partners. These countries include Estonia, Greece, Hungary, Ireland, Poland, Portugal, Romania, South-Africa and Spain. Estonia and Spain attended also as guests in the General Assembly meetings. Furthermore, ICOS ERIC supported the national process and funding proposals in new countries, such as Ireland, Poland and Portugal, e.g. by providing support letters and supporting in the planning of the national station networks.

The representative of the Head Office participated in the RICH expert workshop in April 2018 in Prague to share information on the importance of geographical coverage of environmental RIs, get connected with research infrastructure National Contact Points and increase awareness about ICOS.

## **Management of external cooperation**

### *Cooperation in the European landscape*

ICOS ERIC actively cooperates with other European Research Infrastructures, both bilaterally and within several European frameworks. In its role as the coordinator of the H2020 cluster project ENVRIplus, ICOS has brought significant input to the building of a European community. This long-term work has made it possible for some partners to successfully present an application for the H2020 project ENVRIFAIR, where the Carbon Portal will have an important role. DG Werner Kutsch was also invited to give a presentation at the ESFRI Workshop – Monitoring of RIs, periodic update of Landmarks, use of KPIs in November 2018 in Milano. His talk in the panel discussion ‘Why a common approach to RI monitoring - lessons learned from the Pilot review of ESFRI Landmarks’ was the opportunity to present the work done in 2017 by ICOS on its Impact Assessment.

ICOS was also represented in the meetings, stakeholder workshops and final event of the InRoad project. There, Research Infrastructures and national stakeholders made suggestions to improve the coordination of road-mapping exercises in Europe and the (financial) sustainability of RIs. DG's participation in the EOOS Conference (21-23.11.2018) was an opportunity to strengthen the links with the ocean community in Europe.

In November 2018, a week-long seminar was organised in Hyttälä (Finland) to celebrate the 20<sup>th</sup> anniversary of the Euroflux network. DG and several members of ICOS were present.

### *International collaboration*

The cooperation fostered by ICOS with a number of international organisations aims at building up an integrated, global carbon and greenhouse gas observation system whose European pillar would be ICOS. An important step was made in 2018 with a meeting, initiated by the Chinese Academy of Sciences and its Chinese Ecosystem Research Network (CERN), in Zhaoqing (China). This ‘International Long-Term Ecological Research Network (ILTER) Next Generation Workshop’ (16-21.4.2018) gathered the major actors of ecosystem flux measurements in the world, e.g. NEON in the United States, TERN in Australia, SAEON in South Africa. This meeting expressed the common will to promote a Global Environmental Research Infrastructure (GERI).

The year 2018 was also the year of the International Conference on Research Infrastructures, ICRI, a biannual conference organised this year in Vienna in September. ICOS and several projects (RISCAPE, ENVRI etc.) were prominently presented.

ICOS ERIC applied to become an Observer Organisation to the United Nations Framework Convention on Climate Change (UNFCCC) in August 2017. For administrative reasons, the decision that was expected in 2018 has been delayed to 2019. DG and other members of ICOS nevertheless participated in the Research Dialogue meeting organised by the Subsidiary Body for Scientific and Technical Advice (SBSTA) in Bonn in May. ICOS was also invited to the meeting of SBSTA and its partner organisations (GCOS, WMO, GCP etc.).

The Group on Earth Observations (GEO) is an important partner of ICOS. Specifically, the GEO Carbon and Greenhouse Gas Initiative (GEO-C), accepted into the GEO 2017-2019 Work Program, gave ICOS the opportunity to network with the major global actors and present its expertise in high-quality, standardized measurements of GHGs to a global audience. The first meeting of the 12-member Steering Committee of GEO-C was held in Geneva in February 2018. ICOS also proposed several side-events at the GEO annual meeting (GEO Week) in Kyoto in November 2018. DG moderated a session of the GEO Plenary on 'Earth Observations in Support of the Paris Agreement'. The activities of ICOS in GEO-C were also an important part of the seminar of the Asia-Pacific meeting of AOGEOSS organised just before the GEO Week in Kyoto.

## **Management of ICOS ERIC participation in externally funded projects**

### ***Horizon 2020 Projects and new Proposals***

Director General and Head Office coordinate the ICOS ERIC and ICOS RI participation in different proposals and EU funded projects. ICOS ERIC seeks funding opportunities that support the development of the ICOS RI and enhances European and global integration of greenhouse gas observations. ICOS ERIC follows the guidelines on ICOS participation in proposals, approved by the General Assembly.

#### ***ENVRIplus***

ICOS ERIC coordinates the ENVRIplus, which is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks with technical specialist partners to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe. ENVRIplus entered its last period in 2018. During that time, two ENVRI weeks were organised with a focus on finalizing the work and delivering the results on time. An amendment was submitted with a focus to extend the project until July 2019 (instead originally planned April 2019) to organise a high-level event in Brussels for disseminating the project's results, and to further work on the joint ENVRI strategy and the sustainability of the project developments.

#### ***RINGO - Readiness of ICOS for Necessities of Integrated Global Observations***

RINGO is a Horizon 2020 project coordinated by the Director General of ICOS ERIC. The progress of the project was disseminated in the Annual Meeting held in March 2018 at Antwerpen, NL, with approximately 70 participants. As part of the project, ICOS impact analysis was carried out, and during the annual meeting it was possible to allow wider engagement on the process during the plenary sessions. Relevant and highly significant feedback and contribution was received. The management achievements include updated data, dissemination and risk management plans. Furthermore, detailed instructions were provided for compilation of information needed for the Mid-Term review. The collected material was then compiled and Mid-Term review was successfully carried out.

The process of writing a Stakeholder handbook was initiated in the spring and was almost completed by the end of the year. It was, however, beneficial to engage a wider community and hence more time was requested. This was in accordance with some other tasks requesting a delay, of various reasons. The first Periodic report including first request for interim payment was delivered in a timely manner in August.

### ***RISCAPE – European Research Infrastructures in the International Landscape***

The RISCAPE project aims at describing the landscape of Research Infrastructures outside of Europe. ICOS is the leader of WP3 dedicated to environmental sciences. After having performed in 2017 a series of interviews with the European RIs, in all four traditional scientific domains (atmosphere, biosphere, geosphere, and hydrosphere), the year 2018 was dedicated to interviews with the major international Research Infrastructures. In total, approximately 50 interviews on complementarities and cooperation opportunities should be made by the end of the project. The majority of them were already carried out in 2018.

After a slightly difficult start due to organisational issues at the coordinating institution, the SEACRIFOG project had its first full year of implementation. The meeting of the consortium in Cape Verde (June 2018) was the opportunity to take stock on the progress made towards the design of a pan-African greenhouse gas (GHG) observational system, with a special attention put on land-use, land-use change and climate-smart agriculture. ICOS participated in the realization of one stakeholder engagement workshop in Zambia, in connection with the Science Conference of the Southern African Science Service Center for Climate Change and Adaptive Land Management (SASSCAL). As leader of the WP7 dedicated to the establishment of a High-Level Dialog Platform, ICOS was invited to the closed session with representatives of various high-ranking African stakeholders.

### ***VERIFY – Verifying Greenhouse Gas Emissions***

VERIFY is a new H2020 project where ICOS is a partner. The aim is to develop a system to estimate greenhouse gas emissions to support countries' emission reporting to the UN Climate Change Convention Secretariat. The emissions are estimated based on land, ocean and atmospheric observations. The project focuses on the three major greenhouse gases responsible for global warming: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). The primary aim of VERIFY is to develop scientifically robust methods to assess the accuracy and potential biases in national inventories reported by the parties through an independent pre-operational framework. The main concept is to provide observation-based estimates of anthropogenic and natural GHG emissions and sinks as well as associated uncertainties. The proposed approach is based on the integration of atmospheric measurements, improved emission inventories, ecosystem data, and satellite observations, and on an understanding of processes controlling GHG fluxes (ecosystem models, GHG emission models).

### ***EOSC-pilot – European Open Science Cloud and DANUBIUS-PP***

ICOS HO and Carbon Portal participated EOSC-pilot project supporting the development of the European Open Science Cloud (EOSC). ERFI (Environmental Radiative Forcing Integration) science demonstrator focused on the interoperability between Observational and Climate Modelling Environmental Research Infrastructures. Scientific use case was implemented in a cloud platform provided by EGI and to run land surface model using climate model outputs from IS-ENES data infrastructure.

In addition, ICOS ERIC is a beneficiary in DANUBIUS-PP, a preparatory phase project to build DANUBIUS-RI (International Centre for Advanced Studies on River-Sea Systems).

### ***A new project assistant to fulfil EU Commission rules***

Overall, the funds from these projects contribute significantly to the budget of ICOS ERIC. After 2017, the number of projects has increased. To successfully manage the project portfolio, the practices and procedures established at the Head Office were adjusted to be compliant with the European Commission H2020 funding rules and principles. This was the reason an EU project Administrative Assistant was hired in February 2018.

## **Outreach and communication**

ICOS can significantly increase its impact to the society of ICOS and its data through outreach and communication. During the year, the Head Office made significant efforts towards that end.

### ***Biannual ICOS Science Conference***

The 3<sup>rd</sup> ICOS Science Conference 2018 was in 11-13 September in Prague, the Czech Republic. The location was offered by the Czech University of Life Sciences. The conference was participated by 300 scientists and other stakeholders. The number of participants was higher compared to the previous conferences, even though the participation fee was raised. The geographic coverage of the participants also increased from 2016 with seven new entries: Austria, China, Greece, New Zealand, Nigeria, Romania and Slovakia. The total number of presentations was 232, half of which were poster presentations and half oral presentations.

The Head Office carried out majority of the responsibilities, with several people using a considerable amount of their time with the conference preparations at least for a full year to organise it. This included e.g. programme and side programme preparations as well as hundreds of practicalities regarding food, venue, participant communications and other marketing of the conference. ICOS Czech Republic, Czech Globe, was responsible for the local arrangements.

The feedback on the conference was positive. A feedback survey was filled in by 88 participants, of which 91% agreed or strongly agreed that the venue and facilities worked well. 56% agreed or strongly agreed that they would attend again to the next ICOS Science Conference 2020, whereas 42% were unsure about their attendance. The exhibitor concept that included two different table options worked well, although the concept can of course be developed further. The conference website was considered to be the most important communication channel, with over 6000 views. The largest number of visitors came from Czech Republic, Finland, Germany and USA.

The 2018 conference dates overlapped with the International Conference on Research Infrastructures (ICRI) dates, which most likely decreased the number of participants. Hence, the next Science Conference 2020 was proposed to be organised slightly later in September.

In terms of the media outreach, the conference was a success as well, as ICOS managed to gain visibility in the Czech media, with several written news stories and TV-camera crew visiting on the location and using the material not only in a news broadcast during the conference but also later in a science-related magazine program interviewing ICOS scientists.

### ***External outreach and networking***

In 2018, the Head Office continued to promote ICOS mission and its services to a wide range of stakeholders. For that end, ICOS Head Office organised and attended major international

conferences and events, including UN XV GEO Plenary in Japan, in October and the AGU in USA, in November. Earlier in spring, ICOS participated in the EGU in Austria together with other environmental RIs in the already traditional joint booth.

ICOS also coordinated two ENVRI weeks during the year as part of ENVRIplus project. The weeks gathered on average of 140 participants from 26 RIs to cooperate on joint solutions and services for the RIs as well as to further integrate the complex RI landscape.

ICOS ERIC maintains a communications network for the RI communication officers from the Environmental RIs. The aim is to share the knowledge and best practices and in the same time, promotion of the project's results within the RIs themselves. ICOS was also part of a similar network for other RI clusters to regularly share the best practices in promoting the cluster projects and improving the exploitation of results.

### ***ICOS materials, presence in the web, media and social media***

ICOS' day-to-day external communication activities include production and dissemination of a wide range of engaging content such as news on the website and to the external newsletter. The external newsletter publication schedule was increased from quarterly to monthly, with 11 external newsletters being published during 2018.

The two most important printed publications were the ICOS Progress Report 2015-2017, and the ICOS Impact Assessment 2018 Report. The former was produced in-house, telling the story of ICOS from the project phase to an established RI. The latter was produced by an external consultancy, being the first step towards continuously measuring the performance and the impact of ICOS. Both reports were delivered to all partners and funders and distributed in various events.

As for social media, ICOS focuses its efforts on Twitter, Instagram, YouTube and LinkedIn. During 2018, our presence in all these channels has grown much stronger, mainly thanks to ICOScapes photo and video campaign. The number of Instagram followers continued to grow, by 231 percent from 2017, and also the number of Twitter followers increased by 32%, and LinkedIn group by 6% compared to 2017. The YouTube videos produced in 2018 have been viewed in total 3170 times. Additionally, ICOS was mentioned in at least 56 times in traditional media outlets in 2018, for example, in relation to the station labelling.

### ***ICOScapes photo campaign***

During 2018, ICOS continued its social media campaign, ICOScapes, to gain visibility for greenhouse gas measurements and climate change within the general audience. In 2018, the ICOScapes campaign toured eight countries with the professional photographer, produced videos including station crew interviews, as well as beautiful pictures of the stations and their surroundings were taken.

The campaign was a success: it multiplied the ICOS social media coverage, and connected the audience to ICOS, which is shown by the likes and positive comments received by the Instagram posts (138–505 likes per photo). Additionally, it increased the feeling of togetherness among the community members, showed to the community that their work is being appreciated also by the wide public. Furthermore, on the photographer Konsta Punkka's Instagram account, #ICOScapes photos have gained hundreds of thousands of views, and 35 500-91 000 likes each, as well as positive comments.

The campaign culminated in September to an exhibition of 24 large pictures - two from each country - being printed and presented at the ICOS Science Conference in Prague. From thereon, the exhibition moved to the Czech Parliament. Materials from ICOScapes were also shown e.g. in ICRI conference, ESFRI meeting, and in the GEO Week 2018, where they received positive comments.

### *Internal RI communication*

The Head Office regularly support internal communication activities across the ICOS RI. To enhance timely communication across the RI, a monthly community newsletter was established in the autumn. It shares news from the National Networks, Central Facilities as well as from the Head Office. The HO also continued with the good cooperation with the RI Communications Network in order to align messaging and to share information and best practices. A face-to-face ICOS Communications Network Meeting was organised in March, in connection with the RINGO Annual Meeting in Belgium.

## ICOS Carbon Portal

### Highlights

- Carbon Portal connection to Datacite, minting of DOIs, integrated with data citation in landing pages
- First release of ICOS final high-quality dataset generated and published through Carbon Portal as collection
- Operational provision of daily Near Real Time data from Atmosphere as dynamic data to the users
- Operational data transfer from 15 ecosystem field sites to CP and successful test of cloud processing of eddy the covariance data into a daily NRT product
- Dynamic and user-friendly data usage reporting operational
- Organisation of the successful (>100 participants) and stimulating TRANSCOM/IG3IS workshop in Lund

### Data service development (Task 1)

In 2018, all Thematic Centres have connected to Carbon Portal and data and metadata from raw (Level 0) and Near Real Time (NRT, Level 1) data to final quality controlled (Level 2) data started streaming to Carbon Portal for immediate publishing to our users.

The first Level 2 data of ICOS was published by ATC in the summer, and updated in Q3. Also in Q3, ATC implemented the streaming of Near Real Time data on a daily basis with maximum one day delay for all labelled atmosphere stations. Carbon Portal implemented support for data collections to publish the individual Level 2 data files as one data release object with DOI for easy and correct citation. Carbon Portal also implemented the aggregation of daily NRT files into dynamically growing data objects that are then again bundled into a data collection with a fixed DOI for citation.

ATC NRT data is now delivered daily to the COPERNICUS Atmosphere Monitoring Service. The Level 2 atmosphere data is now also distributed in the global GlobalView Obspack products for CO<sub>2</sub> and CH<sub>4</sub> in a cooperation with NOAA, where each download of a product that includes ICOS data triggers the download count at ICOS Carbon Portal. Further fine-tuning of the data citation inside these Obspack products is ongoing. This is important as Globalview data is one of the key datasets used by the Global Carbon Project and many inversion systems.

For ETC we further developed the so-called façade interface that receives raw data from the eddy covariance directly from the stations at half hourly intervals and assembles daily data collections for further processing. By the end of 2018, altogether 21 ecosystem stations were actively transmitting their raw data to the Carbon Portal. During a visit by ETC to Lund we set up the orchestration of the ETC data processing software to completely automatically process the eddy covariance data to half hourly fluxes and their uncertainties. We performed a live test using the full 20 cores of the fsicos2 server that showed that daily data from 80 stations can be processed within half an hour.

Carbon Portal agreed with OTC to host the Quince data quality control app on the Carbon Portal servers and of the direct use of its metadata system for all OTC data handling.

### *Use of the Carbon Portal website*

The main portal front-end (search interface) that allows for faceted search for all data was further refined throughout 2018 based on user feedback. Performance issues due to the increasing number of data files appeared in summer but have been solved quickly. Next to the already existing support for preview of time series and spatial data we added support for the preview of mobile measurements like those from ships in the ocean domain (see Figure 1).

From the main portal users can narrow down their search, preview data as time-series or spatial data, add data objects to their data cart and download the contents of their data cart in one go.

Each download triggers the check of the ICOS data policy and the download count for the individual data objects (see Figure 2 and Figure 3).

ICOS data portal Search, preview, download data objects

[View data cart](#) 2 items

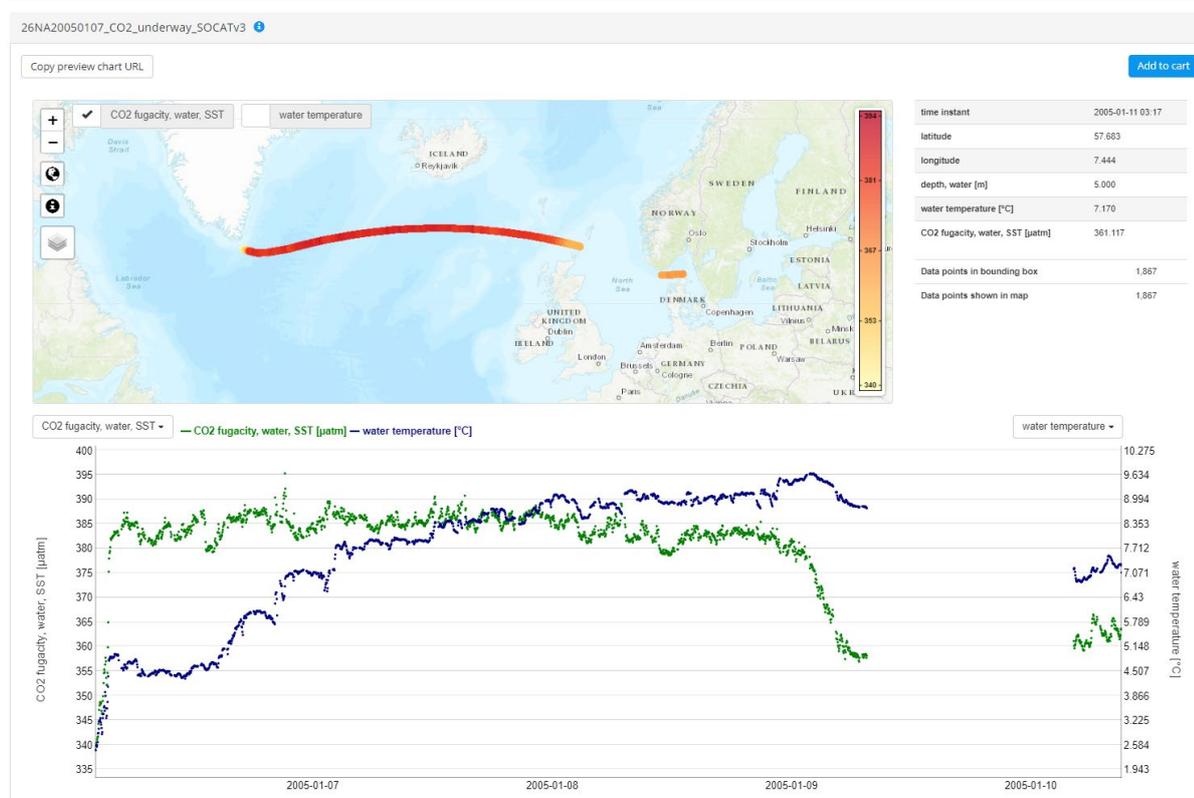


Figure 1 CP preview of ICOS Ocean domain mobile time series, with interactive display of two independent variables along the track.

Based on the work started by the CP communication officer we worked hard on a major update of the Carbon Portal website, including a simplified entry point to the search portal. This updated website went live in Q4.

As EUDAT CDI developed a completely new version of the B2SAFE service that finally implemented the promised REST API, we tested this new service as one of the first users of this new implementation, served by CSC in Finland. As the tests were successful, we will run this B2SAFE service in parallel with the Gridftp service at PDC in Stockholm. After procurement of the B2SAFE service and grid computing services we will hopefully before summer 2019 be able to transfer completely to the selected provider(s) of these services, where we plan to stream all data objects at ingestion directly into the trusted repository at two separate locations in Europe.

Downtime of the CP servers was limited to half a day in December due to a power failure of the Lund city power grid and subsequent failure of the water-cooling system at the Lund University Lunarc computing centre. This limited the availability of the CP services in 2018 to 99.5%.

### Downloads per time period



Figure 2 Download count of ICOS NRT and L2 data objects per month over 2017 and 2018. Please note the steep increase after the publication of the Atmosphere NRT and L2 releases.

### Downloads per country

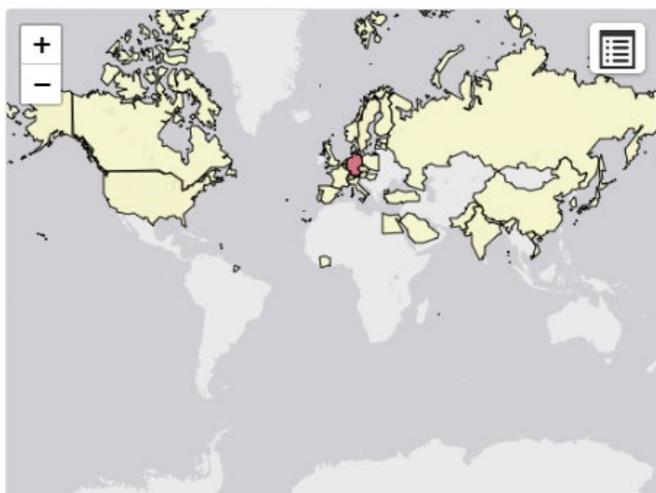


Figure 3 Spatial distribution of downloads of NRT+L2 data 2017+2018. Main countries: Germany (73022), Sweden (3690), USA (3065), Canada (452), France (343), Finland (216), Switzerland (192), China (189), Czech Rep. (168), Spain (102), Norway (88), Italy (78), Egypt (73), Estonia (14).

## References to ICOS in scientific papers

ICOS related literature references are collected through a form at the ICOS website. These references are manually checked and added to the central ICOS RI reference list. As part of the annual reporting, references are also reported by the national networks and central facilities. These, too, are added to the central list. The list is periodically updated on the CP website at <https://www.icos-cp.eu/references> and translated into a number of published articles per year.

Using BibBase allows for easy access to the complete reference list from the web page. Once per year the Lund University library service analyses the number of citations for the papers in the reference list, resulting in another major Key Impact Indicators of ICOS RI. Starting in 2019, the library service will also collect the number of citations for the ICOS data DOIs and PIDs. Citations of data objects will then be added to the landing page of these data objects in a Cited By section.

Table 1 Carbon Portal in numbers by the end of 2018.

Unique IPs of downloads	3 600
Data object downloads	55 000
ICOS L1+L2 downloads	5 500
Registered user accounts	610
Stored data objects	65 000
Stored ICOS data objects	37 600
DOIs minted	43
Unique website visitors	9 000
Average website session length	4:51
Website page views	74 000
New visitors	42.6%

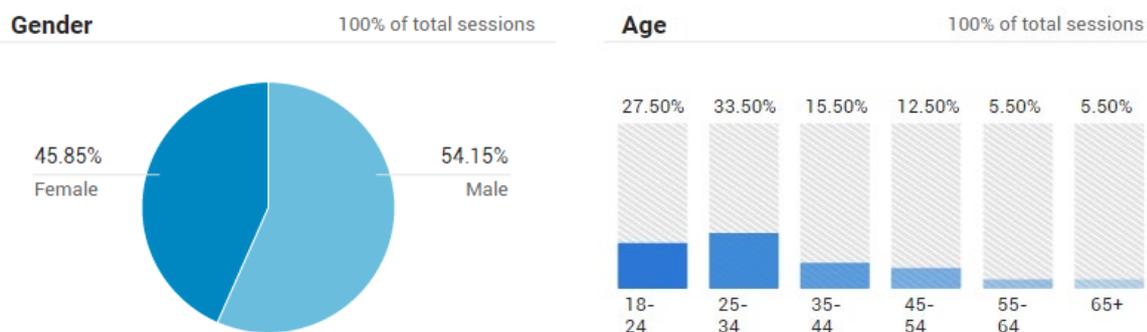


Figure 4 Some demographics of Carbon Portal website visitors.

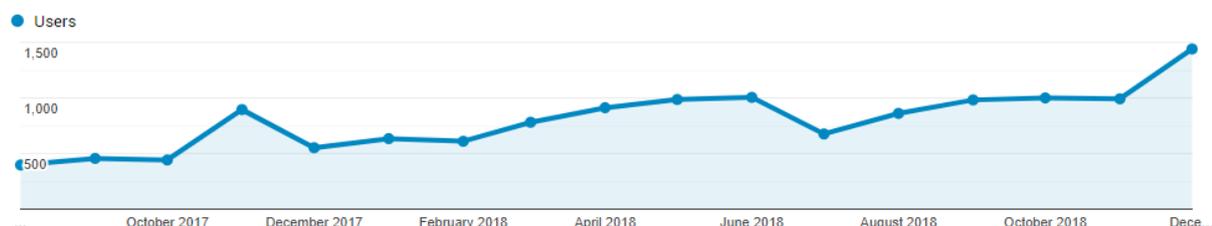


Figure 5 Development of the number of Carbon Portal website users per month since August 2017.

## Infrastructure support (Task 2)

The new server fsicos2 that was physically installed just by the end of 2017 has been taken into production and most old and new services are now running on the new server. The old server fsicos has received a memory upgrade from 64 to 256 gigabyte. The old server will remain in use for serving the Jupyter Hub and Lab products that are used by our scientific users for collaborating and developing scientific analysis of the ICOS data and model results based on that data. This will avoid out-of-memory and delays, due to intensive CPU usage by inherently unpredictable end users, in the core data handling services that are now handled by fsicos2.

Carbon Portal servers continue to support the community by hosting around 10 ICOS related websites. CP also manages the email system for ICOS ERIC and the mailing lists. In 2018 we started to develop a better system for the handling of email discussion lists that will become active in Q1 2019.

After studying the available updates for the Alfresco document management system, it was concluded to follow a different route to improve the collaboration environment for the whole community. After several tests of different environments, it was decided to phase out Alfresco and start using the Nextcloud storage system. By coupling this system with a locally-installed OnlyOffice document service, we can allow users to edit and view documents directly from the server (in a fashion comparable with Google Drive) including sharing links to folders and documents, all with high granularity and flexible sharing options. The system has been gradually tested out by Carbon Portal, and the MEMO2 and EUROCOM projects. By the end of 2018 we opened it up for the ICOS drought task force. In 2019 the system will be rolled out to the whole ICOS community.

## Data management and elaborated products (Task 3)

The STILT footprint tool (see Figure 6) has been developed further into a robust tool. The so-called ‘worker’ part has been transformed into an easy-to-use on-demand footprint calculation service. Next to increased stability and performance, the tool now has been integrated with the STILT result viewer, so that the results from user jobs become available in the footprint viewer service. This footprint-on-demand service has been used intensively since its release, for example in the framework of the RINGO project for the analysis of radiocarbon data, design of sampling strategies for radiocarbon and flask samples, and by ICOS Sweden for analysis of their atmospheric measurements.

The use of Jupyter notebooks has further increased, currently about 30 users make extensive use of this facility to process data and analyse model results, often in a collaborative way. The service has been used by the EUROCOM project, the analysis of the global atmospheric inversions of the Global Carbon Project and the RINGO project, as the Jupyter notebooks have direct access to all ICOS data, including for example the footprint results from the STILT service. In addition, the data contributed to the fileshare cloud service by groups like EUROCOM or MEMO2 will be available in the Jupyter notebooks to the respective group members for collaborative analyses. Outcomes of the mentioned projects can then be directly published through the Carbon Portal ingestion service as L3 products.

### STILT calculation service Job starter

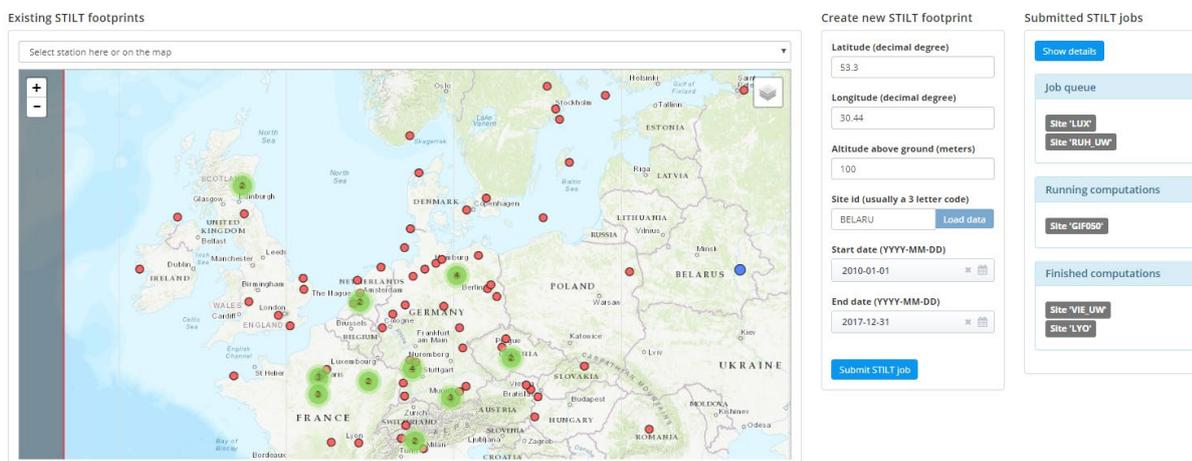


Figure 6 The STILT on demand footprint calculator user interface.

To enable easy access to the time series and other ingested data in Carbon Portal, we started to develop a python library that gives access to that data without that the user needs to know the relative paths, filenames and structure of the data, but can directly access the relevant parameters from the dataset.

## Training and user support (Task 4)

Maggie Hellström provided lectures on identification & citation and data publishing at the ENVRIplus & LifeWatch International Summer School on Data Management in Environmental & Earth Science Infrastructures at Lecce, Italy, July 9-13, 2018. Further, Maggie Hellström and Harry Lankreijer provided a half-day seminar (July 17) on research data management and data publishing at the Copernicus-Climate KIC summer school, Lund university, July 2-20.

Maggie Hellström provided a lecture (October 16) on research data management at the ICOS INES/GIS center graduate student course on Spatial Data Infrastructure, in the context of the course module "INPIRE & FAIR data", autumn semester, 2019.

Feedback from users is gathered from the feedback form on the website (<https://www.icos-cp.eu/form/detailed-feedback>) and by emails received at [info@icos-cp.eu](mailto:info@icos-cp.eu). These messages are usually answered within 24 hours. All in all, we received only about 10 non-spam feedback messages over the course of 2018. Other good feedback has been received at the MSA meetings attended by CP and the EUROCOM discussion, in which many inverse modelling users take part.

### *IG<sup>3</sup>IS/TRANSCOM meeting*

Carbon Portal organised a very successful IG<sup>3</sup>IS/TRANSCOM meeting in Lund on inverse modelling of greenhouse gas fluxes from atmosphere observations. More than 100 scientists from all over the world attended the meeting, held from 17-20 September 2018 (see Figure 7). During the meeting, more than 35 high-level plenary lectures and 35 posters were presented. During lively discussions, the future of IG<sup>3</sup>IS and the role of TRANSCOM for the development of inverse techniques and the observation network to serve greenhouse gas information to stakeholders from local urban scales up to the global scale were outlined.



*Figure 7 Participants of the ICOS/TRANSCOM/IG<sup>3</sup>IS workshop organised by Carbon Portal in Lund on September 17-20.*

## Management (Task 5)

The Carbon Portal involved in 2018 a team of 16 persons, delivering a total of 11.5 fte, including the external projects (4.4 fte). The overall management, including HR and project management (including acquisition)

is performed by the Carbon Portal director, who is employed by ICOS ERIC. All other CP personnel is employed by either Lund University or Wageningen University.

In regular group meetings, every two weeks, progress is discussed with all CP team members. The CP director also takes part in weekly telcos with ICOS Head-Office and bi-weekly ICOS Head of Units telcos. The CP Director is also part of ICOS Rcom, that meets during monthly telcos and two face-to-face meetings every year. In principle, the CP director visits Head Office every two months for a two-day face-to-face update.

Telcos with the thematic centres have been organised based on emerging needs. Furthermore, the CP director and representatives from CP have been attending the MSA meetings from all ICOS Themes, presenting there the progress at CP and receiving feedback on the developments. CP was also invited to two ICOS national meetings to present the progress.

The CP project portfolio in 2017 consisted of six H2020 projects (EUDAT2020, ENVRIplus, SEACRIFOG, RINGO, VERIFY, EOSC-Hub), one national project (SITES) and one international project (COPERNICUS in-situ). The H2020 EOSC-Hub project started on 1 January 2018. Of course, all plenary project meetings related to the CP project portfolio projects have been attended by representatives of CP.

Extensive development work is being carried out through the H2020 projects, that are all beneficial to ICOS with regards to data management and eScience, as well as providing links to EUDAT (CDI) and the other e-infrastructures that will play important roles in the upcoming European Open Science Cloud (EOSC). Maggie Hellström is very active in representing ICOS in several Research Data Alliance working groups as well as in GEDE (Group of European Data Experts in RDA Europe).

The CP director is active as chair of the WMO GAW scientific advisory board for greenhouse gases, member of the executive steering group of WMO IG3IS, member of the expert group of the H2020 CHE project and member of the advisory board of the MEMO2 project. CP is also acting as representative of ICOS in the Copernicus in-situ project lead by EEA.

CP hired one new employee in Lund as post-doc for the RINGO project in Q2 2018 (Claudio D'Onofrio). Unfortunately for CP, our new communication officer decided to leave after six months in the job to pick up her own company. The open position for programmer in Lund was filled with a junior scientific programmer that started in August 2018 (Karolina Pantazatou).

### **Status of deliverables**

OK: D1: Data submission statistics report (continuous)

OK: D2: Data download statistics report (continuous)

OK: D3: Update of DMS (Q1->Q4)

OK: D4: Lund fileserver update (Q2)

OK: D5: Operational atmosphere footprint prediction VRE (Q3)

NO: D6: Operational ecosystem footprint and flux comparison VRE (Q4)

OK: D7: User-friendly submission web interface for publishing elaborated products under ICOS license (Q2)

### **Comments**

D5: footprint calculation at this moment only based on reanalysis meteorological data, prediction depends on operational retrieval of meteorological prognosis data, which is under development, also for other uses at CP

D6: has been replaced by the work on the ETC raw data façade and cloud data processing orchestration

## Atmosphere Thematic Centre (ATC)

### Highlights

The whole ATC moved at the end of 2018, with the whole process taking almost 2 months. The ATC moved into the new LSCE facility recently built that is some 500 m away from our previous location. New features are intakes for the Mlab had to be put in place and ATC is now operating with all new furniture.

A new powerful set of ATC data servers replaced the previous data server end of April. This has been a long-lasting process involving a lot of preparation. The new system architecture speeds up the processing of the data and allows quicker and even better maintenance operations. A new ATC server, the replacement of the ATC server used by the PI to transfer their data and do their quality control has been put in operation mid-October.

ATC had a new recruit in 2018 as permanent staff: Carole Philippon. Carole is now a technician in the ATC Metrology Laboratory. She has a background in analytical chemistry. Her main activity resides in GHG instrument performance testing and support to the atmospheric network.

ATC participated to the ICOS science conference in Prague via the production of several posters. It also co-organised an ICOS-TCCON workshop. The aim of the workshop was to advance the concept of a potential integration of TCCON into ICOS. This included presentation of the current concept, discussion databases as well as the calibration aspects using AirCores.

ATC has participated in RINGO, ENVRiplus, CAMS, ICOS France assembly and ICOS drought workforce initiative. ATC was involved (O Laurent) in WMO working group on low cost sensors, and participated to the edition of the related WMO report:  
[https://www.wmo.int/pages/prog/arep/gaw/documents/Draft\\_low\\_cost\\_sensors.pdf](https://www.wmo.int/pages/prog/arep/gaw/documents/Draft_low_cost_sensors.pdf)

### Data collection and availability (Task 1)

The ATC database structure, used to store meteorological data, has been completely modified to speed the insertion and retrieval of data.

The graphical application for quality control, ATCQc, has evolved to include the new developments done on the processing chain side. In particular, the spike detection scheme was implemented. Local emissions in the vicinity of stations can have a major influence on concentrations, generating brief but intense perturbations, thereafter referred to as "spikes". The aim of the algorithm implemented in the ICOS data processing is to identify in continuous GHG time series the data strongly influenced by local emissions (fluxes within less than few kilometres). The detection is triggered using a threshold calculated from standard deviation of the time series over a period of 10 days prior the measurement to be evaluated. The detected spikes can now be displayed at both the minute and raw level. Both spikes detected on NRT data and spikes detected on L2/L1 data can be displayed.

Processing of tank calibration/re-calibrations information is coming from the CAL. This information is used to process the data of the whole network.

## ***Level 0 data transfer (Task 1.1)***

This task is the maintenance of the operational chain with raw data transfer from atmospheric stations to the ATC. New station and instrument registrations took place and new data transfer have started:

- the German station Torfhaus (TOH) sends GHG data, meteorological data and station data.
- Monte Cimone (CMN), the first Italian station, sends GHG data, meteorological data and station data.
- the Norwegian station Zeppelin (ZEP) has added meteorological data and station data.

Development of the automatic processing of <sup>14</sup>C data (level 1 and level 2) are coming from the CAL. A subset of the automatic warning and error emails sent to the PIs were reshaped to improve their readability.

The task of sending of raw GHG data files daily as well as meteorological data files of all labelled stations: End of 2018 there were 17 stations in operation. The PID of all the files are traced in the database as well as the possible HTTP errors. The software has been enhanced to cope with HTTP errors from the Carbon Portal server.

During initial or on-site tests, water vapor correction is calculated. These values are used in the database to correct the greenhouse instrument data for water vapor content. A script was written to compile these data from these different tests in an adapted format for the database. It was first only getting data from the G24 4 species CRDS Picarro instruments. During 2018, the script has been modified to also compile data from the Picarro G5310 and the LGR N<sub>2</sub>O/CO. For these instruments, the correction differs from the previous one, notably with different regression order.

Several metrology parameters (continuous, short-term and long-term repeatability) from the Mlab initial tests have also been added to the previously mentioned file to feed the database and be accessible by all.

## ***NRT data production (Task 1.2)***

The NRT data production at ICOS ATC is an automatic daily process based on shell scripting, Java and MySQL for the ICOS database. It is documented by ICOS ATC in a joint paper with others ICOS TCs in [Hellström et al., 2016]. A new internal server 'icos-products' has been deployed in 2018 to strengthen the processing capacity for NRT data product generation. In 2018, altogether 9 stations were in step 1 of the labelling process in order to become official ICOS stations, 3 are in step 2 and 17 are officially ICOS labelled. A total of 34 stations (5 stations are waiting to enter the labelling process) are connected to ATC, sending their data to ATC and, consequently, are able to be processed in NRT mode. This represents 8779 (+34% compared to 2017) raw archive files (~64Go, +26% compared to 2017, for a mean of 7.6Mo/station/day) processed for an availability rate of ~0.94 (-0.03 compared to 2017) for 22 (+8 stations compared to 2017) stations which transmit their data over the complete 2018 year.

A first implementation of a spike detection algorithm is in production. The algorithm has been applied on all the L2 data (up to 2018-05-31) and L1 data (from 2018-06-01 to 2018-09-30) and is now routinely applied on the NRT data since October 1st.

NRT ambient air hourly means computed without the detected NRT minute spikes are computed daily, right after the spike detection and are available for extraction.

The daily transfer of ICOS NRT data to the Carbon Portal is effective since end of September. These files contain NRT data for CO<sub>2</sub>, CH<sub>4</sub> and meteorological species since the last release and

are growing every day. Each file gets minted by the Carbon Portal and the PID is stored in the ATC database for traceability.

### ***NRT data visualization and distribution (Task 1.3)***

NRT data visualisation can be accessed on ICOS ATC website [<https://icos-atc.lsce.ipsl.fr/dp>], through the page of the NRT data products generated at ICOS ATC, and/or, depending on the product, directly on the panel board of the concerned station (accessible via its trigram code).

In 2018, 71 families of graphical NRT Data Products, (~ 7700 products in total, for ICOS network stations) are produced daily from NRT measurements (total volume of ~1Go) and freely available on the ATC website for station monitoring and diagnosis. Among new 2018 NRT data products, one can notice new monitoring product dedicated to Radon measurement and inter station comparison.

Those Data Products are helpful for PIs to verify the status of their stations. In total, for the year 2018, nearly ~2460 (+600/2017) users have interacted with ATC's website, for ~43000 (+30%/2017) page views.

### ***Level 2 data production (Task 1.4)***

An ICOS atmosphere pre-release (L2pre2018.1) was issued in May 2018. It contains CO<sub>2</sub>, CH<sub>4</sub>, CO data as well as meteorological data for the 4 labelled stations before the Spring MSA. 14C data for 2 labelled stations were also included.

The first full Level 2 (L2-2018.1, final quality controlled observational) data from the atmospheric network has been released on 24 August 2018 by the ICOS Atmosphere Thematic Centre. The data concerns the stations Gartow, Hohenpeißenberg, Hyltemossa, Jungfraujoch, Křešín u Pacova, Norunda, OPE, Puy de Dome, SMEAR, Svartberget, and Zeppelin Observatory. It contains CO<sub>2</sub>, CH<sub>4</sub>, CO data as well as meteorological data for the 11 labelled stations. 14C data for 7 labelled stations were also included. The time coverage of the data is 2016-2018-05-31. The start date varies for each station, it corresponds to the moment the station is ICOS compliant. A DOI is minted for the complete collection of this release that contains the final quality controlled hourly averaged data for the mole fractions of CO<sub>2</sub>, CO and CH<sub>4</sub> and meteorological observations measured at the relevant vertical levels of the measurement stations, and where available 14C in CO<sub>2</sub> in two-weekly integrated samples, for the years 2016-2018. The data can be found and previewed through at the Carbon portal. The L2 data collection can be found at doi:10.18160/rhkc-vp22.

## **Network coordination, training and development (Task 2)**

### ***Instrument testing (Task 2.1)***

ATC Metrology Lab (MLab) has Performed all the instrument testing required for the station labelling, including: leakage rate, instrument precision, linearity and drift, short term and long-term repeatability, sensitivity to inlet pressure, atmospheric pressure and temperature, H<sub>2</sub>O correction. ATC has provided test report and a certificate of compliance to all the instrument tested.

ATC has improved its semi-automatic reports edition system (improvements of code, reports for new types of instruments). It has defined a new report for the water vapour correction

assessment test performed at the atmospheric station by the station PI/staff. This report allows to monitor over time the change of the instrument sensitivity to water vapour. Based on that report, the ATC takes the decision to update or not the water vapour correction of a given instrument. It is part of the traceability plan of the ATC and site activities. ATC has developed a dedicated semi-automatic report edition system to improve the quality and to harmonize the corresponding reports.

Based on several tests at Mlab and in the field, ATC has optimized the measurement setup and procedure for N<sub>2</sub>O analysers. N<sub>2</sub>O will be proposed as a new ICOS mandatory parameter for class 1 station.

ATC has worked with other groups (Cabauw, weybourne UK, Dave Griffith) on the validation of a sampling setup and procedure for ECOTECH Spectronuous FTIR. The work mainly focuses on the calibration sequence to avoid bias and reduce gas consumption, and on the drying technique to avoid bias. The current drying recommendation is to replace the polytube Nafion which induce a significant bias in several species, by an automatic 2 stage Peltier system. The cell of the instrument is one litre in volume so the stabilization time is relatively long and was evaluated in the tests. Two modes are available, dynamic with constant flow or static with closed cell. Knowing the stabilization time is very important for the static measurement to avoid biases in measurements. At the end of the tests, a proposed set-up allowed to use static measurements for cylinder gases (in order to save gas) but dynamic mode for air, which makes sense when measuring at only one level.

ATC worked on the characterization of Nafion membrane (mono tube and polytube) in order to determine the induced bias on different species in different sampling conditions and determine the optimum setup and procedure for field measurement. ATC has launched field test with Nafion setup in order to validate the setup which should be presented to the ICOS community (next MSA). The use of Nafion dryer instead of specific water vapor correction with regular field assessment will reduce the uncertainty associated to the water vapor effect and the maintenance in the field (less assessment test) and at ATC (no reprocessing after water vapor correction coefficient updates).

ATC determined an in-situ testing strategy on the station sampling system in order to detect and quantify any measurement bias related to these parts which are out of the scope of the automatic quality control system (mainly based on the frequent measurement of a dedicated QC gas: the target gas).

ATC has tested several mid and low-cost sensors for CO<sub>2</sub> and CH<sub>4</sub> like new LICOR analyser using OF-CEAS technology, LGR MGGA, MirSense MultiSense a photoacoustic, Senseair HPP, Figaro CH4 Metal Oxide sensor... This prospective work takes place for new domain of application (mobile measurement, dense low-cost sensor for urban area or industrial site...).

## ***Atmospheric station audit (Task 2.2)***

During the first half of the year 2018 the focus of Mobile Laboratory was in finalising the audit reports of previous audits; the reports of Puy de Dôme (PUY), SMEAR (SMR), Křešín u Pacova (KRE) and Hyltemossa (HTM) audits were published in 2018.

It was decided in the ICOS ATM MSA (June 2018, Jena) that the next AS to be audited was Ispra (IPR) because there were showed issues that needed to be fixed. The audit of IPR AS took place in August–October 2018.

One task of Mobile Laboratory was to continue running the travelling cylinder comparison and to have continuous monitoring of the calibration scales at ICOS CAL and Mobile Laboratory.

Manpower for running the Mobile Laboratory is two full-time persons. The Mobile Laboratory has a fully equipped van, which can be used for parallel measurements. For the instrumentation the Mobile Laboratory has a Picarro G2401 and an Ecotech FTIR. In 2018, the Mobile Laboratory instrumentation was complemented with a Picarro G5301 as well as a dryer unit manufactured by ICOS Central Analytical Laboratory (CAL).

### ***Training activities for ICOS atmospheric measurements (Task 2.3)***

After several consultations (during the 2 MSA and by emails), ATC organised only one training session in 2018. All the initial training requested for new ICOS comers and step 2 labelling have been provided by ATC.

ATC is now working on training session dedicated to new specific topics (instrumentation, sampling setup) and refresh on topics already dispensed in the initial training session in order to maintain atmospheric station staff well trained and achieve the best data quality within the European ICOS network.

### ***Activities and plan reported to the DG, RI Com and General Assembly (Task 2.4)***

The ATC workplan, reports and associated budgets for 2017-2018 were provided to ICOS HO. The ATC contributed to the development of the ICOS strategy and new 5-year plan for ICOS. The ATC attended both General Assemblies that took place in 2018 as well as the two RICOM face to face meetings.

### ***Station labelling process, Steps 1 and 2 (Task 2.5)***

For the step 1 of labelling, two stations were approved in 2018 (Puijo, Finland and Station Nord, Denmark) and three applied leading to three step 1 reports.

Furthermore, 11 sites completed the whole atmospheric labelling process. ATC produced both executive summary and full labelling report. These are openly available. For some station these are completed by atmospheric transport modelling studies to document the capacity of current models to capture the signal measured at the station.

The organisation of labelling Step 2 within ATC included many teleconference calls with the PIs as well as the follow-up of their data transmission and quality.

Thanks to the labelled stations the first ICOS full level 2 atmospheric data could be released in 2018.

## Ecosystem Thematic Centre (ETC)

### Highlights

- One additional person at 50% time hired in Antwerp to assist in the ancillary data processing for labelling and Level2 data production. One 50% expert in database and cloud hired in Italy to transfer the ETC interface on Microsoft Azure (will be completed in the next few months).
- ETC participated to the organisation of the Science Conference and to the Drought Initiative.
- Labelling continued, more sites in the Step2 and data flowing to the Carbon Portal. A slow process but moving forward constantly.
- ICOS ETC Upkeep APP released, first version operational. Will be better developed in 2019 but it is an important tool.
- Development of the processing methodology that will be applied to produce the first Level2 data.

### Data collection and availability (Task 1)

Data collection continued for the three stations labelled (FI-Sii, BE-Lon, SE-Htm) and raw data are transmitted and stored in the Carbon Portal. Particularly continuous high frequency measurements for fluxes and meteo are submitted automatically to the Carbon Portal while results from campaigns of ancillary data collection and metadata are submitted to the ICOS ETC database where they are quality screened before imported. Physical samples are shipped to the ICOS ETC labs in France. For all these data type a standard procedure for submission has been developed and tested. The overall procedure to link ETC and CP (with the PID assignment and data retrieval by ETC for processing) was successfully implemented in 2017 and it is still working well.

PM in this Task: 32 (impossible to split in subtasks)

#### *Raw data transfer (Task 1.1)*

Continuous data (eddy covariance and meteorology): the labelled stations are submitting NRT data directly to the Carbon Portal after a quality check and confirmation performed by the ETC. In December 2018 in addition to the 5 labelled station, additional 10 are submitting continuous data daily (in the Step2 process of the labelling).

Ancillary data and metadata: large number of metadata describing the sensors and setup have been submitted by the stations during the Step 2 of the station labelling. All the data are archived in the ETC database and will be synthesized and transferred to the CP together with the Level 2 data production. Ancillary data on ecosystem characteristics (species composition, biomass, Green Area Index, trees position, litter, etc.) have been submitted by stations in Step2 and quality checked by ETC. Five of the forest sites used the FieldMap instrument provided by the ETC.

Digital Hemispherical Pictures and ceptometer files: DHP and ceptometer files have been submitted by stations in Step2. For both data types the routine and tool to upload them in the CP system and retrieve the PID is active.

Vegetation samples: 21 ecosystem stations collected and submitted a total of 671 samples to the

ETC labs (in 2017 were 10 stations and 318 samples). All these samples are labelled and archived, for 19 of them the analysis results are already available and loaded in the database.

Soil samples: for the first year we received also the first soil samples from two sites for a total of 220 samples and the analysis are under finalization.

### ***NRT data production (Task 1.2)***

The NRT data production didn't start yet but it is ready to be applied. Independently of the final location where the processing will happen (still an open point also related to the general ICOS strategy and ENVRI+ results), the processing has been tested in the ETC highlighting a number of critical quality tests to be performed on the data. A complex file control code (that involves also coherence between data and metadata) has been developed and tested and will become operational beginning of 2019. This plus the Level2 production experience will make the NRT more robust.

### ***NRT data visualization and distribution (Task 1.3)***

No new activities have been performed in this task yet.

### ***Level 2 data production (Task 1.4)***

The Level2 data production is in part tested during the data processing for the Step2 of the labelling. Three sites have been labelled end of 2017 or before middle 2018 and for these stations the collection of data continued until end 2018. For these three sites the Level2 products will be prepared by February 2019.

Eddy covariance and meteo: the processing has been tested during the labelling. For the postprocessing optimized code has been prepared and is ready to be applied.

DHP and ceptometer: the tools ready since 2016 have been tested in the different stations and confirmed the high quality. The Level 2 Green Area Index data will be produced and submitted to the CP together with all the other ancillary data that were collected during the step2 labelling and quality checked by the ETC.

Vegetation samples analysis: 579 vegetation samples have been analysed and the chemical content uploaded in the ETC database, the others have some issue with the metadata under analysis and will be uploaded soon. All this info will be aggregated and processed to produce the best possible Quality controlled Level2 dataset, which will be transferred to the CP together with the other data.

## **Network coordination, training and development (Task 2)**

As planned the largest part of the activities also in 2018 have been dedicated to this Task. The urgency to define all the Instruction documents needed to setup the sites and the respective data and metadata structure, template and system was a key objective of this phase of ICOS because this is directly linked to the possibility to conclude the labelling of the proposed stations. This involved not only the preparation, discussion with the MSA and finalization of all the documents and templates but also a continuous assistance to the station teams and the development of the

Step2 labelling procedure and report. This is better described and specified in the subtasks report here below.

PM in this Task: 100

### ***Training and information of the ICOS ecosystem network (Task 2.1)***

A total of 27 Instruction documents for the data collection, instrument setup and measurements submission are available on the ICOS ETC website and in Alfresco, all with a specific DOI. Out of these, 16 have been updated or modified in 2018 in order to improve the clearness. ETC has been providing the stations team with a continuous technical “hotline” support mainly organised through e-mail exchanges and specific WebEx and tracked through the ETC-information system. An ICOS Upkeep Tool APP to collect and submit metadata directly in the field has been released and is available on Google Play. ETC members participated to the MSA where discussion of the different activities took place and training on specific points have been provided. ETC prepared standard plastic bags that are provided to all the stations ready for the soil sampling.

PM in this subTask: 25

### ***Activities and plan reported to the DG, RI Com and General Assembly (Task 2.2)***

The activity and financial plan for the 2019 and the report of the 2017 activities (including the financial report) have been prepared and submitted to the DG and HO using the agreed template and guidelines approved by the GA. ETC participated to the spring GA presenting the results obtained and situation of the activities. ETC participated to the RI Com meetings and teleconferences. ETC participated to the preparation of the Long-Term Strategy and the 5-Year Action Plan.

PM in this subTask: 5

### ***Station labelling process, Steps 1 and 2 (Task 2.3)***

The station labelling has been the main activity for ETC also in 2018, with a total of 4 stations completing the Step1 of the labelling and 9 starting the Step2. For each of them a specific WebEx has been organised between the station team and the ETC in order to explain the overall procedure. For 24 sites the ETC completed the analysis and design of the spatial sampling scheme that the station teams implemented. 5 stations proposed a timeline and detailed procedure of implementation of the Instructions, including the list of all sensors, that have been checked for the compliance. Three stations ended the labelling process and final reports have been submitted to the GA. Test of example files have been performed for all the stations that installed the equipment in order to check format and possibility to process and instruction for the upload (to the ETC and to the CP directly) have been provided. FieldMap have been borrowed and full support given for the forest stations characterization. Five Associated Stations started the labelling process and other four have been labelled.

PM in this subTask: 70

## Ocean Thematic Centre (OTC)

### Highlights

- Release of the Global Carbon Budget 2018/December
- The Surface Ocean CO<sub>2</sub> Atlas (SOCAT) SOCAT version 6 was released in June 2018

### *Conference and meeting contributions*

- SDG 14.3 methodology working group, Paris (France), 16.-18. January 2018, Benjamin Pfeil attended
- Ocean Sciences meeting, Portland (USA), February 2018, Benjamin Pfeil: From small data to Big Data: Collaborative data rescue, sharing and synthesis initiatives within the marine biogeochemistry community (oral presentation)
- Initial SOCONET, Surface Ocean CO<sub>2</sub> Reference Network meeting, Portland, Feb 2018, Truls Johannessen, Benjamin Pfeil, Roman Baptisti
- ICOS OTC workshop, Bergen (Norway), March 2018, Benjamin Pfeil, Steve Jones: Data management within ICOS OTC and QuinCe (oral presentations)
- ICOS RI COM, Heidelberg (Germany), 13.-15. March 2018, Truls Johannessen, Benjamin Pfeil attended
- IOC UNESCO IODE, Oostende (Belgium), 19. March 2018, Benjamin Pfeil: Marine carbon data management (oral presentation)
- H2020 RINGO, Antwerp (Belgium), 20.-22. March 2018, Benjamin Pfeil: Establishing ICOS as regional pillars for global networks
- ICOS MSA/OTC meeting, Trieste (Italy), May 2018, Benjamin Pfeil, Steve Jonas: ICOS OTC data management (oral); Ingunn Skjelvan: Step 2 Station Labelling
- GOA-ON scientific committee meeting, Gdansk (Poland), May 2018, Benjamin Pfeil attended
- ICOS Scientific Steering Committee and General Assembly, Bergen (Norway), May 2018, Truls Johannessen attended
- Friends of Ocean Action, Stockholm (Sweden), July 2019, Benjamin Pfeil attended
- IOC UNESCO Ocean for Sustainability conference, September 2019, Benjamin Pfeil attended
- ICOS Scientific Conference, September 2019, Steve Jones attended
- Workshop on carbon data management automation and aligning ICOS OTC and NOAA OAP (Ocean Acidification Program) needs, Seattle (USA), September 2018, Steve Jones, Rocio Primo and Benjamin Pfeil attended
- ICOS RI COM, 2.-4. October 2018, Todi (Italy), Benjamin Pfeil attended
- SDG 14.3 methodology and data management working group, Paris (France), 17.-19. October 2018, Benjamin Pfeil attended
- EOOS conference, October 2018, Brussels (Belgium), Benjamin Pfeil attended
- ICOS Scientific Steering Committee and General Assembly, Offenbach (Germany), 28.-30. October 2018, Benjamin Pfeil attended
- Workshop on Interoperability Technologies and Best Practices in Environmental Monitoring, Brest, Oct 2018. Ingunn Skjelvan: CO<sub>2</sub> metrology - present situation for the marine community - Instrumentation (oral)

## **Data collection and availability (Task 1)**

The data lifecycle within the OTC has many steps, including transmissions of data and metadata between the PIs, the OTC, and the Carbon Portal. The steps include different levels of quality assurance and control, version control, standardized vocabularies, data archiving, assigning of persistent digital identifiers, and data publications. From data collection at the sensor until final publication, all standardized processing applied to a dataset will be documented. This allows transparent tracking of all procedures applied. OTC also implement a version control system so that older versions of the data can be restored if needed. The OTC aims to follow international procedures and best practices for the above steps. All data coordinated by the OTC will be made public available at the Carbon Portal website.

### ***Raw and Level 0 data transfer (Task 1.1)***

Historical (prior 2016) QCed data from ICOS stations has been submitted to the Carbon Portal where they were made available. This was the first data transactions between the OTC and the CP. More than 1000 datasets were shared and made available. These data are not per definition ICOS data, but they are historical (collected 2015 and earlier) and pre-labelling (collected after 2016) data from stations in the labelling process.

### ***NRT data visualization and distribution (Task 1.2)***

Tasks in the 2018 work plan related to transfer of ICOS data (L0, L1, L2, NRT) from labelled stations to the Carbon Portal were not completed but initiated for labelled stations. Metadata handling was set up as the CP and the essential software QuinCe that is needed for data reduction, quality control and tracking changes was released in the third quarter of 2018. The reason for the delay is that the labelling process has taken more time than previously anticipated for the data management group. NRT data transfer is tested in the fourth quarter of 2018. Data management and transfer will be operational for labelled ICOS OTC stations in 2019.

### ***Production and transmission of L2 data (Task 1.3)***

Delayed, see task 1.2.

## **Network coordination, training and development (Task 2)**

OTC ensures exchange of information with the marine ICOS network, ICOS RI and the Monitoring Station Assembly (MSA) through regular face-to-face and web meetings. During May 14-15, 2018, the fifth joint meeting for the ICOS Monitoring Station Assembly (MSA) and OTC was held in Trieste, Italy. Delegates from more than 2/3 of the Marine stations covering all the 7 ICOS Marine Members States attended.

### ***Change of OTC Director***

Truls Johannessen stepped down as Director for OTC in June 2018. Meeting with the ICOS Director General and the OTC Host Institution leaders in May 2018 concluded that if possible, a full-time dedicated Director would be the best strategy for the next phase of the central facilities, including the OTC. A call for a full-time permanent OTC director was launched and in the meantime the Deputy Director Benjamin Pfeil was the acting Director in collaboration with Administrative Director Erik Sandquist. The MSA Community and the ICOS leadership has welcomed this message. Candidates for the OTC Director position and are currently in negotiations. It was

agreed that Pfeil and Sandquist will continue in their shared leadership roles until the new Director is ready to take office.

### ***Status of UK joining OTC***

In spring 2018, UK financial contribution to the OTC CF was solved and negotiations started in May 2018 with the aim of concluding updated host institution agreements in September 2018. A roadmap concluding that was that UK would officially join the OTC CF from January 2019 was supported by the ICOS GA in May 2018.

From June-September the UK and Norwegian host institutions together with participation from the Head Office held several videoconferences, and concluded on an updated annex 2 “Deliverables by the OTC” and annex 3 “Management of the OTC”. The progress was welcomed by the ICOS GA in November and the ICOS Director was given the go-ahead to sign the updated legal documents. Financial contributions from the UK for 2019 were delayed and could not be part of the OTC 2019 budget adopted by the ICOS GA. UK budget for the next 5-year ICOS financial period (2020-2024) was also not part of the GA documentation but was promised to be ready shortly thereafter. The ICOS director general (DG) was tasked to report more details to the ICOS Financial Committee in early spring 2019.

In December UK host institutions asked for major changes to the CF Cooperation Agreement, which were solved out later in 2019. Further, the Head Office also seek guidance from the European Commission towards the consequences for the ERIC agreements in case of a “hard BREXIT”. However, in spring 2019, ICOS ERIC received a message from the Commission that the Brexit will not affect ICOS. Thus, after these complications, the legal agreements were finalised for signatures in April 2019.

### ***Meetings, training and interactive discussion groups (Task 2.1)***

During the labelling process in particular and regarding OTC services in general, OTC has had extensive contact with station PIs. In this way, the OTC has gained knowledge on where the marine community needs support regarding e.g. instrument issues, calibration, contact with vendors, and operational procedures. Weekly meetings have been held locally, where the OTC personnel has discussed the daily operation and ensured continuous progress of the OTC. The most labour intensive in 2018, as for 2017, have been work related to data quality control and station labelling.

A workshop aiming to improve communication between instrument vendors and PIs was held in Bergen 7-9 March 2018. The workshop was split between presentations, discussions, and laboratory demonstrations, and the topics covered was use of pCO<sub>2</sub> measurement systems, recalibration, installation on ships, data handling, data reduction, QC procedures, and alternative ways to conserve discrete carbon samples. Two commercial companies (Contros and General Oceanics), which provide essential instrumentation used by the marine ICOS community, were represented at the workshop. The workshop also included representatives from the OTC, MSA, ICOS station PIs, the University of Miami, the European Multidisciplinary Seafloor and water-column Observatory (EMSO), and International Ocean Carbon Coordination Project (IOCCP). The feedbacks were very positive. Minutes and other documents from the workshop are made available here: <https://otc.icos-cp.eu/node/67>

The work with the uncertainty analyses for the marine VOS data has continued in 2018, and an internal report has been produced. This has been of high value for the data evaluation part of the station labelling. Furthermore, discussions between MSA leaders, OTC personnel, and the ATC Cal lab stemmed from these analyses to provide adequate gas standards for underway pCO<sub>2</sub>

instruments in the future but this will require additional future funding resources. These gas standards are important to calibrate the underway instruments and are one of the requirements set forth by the OTC to produce high quality data. These discussions are still ongoing.

An intercalibration exercise/test of carbonate chemical instrumentation and promising sensors was originally planned in 2018 as a cruise. In the annual MSA meeting in Trieste it was decided to change this to an intercalibration exercise in a tank environment and the activity should be postponed to autumn 2019 or spring 2020. An organising committee has been defined, consisting of representatives from the Institute of Marine Research (IMR), the University of Exeter, the marine MSA, and the OTC. The committee contains people with highly qualified experience from this type of experiments. Planning has started and date and location are close to be settled

### ***Training and information of the ICOS ocean network (Task 2.2)***

Covered in 2.2.

### ***Activities reported to the DG, RI Com and General Assembly (Task 2.3)***

The OTC Work Plan and the financial plan for 2019 were approved by the GA7. The OTC CF 2017 report was adopted by the GA6. In 2018, OTC also prepared a 5-year (2020-2024) financial plan on the request of the ICOS GA. It was stressed that the Norwegian host institutions only have financing for the current activities until 2021 in accordance with this project and the plan thus mainly built on the proposal ICOS and OTC phase 2 to be sent to the RCN Infrastruktur call on 10.10.18.

### ***Station labelling process Steps 1 and 2 (Task 2.4)***

13 European institutions within 7 countries have reported 21 stations to join the OTC. At the end of 2018, all 21 stations have passed step 1 of the station labelling, 5 stations have passed the step 2 evaluation and been accepted as ICOS stations by the GA, and additional 7 stations have provided data and metadata for the OTC and are undergoing step 2 evaluation.

It is not yet solved how to include the ROS category with respect to station contribution and responsibility into the ICOS community. Regard Flux Towers, which consist of a marine part (buoy/mooring) and a terrestrial part (flux tower), there was extensive discussions in 2017 and into 2018 on how to perform station labelling and data quality check of these dual nature stations. OTC aimed for a solution in 2018, but this was not achieved, and will therefore continue in 2019. At present, the marine data from this station (currently only one station in this category) is submitted to the OTC, while the terrestrial data goes to the ETC.

## Central Analytical Laboratories - Flask and Calibration Laboratory (CAL-FCL)

### Highlights

- Revision of CO data set after thorough characterization of the drifts in primary reference gases (12/2018)
- Successful test of the flask sampler and the flask sampling strategy by the CRL and FCL with an excellent agreement of the composition of flask samples collected with the automated ICOS flask sampler with continuous measurements under stable atmospheric conditions (CO<sub>2</sub>: 0.01 ppm ± 0.11 ppm; CH<sub>4</sub>: 0.15 ± 0.79 ppb) (09/2018)
- Lars Borchard works since November 2018 as technician at the ICOS-FCL. His current main tasks are the assembly and functionality tests of automated flask samplers and air-drying units.
- Markus Eritt attended the RINGO Annual Meeting March 2017 Antwerp. Daniel Rzesanke attended the GAWG meeting on CCQM-K120.a/b key comparison on the ambient level CO<sub>2</sub> and paralleled pilot study CCQM-P188, BIPM 16. /17. April 2018, Paris.

### Trace gas analysis (CO<sub>2</sub>, CH<sub>4</sub>, CO, N<sub>2</sub>O, SF<sub>6</sub>, H<sub>2</sub>) of flask samples (Task 1)

Flask sample analysis by gas chromatography has been performed for two stations that operate pre-ICOS sampling equipment. The main activity was in support of the establishment of the ICOS flask sampling program that made big advances in 2018. When a mature design of the glass flasks was produced reliably by the manufacturer test series were started to ascertain that sample air was maintaining its composition during storage without changes in the relevant tracer composition. Up to date the results confirm the suitability of the flasks with no indication for drifts in the trace gases. A flask sampling strategy that was elaborated by the CRL together with the Carbon Portal within RINGO was presented to the MSA in June 2018. Tests of this flask sampling strategy were made at the CRL pilot station using the flask sampler developed by the FCL team and the respective flask samples were analysed at the FCL. Additional test samples were analysed as performance check for ICOS flask sampler. All ongoing QC activities involving flask samples have been undertaken.

An instrumental failure of the CO<sub>2</sub> converter of the GC was addressed in summer that moderately affected the precision of the CO<sub>2</sub> GC data for several weeks.

The problem with the Los Gatos Research CO/N<sub>2</sub>O-30-EP-Analyzer could not be fixed by the manufacturer but the instrument was replaced. It was not returned before fall 2018. A key member of the FCL GasLab team was off for several months in the suite of a traffic accident. For these reasons Milestone 1 could not be achieved.

## **Analysis of supplement parameters (CO<sub>2</sub> stable isotopes and O<sub>2</sub>/N<sub>2</sub> ratios) (Task 2)**

As envisaged in the 2018 work plan the focus of Task 2 activities was to ensure the availability of obtain proper sampling equipment to be distributed in the atmospheric network. The main efforts and results in 2018 were:

- Enforcement of a rigid pre-delivery inspection by the flask manufacturer. After long delays the first lots of glass flasks that were delivered in spring 2018 had nearly 100%deficient products that were not compliant to the specifications agreed with the manufacturer. These quality issues with the sample containers significantly increase the risk of glass breakage or leaks. To remedy these long-lasting problems the FCL flask sampler team developed test facilities that were provided to the manufacturer that perform standardized tests and document the results for every single flask. This procedure successfully reduced the number of flasks to be rejected to <2 %.
- The sample air drier to complement flask samplers that was developed and tested in 2017 was ameliorated based on the test results. 13 units were produced to equip class 1 stations that plan to start flask sampling.
- An additional four class 1 stations have been equipped with flask samplers (12/17 class 1 stations received a flask sampler by end of 2018)
- Demands that arose from the proposed flask sampling strategy at the June 2018 MSA were picked up and required an extension of the flask sampler software and hardware design. These design upgrades that will allow a dynamic flow sampling scheme were intensively tested in collaboration with the CRL. Respective upgrades of samplers that have been delivered already have been postponed to the time when these tests are evaluated.

Flask samples are being re-conditioned with dried transport air before being returned to the station for new sampling. The automated facility for leak testing and filling with gas (Milestone 2) had to be deferred due to extra efforts for the test stand of the flask pre-delivery check mentioned before.

## **Production of real air high pressure standard gases (CO<sub>2</sub>, CH<sub>4</sub>, CO) (Task 3)**

All nominated ICOS atmospheric stations have now been equipped with reference standards to allow their rapid labelling (Deliverable 3; exception: no request has come for the Greenland station Nord, yet). At several stations some highly consumed standard gases have already been exhausted and needed to be replaced. Additional standard gases are regularly needed for the FCL, CRL and ATC operations, and the ICOS internal and external quality control (QC) activities. This provision of gas standards for atmospheric monitoring stations is in routine mode and amounted to a production of 142 real air standard gases in high pressure cylinders in 2018.

## **Calibration and re-calibration of standard gases (Task 4)**

Up to 500 standard calibrations per year.

All standard gases prepared for ICOS atmosphere stations have been calibrated using the high-precision optical analysers (Deliverable 4). In 2018, 176 calibrations have been made. The link to the WMO calibration scales has been maintained by re-calibration of three of the FCL primary standard gases by the WMO Central Calibration Laboratory.

The routine procedure to return reference standards used at ICOS stations for a re-calibration at the FCL is established and used. Results of an evaluation of the first standard gases that have been re-calibrated after extended use (> one year) confirm the adequacy of the approach adopted for ICOS Atmosphere (three-year re-calibration cycle). The required replacement standards to bridge these periods are available (Deliverable 5). CH<sub>4</sub> and N<sub>2</sub>O concentrations in the standards are stable to the level that can be detected. This also holds for CO<sub>2</sub> concentrations in most cases but in some gases (<20 %) small drifts are suspected. For none of those re-analysed after one year or later a drift rate >+0.05 ppm/yr is detected. However, significant growth of CO within most of the cylinders is clearly observed. This needs to be well characterized in order to have the correct assigned values for the calibration of the continuous in-situ measurements. The same phenomenon affects also the primary reference standards of the ICOS FCL. The temporal development of CO in those primary FCL standards could be better characterized in 2018 after the last sub-set of these standards has been re-calibrated by the CCL. Updating the assigned CO reference values improved the consistency of all quality control measurements considerably (see QC Report 2018). Discussions with the ATC have started on updating all ICOS atmospheric CO measurement data that are based on the FCL measurements.

Milestone 3 was achieved in cooperation with the ICOS ocean colleagues from the Ocean MSA and the OTC. The specification of the calibration requirements led to a respective proposal as short specific plan for the 2020-2024 5-year action plan submitted to the 7<sup>th</sup> General Assembly in Offenbach November 2018. Milestone 4 could not be addressed due to the case of illness mentioned above.

## **Organisation of and participation in international QC activities (Task 5)**

All activities in international QC programs have been conducted as planned (Deliverable 6).

For the new intercomparison program ("MENI" – MPI-EMPA-NOAA-ICOS) that involves the ICOS FCL, the ICOS Mobile Lab (FMI), the WMO World Calibration Center at EMPA (CH), as well as all WMO Central Calibration Laboratories at NOAA (USA) and the MPI (D) the first circulation has been completed in 2018. Subsequently, the sample for the blind comparison has been replaced and the second circulation was started.

For the ongoing quarterly flask intercomparison with eleven international partner laboratories four sets of each six flasks have been prepared, distributed to partners and analysed. This maintains an external QC at relatively high frequency.

The QC report was updated considering the results from all internal and external QC activities conducted in 2018. All previous data were revised for CO based on the new information on the CO reference values for the FCL primary reference standards (Deliverable 7).

## **Activities and plan reported to the DG, RI Com and General Assembly (Task 6)**

The general report (Deliverable 8) including the financial and activity report 2017 has been submitted to the HO in Feb 2018, the budget and work plan for 2019 were provided in October 2018. Additional time was devoted to contribute to the preparation of the next 5 years plan and the ICOS strategy document. Updates on FCL activities were also presented at the General Assemblies and an FCL representative was participating at the General Assembly in November 2018.

## Interaction with station PIs (Task 7)

The FCL team has organised an ICOS Atmosphere MSA in Jena in June 2018. The reports on FCL activities were put up for discussion in particular the state of the flask sampler development and the progress in the cooperation with the manufacturer of the glass flasks. All participants were invited to visit the FCL laboratories to learn about the laboratory procedures. FCL scientists have also participated in person or remotely in the atmospheric MSA in Prague in September 2018 (Deliverable 9). Daily communication of specific topics (e.g. reference gases, flask samples, flask sampler) between individual station PIs, other central facilities and FCL is facilitated by dedicated mailing lists and named contact persons. Topics concerning the entire atmospheric domain have been brought up for discussion with the MSA chairs and colleagues from ATC and CRL.

## Central Analytical Laboratories -Central Radiocarbon Laboratory (CAL-CRL)

### Highlights

In 2018 ICOS-CRL recruited two new members: Julian Della Coletta works since August 2018 on an 80% position as engineer and is funded via the RINGO project until end of 2020. Mr Della Coletta is currently working with the extraction- and graphitisation-line which was developed by Dr. Johannes Lux who is leaving the CRL by mid-2019. For the CRL it is of utmost importance to find continuation for Mr. Della Coletta's position after RINGO funding ends. Dr. Penelope Pickers was hired in June 2018 on a 50% post-doc position to operate the O<sub>2</sub>/N<sub>2</sub> system at the CRL pilot station and to assess the potential of atmospheric potential Oxygen (APO) as ffCO<sub>2</sub> surrogate tracer.

CRL pilot station: Penelope Pickers did assemble and test an O<sub>2</sub>/N<sub>2</sub> system at the University of East Anglia, which was transferred to Heidelberg in October 2018 (Deliverable 9). The CRL pilot station was therefore equipped with two new intake lines. The first measurements of O<sub>2</sub>/N<sub>2</sub> and the inferred atmospheric potential oxygen (APO), show large variations which are most likely caused by fossil fuel CO<sub>2</sub> (ffCO<sub>2</sub>) making APO a very interesting new surrogate tracer. We are now sampling flasks in parallel to validate the potential of APO using 14C analysis. 9.0 PM allocated for this task.

The core instrumentation of the CRL pilot station was running smoothly in 2018. The Picarro G2401 was operating continuously. The FTIR system needed to undergo a PC hard- and software update which caused unexpected problems, leading to a sparse data record in January and February 2018. Throughout 2018 tests with the ICOS flask-sampler were performed. Different flask filling methods were tested involving mass flow controllers with different flow ranges. It could be shown that for CO<sub>2</sub> the mean difference between the in-situ instrument and the flask sample is  $-0.06 \pm 0.38$  ppm. For ambient air variabilities smaller than 0.5ppm the mean CO<sub>2</sub> difference was  $-0.03 \pm 0.12$  ppm and stayed within 0.3ppm. This makes the flask sampler applicable for quality control purposes in the ICOS atmospheric network. We could also show that, in the current sampler configuration, it is not possible to take duplicate samples with identical sample flows. 7.0 PM allocated for this task (Deliverable 10).

Participation in RINGO: In the course of RINGO Task 1.3, together with the CP we developed a flask sampling strategy for class-1 atmospheric stations serving two purposes: (1) Ongoing

independent quality control of in-situ observations and measurement of an extended tracer set not covered in-situ and (2) monitor and characterize isotopically important source regions in the catchment area of the station. The results will be presented at the RINGO annual meeting in Southampton, in March 2019. For RINGO Task 1.2, about 100 flasks from Heidelberg and Freinsheim have been analysed. In addition to this experimental work, we developed together with our European partners the foundation of a  $^{14}\text{C}$  observing system simulation experiment (OSSE) to assess the benefit of different  $^{14}\text{C}$  sampling strategies. 4.0 PM allocated for this task.

Participation in VERIFY: The CRL is leading Task 2.2 named: "Assessment of atmospheric proxy/ffCO<sub>2</sub> ratios and independent  $^{14}\text{C}$ -based ffCO<sub>2</sub> emission estimates" in the EU funded project VERIFY. In the course of this, we installed a NO<sub>2</sub> instrument at the Heidelberg pilot station. The NO<sub>2</sub> measurements are interpreted in combination with CO and APO and appear to be another potential surrogate tracer for ffCO<sub>2</sub>. Up to now, no  $^{14}\text{C}$  samples have been processed for VERIFY. 2.5 PM allocated for this task.

Participation in ATTO: In 2018 the integrated  $^{14}\text{C}$  sampler was installed at the ATTO tower. So far, no samples did return. 0 PM allocated for this task.

Organised events to promote ICOS: ICOS RI COM meeting, Heidelberg Germany, March 2018.  
Attended events to promote ICOS: IG3IS/Transcom Meeting, Lund Sweden September 2018.

## **Radiocarbon analysis of two-weekly integrated CO<sub>2</sub> samples (Task 1)**

By the end of 2018, all atmospheric ICOS class 1 stations have been equipped with  $^{14}\text{C}$  samplers and 13 of these stations delivered integrated samples to the ICOS CRL. Additionally, we analysed samples from the ICOS stations Cabauw, Trainou and Heidelberg, as well as from the non-ICOS stations Mace Head, Schauinsland and Izaña, which serve, together with Jungfraujoch as reference sites to estimate fossil fuel CO<sub>2</sub> concentrations. All samples provided from the ICOS network have been analysed (or are in preparation). In total, 330 European samples were analysed by low-level counting. As outlined in the work plan, we used idle measurement capacity for analysing integrated  $^{14}\text{C}$  samples from the polar stations Neumayer (Antartica) and Alert (Arctic) as well as from Cape Grim and Toronto (paid by AES, Canada in 2019). In total 63 samples from the global network were analysed. Station specific reporting: The  $^{14}\text{C}$  contamination at Hyytiälä station (FI) resulted from a broken aerosol neutralizer which did use  $^{14}\text{C}$  as a beta emitter (370MBq). During the accident, most of the  $^{14}\text{C}$  source was lost to the environment around Hyytiälä station. This accident explains the extreme  $^{14}\text{C}$  activities measured in Hyytiälä; as a consequence,  $^{14}\text{C}$  sampling was ceased permanently. At the KIT station, we observed occasional  $^{14}\text{C}$  contamination of up to 50 per mil. On KIT campus a waste treatment company operates, which burns low-intensity radioactive waste.  $^{14}\text{C}$  stack monitoring exists with weekly integrated samples operated by KIT. The sampling interval of both measurements were harmonized. Only if the stack measurements are void of  $^{14}\text{C}$ , the integrated ICOS sample is analysed. At LIN the integrated  $^{14}\text{C}$  sampling was temporality interrupted due to safety concerns of the local safety engineer. This triggered a revision of the documentation of the  $^{14}\text{C}$  sampler involving the Heidelberg University safety department. Sampling will be resumed in 2019. All level-1 results have been transferred to the CAL database in Jena. The level-2 data product for the ICOS atmospheric pre-release and the first ICOS data release were transferred to the ATC directly. Therewith, deliverables 1 and 2 were fulfilled.

25 PM allocated for this task

## **Radiocarbon analysis of CO<sub>2</sub> from flask samples (Task 2)**

Apart from one flask sampler operated at the CRL pilot station, the other flask samplers were installed only by the end of 2018 so that no flask samples from the network arrived at the CRL in 2018. Nevertheless, the CRL performed in total about 550 AMS samples for quality control and assessing of the <sup>14</sup>C sampling strategy in collaboration with Task 1.2 of the RINGO project. The quality control measurements carried out at the extraction- and graphitization-line (EGL) were ongoing and intensified in 2018. Based on oxalic acid 1 (SRM 4990 B) measurements, the international <sup>14</sup>C scale could be reproduced to better than 0.1±0.4 ‰. Internal quality control gases show for 2018 a reproducibility (1σ) between 2.3 and 2.9 ‰, the latter comparably large repeatability is caused by occasional outliers. The underlying cause behind these outliers is currently investigated. The comparison between the AMS and the LLC measurement technique showed a mean deviation of 0.65 ± 0.4 ‰. (N=197). Therewith, the small offset between the LLC and AMS technique, which was first observed in 2017, is affirmed. The current LLC working standard generation will last one more year, thereafter a potential re-assessment of the LLC working standard will be reviewed. About 150 flask samples were processed in order to test the <sup>14</sup>C flask sampling strategy including about 100 flasks for Task 1.2 of the RINGO project. The graphitization was operated by Julian Della Coletta, who is funded by the RINGO project (see new recruits). Final evaluation of the weekly integrated flask sampling device showed that the sampling device is not robust enough to be operated in the ICOS network. Thus, integrated samples will continue to be sampled using absorption in NaOH solution. No level-1 or level-2 flask data has been transferred to the CAL database since no flask samples from the ICOS network did exist. Thus deliverable 3 and 4 do not apply.

25 PM allocated for this task

## **Production of integrated CO<sub>2</sub> samplers (Task 3)**

In 2018, no integrated <sup>14</sup>CO<sub>2</sub> samplers have been built, and there was no request for integrated samplers for 2019. The revision of the sampler documentation and its accompanying paperwork was carried out in close collaboration with the Heidelberg University safety department. This will lead to an additional safety switch, which will be installed in all samplers in the course of 2019.

1.0 PM allocated for this task

## **Interaction with station PIs (Task 4)**

CRL scientists have participated in person or remotely in both atmospheric MSAs, in Jena (DE) in spring and in Prague (CZ) in autumn 2018 (Deliverable 5&6). All available <sup>14</sup>CO<sub>2</sub> results from integrated sampling had been presented to the participants and were discussed with the station PIs. There is a regular email exchange between the CRL and the stations, concerning supply of sampling bottles, spare parts and other issues. The regular transfer of samples to the CRL works smoothly and analysis is on track.

2.0 PM allocated for this task

## **Activities and plan reported to the DG, RI Committee and General Assembly (Task 5)**

Reporting of activities and finances in 2017 (Deliverable 7), as well as the work plan and financial plan for 2019 (Deliverable 8), have been submitted to the HO in time. Additional time was devoted to preparing the next 5 years plan and the ICOS strategy document. At both GA meetings, in Bergen in May and in Offenbach in November 2018, one CRL representative has participated and discussed CAL issues with the GA and the Scientific Advisory Board. Both CRL representatives were present at the RI COM face-to-face meetings in Heidelberg in March and in Todi in October 2018, with very few exceptions, either I. Levin or S. Hammer or both have participated at the regular monthly teleconferences of the RI COM.

5.0 PM allocated for this task

## Monitoring Station Assemblies (MSAs)

### Atmosphere MSA

#### *Important milestones and highlights in 2018*

- We have organised two MSA meetings, one in Jena Germany, June 5-7, 2018, and one in Prague, September 10, 2018, respectively.
- The ICOS atmosphere network became an official contributing network to the Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO).
- The first level2 data of 11 atmospheric stations were released in August 2018.
- Discussions were launched about a revision of the mandatory set of measured parameters taking the latest technical developments into account.

### Ecosystem MSA

#### *Important milestones and highlights in 2018*

- Ecosystem MSA meeting (16 - 18 April 2018), Rome, Italy.
- Ecosystem MSA meeting (10 September 2018), Prague, Czech Republic.

### Ocean MSA

#### *Important milestones and highlights in 2018*

- 1st ICOS OTC Instrumentation workshop; March 2018; Bergen NO. A significant number of ICOS Oceans stations participated in the workshop. The workshop provided the opportunity for the community to come closer to 2 suppliers of instrumentation for seawater pCO<sub>2</sub> (General Oceanics and Kongsberg Maritime - Contros)
- ICOS Oceans MSA meeting; May 2018; Trieste Italy
- 2018 was the year that the first 5 ICOS Oceans stations completed step 2 of the labelling procedure and received the official ICOS label
- Started communications with other observations networks (SOCONET, GOA-ON)
- A significant number of ICOS Oceans stations submitted data to SOCAT v7
- PALOMA (Italy): participation in a Joint Research Activity within JERICO-NEXT project (H2020)
- Carbon -VOS Kronprins Håkon (Norway): successful re-installation after ship change and first pCO<sub>2</sub> measurements in the Atlantic Ocean
- Submitted a manuscript for a community white paper for the Oceanobs 2019 (September 16-20, 2019, Honolulu, Hawaii, USA): "Constraining the oceanic uptake and fluxes of greenhouse gases by building an ocean network of certified stations: the ICOS-Oceans Network", all station PI's are co-authors
- December 2018: A significant number of ICOS Oceans stations submitted data to SOCAT v7

## ICOS National Networks' Highlights

### ICOS Belgium

#### Highlights

- ICOS Flanders (UAntwerp and VLIZ) secured funding for core ICOS operations from Flemish government (FWO) for 2019 and 2020.
- BIRA followed a training at the ICOS Atmospheric Thematic Centre (ICOS-ATC) to learn the methodologies and techniques needed for running an atmospheric ICOS station. UAntwerp attended an advanced course for programming data loggers (CRBasics) used at the ecosystem stations, organised by Campbell Scientific in the UK. Several PIs from the ecosystem and ocean network attended the Drought paper meeting on 16 November 2018 in Brussels.
- VLIZ collaborated with NIOZ on a 3-day training course for optimisation of analysis for Inorganic Nutrients in Seawater samples. June, 2018, Ostend.
- Ecosystem Monitoring Station Assembly (MSA) meeting in Rome from 16 to 18 April 2018. Ecosystem MSA meeting in Prague on 10/09/2018. Atmospheric MSA meeting in Jena, Germany. BIRA attended workshops and discussions in the framework of RINGO for embedding TCCON in ICOS. BIRA promoted ICOS at the TCCON annual meeting in Mexico. Focal Point participated in the ICOS Impact Analysis Workshop on 13 February 2018 in Brussels. Prof. dr. Reinhart Ceulemans (FP) and dr. Bert Gielen (ETC Antwerp) were also interviewed by Technopolis for the Impact Analysis.
- Presentation of ICOS activities conducted at the Vielsalm station to the Master 1 students of the University of Gembloux, on 16/04/2018 in Vielsalm. Presentation of ICOS Wallonia activities during visit of scientific researchers of the University of Jülich, on 02/07/2018 in Gembloux. Presentation of the Lonzée station to students from AgroSup Dijon during their study trip, on 02/10/2018 in Lonzée. Presentation of the Lonzée station to students in the framework of Vivasciences, on 12/11/2018 in Lonzée. ICOS Flanders participated in "Dag van de Wetenschap" (Science Day) on 25 November 2018 with workshops for children in Ostend (VLIZ) and Maasmechelen (UAntwerp). UAntwerp participated to the Kinderuniversiteit (Children's University) on 18 March 2018 in Antwerp.
- Presentation of the « Rotational and continuous grazing does not affect the total net ecosystem exchange of a pasture grazed by cattle but modifies CO<sub>2</sub> exchange dynamics » paper at the 2018 EGU conference in Vienna by Louis Gourlez de la Motte (ULG). 3<sup>rd</sup> ICOS Science Conference from 11 to 13/09/2018 in Prague, Czech Republic with oral presentation by Marc Aubinet (Carryover impacts on Net Ecosystem Productivity in a temperate mixed forest) and poster presentations from all the Belgian groups and a National Network poster by the Focal Point.
- VLIZ stations participated in the ICOScapes campaign in April 2018. Within the framework of a citizen science project, UAntwerp organised workshops for secondary schools in BE-Bra during the Autumn months of 2018. UAntwerp participated in Proefkot, an afterschool science academy for children aged 11 – 13 years old. UAntwerp visited five Flemish high schools in May 2018 presenting and educational workshop.
- Presentation of the carbon balance results of the Dorinne station at the general assembly of "Fourrage mieux", an assembly providing advice for crop management, on 20/06/2018 in Dorinne, by Louis Gourlez de la Motte (ULG). Presentation of the activities conducted at the Dorinne and the Lonzée stations during the inauguration of the TERRA Research Center in Gembloux on 24/05/2018. Presentation of ICOS Wallonia project during the Walloon week « air, climate and energy » of the AWAC, on 17/11/2018 in Namur. Projection of the Icelandic film "Woman at War " by Benedikt ERLINGSSON followed by a meeting entitled "Climate Change... Acting to Prevent?" Participation of prof. Bernard Heinesch in the

debate, on 11/12/2018 in Liège. BIRA presentation by Nicolas Kumps at the "Assemblée Scientifique et Technique ICOS France: 4 - 6 December 2018". UAntwerp presented ICOS at the Science event of the National Park Hoge Kempen, 12/12/2018 in Maasmechelen. On 8 June 2018 Focal Point attended the presentation of an advice note written by the Royal Flemish Academy of Belgium (KVAB) on Flanders' participation in international research infrastructures in Brussels. Prof. dr. Reinhart Ceulemans (FP) was one of the contributors to the advice note.

- 4<sup>th</sup> ICOS Belgium Consortium Study Day on 01/06/2018 in Vielsalm plus visit to the nearby ecosystem station.
- Inauguration of the Lonzée station in the presence of the Walloon minister of climate (Mr. Jean-Luc Crucke) and the press (Le Soir, Canal Zoom, L'Avenir, ...) following the ICOS labelling of the station, on 29/03/2018 in Lonzée.
- Participation to projects CEOS/WGCV/LPV initiative: the Lonzée station is a candidate "super site" for the validation of terrestrial products. (<https://lpvs.gsfc.nasa.gov/>). Forest Flow (BELSPO): Estimation of dissolved organic compound flows at the scale of the plot and the watershed (UAntwerp, KUL, UCL, IRM) -Vielsalm and Brasschaat ecosystem stations are involved. BELAIR (Sylva): Study of the spatial and temporal variability of indicators related to forest cover (NDVI, PRI, LAI, PAR) on the BELAIR SILVA site by terrestrial measurements coupled with BELAIR measurements (APEX flights and drones in July 2018) - Vielsalm station is involved. NEC (Agence wallonne de l'air et du climat): Assessing the impact of atmospheric pollution on ecosystems / habitats (acidification, eutrophication, ozone damages) - Vielsalm station is involved. STRENGTHENING PRIORITY FSI COMPONENTS INTO KEY ESFRI RESEARCH INFRASTRUCTURES: BIRA obtained a PTR-TOF-MS (300 k€) which will be installed at the Vielsalm station. Participation in the 2018 Task Force on Drought. RINGO project (H2020) (1 January 2017 – 31 December 2020)
- Networking success Representation of ICOS Wallonia within the internal structure of the faculty. Two of our sites have been officially integrated into a CARE (Centre d'Appui à la Recherche et à l'Enseignement), an official component of the research infrastructure of ULG UAntwerp and ULG are important partners of the Ecotron projects operated by the University of Hasselt (UHasselt) and ULG in the framework of AnaEE at the national park 'Hoge Kempen' in Maasmechelen and in Gembloux respectively. The Maasmechelen ecosystem station is one of the first stations where two ESFRI's are actively linked.

### ***Scientific publications in 2018***

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### ***Other publications in 2018***

- Update of the ICOS Belgium and ICOS Wallonia folders by replacing the La Robinette station with the Dorinne station.
- Creation and installation of an information panel explaining ICOS activities at the Vielsalm ecosystem station.
- Organisation of a photography campaign carried out by a professional photographer (Eli Verheyen) at Brasschaat, Lochristi, Maasmechelen, Lonzée and Dorinne ecosystem stations.

### ***List of labelled stations in 2018***

1 ocean station: Thornton Buoy of VLIZ (PI dr. Thanos Gkritzalis)

### 1-3 Scientific Highlights from 2018

- Aubinet, M., Hurdebise, Q., Chopin, H., Debacq, A., De Ligne, A., Heinesch, B., Manise, T. & Vincke, C. 2018. Inter-annual variability of Net Ecosystem Productivity for a temperate mixed forest: a predominance of carry-over effects? *Agricultural and Forest Meteorology*, 262: 340-353. This is a site-specific study but nevertheless interesting for the ICOS network. Prof. Marc Aubinet uses one of the longest time series in the world to discuss a crucial point, the inter-annual variability of fluxes and its causes.
- Gourlez de la Motte, L.; Mamadou, O.; Beckers, Y. et al. 2018. Rotational and continuous grazing does not affect the total net ecosystem exchange of a pasture grazed by cattle but modifies CO<sub>2</sub> exchange dynamics in Agriculture. *Agriculture, Ecosystems & Environment*, 253: 157-165. In this paper, Louis Gourlez de la Motte proposes a methodology that will help ICOS to manage flux data from grazed grasslands. This is an issue that is currently missing from the ICOS protocols.
- Data from ocean station RV Simon Stevin, have been submitted to SOCAT v6.
- Total Carbon Column Observing Network (TCCON) data are included in Copernicus Atmosphere Monitoring Service (CAMS); in Copernicus Climate Change Service (C3S), there is a plan to approach ICOS for including ICOS data in the Climate Data Store.
- Update of RV Belgica AUMS was initiated in 2018 and finalized in 2019 via an in-kind contribution of 185 k €. A contract for building a new research vessel to replace RV Belgica has started on 08.06.2018.

## ICOS Czech Republic

### Highlights

- Co-organisation of the 3<sup>rd</sup> ICOS Science Conference 2018, 11-14 September, Prague.
- Co-organisation of ICOScapes Photo Exhibition Opening, 11 September 2018, Prague.
- Excursion to CZwet wetland ecosystem station within the 3<sup>rd</sup> ICOS Science Conference 2018, 14 September. Prague.
- QUO Vadis, SCIENTIA? Towers for carbon - ICOScapes Photo Exhibition in the Parliament House, Prague, The Czech Republic, 10-21 September 2018.
- In May 31, 2018; Atmosphere station Křešín u Pacova has become a labelled Class 1 ICOS station.
- During summer – in June – extensive and costly technical upgrades were implemented into sampling system for GHG measurements at atmospheric station (new valves were installed for easier performing of leak tests, which became a new routine mandatory at ICOS atmospheric stations).
- Since April 2018, the Department of Atmospheric Matter Fluxes and Long-Range Transport has got a new PhD student, Marek Lahoda. His domain is mainly meteorology and he is already a valuable reinforcement for the team.
- Proposed ICOS Ecosystem stations (Lanžhot- class 1; Bily Kriz – class 2; Trebon – Associated station) were upgraded during 2018 according to current requirements of ICOS.
- The Government of the ISRAEL visited by CzechGlobe - On June 11, 2018; the Ambassador of the State of Israel in the Czech Republic Mr. Daniel Meron visited CzechGlobe. He met the management of the institute and the representatives of the scientists. During a short visit the Institute Director Michal Marek introduced the Institute and to projects of international cooperation and interconnection with European research infrastructures, including ICOS.
- On March 24, 2018; from 9 am to 2 pm, an Open Door Day was hold at the Atmospheric Station in Kresin (Proposed as atmospheric ICOS station), it was held on the occasion of World Water Day (22 March) and World Meteorological Day (23 March).

- Excursion for participants of ACTRIS PPP meeting on September 19 and ACTRIS Transnational Access (TNA) activities, which welcomed two groups of researchers at the Atmospheric Station infrastructure (Croatian group in September 24 – 27, Slovak group in November 13 – 16).
- Aerodyne QCL Workshop 16-18 April 2018, Brno.
- [https://www.youtube.com/watch?v=MKfHKmecs\\_8](https://www.youtube.com/watch?v=MKfHKmecs_8)

### **Scientific publications in 2018**

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### **Other publications in 2018**

- Software: Šigut, L.; Mauder, M.; Sedlák, P.; Wutzler, T., Fischer, M.; Mžourková Macálková, L., McGloin, R.P.; Fratini, G. Openeddy 0.0.0.9004. Global Change Research Institute CAS v. v. i., Brno; University of Ostrava, 2018.
- Dušek, J., Stellner, S., Hudecová, Š., 2018. Změny mikroklimatu ostřicové louky během posledních 40 let, in: Hospodaření s vodou v krajině. p. 14.

### **Video/article in the web**

- <https://brnensky.denik.cz/z-regionu/luzni-lesy-jako-prirodni-laborator-dominanta-krajiny-zkouma-dopady-zmen-klimatu-20190121.html>
- [https://www.idnes.cz/brno/zpravy/klima-lanzhot-breclavsko-pristroj-mereni-sucho.A181128\\_442138\\_brno-zpravy\\_vh](https://www.idnes.cz/brno/zpravy/klima-lanzhot-breclavsko-pristroj-mereni-sucho.A181128_442138_brno-zpravy_vh)
- <https://www.ceskatelevize.cz/porady/12318068320-klima-meni-cesko/218562220300001/>
- <https://www.ceskatelevize.cz/porady/1181680258-tyden-v-regionech-brno/318281381891103-tyden-v-regionech/video/654563>
- <https://www.euro.cz/udalosti/vez-v-lanzhote-vedci-sleduji-globalni-zmenu-i-v-cesku-1427343>
- <https://www.info.cz/magazin/hlidaci-lesa-v-lanzhotu-na-morave-hlidaji-klimatickou-zmenu-svoji-cinnost-se-snazi-tajit-36626.html>
- <https://www.ceskatelevize.cz/ivysilani/10101491767-studio-ct24/218411058270913> (21:12-29:00 min.)
- <https://www.nejbusiness.cz/zpravy/2018-09-10-treti-vedecka-konference-panevropske-site-icos-se-uskutecni-v-praze>
- <https://www.ceskatelevize.cz/porady/1181680258-tyden-v-regionech-brno/318281381891103-tyden-v-regionech/video/654563>
- <https://www.ceskatelevize.cz/porady/10435049455-dobrerano/318291310020049/video/622068>
- [http://regiony.impuls.cz/atmosfera-stozar-kosetice-stanice-meteorolog-observator-kresin-phk-/vysocina.aspx?c=A180323\\_173807\\_imp-vysocina\\_kov](http://regiony.impuls.cz/atmosfera-stozar-kosetice-stanice-meteorolog-observator-kresin-phk-/vysocina.aspx?c=A180323_173807_imp-vysocina_kov)
- [http://regiony.impuls.cz/stozar-kresin-kosetice-pelhrimov-vysocina-meteo-atmosfera-veda-vyzkum-pocasi-1y9-/vysocina.aspx?c=A180315\\_163404\\_imp-vysocina\\_kov](http://regiony.impuls.cz/stozar-kresin-kosetice-pelhrimov-vysocina-meteo-atmosfera-veda-vyzkum-pocasi-1y9-/vysocina.aspx?c=A180315_163404_imp-vysocina_kov)
- [http://www.czechglobe.cz/media/filer\\_public/95/f9/95f95a1b-4f8e-4670-a70d-5ad4b1ad624f/newsletter\\_2\\_2018\\_cz.pdf](http://www.czechglobe.cz/media/filer_public/95/f9/95f95a1b-4f8e-4670-a70d-5ad4b1ad624f/newsletter_2_2018_cz.pdf)

### **List of labelled stations in 2018**

- CZ - KRE (Křešín u Pacova) – Tall Tower (PI: Gabriela Vítková), The Tall tower was labelled in May 2018 as Atmospheric ICOS station – Class 1.
- CZ- Lnz (Lanžhot) - Proposed as Ecosystem Station - Class 1 (PI: Natalia Kowalska) not labelled in 2018, labelling process ends 31.12.2019. During 2018 according to ICOS

requirements EC tower was prolonged and now is 48 m high. We are now working in Action 4 of labelling Step 2.

- CZ - BK1 (Bily Křiž Forest) - Proposed as Ecosystem Station - Class 2 (PI: Ladislav Šigut), we are in Action 7 of labelling Step 2.
- CZ - wet (Třeboň) - Proposed as Associated Station (PI: Jiří Dušek), Sedge-grass marsh, no labelled.

### ***1-3 Scientific Highlights from 2018***

- The ICOS labelling of the Křešín Tall Tower in May 2018
- The co-organisation of the 3rd ICOS Science Conference 2018, 11-14 September, Prague and the organisation of ICOScapes Photo Exhibition at the Czech Parliament House, QUO Vadis, SCIENTIA? - Towers for carbon, Prague, The Czech Republic, 10-21 September 2018
- Authors and co-authors of 10 ICOS protocols published in International Agrophysics, December 2018

## **ICOS Denmark**

### ***Highlights***

The Danish ICOS network entered its third year in 2018. The main activity has been to bring the stations forward in the labelling process. The national steering committee held a number of meetings and a 2-day workshop was organised in late summer 2018 for all Danish ICOS staff, including scientists and technicians. During the workshop, we visited two of the Danish stations the short rotation coppice at Risø and the beech forest at Sorø.

### ***Scientific publications in 2018***

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### ***List of labelled stations in 2018***

- Soroe, Ecosystem, Andreas Ibrom, Step 2 started
- Voulundgaard, Ecosystem, Thomas Friborg, Step 1 approved
- Zackenberg Fen, Ecosystem, Step 1 acknowledged
- Station Nord, Atmosphere, Step 1 approved

### ***1-3 Scientific Highlights from 2018***

The effect of the summer drought on the NEE in the beech forest showed a substantial decrease in net carbon uptake in July and August, amounting to a reduction in the annual NEE of 25% compared to the expected.

## ICOS Finland

### *Highlights*

#### ***New recruits***

- Annalea Lohila to Assoc. prof in Atmospheric Sciences and Physics (Biogeochemical cycles, ICOS)
- Lenka Foltynova from Czech Globe visited 6 months

#### ***New funding acquired***

- VERIFY "Observation-based system for monitoring and verification of greenhouse gases" (100 k€), 2018–2021
- SOMPA "Novel soil management practices – key for sustainable bioeconomy and climate change mitigation" (360 k€), 2018–2020

#### ***Workshops***

- 20<sup>th</sup> Anniversary of EUROFLUX workshop, Hyytiälä, 10–14 December, 2018

#### ***Attended events to promote ICOS***

- Climate University event 27.11.2018 / How European RI's can support sustainability teaching in Finland? / Leena Järvi (presenting urban meteorology measurements at Hotel Torn measurement station, Helsinki)
- Seminar on "Mitigation options for climate change in agriculture and forestry" for visitors on Polish universities and Polish Ambassador, 14 March 2018, Helsinki / Timo Vesala
- Open access to information / for European parliament audience / 23.1.2018 / Timo Vesala
- Speech in the Conference on Forests and the climate / The Royal Swedish Academy of Agriculture and Forestry / 12.3.2018 / Timo Vesala
- Mitigation options for climate change in agriculture and forestry / LUKE / Speech on "Forests and climate change mitigation" / 14.3.2018 / Timo Vesala
- Opening lecture of the conference 12<sup>th</sup> International Conference on Agrophysics: Soil, Plant & Climate / "Forest harvesting and climate and a public discourse" / 17.9.2018 Lublin, Poland / Timo Vesala
- Smart as Hel event / public presentation about climate change / Science corner of the University of Helsinki / 14.11.2018 / Timo Vesala
- GEO Finland meeting / ICOS Finland oral presentation / 23.5.2018 / Elisa Halmeenmäki

#### ***Organised events to promote ICOS***

- Visit of Ilkka Herlin (Finnish billionaire, the chairman and one of the owners of Cargotec, and one of the owners of the elevator and escalator maker Kone, Chair of the Board of University of Tampere) and Saara Kankaanrinta to Hyytiälä ICOS ATM and ECO station, 8 March, Hyytiälä, Finland

#### ***Major meetings within the National Network***

- ICOS-FI PI meeting, 6 Nov, Hyytiälä, 21 participants (Topics discussed: updates on the station labelling, RI updates, Measurement protocols and technical implementations)

### ***Events where you have been invited as a speaker/presenter to represent ICOS***

- OPTIMISE Conference 2018, 21 February 2018, Sofia, Bulgaria 'ICOS – From science projects to integrated infrastructure' (Timo Vesala)

### ***National ICOS scientists in media***

- University of Helsinki news + video / Climate change and carbon sequestration / Timo Vesala (Link: <https://www.helsinki.fi/en/news/sustainability-news/timo-vesala-climate-change-can-no-longer-be-stopped-but-science-can-help-to-curb-it>)
- TV YLE News 26.7. and YLE Lapland News 27.7. + 2 newspaper interviews / "The role of rivers in climate change" / Timo Vesala
- Helsingin Sanomat / Urban meteorology / Leena Järvi (Link: <https://www.hs.fi/sunnuntai/art-2000005737955.html>)
- YLE Radio 1 Ajantasa, interview about reducing emissions / 19.11.2018 / Timo Vesala
- Helsingin Sanomat / GHG emissions of Finland / 24.5.2018 / Tuomas Laurila (<https://yle.fi/uutiset/3-10220889>)

### ***Presentations in scientific conferences by ICOS Finland staff***

- 3<sup>rd</sup> ICOS Science Conference, 11–13 September 2018, Prague, Czech Republic: Annalea Lohila / Increasing soil respiration has threatened the carbon sink at a northern boreal fen; Mika Korkiakoski / Performing a partial harvest instead of clearcutting causes less greenhouse gas emissions in a peatland forest; ICOS Finland general poster
- Suopäivä 2018 Seminaari, 2 February 2018, Helsinki, Finland: Mika Korkiakoski / Alikasvosuudistamisen ja avohakkuun vaikutus runsasravinteisen suometsän hiilidioksidin-, metaani- ja typpioksiduulitaseisiin; Elisa Männistö / Poster / Boreaalisen rahkasuon metaanipäästöjen paikallinen ja ajallinen vaihtelu
- EGU General Assembly, 8–13 April 2018, Vienna Austria: Annalea Lohila / Long-term GHG measurements at a northern boreal fen show stable CH<sub>4</sub> emissions, increasing soil respiration and endangered carbon uptake as climate is warming; Mika Korkiakoski / Poster / The effect of partial harvesting and clearcutting on CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O balances in a drained peatland forest; Elisa Männistö / Small spatial variability in methane emission measured from a wet patterned boreal bog; Leena Järvi / Simulating the effect of urban planning choices on the spatial variability of net carbon dioxide exchange Helsinki, Finland
- USCCC15 (US-China Carbon Consortium) Annual Workshop, 14–18 August 2018, Jiujiang, China: Keynote invited speaker / Benefits and challenges of long-term eddy covariance measurements over lakes / Ivan Mammarella
- Science conference "Changing ecosystems – Opportunities and challenges in integrated research", INAR Ecosystems, 20–22 August 2018, Oulanka, Finland: Annalea Lohila / ICOS Finland general poster/ Continuous cover management as a tool to mitigate emissions from peatlands forestry – a case study from Southern Finland
- The 20<sup>th</sup> Anniversary of EUROFLUX workshop, 10–14 December, Hyttiälä, Finland: Mika Aurela / Interannual variation of CH<sub>4</sub> exchange in a northern boreal fen; Elisa Halmeenmäki / Upscaling forest floor CH<sub>4</sub> flux
- 10<sup>th</sup> International Conference on Urban Climate, 6–10 August 2018, New York, USA: Leena Järvi / Impact of different planning alternatives on net carbon dioxide emissions in Helsinki
- Gordon Research Conference: Biogenic Hydrocarbons & the Atmosphere: Elisa Halmeenmäki / Forest floor methane flux modelled by environmental factors – comparison to ecosystem-scale measurements
- SOMPA project workshop "Peatlands: Greenhouse Gas Budgets and Hydrology", 25–27 April, Helsinki: Annalea Lohila / Impacts of anthropogenic disturbance on carbon fluxes at pristine and managed peatland ecosystems—Two case studies

- Smart Cities in Smart Regions, 26–27 September 2018, Lahti, Finland: Minttu Havu / Poster / Impact of different urban planning choices on the spatial variability of carbon dioxide exchange in Helsinki
- Viikki Soil Science Seminar, 29 January, 2019, University of Helsinki: Annalea Lohila / Insights into measuring highly variable and sporadic N<sub>2</sub>O emissions in a fertile peatland forest

### ***Scientific publications in 2018***

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### ***Other publications in 2018***

- New website (icos-finland.fi) open in April 2018
- New ICOS-Finland general presentation (updated in May 2018)
- New ICOS-Finland general poster (updated in August 2018)

### ***List of labelled stations in 2018***

- Pallas ATM, PI Juha Hatakka;
- Hyttiälä ECO, PI Ivan Mammarella;
- Värriö ECO Associate, PI Pasi Kolari;
- Lettosuo ECO Associate, PI Mika Korkiakoski.

### ***1-3 Scientific Highlights from 2018***

- The decade-long methane flux from a boreal fen, Siikaneva, Class 2 ICOS site, showed seasonal cycle but no systematic diel cycle and on interannual time scales the gross primary productivity (photosynthesis) controls methane emission variability. The weak relation of methane emission to water table position indicates that space-to-time analogy, used to extrapolate spatial chamber data in time, may not be applicable in seasonal time scales. (Rinne et al. 2018, Temporal variation of ecosystem scale methane emission from a boreal fen in relation to temperature, water table position, and carbon dioxide fluxes. *Global Biogeochemical Cycles*, 32(7): 1087–1106)
- Typically, an ecosystem is monitored by only one single EC measurement station at a time, making the ecosystem-level flux values subject to random and systematic uncertainties. Furthermore, in urban ecosystems we often have no choice but to conduct the single-point measurements in non-ideal locations such as close to buildings and/or in the roughness sublayer, bringing further complications to data analysis and flux estimations. In order to tackle the question of how representative a single EC measurement point in an urban area can be, two identical EC systems – measuring momentum, sensible and latent heat, and carbon dioxide fluxes – were installed on each side of the same building structure in Helsinki City Centre (Hotel Tornio being under labelling in ICOS). The momentum and measured scalar fluxes respond very differently to the distortion caused by the building structure. The momentum flux is the most sensitive to the measurement location, whereas scalar fluxes are less impacted. Different gap filling methods with which to yield annual cumulative fluxes show how using data from a single EC measurement point can cause up to a 12% (480 g Cm<sup>-2</sup>) underestimation in the cumulative carbon fluxes as compared to combined data from the two systems. We also show how the commonly used data flagging criteria in natural ecosystems, kurtosis and skewness, are not necessarily suitable for filtering out data in a densely built urban environment. (Järvi et al. 2018, Uncertainty of

eddy covariance flux measurements over an urban area based on two towers, *Atmos. Meas. Tech.*, 11: 5421–5438)

- Freshwaters bring a notable contribution to the global carbon budget by emitting both carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) to the atmosphere. We compared CH<sub>4</sub> and CO<sub>2</sub> fluxes eddy covariance (EC) and floating chamber (FC) at Lake Kuivajärvi (being under labelling in ICOS). FC measurements resulted in higher fluxes than simultaneous EC measurements. EC measurements did not show a diurnal behaviour in CO<sub>2</sub> flux. CH<sub>4</sub> flux had higher values in daytime than night-time during lake mixing period according to EC measurements, with highest fluxes detected just before sunset. FC measurements did not detect spatial variation in either CH<sub>4</sub> or CO<sub>2</sub> flux. EC measurements, on the other hand, did not show any spatial variation in CH<sub>4</sub> fluxes but did show a clear difference between CO<sub>2</sub> fluxes from shallower and deeper areas. We highlight that while all flux measurement methods have their pros and cons, it is important to carefully think about the chosen method and measurement interval, as well as their effects on the resulting flux. (Erkkilä et al. 2018, Methane and carbon dioxide fluxes over a lake: comparison between eddy covariance, floating chambers and boundary layer method, *Biogeosciences*, 15: 429–445)

## ICOS France

### Highlights

- The French national network of stations is completing its action plan with 100% of Atmospheric and Oceanic stations labelled. The Ecosystem stations network is lagging a bit behind its labelling plan due to the temporary lack of human resources and the large amount of field and computing workloads induced by the labelling process. Several inter-comparison field campaigns gathering international partners (NOAA, Bern Un., FMI...) have been involving the French ATM stations (aircore systems, airborne instruments, tall towers profiles, TCCON, Copernicus products) such as the COMET2018 and Sodankyla projects. The Ecosystem stations will be included in the drought 2018 synthesis. The Ocean data were used for mapping the surface pCO<sub>2</sub> in the North Atlantic Ocean.
- The ATC and ETC French part are now fully operational. The ATC hosted by LSCE in Saclay has moved into a new building entirely dedicated to ICOS activities and has been developing new services and activities (low-cost sensors, FTIR data processing, website upgrading). A set of near real-time data sets from 11 ICOS stations have been delivered to the CP. The ETC French branch has successfully received, analysed and stored the soil (220) and plant (671) samples sent from the Ecosystem stations across Europe.

### Scientific publications in 2018

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### List of labelled stations in 2018

- Atmospheric stations: Trainou (TRN), Puy-de-Dome-DOME (PUY) and Saclay (SAC) PI: Michel Ramonet (CNRS)
- Ecosystem: Estrees-Mons FR-EM2, PI: Joel Leonard (INRA)
- Ocean: France-Brazil Voluntary Observing ship, PI: Nathalie Lefevre (IRD)

## 1-3 Scientific Highlights from 2018

The annual French assembly of ICOS organised by Irene Remy-Xueref (CNRS) gathered 60 participants in the Haute-Provence Observatory from 4th to 6th November. Invited keynote speakers Elena Paoletti (CNR, Firenze) and Joel Guyot (CNRS, Marseille) delivered conferences about the stomatal deposition of Ozone and Climate change impacts in Mediterranean ecosystems respectively. The field tour included demonstration of atmospheric instruments and visit of the ICOS class-2 site Font -Blanche, a mixed Mediterranean forest few km East from the city of Marseille.

## ICOS Germany

### Highlights

#### ***New recruits***

- 01.02.2018: new technical officer in ICOS-D-Atmosphere: Mr. Thomas Brennauer
- Matthias Mauder and Ingo Völksch joined the DE-Fen station team in 2018 as Co-PI and scientific member, respectively.

#### ***New funding acquired***

- Project "Carbon storage and release in soils under agricultural and forest use" funded by Saxonian LfULG (Aug 2018 - Jul 2020) – Technical University Dresden
- EU project SO-CHIC "Southern Ocean Carbon and Heat Impact on Climate". The proposal submitted in 2018 was successful; the project will be funded from 2019 – 2023. pCO<sub>2</sub> data from the Southern Ocean will be part of it. – AWI (Alfred Wegener Institute)
- Project "Towards improved understanding of the coupled water and carbon cycles of terrestrial ecosystems with special focus on extreme events" including 4 PhD positions – UFZ (Centre for Environmental Research)
- Cooperation within Marie-Curie-Proposal (Head Silvano Fares, ICOS Italy, "NEWFOREST")
- Project UNFLUP "Subsurface flooding as a GHG mitigation measure for intensively managed grassland on bog peat" (2018 – 2021) – TI-AK (Thünen Institute)
- Project KliMoBay "Klimaschutz- und Anpassungspotenziale in Mooren Bayerns" Eddy-Msr included in the measurement programme (co-funding: BStMUV and EFRE; 2019-2022)

#### ***Domain specific training***

- A technical short course on flux measurement fundamentals was held at IMK-IFU (Flux Measurement Fundamentals, KIT/IMK-IFU, Garmisch-Partenkirchen, 30.7.-3.8.2018)
- Initiation of the working group on urban measurements
- Instruments workshop to discuss ICOS' needs with manufacturers, 07.-09.03.2018, Bergen, Norway, Instruments workshop

#### ***Organised events to promote ICOS***

- 30.01.2018, Offenbach, Germany: 1<sup>st</sup> Round Table for planning a national network "Integrated Greenhouse Gas Monitoring System - Deutsches Integriertes Treibhausgas Monitoring System (ITMS)", incorporating the ICOS, IAGOS, satellite community, and science programmes
- 25.04.2018, Offenbach, Germany: 1<sup>st</sup> meeting for planning inverse modelling of greenhouse gases within DWD using the ICON NWP model
- 15.10.2018, Offenbach, Germany: 2<sup>nd</sup> Round Table for planning the ITMS

- 13.12.2018, Offenbach, Germany: Presentation of intended ITMS to DWD department heads, including the planning of routine inverse modelling using the operational ICON model by DWD in limited area model

#### ***Attended events to promote ICOS***

- 16./17.5.2018, Annaberger Klimatage 2018, Annaberg-Buchholz
- 11.-15.06.2018, Baltic Earth conference in Helsingor, Denmark
- 18.-19.6. 2018, Ispra, Italy: Christian Plass-Dülmer representing ICOS-D at the CEOS Workshop “Interfaces Between CEOS Agencies and the GHG Monitoring System”
- June 2018, Geneva, Switzerland: 70. Executive Council of WMO: Declaration of Germany to support IG3IS by its planned ITMS (Integrated Greenhouse Gas Monitoring System)
- 25.09.-29.09.2018, Takamatsu, Japan: Presentation “ICOS atmospheric network Germany for long term monitoring of greenhouse gases”, 15th IGAC conference
- 08.-11.10.2018, TERENO Conference, Berlin
- 04.12. 2018, Andrea Kaiser-Weiss (DWD) presenting ITMS and ICOS at COP-24 in Katowice

#### ***Events where you have been invited as a speaker/presenter to represent ICOS***

- 9.8.2018, Hohenpeissenberg, Germany: Presentation given for candidates of the Liberal Democratic Party (FDP) in Bavarian State Parliament election by Christian Plass-Dülmer on ICOS and climate change
- Matthias Mauder (KIT) attended the 3<sup>rd</sup> International Greenhouse Gas Flux Workshop (Nanjing, China, 22.10. – 25.10.2018) as invited speaker
- HaPe Schmid (KIT) gave a keynote talk at the 2018 AmeriFlux PI Meeting (Bloomington, USA, 24.10/25.10.2018)
- 16.11.2018, Christian Brümmer (Thünen Institute) was invited speaker at iLeaps Workshop on Eddy-Covariance Flux Tower Measurements and Research Infrastructures in Pretoria, South Africa

#### ***Major meetings within the National Network***

- ICOS Germany Annual Scientific Meeting, Jun13-14, Braunschweig

#### ***Other attended/hosted major meetings***

- 16.-17.04.2018, Rome, MSA Meeting Ecosystems
- 30.-31.5.2018, Bergen, Norway: General Assembly
- 05.-07.06.2018, Jena, Germany: MSA Atmosphere
- 10.09.2018, Prague, Czech Republic: MSA Atmosphere
- 11.-13.09.2018, Prague, Czech Republic: 3<sup>rd</sup> ICOS Science Conference
- 17.-20.09.2018, Lund, Sweden: IGI3S/TRANSCOM meeting
- 29.-30.11.2018, Offenbach, Germany: ICOS GA hosted by DWD
- 14.-16.05.2018, Trieste, Italy, MSA Ocean

#### ***National ICOS scientists in media***

- March 2018: Press article “So viel Kohlenstoff durchströmt unsere Luft”, Altlandkreis Ausgabe March/April 2018, pages 46-47
- April 2018: Portrait of forest CO<sub>2</sub> measurements of TU Dresden and interview with Dr. Thomas Grünwald on MDR (Mitteldeutscher Rundfunk) website, <https://www.mdr.de/wissen/co-zwei-speicher-wald-100.html>
- 07.06.2018: Press article “Wissenschaft über den Wolken”, Süddeutsche Zeitung
- 22.11. 2018: Andrea Kaiser-Weiss presenting climate change and greenhouse gas concentration development (Including ICOS data) in German TV (ZDF)

(<https://www.zdf.de/nachrichten/heute-sendungen/videos/181122-h17-100.html>, start 6:50min)

## ***Scientific publications in 2018***

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

## ***Other publications in 2018***

- A promotional video introducing DE-Fen was produced and published on the #ICOScapes Campaign webpage (<https://www.icos-ri.eu/icoscapes/fendt>) and the #ICOScapes YouTube channel (<https://www.youtube.com/watch?v=iVjH4Bkf1-w>).
- Press release “Hothouse Earth” via Institute’s websites and other media channels, Sep 6

## ***List of labelled stations in 2018***

- ECO – Class 1 Site Hohes Holz (DE-HoH) successfully finished step 2 of labelling (final report has been sent to DG); will be formally approved in next GA, PI Corinna Rebmann
- ECO – DE-Gri, associated site Grillenburg, ecosystem, Christian Bernhofer
- ECO – Step 1 of the labelling process was completed for the ICOS Class 1 ecosystem site Fendt (DE-Fen, PI: Hans Peter Schmid), which is now in step 2 of the labelling process since October 2018.
- ATM – Hohenpeissenberg (HPB), ICOS - Atmosphere, Germany, D. Kubistin
- ATM – Gartow (GAT), ICOS - Atmosphere, Germany, D. Kubistin
- ATM – Torfhaus (TOH), ICOS - Atmosphere, Germany, D. Kubistin
- ATM – Lindenberg (LIN), ICOS - Atmosphere, Germany, D. Kubistin
- ATM – Labelling Step 1 pending: Karlsruhe (KIT), ICOS - Atmosphere, Germany, D. Kubistin (since February 2019 in Step 2)

## ***1-3 Scientific Highlights from 2018***

- ICOS-D scientists co-authored the Global Carbon Budget 2018 study
- Regional Carbon Budget of Saxony (Germany) Based on Flux Measurements and Inventories: The net carbon budget of managed ecosystems (forests, agriculture) using repeated inventories of carbon pools (biomass, soil) in regular grids and using long-term continuous Eddy Covariance flux measurements at ICOS sites are in good agreement for forests but not for agricultural land use in Saxony. Ongoing research activities relate to the long-term soil carbon stock change of agricultural soils to check their assumed C neutrality Sep 2018
- Contrasting response of NEP to the drought 2018 at saxonian ICOS sites (ongoing research)
- A field inter-comparison experiment involving ICOS RI was carried out within the MOSES (Modular Observation Solutions for Earth Systems) heat wave test campaign at the Forschungszentrum Jülich (FZJ) measurement site Selhausen in July 2018. To this end, the standard MOSES EC setup (CSAT3B 3D sonic anemometer, LI-7500RS open-path CO<sub>2</sub>/H<sub>2</sub>O gas analyzer), a mini EC system (TriSonica Mini 3D sonic anemometer, mini dew-point mirror) and the ICOS EC system (Gill HS-50 ultrasonic research anemometer, LI-7200 enclosed CO<sub>2</sub>/H<sub>2</sub>O gas analyser) were installed on top of a trailer-mounted telescopic 30 m mast and inter-comparison measurements were carried out from 1.7.2018 until 12.7.2018. Scientific analysis is still ongoing

- Measurements investigating the influence of different filter configurations within the intake tube of a LI-7200 CO<sub>2</sub>/H<sub>2</sub>O gas analyzer on signal attenuation were carried out at DE-Fen in May / June 2018. Analysis of the measurements is still ongoing
- A scientific highlight of 2018 in the Ocean component was surely the formerly unprecedented low pCO<sub>2</sub> partial pressures in the central Baltic Sea in spring, a result of the very stable meteorological conditions, with strong impact on the biogeochemical processes. The findings are foreseen as a contribution to the special issue foreseen on observations during the spring / summer 2018

## ICOS Italy

### *Highlights*

Silvano Fares as a member of the scientific committee of ILEAPS promoted ICOS activities at the recent SSC in South Africa followed by a workshop addressed at students where the goals of ICOS have been explained (12-17 Nov 2018). Performed instrumental setup according to ICOS Protocol.

### *Scientific publications in 2018*

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### *Other publications in 2018*

- We presented a poster at the ICOS Science Conference in Prague entitled: 'ICOS Italy: in the sign of biological and climatic diversity'. This was presented by S. Fares on behalf of the ICOS national focal point.
- Cantoni C., Sparnocchia S., Meccia V., Raicich F., Cozzi S., Luchetta A. 2018. Air-sea CO<sub>2</sub> fluxes from pCO<sub>2</sub> continuous measurements in a coastal area: the role of atmospheric forcing under different wintry seasons. Book of Abstracts of the 3rd ICOS Science Conference, Prague, 11-13th September 2018., page 58-59.
- Luchetta A., Sparnocchia S., Meccia V., Raicich F., Cozzi S., Cantoni C. 2018. CO<sub>2</sub> exchange at the air-sea interface in a Mediterranean coastal region from pCO<sub>2</sub> continuous measurements within the ICOS network. Libro degli Abstrac del 1° Workshop Nazionale "TERRA, VITA e CLIMA. Il ciclo del carbonio." Area della Ricerca CNR di Pisa, 22-23 Novembre 2018, page 44.
- T. Steinhoff, T. Gkritzalis, B. Pfeil, S. K. Lauvset, S. Jones, U. Schuster, et al., 2018. Constraining the oceanic uptake and fluxes of GHG by building a certified ocean network of stations: ICOS Oceans Network. submitted to Frontiers in Marine Science, 8 November 2018 (manuscript ID: 435598).

### *List of labelled stations in 2018*

#### ***Under labelling (level I):***

- IT-Cp2 evergreen oak forest, PI Dr Fares
- IT-BCi Borgo Cioffi, crop, PI Dr Magliulo

#### ***Under labelling (level II):***

- IT-Lsn, PI Dr Pitacco
- IT-Ren Renon, PI Dr Montagnani

- IT-MBo Monte Bondone, PI Dr Gianelle

***Under labelling (Associated stations):***

- IT-BFt Bosco Fontana, PI Dr Finco
- IT-Noe Arca di Noe - Le Prigionette, PI Dr Sirca
- IT-PCm Parco Urbano di Capodimonte, PI Dr Calfapietra

***Labelled sites as associated:***

- IT-Tor Torgnon, PI Dr Cremonese

## ICOS Netherlands

### *Highlights*

- ICOS-NL, with the Carbon Portal (CP), stations LUT, CES (renamed CBW) and LOO has finally been funded through gaining a large-scale scientific observation facility: Ruisdael observatory, together with ACTRIS.
- The ICOS Atmospheric station Cabauw (CES) is operated by ECN/TNO and has a Picarro 2301 and Spectronus measuring from a buffer system with air inlets at four heights (200, 120, 60, 20m) throughout 2018. In addition, radon measurements at two heights and monthly <sup>14</sup>C samples were taken.
- We have been working on ICOS compliance for the Spectronus, maintenance of the Radon equipment and working on renewing and additional infrastructure after the infrastructure project grant Ruisdael in the Netherlands, which allows to extend from class 2 to class 1 station.
- The labelling of the CES station is delayed but foreseen for 2019 due to the Spectronus tests, the institute change from ECN to TNO and a foreseen class change although the Picarro data is continuously uploaded.
- During the ICOS Science meeting in September 2018 and during the national Ruisdael Science day in May 2018, an overview of 25 years of GHG measurements is given by poster and oral presentations, respectively.
- NL-LUT: Lutjewad was labelled in 2018 and in 2019 will be equipped with a new Picarro CRDS analyser for N<sub>2</sub>O and CO. NL-LOO was 'kept alive' in 2018 on zero funding. In 2019 it will be transformed to qualify for Class 2 labelling: tower height, mains power, Smart flux, plus it will be equipped with measuring VOC and Ozone fluxes.

### *List of labelled stations in 2018*

- NL-LUT was labelled Class 2, PI Huilin Chen of RUG
- NL-CES was labelled Class 2, now aiming for Class 1, PI Arnoud Frumau of TNO (former ECN)

### *1-3 Scientific Highlights from 2018*

- CP work @ WUR contributed directly to the publication of the new Global Carbon Project release, as well as to the EUROCOM, CARBAM and CHE projects. This was done by facilitating Jupyter Notebook access to groups of modelers for shared analyses of model results. Presentations about this new technology were given at ICOS Science conference as well as at TransCOM/IG3IS.
- Several ObsPacks with now for the first time also ICOS data were created for user access.

- A new initiative was started to collectively analyse the 2018 summer drought in Europe, with the ICOS-CP facilitating meetings and hardware/software infrastructure.

## ICOS Norway

### Highlights

- The Norwegian National ICOS Network and the Ocean Thematic Centre has submitted a new proposal to the Research Council to upgrade and maintain the national station network in the next ICOS 5-year financial period. The proposal was submitted in October and we expect to have initial feedback in June 2019.
- On June 12, 2018 ICOS Norway hosted an open stakeholder meeting with Miljødirektoratet (the Norwegian Environmental Directorate) in Oslo highlighting the role of the ICOS stations in monitoring regional carbon emissions. The meeting had participation from key stakeholders from research and national agencies and it was agreed that the meeting should be an annual activity of ICOS Norway and Miljødirektoratet.
- ICOS Norway spring seminar in Vitenparken, Ås on June 13, 2018. There were several presentations from the consortium.
- An annual meeting for ICOS marine Norway was organised in Bergen 19-20 November. All station PIs participated.
- Conference and Meeting contributions:
  - Ocean Sciences, Portland, Feb 2018, Meike Becker: Regional mapping of surface ocean pCO<sub>2</sub> (poster)
  - ICOS Science Conference, Prague, Sep 2018, Meike Becker: Regional maps of surface ocean ΔfCO<sub>2</sub> and ocean acidification along the Norwegian coast (oral); Holger Lange: Combining remote sensing earth observations and in situ networks: detection of extreme events and optimal network size and design (invited plenary talk)
  - ICOS MSA/OTC meeting, Trieste, May 2018, Meike Becker: A detailed view on the seasonality of stable carbon isotopes across the North Atlantic (oral); Are Olsen: Interannual pCO<sub>2</sub> variations in the subpolar North Atlantic (oral); Bjerknæs Getaway, Geilo, Jan 2018, Meike Becker: Mapping of surface ocean fCO<sub>2</sub> in coastal regions based on MLR (poster)
  - Workshop on Interoperability Technologies and Best Practices in Environmental Monitoring, Brest, Oct 2018, Meike Becker: CO<sub>2</sub> metrology - present situation for the marine community (oral)
  - Informasjonsmøte om satellittfjernmåling og jordobservasjon, Ås, Holger Lange: Combining remote sensing earth observations and in situ networks for the detection of extreme events. Presentation
  - Medyfinol 2018, Santiago, Chile, Holger Lange (and co-workers): When length is not an issue: nonlinear insights into high-resolution Eddy Covariance data (invited plenary talk) <http://medyfinol.org/>
  - Hvordan styre utslipp av klimagasser (seminar), Norwegian Environment Agency, Oslo, June 2018: Ingunn Skjelvan: ICOS data used for Ocean Acidification research.

### Scientific publications in 2018

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

## **Other publications in 2018**

- Access to semi-operational inversion results, as well as transport modelling products for methane can be found at the website <https://shiny.nilu.no/ICOS/>. Currently, results until the year 2017 are available, but the website will be updated once enough measurement data for 2018 become available.
- We posted 28 updates on the ICOS Norway Facebook page addressing field work, new publications and conference presentations. In order to create visibility to a broad public in Bergen we baked and built a gingerbread version of the largest vessel that we have a pCO<sub>2</sub> system on, M/V Nuka Arctica.
- Popular Science online magazine article Bjune, A. E., H. Lee and H. Lange. Jorda er vårt viktigste karbonlager. Harvest: Mennesket & naturen. <https://www.harvestmagazine.no/pan/jorda-er-vart-viktigste-karbonlager>

## **List of labelled stations in 2018**

- Ocean: M/S Nuka Arctica and R/V G.O. Sars Class 1
- Atmosphere: Zeppelin Observatory Class 1

## **1-3 Scientific Highlights from 2018**

- Le Quéré et al., 2018. Global Carbon Budget 2018. Earth System Science Data, 10(4), 2141-2194. doi:10.5194/essd-10-2141-2018.
- Le Quéré et al., 2018. Global Carbon Budget 2017. Earth System Science Data, 10, 405-448. doi:10.5194/essd-10-405-2018
- Access to the ocean pCO<sub>2</sub> data measured on the marine stations of ICOS Norway is assured through the Surface ocean CO<sub>2</sub> atlas (SOCAT).
- We submitted 24 transects from Nuka Arctica (about 200 days of data), 10 transect from Trans Carrier (about 30-40 days) and 168 days of data from G.O. Sars. Atmospheric data from Zeppelin is operational, and transferred in NRT to ICOS ATC.

## **ICOS Sweden**

### **Highlights**

- Science festival, Gothenburg, 18-22 April 2018
- Outreach to general public ICOS Sweden national network
- Poster presented on ICOS RI Science Conference, Prague "ICOS Sweden forest stations – are they carbon sinks or sources?"
- Poster presented at KSLA conference on forests and climate, Stockholm
- Poster at EGU Sveriges
- Radio P1 visited the ICOS ERIC Carbon Portal and ICOS Sweden Hyltemossa station. RINGO workshop at Skogaryd organised by University of Gothenburg
- Climate-KIC summer school visited Hyltemossa
- The co-localization of ICOS Sweden and ACTRIS Sweden sites is progressing; ongoing dialogue on possibilities to include SITE ecosystem flux measurements ([www.fieldsites.se](http://www.fieldsites.se)) as Associated ICOS sites
- Examples from research at the stations: Stefan Osterwalder and Kevin Bishop from SLU Umeå investigated ecosystem-atmosphere mercury exchange at several of our stations. M. Peichl from SLU investigated the topic 'Bridging scales – carbon and greenhouse gas budgets from the plot to regional level in boreal Sweden'

## *Scientific publications in 2018*

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

## *Other publications in 2018*

- SLU Umeå arranges a series of lunch lectures under the name of Worth Knowing. Listen to Prof Mats Nilsson, PI at the ICOS Sweden station Degerö, when talking about 'The land-atmosphere exchange of green-house gases of boreal ecosystems under climate change'. Available on YouTube (in Swedish)

## *List of labelled stations in 2018*

- Svartberget, Class 1 Atmosphere station, PI: Mikael Ottosson Löfvenius
- Norunda Class 1 Atmosphere station, PI: Meelis Mölder
- Hyltemossa Class 1 Atmosphere station, PI: Michal Heliasz
- Hyltemossa Class 2 Ecosystem station, PI: Michal Heliasz
- Norunda Class 2 Ecosystem station, PI: Meelis Mölder

## *1-3 Scientific Highlights from 2018*

- Matthias Peichl, SLU Umeå, 2016-2018 led a project 'Is the managed boreal forest landscape a carbon sink?' at Svartberget and Degerö. The goal of this project was to estimate the carbon balance and to identify local sinks and sources across a managed forest landscape in boreal Sweden. In this study, the landscape carbon balance is estimated with two methods, including a plot-based bottom-up approach and tall tower eddy covariance measurements.
- Initiation of drought analyses to analyse the drought 2018 carbon in Nordic countries (2018).
- The co-localization of ICOS Sweden and ACTRIS Sweden sites is progressing (2018); ACTRIS Sweden measurements started at Hyltemossa (ACTRIS measurements by Lund University) and Norunda (ACTRIS: Stockholm University).

## **ICOS Switzerland**

### *Highlights*

- The National Climate Observing System (GCOS Switzerland) report was released. The importance of ICOS for the Swiss monitoring of the Essential Climate Variables was reflected by various references to ICOS in the chapter on CO<sub>2</sub> observations, the chapter on other long-lived GHGs, on forest ecosystems, and the newly added chapter on greenhouse gas fluxes (Feb 2018)
- The ICOScapes Campaign visited the Jungfrauoch station (Mar 2018). ICOS-CH people working at the Davos station met for an informal meeting where the upcoming field season and especially the last steps in the ICOS labelling process were discussed. As last year, this event was very fruitful and necessary in order to keep on track towards the ICOS label. (17 May 2018)
- The Jungfrauoch station officially got labelled as ICOS Class 1 Atmosphere site (31 May 2018). Press release about the ICOS certification of Jungfrauoch, subsequently taken up in 10 newspapers (31 May 2018)

- Martin Steinbacher organized the ICOS Atmospheric Monitoring Station Assembly in Jena, Germany (5-7 Jun 2018)
- The first SwissForestLab summer school with international PhD students visited the Davos station for an excursion (guided by Mana Gharun) (19 Aug 2018)
- Intensive fieldwork at the Davos station during the summer months led us closer to the Class 1 labelling: four CP and 20 SP plots were established to quantify the biomass by geo-referencing and to measure tree height, diameter at breast height (dbh) and tree health status of more than 700 trees; 54 soil profiles were dug to characterize the soil structure and to measure soil carbon content; about 100 hemispherical photographs were taken and 20 new litter traps were placed; and last but not least five trees from small to 30 m tall were cut, separated into needles, twigs and stem wood, dried and weighted to establish biomass allocation functions. (Summer 2018)
- New info board installed at the Davos station (in German, to inform the public) (15 Nov 2018)
- The ICOS-CH consortium met for the 6th ICOS-CH Annual Meeting 2018 in Berne (30 Nov 2018)
- The ICOS-CH Annual Meeting 2018 was linked to the Swiss Geoscience Meeting, where a dedicated session “Atmospheric Processes and Interactions with the Biosphere” was co-organized by ICOS members (30 Nov / 1 Dec 2018)
- An article about the greenhouse gas observations at Jungfraujoch including an interview with Martin Steinbacher was published in several Swiss newspapers (27-28 Dec 2018)

### *Scientific publications in 2018*

Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>

### *Other publications in 2018*

#### **Conference Contributions**

- Steinbacher M, Long-term Time Series, Quality Assurance and Control — Atmospheric Composition, oral presentation, 15th National GCOS Roundtable, Bern, Switzerland, 25 January, 2018.
- Affolter, S, Berhanu T, Leuenberger M; Comparison of two high Alpine CO<sub>2</sub> records from the Jungfraujoch area, oral presentation, VAO symposium, Grenoble, France, 13-15 March 2018
- Leuenberger M, Conen F: Seasonal cycle in ‘near baseline’ CO<sub>2</sub> and O<sub>2</sub> at Jungfraujoch, poster presentation, VAO symposium, Grenoble, France, 13-15 March 2018
- Yuan Y, Ries L, Petermeier H, Menzel A: Selection of representative atmospheric data from continuous in-situ measurement series, oral presentation, VAO symposium, Grenoble, France, 13-15 March 2018
- Hundt M, Kapsalidis F, Shahmohammadi M, Liu C, Scheidegger P, Aseev O, Tuzson B, Looser H, Faist J, Emmenegger L: Multi-Component Environmental Gas Sensing using Dual-Wavelength Quantum Cascade Lasers, poster presentation, EGU2018, Vienna, Austria, 8-13 April 2018
- Yu L, Harris E, Eggleston S, Ibraim E, Henne S, Steinbacher M, Emmenegger L, Zellweger C, Mohn J: Seasonal patterns of atmospheric N<sub>2</sub>O isotopic composition observed at the alpine station Jungfraujoch, Switzerland, oral presentation, EGU2018, Vienna, Austria, 8-13 April 2018
- Buchmann N, Brinkmann N, Burri S, Etzold S, Haeni M, Haesler R, Hörtnagl L, Merbold L, Paul-Limoges E, Eugster W: Carbon sequestration and climate sensitivity of two Swiss

mountain forests, poster presentation, Swiss Global Change Day, Berne, Switzerland, 19 April 2018

- Zweifel R: Integrated Carbon Observation System (ICOS) - the WSL contribution, poster presentation, WSL annual meeting for innovative projects, Birmensdorf, Switzerland, 11 June 2018
- Steinbacher M, Quality Control of Greenhouse Gas Measurements, oral presentation, International Workshop on GAW Activities Jakarta, Indonesia, 07-08 August, 2018
- Brunner D, Mueller M, Jaehn M, Graf P, Meyer J, Hueglin C, Pentina A, Perez-Cruz F, Emmenegger L: A low-cost sensor network to monitor the CO<sub>2</sub> emissions of the City of Zurich, oral presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Burri S, Buchmann N: ICOS Switzerland – Greenhouse gas stories from high altitudes, poster presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Gharun M, Hörtnagl L, Meier P, Burri S, Eugster W, Buchmann N: Twenty years of evapotranspiration measurement over a sub-alpine coniferous forest in Switzerland, oral presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Henne S, Brunner D, Mohn J, Leuenberger M, Meinhardt F, Steinbacher M, Emmenegger L: Inverse Modelling of Swiss CH<sub>4</sub> and N<sub>2</sub>O Emissions, poster presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Hörtnagl L, Baur T, Eugster W, Etzold S, Haesler R, Käslin F, Meier P, Merbold L, Pluess P, Zielis S, Buchmann N, Gharun M, Häni M, Burri S: Two decades of ecosystem CO<sub>2</sub> gas exchange above a sub-alpine coniferous forest in Switzerland, poster presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Leuenberger M and Herrmann L: First eddy covariance flux analysis at the tall tower site Beromünster, Switzerland, poster presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Meier P, Käslin F, Baur T, Koller P, D’Odorico P, Eugster W, Buchmann N: The Flying Tree Top Sampler - Sampling foliage from the uppermost canopy of trees using a Drone, oral presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Schibig M, Nyfeler P, Leuenberger M: Measuring atmospheric argon at Jungfrau East Ridge to estimate the oceanic influence on atmospheric oxygen using a mass spectrometer, poster presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Steinbacher M, Anet J, Emmenegger L, Buchmann B: Continuous atmospheric greenhouse gas measurements in a semi-remote area in the Kyrgyz Republic – first scientific findings towards policy making, oral presentation, ICOS Science Conference 2018, Prague, Czech Republic, 11-13 September 2018
- Henne S, Mohn J, Leuenberger M, Meinhardt F, Steinbacher M, Vollmer M, Reimann S, Emmenegger L, Brunner D: Top-down Validation of Swiss non-CO<sub>2</sub> Greenhouse Gas Emissions, oral presentation, IG3IS - TRANSCOM meeting, Lund, Sweden, 17-20 September 2018
- Brunner D, Henne S, Reimann S, Steinbacher M, Mohn J, Emmenegger E: Top-down emission estimation to support national inventories: A Swiss perspective, oral presentation, First IG3IS Symposium, Geneva, Switzerland, 13-15 November, 2018
- Pieber S, Brunner D, Henne S, Steinbacher M, Tuzsan B, Emmenegger L: A decade of continuous atmospheric CO<sub>2</sub> isotope ratio measurements at Jungfrauoch, oral presentation, Swiss Geoscience Meeting 2018, Bern, Switzerland, 1 December, 2018
- Gharun M, Hörtnagl L, Meier P, Burri S, Eugster W, Siegwolf R, Buchmann N: Subalpine coniferous forest in Switzerland has been a C sink and increased its water use efficiency,

oral presentation, 20th Anniversary of EUROFLUX Workshop 2018, Hyytiälä, Finland, 10-14 December 2018

### **Press releases**

- Research station at Jungfraujoch certified: At the «Top of Europe» for greenhouse gas measurements (31 May 2018)
- Jungfraujoch-Forschungsstation zertifiziert: «Top of Europe» – auch bei Treibhausgasmessungen (31 May 2018)

### **Media articles**

- «Top of Europe» – auch bei Treibhausgasmessungen. myScience (31 May 2018)
- «Top of Europe» - auch bei Treibhausgasmessungen. Media Relations Universität Bern (31 May 2018)
- «Top of Europe» - auch bei Messung von Treibhausgasen. Naturwissenschaften Schweiz (31 May 2018)
- “Top of Europe” – auch bei Treibhausgasmessungen. Der Brienzer (1 Jun 2018)
- “Top of Europe” – auch bei Treibhausgasmessungen. Der Oberhasler (1 Jun 2018)
- «Top of Europe» - auch bei Treibhausgasmessungen. Echo von Grindelwald (1 Jun 2018)
- Forschungsstation Jungfraujoch übernimmt wichtige Rolle beim Klimaschutz. Punkt4info (1 Jun 2018)
- Jungfraujoch gehört zu den Besten. Tagesanzeiger (4 Jun 2018)
- Zertifizierte Messung der Treibhausgase. Energie-cluster.ch (4 Jun 2018)
- «Top of Europe» for Greenhouse Gas. MyScience (4 Jun 2018)
- «Top of Europe» - auch bei Treibhausgasmessungen. Jungfrau Zeitung (5 Jun 2018)
- La Sentinelle du Climat, La Liberté (27 Dec 2018)
- La Sentinelle du climat, Le Nouvelliste (27 December 2018)
- La Sentinelle du climat, La Côte (27 December 2018)
- La Sentinelle du climat, Journal du Jura (27 December 2018)
- Jungfraujoch, la Sentinelle du climat, Le Quotidien Jurassien (27 December 2018)
- La Sentinelle du climat, ArcInfo, (27 December 2018)
- La Sentinelle du climat, Le Courrier Genève (28 December 2018)

### **Info board**

- Messen und Forschen für die Umwelt. Info board at the Davos station (installed in Nov 2018)

### **List of labelled stations in 2018**

- Jungfraujoch, Class 1 Atmosphere Station, Markus Leuenberger / Lukas Emmenegger

### **1-3 Scientific Highlights from 2018**

- Jungfraujoch station officially labelled as ICOS Class 1 Atmosphere site (31 May 2018)
- The first level 2 (i.e. final, quality-controlled) data from 11 atmospheric stations including Jungfraujoch were released in August 2018 providing hourly averaged mole fractions of CO<sub>2</sub>, CH<sub>4</sub> and CO, meteorological observations, and two weekly integrated samples of <sup>14</sup>CO<sub>2</sub> (Colomb et al. 2018)
- The (updated) algorithm initially developed within ICOS-CH to retrieve boundary layer heights from the backscatter signal of ceilometers is now about to become one of the algorithms used in the E-PROFILE network of the EUMETNET (consortium of 31 European National Meteorological Services) with nearly 200 stations.

## ICOS UK

### *Highlights*

- Meetings attended within the National Network include: EOOS Conference 2018, Brussels, Belgium, 21 - 23 November 2018; Trieste MSA/OTC meeting 2018, ICOS MSA Meeting-Monday 18th March 2019 at the National Oceanography Centre, UK.
- The Weybourne Atmospheric Observatory have a new PhD student, Leigh Fleming who is funded through the EnvEast Doctoral Training Partnership (DTP). They have also successfully obtained renewal of the contract with the National Centre for Atmospheric Sciences (NCAS) for 2018/19 and received funding for CO<sub>2</sub>, O<sub>2</sub> and Radon measurements through the NERC funded DARE-UK project (NERC Highlight Topic). Further funding has been received for a new automated flask sampler at the Weybourne Atmospheric Observatory, which we hope to use to collect samples to be analysed at the ICOS Flask and Calibration Laboratory (FLC).
- We have successfully secured funding for the next 5 years through a programme called CLASS, funded through NERC for our stations.

### *Other publications in 2018*

- Grant Forster and Weybourne Atmospheric Observatory featured in an award-winning BBC World Service documentary entitled "Crowd Science: Is Carbon Dioxide Higher Than Ever?" This won Gold in the audio category of the AAAS Kavli science journalism awards. The link can be found here; <https://www.bbc.co.uk/programmes/w3csv3f1>.

### *List of labelled stations in 2018*

- Weybourne Atmospheric Observatory, Atmospheric Station Class 2, PIs: Grant Forster, Andrew Manning.

### *1-3 Scientific Highlights from 2018*

- In March 2018, a continuous radon detector (ANSTO) was installed at the Weybourne Atmospheric Observatory. Radon is not mandatory within ICOS but it is a "recommended" parameter. The ATC is currently developing near real time processing of radon measurements from several of the ICOS stations that will support the processing of radon measurements from WAO in the near future.
- In 2018, we worked closely with the MLab to test a new drying system for the Fourier Transform Infrared Spectrometer (FTIR) greenhouse gas analyser at the Weybourne Atmospheric Observatory. This new drying system, alongside a well-characterised Picarro instrument that the Mlab have agreed to loan us, will enable us to gather the evidence required to get the instrument approved for use on the ICOS network at the MSA in spring 2019.
- The PAP SO buoy run by the National Oceanography Centre: In May/June 2018 there was a cruise to the PAP site and turn-around of the buoy (1m and 30m pCO<sub>2</sub>, with T, S, O<sub>2</sub>, pH, nutrients). We have now added atmospheric CO<sub>2</sub> (Pro-Oceanus) at the site <http://pro-oceanus.com/co2-pro-atmosphere.php>.

## List of ICOS Training and Workshops

- The 3<sup>rd</sup> ICOS Science Conference, 11–14 September 2018, Prague.
- VLIZ collaborated with NIOZ to organize a 3-day training course at Ostend for optimisation of analysis for Inorganic Nutrients in Seawater samples in June, 2018.
- UAntwerp organized workshops for secondary schools in BE-Bra during the Autumn months of 2018.
- ICOS Impact Analysis Workshop on 13 February 2018 in Brussels.
- 4<sup>th</sup> ICOS Belgium Consortium Study Day on 01 June 2018 in Vielsalm plus visit to the nearby ecosystem station.
- ICOS Denmark national steering committee held a number of meetings and a 2-day workshop was organized in late summer 2018 for all Danish ICOS staff, including scientists and technicians. During the workshop, we visited two of the Danish stations the short rotation coppice at Risø and the beech forest at Sorø.
- A technical short course on flux measurement fundamentals was held at IMK-IFU (Flux Measurement Fundamentals, KIT/IMK-IFU, Garmisch-Partenkirchen), 30 July–03 August 2018, Germany.
- The first SwissForestLab summer school with international PhD students visited the Davos station for an excursion (guided by Mana Gharun), 19 August 2018, Switzerland.
- 1<sup>st</sup> ICOS OTC Instrumentation workshop (07–09 March 2018), Bergen, Norway.

## List of Main Internal Meetings

- ICOS General Assembly (30–31 May 2018), Bergen, Norway.
- ICOS General Assembly hosted by DWD (29–30 November 2018), Offenbach, Germany.
- Ecosystem MSA meeting (16 - 18 April 2018), Rome, Italy.
- Ecosystem MSA meeting (10 September 2018), Prague, Czech Republic.
- Atmosphere MSA meeting (05–07 June 2018), Jena, Germany.
- Atmosphere MSA meeting (10 September 2018), Prague, Czech Republic.
- Ocean MSA meeting (14–16 May 2018), Trieste, Italy.
- ICOS RI COM meeting (13–15 March 2018), Heidelberg Germany.
- ICOS RI COM meeting (3-5 October 2018), Todi, Italy
- Science festival (18-22 April 2018), Gothenburg, Sweden.
- Retreat at the DWD Lindenberg Observatory (August 2018), Germany.
- Visit of Ilkka Herlin (Finnish billionaire, the chairman and one of the owners of Cargotec, and one of the owners of the elevator and escalator maker Kone, Chair of the Board of University of Tampere) and Saara Kankaanrinta to Hyytiälä ICOS ATM and ECO station, 8 March 2018, Hyytiälä, Finland.
- 1<sup>st</sup> Round Table for planning a national network 'Integrated Greenhouse Gas Monitoring System - Deutsches Integriertes Treibhausgas Monitoring System (ITMS)', incorporating the ICOS, IAGOS, satellite community, and science programmes, 30 January 2018, Offenbach, Germany.
- ICOS Norway hosted an open stakeholder meeting, 'the role of the ICOS stations in monitoring regional carbon emissions' with Miljødirektoratet (the Norwegian Environmental Directorate), 12 June 2018, Oslo, Norway.
- ICOS-FI PI meeting, 6 November 2018, Hyytiälä, Finland. Topics discussed: updates on the station labelling, RI updates, Measurement protocols and technical implementations.

## List of Main ICOS National Network Meetings

- The annual French assembly of ICOS organised by Irene Remy-Xueref (CNRS), which gathered 60 participants in the Haute-Provence Observatory, 4–6 November, 2018.
- ICOS Germany Annual Scientific Meeting (13–14 June 2018), Braunschweig, Germany.
- Inauguration of the Lonzeé station in the presence of the Walloon minister of climate (Mr. Jean-Luc Crucke) and the press (Le Soir, Canal Zoom, L'Avenir, ...) following the ICOS labelling of the station, 29 March 2018, Lonzeé.
- ICOS Norway spring seminar (June 13, 2018), Vitenparken, Norway.
- An annual meeting for ICOS marine Norway (19–20 November 2018), Bergen, Norway.
- The ICOS-CH Annual Meeting 2018 was linked to the Swiss Geoscience Meeting, where a dedicated session “Atmospheric Processes and Interactions with the Biosphere” was co-organized by ICOS members (30 November–1 December 2018), Switzerland.

## List of Main Events Organised or Co-organised by ICOS

- ICOScapes Photo Exhibition Opening, 11 September 2018, Prague.
- QUO Vadis, SCIENTIA? Towers for carbon - ICOScapes Photo Exhibition in the Czech Republic Parliament House, Prague, 10-21 September 2018.

## List of Main Events Attended by ICOS

- GEO-C Steering Committee meeting (01–02 February 2018) Geneva, Switzerland.
- VERIFY kick-off meeting (12–15 February 2018) Brussels, Belgium.
- ENVRIplus Executive Board meeting (19 February 2018) Amsterdam, The Netherlands.
- RI COM face to face meeting (13–16 March 2018) Heidelberg, Germany.
- RINGO Annual Meeting (19–23 March 2018) Antwerp, Belgium.
- EGU Conference (08–11 April 2018) Vienna, Austria.
- ILTERN Next Generation Workshop (15–21 April 2018) Guangzhou, China.
- SBSTA Meeting (0 –04 May 2018) Bonn, Germany.
- 6<sup>th</sup> ENVRI week (14–18 May 2018) Zandvoort, The Netherlands.
- ICOS HO Staff Planning Day (24–25 May 2018) Hyytiälä, Finland.
- 6<sup>th</sup> ICOS ERIC General Assembly (29 May–01 June 2018) Bergen, Norway.
- UFZ and Atmosphere MSA meetings (05–07 June 2018) Leipzig and Jena, Germany.
- BONUS Ocean meeting (08–10 June 2018) Helsingor, Denmark.
- SEACRIFOG Annual Meeting (17–24 June 2018) Cap Verde.
- ICOS Strategy discussion meeting (10–11 August 2018) Paris, France.
- ICOS Strategy discussion meeting (15–17 August 2018) Hyytiälä, Finland.
- ICOS Head Office visit to Carbon Portal (22–23 August 2018) Lund, Sweden.
- RINGO mid-term review meeting (03–04 September 2018) Brussels, Belgium.
- ICRI Conference (13–15 September 2018) Vienna, Austria.
- RI Com face to face meeting (03–06 October 2018) Todi, Perugia, Italy.
- GEO week (26 October–04 November 2018) Kyoto, Japan.
- ENVRI week (06–09 November 2018) Riga, Latvia.
- ESFRI workshop (19 November 2018) Milan, Italy.
- COOP and EOOS Conferences (19–23 November 2018) Brussels, Belgium.
- 7<sup>th</sup> ICOS ERIC General Assembly (28–30 November 2018) Offenbach, Germany.
- EUROFLUX Workshop (12–14 December 2018) Hyytiälä, Finland.
- InRoad Meeting (15–16 January 2018) Brussels, Belgium.

- RISCAPÉ Work Package Leader Meeting (06 February 2018) Brussels, Belgium.
- SASSCAL Science Conference (16–19 April 2018) Lusaka, Zambia.
- GEO Week XV (29 October–2 November 2018) Kyoto, Japan.
- COOP+ Final Meeting (19–21 November 2018) Brussels, Belgium.
- DANUBIUS Meeting (11 December 2018) Cork, Ireland.
- InRoad Final Meeting (12 December 2018) Brussels, Belgium.

## List of Main Publications

- Full list of ICOS RI publications, including the National Networks is available at: <https://www.icos-cp.eu/references>
- ICOS Progress Reports 2015–2017.
- ICOS Impact Assessment Report 2018.

- Andersen, T., Scheeren, B., Peters, W., & Chen, H. (2018). A UAV-based active AirCore system for measurements of greenhouse gases. *Atmospheric Measurement Techniques*, 11(5), 2683–2699. <https://doi.org/10.5194/amt-11-2683-2018>
- Arrouays, D., Saby, N. P. A., Boukir, H., Jolivet, C., Ratié, C., Schrumpf, M., ... Loustau, D. (2018). Soil sampling and preparation for monitoring soil carbon. *International Agrophysics*, 32(4), 633–643. <https://doi.org/10.1515/intag-2017-0047>
- Arzoumanian, E., Vogel, F. R., Bastos, A., Gaynullin, B., Laurent, O., Ramonet, M., & Ciais, P. (2018). Characterization of lower-cost medium precision atmospheric CO<sub>2</sub> monitoring systems for urban areas using commercial NDIR sensors. *Atmospheric Measurement Techniques Discussions*, 1–22. <https://doi.org/10.5194/amt-2018-329>
- Assan, S., Vogel, F. R., Gros, V., Baudic, A., Staufer, J., & Ciais, P. (2018). Can we separate industrial CH<sub>4</sub> emission sources from atmospheric observations? - A test case for carbon isotopes, PMF and enhanced APCA. *Atmospheric Environment*, 187, 317–327. <https://doi.org/10.1016/j.atmosenv.2018.05.004>
- Balsamo, G., Agustii-Parareda, A., Albergel, C., Arduini, G., Beljaars, A., Bidlot, J., ... Zeng, X. (2018). Satellite and In Situ Observations for Advancing Global Earth Surface Modelling: A Review. *Remote Sensing*, 10(12), 2038. <https://doi.org/10.3390/rs10122038>
- Barba, J., Cueva, A., Bahn, M., Barron-Gafford, G. A., Bond-Lamberty, B., Hanson, P. J., ... Vargas, R. (2018). Comparing ecosystem and soil respiration: Review and key challenges of tower-based and soil measurements. *Agricultural and Forest Meteorology*, 249. <https://doi.org/10.1016/j.agrformet.2017.10.028>
- Bastos, A., Peregón, A., Gani, É. A., Khudyaev, S., Yue, C., Li, W., ... Ciais, P. (2018). Influence of high-latitude warming and land-use changes in the early 20th century northern Eurasian CO<sub>2</sub> sink. *Environmental Research Letters*, 13(6), 65014. <https://doi.org/10.1088/1748-9326/aac4d3>
- Bergamaschi, P., Karstens, U., Manning, A. J., Saunois, M., Tsuruta, A., Berchet, A., ... Dlugokencky, E. (2018). Inverse modelling of European CH<sub>4</sub> emissions during 2006–2012 using different inverse models and reassessed atmospheric observations. *Atmospheric Chemistry and Physics*, 18(2), 901–920. <https://doi.org/10.5194/acp-18-901-2018>
- Carrara, A., Kolari, P., de Beeck, M. O., Arriga, N., Berveiller, D., Dengel, S., ... Biraud, S. C. (2018). Radiation measurements at ICOS ecosystem stations. *International Agrophysics*, 32(4), 589–605. <https://doi.org/10.1515/intag-2017-0049>
- Collalti, A., Trotta, C., Keenan, T. F., Ibrom, A., Bond-Lamberty, B., Grote, R., ... Matteucci, G. (2018). Thinning Can Reduce Losses in Carbon Use Efficiency and Carbon Stocks in Managed Forests Under Warmer Climate. *Journal of Advances in Modeling Earth Systems*, 10(10), 2427–2452. <https://doi.org/10.1029/2018ms001275>
- Colomb, A., Conil, S., Delmotte, M., Heliasz, M., Hermannsen, O., Holst, J., ... Yver-Kwok, C. (2018). ICOS Atmospheric Greenhouse Gas Mole Fractions of CO<sub>2</sub>, CH<sub>4</sub>, CO, 14CO<sub>2</sub> and

- Meteorological Observations 2016-2018, final quality controlled Level 2 data. ICOS ERIC.  
<https://doi.org/10.18160/rhkc-vp22>
- de Beeck, M. O., Gielen, B., Merbold, L., Ayres, E., Serrano-Ortiz, P., Acosta, M., ... Hörtnagl, L. (2018). Soil-meteorological measurements at ICOS monitoring stations in terrestrial ecosystems. *International Agrophysics*, 32(4), 619–631. <https://doi.org/10.1515/intag-2017-0041>
- Dengel, S., Graf, A., Grünwald, T., Hehn, M., Kolari, P., Löfvenius, M. O., ... Pavelka, M. (2018). Standardized precipitation measurements within ICOS: rain, snowfall and snow depth: a review. *International Agrophysics*, 32(4), 607–617. <https://doi.org/10.1515/intag-2017-0046>
- Denvil-Sommer, A., Gehlen, M., Vrac, M., & Mejia, C. (2018). FFNN-LSCE: A two-step neural network model for the reconstruction of surface ocean pCO<sub>2</sub> over the Global Ocean. *Geoscientific Model Development Discussions*, 1–27. <https://doi.org/10.5194/gmd-2018-247>
- Ducker, J. A., Holmes, C. D., Keenan, T. F., Fares, S., Goldstein, A. H., Mammarella, I., ... Schnell, J. (2018). Synthetic ozone deposition and stomatal uptake at flux tower sites. *Biogeosciences*, 15(17), 5395–5413. <https://doi.org/10.5194/bg-15-5395-2018>
- Enberg, S., Majaneva, M., Autio, R., Blomster, J & Rintala, J-M. (2018). Phases of microalgal succession in sea ice and the water column in the Baltic Sea from autumn to spring. *Marine Ecology Progress Series*, 599: 19-34. <https://doi.org/10.3354/meps12645>
- Ericson, Y., Falck, E., Chierici, M., Fransson, A., Kristiansen, S., Platt, S. M., ... Myhre, C. L. (2018). Temporal Variability in Surface Water pCO<sub>2</sub> in Adventfjorden (West Spitsbergen) With Emphasis on Physical and Biogeochemical Drivers. *Journal of Geophysical Research: Oceans*, 123(7), 4888–4905. <https://doi.org/10.1029/2018JC014073>
- Fassbender, A. J., Rodgers, K. B., Palevsky, H. I., & Sabine, C. L. (2018). Seasonal Asymmetry in the Evolution of Surface Ocean p CO<sub>2</sub> and pH Thermodynamic Drivers and the Influence on Sea-Air CO<sub>2</sub> Flux. *Global Biogeochemical Cycles*, 32(10), 1476–1497. <https://doi.org/10.1029/2017gb005855>
- Franz, D., Acosta, M., Altimir, N., Arriga, N., Arrouays, D., Aubinet, M., ... Vesala, T. (2018). Towards long-term standardised carbon and greenhouse gas observations for monitoring Europe's terrestrial ecosystems: a review. *International Agrophysics*, 32(4), 439–455. <https://doi.org/10.1515/intag-2017-0039>
- Fratini, G., Sabbatini, S., Ediger, K., Riensche, B., Burba, G., Nicolini, G., ... Papale, D. (2018). Eddy covariance flux errors due to random and systematic timing errors during data acquisition. *Biogeosciences*, 15(17), 5473–5487. <https://doi.org/10.5194/bg-15-5473-2018>
- Gielen, B., Acosta, M., Altimir, N., Buchmann, N., Cescatti, A., Ceschia, E., ... Wohlfahrt, G. (2018). Ancillary vegetation measurements at ICOS ecosystem stations. *International Agrophysics*, 32(4), 645–664. <https://doi.org/10.1515/intag-2017-0048>
- Goris, N., Tjiputra, J. F., Olsen, A., Schwinger, J., Lauvset, S. K., & Jeansson, E. (2018). Constraining Projection-Based Estimates of the Future North Atlantic Carbon Uptake. *Journal of Climate*, 31(10), 3959–3978. <https://doi.org/10.1175/jcli-d-17-0564.1>
- Hari, P., Noe, S., Dengel, S., Elbers, J., Gielen, B., Kerminen, V.-M., ... Bäck, J. (2018). Prediction of photosynthesis in Scots pine ecosystems across Europe by a needle-level theory. *Atmospheric Chemistry and Physics*, 18(18), 13321–13328. <https://doi.org/10.5194/acp-18-13321-2018>
- Hauck, J. (2018). Unsteady seasons in the sea. *Nature Climate Change*, 8(2), 97–98. <https://doi.org/10.1038/s41558-018-0069-1>
- He, Y.-C., Tjiputra, J., Langehaug, H. R., Jeansson, E., Gao, Y., Schwinger, J., & Olsen, A. (2018). A Model-Based Evaluation of the Inverse Gaussian Transit-Time Distribution Method for Inferring Anthropogenic Carbon Storage in the Ocean. *Journal of Geophysical Research: Oceans*, 123(3), 1777–1800. <https://doi.org/10.1002/2017jc013504>
- Henson, S. A., Humphreys, M. P., Land, P. E., Shutler, J. D., Goddijn-Murphy, L., & Warren, M. (2018). Controls on Open-Ocean North Atlantic ΔpCO<sub>2</sub> at Seasonal and Interannual Time Scales Are Different. *Geophysical Research Letters*, 45(17), 9067–9076. <https://doi.org/10.1029/2018gl078797>

- Hodgkins, S. B., Richardson, C. J., Dommair, R., Wang, H., Glaser, P. H., Verbeke, B., ... Chanton, J. P. (2018). Tropical peatland carbon storage linked to global latitudinal trends in peat recalcitrance. *Nature Communications*, 9(1). <https://doi.org/10.1038/s41467-018-06050-2>
- Hufkens, K., Filippa, G., Cremonese, E., Migliavacca, M., D'Odorico, P., Peichl, M., ... Wingate, L. (2018). Assimilating phenology datasets automatically across ICOS ecosystem stations. *International Agrophysics*, 32(4), 677–687. <https://doi.org/10.1515/intag-2017-0050>
- Järvi, L., Rannik, Ü., Kokkonen, T. V., Kurppa, M., Karppinen, A., Kouznetsov, R. D., ... Wood, C. R. (2018). Uncertainty of eddy covariance flux measurements over an urban area based on two towers. *Atmospheric Measurement Techniques*, 11(10), 5421–5438. <https://doi.org/10.5194/amt-11-5421-2018>
- Jiskra, M., Sonke, J. E., Obrist, D., Bieser, J., Ebinghaus, R., Myhre, C. L., ... Dommergue, A. (2018). A vegetation control on seasonal variations in global atmospheric mercury concentrations. *Nature Geoscience*, 11(4), 244–250. <https://doi.org/10.1038/s41561-018-0078-8>
- Kaisermann, A., Ogée, J., Sauze, J., Wohl, S., Jones, S. P., Gutierrez, A., & Wingate, L. (2018). Disentangling the rates of carbonyl sulfide (COS) production and consumption and their dependency on soil properties across biomes and land use types. *Atmospheric Chemistry and Physics*, 18(13), 9425–9440. <https://doi.org/10.5194/acp-18-9425-2018>
- Kountouris, P., Gerbig, C., Rödenbeck, C., Karstens, U., Koch, T. F., and Heimann, M. (2018). Atmospheric CO<sub>2</sub> inversions on the mesoscale using data-driven prior uncertainties: quantification of the European terrestrial CO<sub>2</sub> fluxes. *Atmospheric Chemistry and Physics*, 18, 3047–3064. <https://doi.org/10.5194/acp-18-3047-2018>
- Landschützer, P., Gruber, N., Bakker, D. C. E., Stemmler, I., & Six, K. D. (2018). Strengthening seasonal marine CO<sub>2</sub> variations due to increasing atmospheric CO<sub>2</sub>. *Nature Climate Change*, 8(2), 146–150. <https://doi.org/10.1038/s41558-017-0057-x>
- Laruelle, G. G., Cai, W.-J., Hu, X., Gruber, N., Mackenzie, F. T., & Regnier, P. (2018). Continental shelves as a variable but increasing global sink for atmospheric carbon dioxide. *Nature Communications*, 9(1). <https://doi.org/10.1038/s41467-017-02738-z>
- Le Quéré, C., Andrew, R. M., Friedlingstein, P., Sitch, S., Pongratz, J., Manning, A. C., ... Zhu, D. (2018). Global Carbon Budget 2017. *Earth System Science Data*, 10(1), 405–448. <https://doi.org/10.5194/essd-10-405-2018>
- Leip, A., Skiba, U., Vermeulen, A., & Thompson, R. L. (2018). A complete rethink is needed on how greenhouse gas emissions are quantified for national reporting. *Atmospheric Environment*, 174, 237–240. <https://doi.org/10.1016/j.atmosenv.2017.12.006>
- López-Ballesteros, A., Beck, J., Bombelli, A., Grieco, E., Lorencová, E. K. E. K., Merbold, L., ... Saunders, M. (2018). Towards a feasible and representative pan-African Research Infrastructure network for GHG observations. *Environmental Research Letters*, 13(8), 85003. <https://doi.org/10.1088/1748-9326/aad66c>
- Loustau, D., Altimir, N., Barbaste, M., Gielen, B., Jiménez, S. M., Klumpp, K., ... Waldner, P. (2018). Sampling and collecting foliage elements for the determination of the foliar nutrients in ICOS ecosystem stations. *International Agrophysics*, 32(4), 665–676. <https://doi.org/10.1515/intag-2017-0038>
- Luhtanen, A.-M., Eronen-Rasimus, E., Oksanen, H., Tison, J.-L., Delille, B., Dieckmann, G., Rintala, J.-M. & Bamford, D.H. (2018). The first known virus isolates from Antarctic sea ice have complex infection patterns. *FEMS Microbiology Ecology*, 94(4): fiy028. <https://doi.org/10.1093/femsec/fiy028>
- Nemitz, E., Mammarella, I., Ibrom, A., Aurela, M., Burba, G. G., Dengel, S., ... Zahniser, M. (2018). Standardisation of eddy-covariance flux measurements of methane and nitrous oxide. *International Agrophysics*, 32(4), 517–549. <https://doi.org/10.1515/intag-2017-0042>
- Pavelka, M., Acosta, M., Kiese, R., Altimir, N., Brümmer, C., Crill, P., ... Kutsch, W. (2018). Standardisation of chamber technique for CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> fluxes measurements from terrestrial ecosystems. *International Agrophysics*, 32(4), 569–587. <https://doi.org/10.1515/intag-2017-0045>

- Pereira, R., Ashton, I., Sabbaghzadeh, B., Shutler, J. D., & Upstill-Goddard, R. C. (2018). Reduced air-sea CO<sub>2</sub> exchange in the Atlantic Ocean due to biological surfactants. *Nature Geoscience*, 11(7), 492–496. <https://doi.org/10.1038/s41561-018-0136-2>
- Rebmann, C., Aubinet, M., Schmid, H., Arriga, N., Aurela, M., Burba, G., ... Franz, D. (2018). ICOS eddy covariance flux-station site setup: a review. *International Agrophysics*, 32(4), 471–494. <https://doi.org/10.1515/intag-2017-0044>
- Rödenbeck, C., Zaehle, S., Keeling, R., & Heimann, M. (2018). How does the terrestrial carbon exchange respond to inter-annual climatic variations? A quantification based on atmospheric CO<sub>2</sub> data. *Biogeosciences*, 15(8), 2481–2498. <https://doi.org/10.5194/bg-15-2481-2018>
- Roobaert, A., Laruelle, G. G., Landschützer, P., & Regnier, P. (2018). Uncertainty in the global oceanic CO<sub>2</sub> uptake induced by wind forcing: quantification and spatial analysis. *Biogeosciences*, 15(6), 1701–1720. <https://doi.org/10.5194/bg-15-1701-2018>
- Sabbatini, S., Mammarella, I., Arriga, N., Fratini, G., Graf, A., Hörtnagl, L., ... Papale, D. (2018). Eddy covariance raw data processing for CO<sub>2</sub> and energy fluxes calculation at ICOS ecosystem stations. *International Agrophysics*, 32(4), 495–515. <https://doi.org/10.1515/intag-2017-0043>
- Tiwari, T., Sponseller, R. A., & Laudon, H. (2018). Extreme Climate Effects on Dissolved Organic Carbon Concentrations During Snowmelt. *Journal of Geophysical Research: Biogeosciences*, 123(4), 1277–1288. <https://doi.org/10.1002/2017jg004272>
- van Leeuwe, M. A., Tedesco, L., Rintala, J.-M., Assmy, P., Meiners, K.M., Thomas, D. & Stefels, J. (2018). Microalgal community structure and primary production in Arctic and Antarctic sea ice: A synthesis. *Elementa: Science of the Anthropocene*, 6(4). <https://doi.org/10.1525/elementa.267>
- von Buttlar, J., Zscheischler, J., Rammig, A., Sippel, S., Reichstein, M., Knohl, A., ... Mahecha, M. D. (2018). Impacts of droughts and extreme-temperature events on gross primary production and ecosystem respiration: a systematic assessment across ecosystems and climate zones. *Biogeosciences*, 15(5), 1293–1318. <https://doi.org/10.5194/bg-15-1293-2018>
- Zhang, Y. Y., Xiao, X., Zhang, Y. Y., Wolf, S., Zhou, S., Joiner, J., ... Pilegaard, K. (2018). Estimating the storage term in eddy covariance measurements: the ICOS methodology. *International Agrophysics*, 32(4), 589–605. <https://doi.org/10.1515/intag-2017-0045>

## List of Other Materials

### General ICOS materials produced in 2018

- 1000 printed Progress Reports 2015–2017
- 1000 printed Impact Assessment 2018 Reports
- Official ICOS wooden plates for certified stations
- Official ICOS paper certificates
- Infographics, incl. updated stations map
- Brochures
- Flyers
- Posters
- Stickers
- USB sticks
- Microfiber cloths
- Pens
- Business cards
- PowerPoint template

### Materials produced for the 3rd ICOS Science Conference 2018

- 14 videos, 24 photos, 24 laminated A4s, 2 wooden boxes and 1 rollup for the ICOScapes photo exhibition opening

- Book of Abstracts
- Conference Programme booklet
- Invitation letter template
- Rollups: 8 graphic designs and multiple prints
- 3 large advertise sheet
- Maps
- Lanyards
- Name tags
- Conference bags
- Notebooks
- Microfiber cloths
- Pens
- Keyrings
- Postcards