



ICOS SWEDEN Operational Plan 2022

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Sweden



Swedish
Research Council

ICOS Sweden Operational Plan 2022

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The ICOS Sweden Steering Committee endorsed this Operational Plan on 2022-01-12. The plan is complemented by other documents from ICOS Sweden, including the Strategic Plan (2021-2024) and the Annual Report (2021).

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1. Introduction to ICOS RI

ICOS - Integrated Carbon Observation System - is a European research infrastructure (RI) for quantifying and understanding the greenhouse gas balance of the European continent and of adjacent regions.

High-precision, standardized observations of the exchange of greenhouse gases and heat between the Earth's surface and its atmosphere form an essential basis for understanding not only our planet's present climate, but also past and future developments. It has also become clear that these studies must be secured beyond the lifetime of a typical research project. The aim of ICOS is therefore to construct, equip, and operate a network of standardized, long-term, high precision integrated monitoring stations for atmospheric greenhouse gas concentrations and fluxes. The infrastructure is founded in two pillars: 1) research and measurement infrastructure and 2) ICOS ERIC (European Research Infrastructure Consortium), a legal entity for ICOS data release, coordination, and integration of the whole system. A full description of the ICOS RI organization is included in Appendix A.

In 2022, ICOS RI has more than 140 stations in 13 European countries. The current ICOS Atmosphere and Ecosystem Networks include more than 30 atmosphere and around 70 ecosystem stations located across Europe. The ICOS Ocean Network covers the North Atlantic and European marginal seas. The ocean observation system consists of more than 20 facilities: voluntary observatory ships, so called Ships Of Opportunity (SOO), fixed stations and research vessels.

Stations within ICOS RI are separated into 3 different classifications:

- Class 1 Station: ICOS Ecosystem, Ocean or Atmosphere Station with a complete equipment setup for measuring the full set of ICOS core variables.
- Class 2 Station: ICOS Ecosystem, Ocean or Atmosphere Station with a complete equipment setup for measuring ICOS core variables. Less variables are measured compared to a Class 1 station and ancillary data are determined less frequently.
- Associated Station: The network of ecosystem sites in ICOS is enlarged with a set of Associated Stations where the requirements in terms of variables collected and standards to follow are different from the Class 1 and Class 2 ICOS stations. In contrast to Class 1 and Class 2 Stations, already calculated fluxes and processed data at the final time resolution must be submitted.

To assure that the stations fulfil the requirements set by the ICOS RI measurement protocols, all stations need to pass a 3-step labelling process¹ (2 steps for Associated Stations). During this process, the stations prove the suitability of the station and its surrounding, the correctness of the instrumentation, the instruments' installation as well as functioning of the frictionless data transmission. Once the stations have passed this process, they get promoted to the General Assembly to get labelled as ICOS station.

¹ <https://www.icos-cp.eu/about/join-icos/process-stations>

2. Status of ICOS Sweden

The national network ICOS Sweden is the Swedish contribution to this European effort. ICOS Sweden is fully integrated with and plays an important role in the European ICOS RI. ICOS Sweden has been providing data, and thereby helped to compile information on greenhouse gas exchange of typical northern ecosystems to the research community as well as Swedish stakeholders. Furthermore, ICOS Sweden has been providing test sites for national inventory systems as well as sites and databases for advanced research. ICOS Sweden gets funded as national research infrastructure by the Swedish Research Council (SRC, DNo. F2020-11498) and the partner institutions of the consortium: Lund University (LU, host of ICOS Sweden), Swedish University of Agricultural Sciences (SLU), University of Gothenburg (GU), Uppsala University (UU), Swedish Polar Research Secretariat (PFS) and Swedish Meteorological and Hydrological Institute (SMHI). More information about the organization of the national research infrastructure ICOS Sweden can be found in Appendix B.

Station labelling

ICOS Sweden became, for most of the measurement systems, fully operational during 2014. In 2016, the station labelling process procedures and the criteria for the different types of stations were specified by ICOS RI.

In spring 2018, all three Atmosphere Stations (Svartberget, Norunda, Hyltemossa) were labelled as Class 1 ICOS RI Atmosphere Stations. Measurements and calibrations following the schedule of the Atmosphere Thematic Centre (ATC) and the Central Analytical Laboratory (CAL) are ongoing; data is transferred automatically to the ATC each night. The last release by the ATC of finally calibrated and quality-controlled data products (Level 2 data) including data from ICOS Sweden stations was in spring 2021 and included data until January 2021. These data as well as near real time data (Level 1 data) from the Atmosphere Stations are available for users via access through the ICOS Carbon Portal (CP)².

All three forest Ecosystem Stations Hyltemossa, Norunda and Svartberget as well as the mire Ecosystem Station Degerö were labelled as ICOS RI Class 2 Ecosystem Stations by the ICOS ERIC General Assembly (in 2018 and 2019). Measurements (automatic data sampling and manual for ancillary vegetation data) are ongoing following the instructions of the Ecosystem Thematic Centre (ETC), which are based on the elaborated protocols for Ecosystem Station measurements³. Data is automatically transferred to the ETC via the ICOS Carbon Portal each night. The ETC released Level 2 data including data from the labelled ICOS Sweden stations until the end of 2020 in spring 2021. In 2021, ETC agreed on releasing interim Level 2 products to enable faster access to the data. A first set of interim Level 2 data was released for selected stations, including the labelled ICOS Sweden sites, in late 2021. The processing of more station data is ongoing. The ETC data products are available through the ICOS Carbon Portal.

² data.icos-cp.eu/portal

³ www.international-agrophysics.org/infopage/articles/y/2018/pub/1/issue/4

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The status of the not yet labelled ICOS Sweden stations is as follows:

- Östergarnsholm is expected to become labelled by ICOS ERIC General Assembly in spring 2022. The labelling has been delayed several times due to staff changes at the Ocean Thematic Centre (OTC) and new rules for the labelling process.
- Abisko-Stordalen has taken up the labelling process in 2021 and is expected to be certified by ICOS ERIC General Assembly in spring 2022.
- The new stations, the Ecosystem Station Mycklemossen and the Ocean Station SOOP M/S Tavastland, passed the first step of the labelling process in 2021 and are now in step 2.

The status of all measurement stations in December 2021 is summarized in Fig. 1.

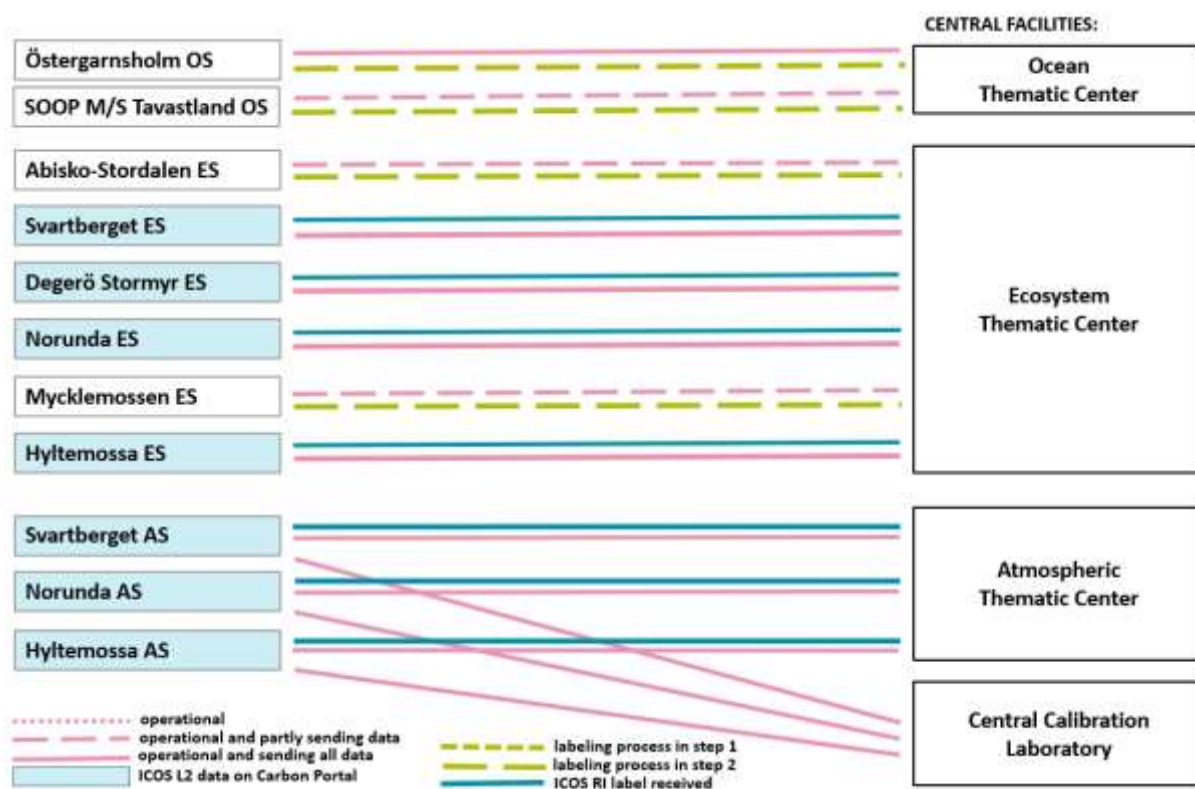


Figure 1. The development status for the delivery of data and information from the ICOS Sweden measurement stations to the ICOS Central Facilities (status December 2021). Coloured lines – status ICOS labelling. AS – Atmosphere station, ES – Ecosystem station, OS – Ocean station.

ICOS Sweden data

Most data from the ICOS Sweden ecosystem network (start in 2014, resp. 2015) has been made available and searchable as Swedish national Network data on the ICOS Carbon Portal. ICOS Sweden is continuously working on updating the files from all Swedish ICOS Ecosystem Stations in the repository (Table 1). ICOS Sweden contributed to several data collections initiated by the ICOS network. These aimed for (i) fast analyses of consequences of the hot and dry weather during 2018 (Drought 2018), (ii) effects of the warm weather conditions during winter 2019/20, and (iii) consequences of the

shutdown due to the covid-19 pandemic in spring 2020. Data from these initiatives is (Drought 2018⁴), resp. will be (Winter 2019/20-Covid19) available through the ICOS Carbon Portal. Furthermore, ETC has opened the possibility to upload data from before the date of ICOS labelling as Associated Station data: Data and the full set of metadata for Svartberget (SE-Svb, 2014-2019), Degerö (SE-Deg, 2014-2019), and Hyltemossa (SE-Htm, 2015-2018) has already been uploaded to the ICOS Carbon Portal; the upload of (meta)data for Norunda (SE-Nor, 2014-2018) has been started. The status of all data from ICOS Sweden stations is summarized in Fig. 2.

Table 1. Status of the Swedish National Network data on the ICOS Carbon Portal on 2021-12-01. The table includes even the agricultural site Lanna (SE-Lnn) which was part of ICOS Sweden until the end of 2020.

	Fluxes (annual files)	Meteo variables (annual files)	Gas and temperature profile variables (annual files)	Eco variables (annual files)	Metadata on instruments and variables
SE-Htm	2015-2020	2015-2020	2015-09/2020	2015-2020	On landing page at CP (variables and heights), resp on icos-sweden.se
SE-Lnn	2014-2019	2014-2019	–	2014-2018	On landing page at CP (variables and heights), resp on icos-sweden.se
SE-Nor	2014-2020	2014-2020	–	2014-2020	On landing page at CP (variables and heights), resp on icos-sweden.se
SE-Deg	2014-2020	2014-2020	–	2014-2020	On landing page at CP (variables and heights), resp on icos-sweden.se
SE-Svb	2014-2020 (not: 2017)	2014-2020	2014-07/2020 (not: 2018)	2014-2020	On landing page at CP (variables and heights), resp on icos-sweden.se
SE-Sto	2014-2019	2014- Oct 2021	–	2014-Oct 2021	On landing page at CP (variables and partly heights), resp on icos-sweden.se

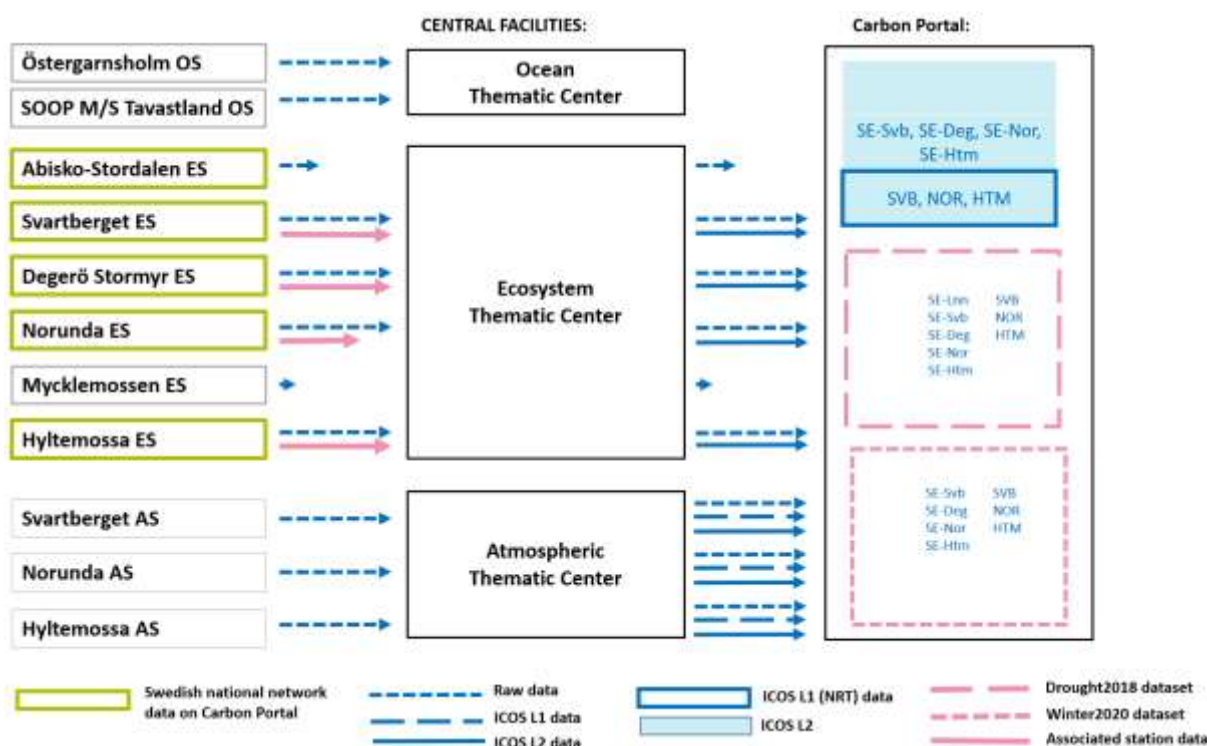


Fig 2. Status of ICOS Sweden data products on the ICOS Carbon Portal on 2021-12-01. The table includes even the agricultural site Lanna (SE-Lnn) which was part of ICOS Sweden until the end of 2020.

⁴ www.icos-cp.eu/data-products/YVR0-4898

3. Planned activities during 2022

General

At the stations, fulfilling the commitments to ICOS RI is of highest priority.

During 2022, the aim is to continue with the labelling process for the remaining stations and if possible, receive the ICOS label. This will also include to start delivering all data to ICOS RI in the ICOS operational mode. We will continue to provide data from the National Network Sweden ecosystem stations as near real time data through the ICOS Carbon Portal. Adaptions of this near real time data to final ICOS data products will be done after publication of the ICOS Level 2 data.

The main emphasis of outreach activities in 2022 will again be on attracting scientific users to ICOS Sweden data and facilities. The primary goal will be to show the usability of ICOS data for scientific questions. Among other options, this will be done by actively contributing to joint efforts by the ICOS community regarding current research questions. But also, by actively follow and contribute to the developments in larger European wide scientific monitoring proposals and projects (e.g. PAUL⁵, ATMO-ACCESS⁶). The co-location of the ICOS sites with other national research infrastructures (SITES⁷ and ACTRIS Sweden⁸) opens a wide field of research questions, which will be closer defined in dialogues between the RI representatives. This will be the first step to extend and deepen the collaboration with other research infrastructures to enlarge synthesis effects of sites. As in previous years, the deep involvement in education from school to higher education levels will continue as well as information to stakeholders and the general public.

Summary of planned activities

Below the activities are listed divided into 1) measurement stations, systems, and data, 2) management of the organization, and 3) collaboration and outreach activities. Acronyms are explained in Appendix D.

1) Measurements stations, systems, and data

- At the Atmosphere Stations the station teams will continue with the necessary tasks, defined in the ICOS RI protocols for atmospheric stations. These tasks include e.g. regular system tests (more detail in Fig. 3).
- Gas analysers for measuring N₂O concentrations at the Atmosphere Stations will be purchased and implemented in the existing measurement system.

⁵ www.icos-cp.eu/event/1064

⁶ www.atmo-access.eu/

⁷ www.fieldsites.se/en-GB

⁸ www.actris.se/

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- Hyltemossa and Norunda Atmosphere Station will continue sending near real time ceilometer data to the EUMETNET project E-PROFILE⁹. Norunda data is in addition part of a PROBE COST action in collaboration with E-PROFILE.
- We will continue to follow up the sampling strategy for the automatic flask sampler with one flask every third day. These flasks are analysed at the CAL; one flask per month is specially analysed for carbon isotope. Hyltemossa has already and Svartberget and Norunda will implement additional sampling every day for a potential isotope analysis if the atmospheric conditions are given following the ICOS RI protocol.
- The ecosystem stations having received the ICOS RI label will follow the strict schedule to fulfil all tasks defined in the ICOS RI protocols and instructions for ecosystem stations (Fig. 4). These tasks include above all regular vegetation sampling and the acquisition of hemispherical pictures for calculating green area index. Also connected to these tasks, ICOS Sweden will continue the already upstarted manual data delivery of ancillary data from all ecosystem stations to the ETC
- New methane analysers will be purchased at the ecosystem mire sites to replace analysers that have been in use for many years by now (Degerö and Mycklemossen); at Abisko-Stordalen this investment is planned for 2023.
- The ocean station Östergarnsholm, soon labelled by ICOS ERIC General Assembly, will follow the schedule to fulfil all tasks defined in the ICOS RI protocols for ocean stations (Fig. 5). Furthermore, the station team will continue the discussion on the implementation of the land-based flux measurements into ICOS RI.
- Furthermore, the UU will renew and update some of the waterside and land-based instruments (wind and humidity profile, oxygen, pCO₂, CO₂ analyser for the marine flux tower); a new buoy will be purchased to meet the requirements of the OTC.
- On SOOP M/S Tavastland, the new ferrybox will be finally installed; this was planned for 2021 but is delayed to covid-19 constraints. Furthermore, sensors for pCO₂/CH₄, oxygen and fluorescence will be purchased and implemented into the system.
- The not yet labelled stations (Abisko-Stordalen, Mycklemossen, and SOOP M/S Tavastland) will continue the labelling process during 2022.
- Connected to the tasks for stations that have been labelled or that are in the preparation to become labelled, ICOS Sweden will continue the automatic delivery of data from the atmosphere stations to ATC, from Östergarnsholm and M/S Tavastland to OTC and from the Ecosystem Stations to the ETC.
- We will continue following the development and updates of ETC instructions for all type of measurements, continuous automatic as well as manual, and we will continue working on adapting our routines and make sure that they fulfil the ICOS requirements. Svartberget and Hyltemossa Ecosystem Stations will continue to send data from below-canopy photosynthetic active radiation to the ETC as part of a pilot study; aim of the test is whether it is possible to substitute and complement hemispherical pictures to determine green area index in forests.

⁹ <https://www.eumetnet.eu/activities/observations-programme/current-activities/e-profile/>

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- The staff will continue to participate in training on site routines and working practices as well as on the standardized measurement protocols and recommended data practices, arranged by ICOS RI and/or ICOS Sweden. The staff will also continue to follow up on health and security checks necessary for their working environment.
- The compilation of descriptions of all non-ICOS research activities that are ongoing inside the domains will be updated continuously and we will continue to provide service and support to projects at the stations if time allows.
- The ICOS Sweden personnel will participate in workshops and other types of meetings organized by the ICOS ERIC Head Office and Central Facilities if funding is available. The SPI will also participate in the ICOS RI MSA meetings.
- Monitoring of the measurements and service, maintenance and update of systems as well as follow up of safety and rules at the stations will be ongoing.
- ICOS Sweden data, which is not available from the ICOS Carbon Portal will be made available upon request. We will continue to upload ICOS Sweden ecosystem data for download from the ICOS Carbon Portal. Once, reliable ICOS Level 2 ecosystem data products are available through the ICOS Carbon Portal, we will update the ICOS Sweden products to avoid different time series.
- Monthly meetings of the research engineers will be continued to keep an active information flow about best practices and problems at the stations.

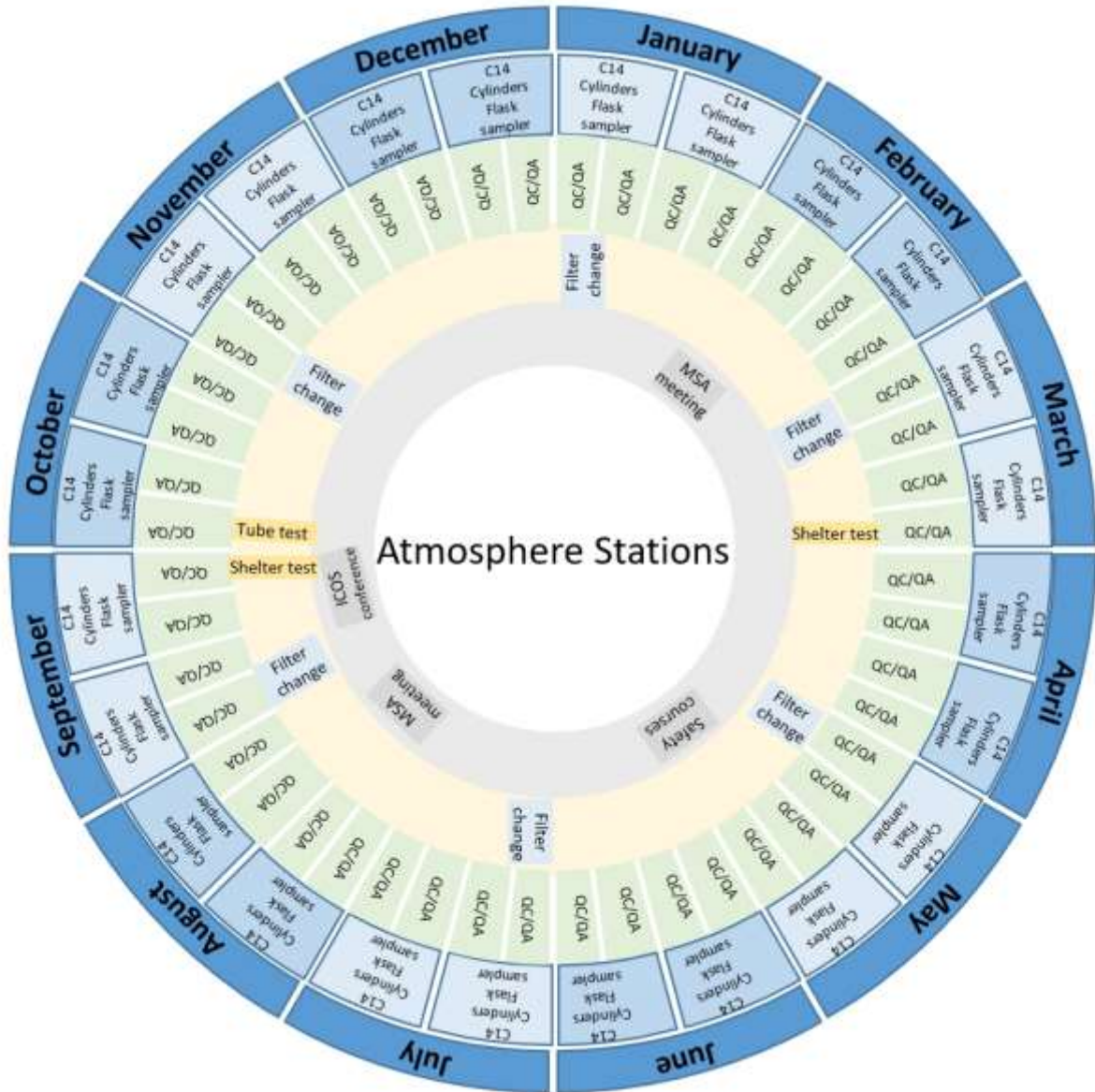


Figure 3: Tasks at the Atmosphere stations within ICOS RI/ICOS Sweden.

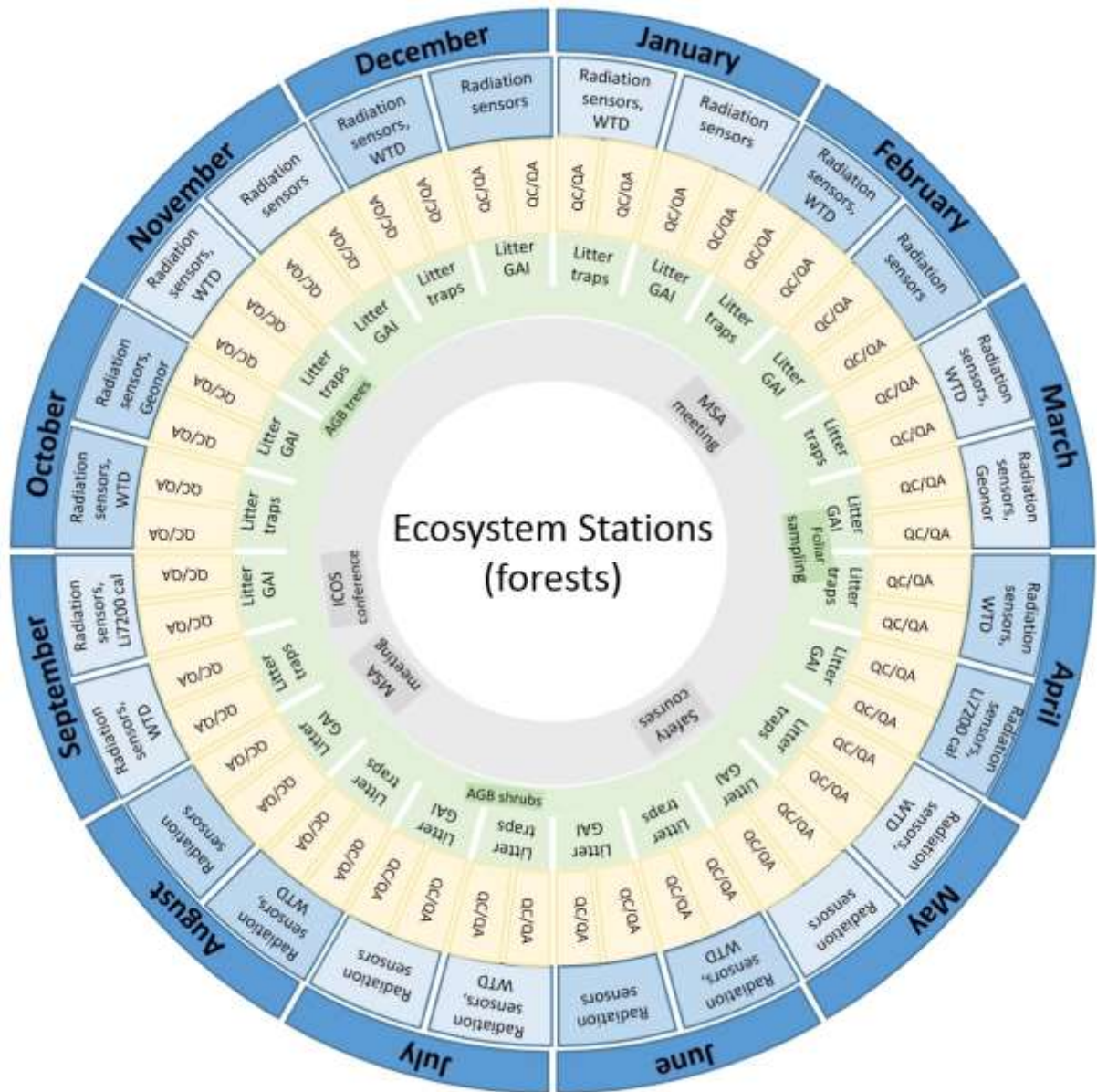


Figure 4: Tasks at the Ecosystem stations within ICOS RI/ICOS Sweden.

- For internal communication, we will continue to arrange internal information meetings via video online meetings every two months for the whole consortium. We will also arrange at least two management team meetings per year, face to face, via phone or internet.

3) Collaborations and outreach activities

- ICOS Sweden will continue disseminating information and support education efforts through courses, field visits, media contacts, and through social media (ICOS Sweden homepage¹⁰, twitter, ResearchGate and LinkedIn).
- ICOS Sweden will continue to adjust the possibilities for visiting scientists and field visits following the Swedish Government's and Public Health Authority's recommendations regarding measures to reduce the spread of the coronavirus (Covid-19).
- ICOS Sweden will continue to take initiatives on deepening the collaboration between ICOS Sweden and other Nordic infrastructures such as SITES, ACTRIS Sweden and NordSpec¹¹.
- ICOS Sweden will continue to encourage applications from ICOS-external researchers aiming at setting up new projects at the stations.
- ICOS Sweden will support and encourage scientists and stakeholders to make use of data measured at the ICOS Sweden stations.
- ICOS Sweden will also continue to support ongoing activities at the sites.
- ICOS Sweden will take part in the ICOS Science Conference in the Netherlands in autumn 2022. The conference is organized by the ICOS ERIC Head Office in cooperation with University of Utrecht.

¹⁰ www.icos-sweden.se

¹¹ nordspec.nateko.lu.se/home

Appendix A: The ICOS RI organization

ICOS is a European research infrastructure founded in 2008, which provides data on greenhouse gas concentrations. ICOS RI is part of the European Environmental Research Infrastructure landscape. ICOS RI organization is founded in two pillars: research and measurement infrastructure and ICOS ERIC¹², a legal entity for ICOS data release, coordination, and integration of the whole system.

ICOS RI (Fig. A1) is coordinated and integrated by the ICOS ERIC. ICOS is one of 18 currently existing ERICs. The legal entity of ICOS ERIC has held a Landmark status as successfully implemented RI in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap¹³ since March 2016. The ESFRI Roadmap identifies new RIs of European interest corresponding to the long-term needs of the European research communities, covering all scientific areas, regardless of possible location.

ICOS RI receives funding from member and observer countries through annual membership contributions, and through host contributions towards specific facilities in ICOS RI. The station networks are funded by different national agencies.

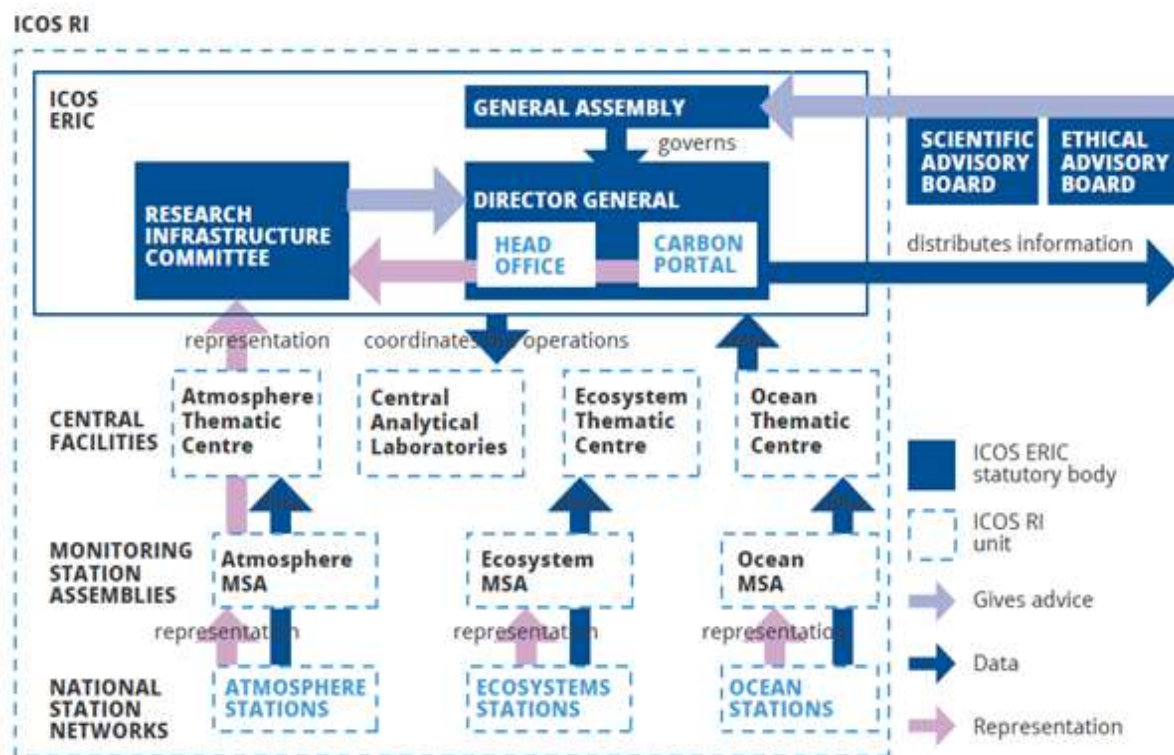


Figure A1. Outline of the ICOS RI organization (ICOS RI, 2021).

¹² https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures/eric_en

¹³ <https://roadmap2021.esfri.eu/projects-and-landmarks/>

ICOS National Station Networks

ICOS RI has more than 140 measurement stations in 13 European countries. These stations measure greenhouse gas concentrations in the atmosphere and fluxes over the terrestrial and marine ecosystems. The ICOS stations are run and funded by national funding agencies, institutes, and universities, demonstrating an impressive joint effort to enable climate change research.

The current ICOS Atmosphere and Ecosystem Networks include more than 30 atmospheric and around 70 ecosystem stations located across Europe. The ICOS Ocean Network covers the North Atlantic and European marginal seas. The ICOS Ocean Observation System consists of more than 20 facilities: voluntary observatory ships, fixed stations, and research vessels.

Monitoring Station Assemblies (MSA)

Monitoring Station Assemblies (MSAs) for the Atmosphere, Ecosystem and Ocean Station Networks consist of SPIs. The MSAs monitor, develop and improve the scientific and technical basis of the ICOS RI. The MSAs usually meet twice a year and they work closely with the ICOS Central Facilities (CF).

Central Facilities (CF)

All measurement raw data from each atmosphere, ecosystem, and ocean station within the ICOS Station Network is transferred to and processed in the ICOS CFs: the Atmosphere, Ecosystem and Ocean Thematic Centres (ATC, ETC and OTC). The CFs ensure that highly standardized and coordinated data is maintained and respected. The CFs ensure that all data are treated and quality controlled with the same algorithms and properly archived for the long term.

ICOS ERIC

ICOS RI is coordinated by the legal entity of ICOS ERIC. ICOS ERIC was established by the decision of the European Commission on 23 November 2015, with the statutory seat in Finland. The principal task of ICOS ERIC is to coordinate the operations of ICOS RI, distribute information from ICOS RI to user communities and to provide integrated data and analysis from greenhouse gas observation systems.

ICOS ERIC Head Office

ICOS ERIC Head Office, located in Helsinki, Finland, manages the legal entity of ICOS ERIC. The Head Office promotes network extension to new countries in cooperation with the ICOS CFs and Focal Points of the ICOS National Networks. ICOS ERIC Head Office supports the scientific and technological developments in ICOS RI and facilitates the outreach, training, and mobility of participants.

ICOS ERIC General Assembly

The ICOS ERIC General Assembly is the governing and decision-making body of ICOS ERIC. It is composed of representatives of the member and observer countries of ICOS ERIC. Jean-Marie Flaud from the French Ministry of Higher Education, Research and Innovation is the current chair.

ICOS ERIC Director General

The Director General, appointed by the ICOS ERIC General Assembly, is the legal representative of ICOS ERIC. The Director General carries out the day-to-day management of ICOS ERIC and is responsible for the implementation of the decisions by the ICOS ERIC General Assembly, as well as overseeing and

coordinating the activities of ICOS RI. Werner Kutsch is the current Director General of ICOS ERIC; Alex Vermeulen, Director of the ICOS Carbon Portal, has been elected as deputy director.

ICOS ERIC Research Infrastructure Committee

The ICOS ERIC Research Infrastructure Committee is a key advisory body in ICOS RI that supports the Director General in all matters relevant to the coordination and management of ICOS RI. ICOS Research Infrastructure Committee consists of representatives from the Head Office, ICOS Carbon Portal, each ICOS CF and each MSA. The Director General chairs the committee.

ICOS Scientific Advisory Board

The ICOS Scientific Advisory Board is an external body and monitors the scientific quality of ICOS RI, gives feedback on and makes recommendations for the development of ICOS RI activities, and advises ICOS ERIC with the objective of achieving the scientific goals of ICOS RI. It also provides programmatic support by commenting on the overall science plans and directions and analyses the output of ICOS RI.

ICOS Ethical Advisory Board

The second external body, the ICOS Ethical Advisory Board giving advice to the ICOS ERIC based on periodical reports on ethical issues related to science, data, discrimination, or any kind of conflict of interest.

ICOS ERIC Carbon Portal

The ICOS Carbon Portal, an operative unit of ICOS ERIC, offers free access to ICOS RI data on greenhouse gases observations from the ICOS Station Networks, as well as easily accessible and understandable science and education products. The system design for the ICOS Carbon Portal management, databases, web services, and elaborated products is carried out by the system architect in a dialogue with both internal and external scientists. Dedicated researchers from all over the world will contribute to the elaborated products catalogue.

Appendix B: The ICOS Sweden organization

Consortium partners

ICOS Sweden makes measurements at stations distributed across Sweden, from Abisko-Stordalen in the north to Hyltemossa in the south (Fig. A2). There are three Atmosphere Stations for measurement of concentrations of GHGs in the well-mixed boundary layer, six Ecosystem Stations for measurements of exchanges of GHGs between ecosystems and the atmosphere, one fixed Ocean Station for observations of the coastal Baltic Sea, and one Ocean Station based on a SOOP, for measurements of the surface ocean traveling between The Netherlands and Finland.

The measurement stations are run by four universities and two institutes. The framing of the cooperation is set by a formal agreement. The consortium partners of ICOS Sweden are the following:

- Lund University (LU) is the host organization with overall responsibility for the coordination of ICOS Sweden. LU also operates four ICOS stations: the Norunda forest Ecosystem and Atmosphere stations and the Hyltemossa forest Ecosystem and Atmosphere stations.
- Swedish University of Agricultural Sciences (SLU) operates three ICOS stations: Svartberget forest Ecosystem and Atmosphere stations, and the Degerö mire Ecosystem station.
- University of Gothenburg (GU) is responsible for the operations of the Mycklemossen mire Ecosystem station.
- Uppsala University (UU) operates the Östergarnsholm fixed Ocean station incl. a marine flux tower.
- Swedish Polar Research Secretariat (PFS) runs the Abisko-Stordalen mire Ecosystem station.
- Swedish Meteorological and Hydrological Institute (SMHI) is responsible for the Ocean station aboard the regularly scheduled SOOP M/S Tavastland.



Fig A2. Map of the site locations of the observation network of ICOS Sweden.

The organization of ICOS Sweden (Fig. A3) is structured according to the directions given in the original agreement with the Swedish Research Council (SRC) for the funding period 2021-2024.

Lund University, as host for ICOS Sweden, is responsible for the financial resources and reporting to the donors. The host is the director's employer and formally appoints the director and the assistant director after consultation with the so-called stämman. The stämman is a forum for consultation and agreement between all participating parties: all consortium partners are represented in the stämman which decides on matters concerning the activities within the infrastructure but has no mandate in addition. The host also formally appoints the Steering Committee (SC) in consultation with the SRC.

Each partner has employer’s liability for the personnel at its station(s) and is represented in the ICOS Sweden Reference Group (RG) and in the ICOS RI Monitoring Station Assembly (MSA) by the Station Principal Investigator (SPI).

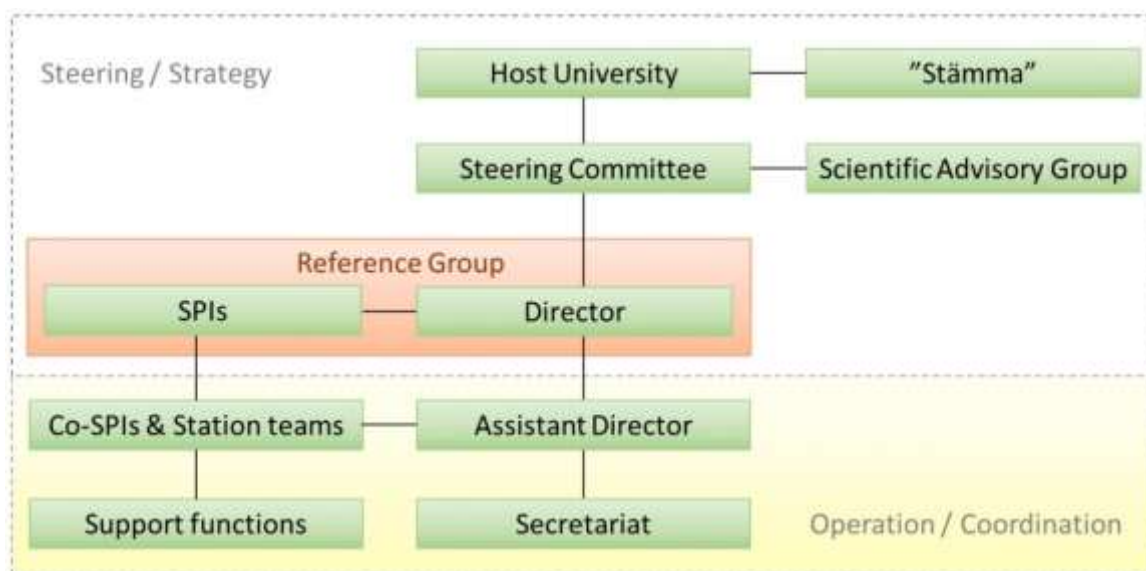


Fig. A3. The organization structure of ICOS Sweden.

ICOS Sweden Steering Committee (SC)

The SC has a broad composition with expertise that covers both the management of research infrastructure and qualified research in the area. The task of the SC is, independently of the parties and within the given frames by the stämman, to work for optimal development, operation, and management of ICOS Sweden as a national research infrastructure. The SC is responsible for overall strategic and financial monitoring and shall promote development, operation, and management. The SC has also to decide on the focus and objectives for the collaboration between the different partner organizations that constitute ICOS Sweden.

The present SC members have been appointed on 16 December 2021 until the end of 2024, where after the LU Vice-Chancellor will appoint new members selected in agreement with the SRC and the consortium partners. The present members are Eija Juurola (Chair; Finnish Meteorological Institute), Lars Arneborg (SMHI), Hjalmar Laudon (SLU), Heather Reese (GU), Isaac R Dos Santos (GU), Linda Kanders (Swedish Environmental Research Institute), Marko Scholze (LU), and Lars Tranvik (UU).

Scientific Advisory Group (SAG)

The SAG consists of four leading international scientists, appointed by the SC. The SAG is independent and contributes with scientific advice, establishes external contacts, and acts as ambassadors to the wider community. SAG participates in the annual workshop and, in conjunction to the workshop, meets the SC to discuss strategic issues.

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The current members of the SAG are Inez Fung (University of California, Berkeley, USA), Yiqi Luo (Northern Arizona University, Flagstaff, USA), Monique Leclerc (University of Georgia, Georgia, USA), and Peter Rayner (University of Melbourne, Australia).

Reference Group (RG)

The RG consists of the director and scientifically merited and active representatives from each partner (SPIs). The RG shall provide the director with advice on strategic plans and budgets. Furthermore, the RG shall promote the use of research at ICOS Sweden at each partner institution and work on the outreach in Sweden in accordance with the strategic plan. The director is responsible for the management of the research infrastructure. The role as director of ICOS Sweden was given to Jutta Holst for the time period 2021-07-01 to 2022-06-30. The director's tasks include planning, leading, and prioritization of ICOS Sweden's operations within the framework of its business plan and budget and with the support of the SPIs, while the operational management can be delegated to the assistant director according to the consortium agreement. As contact point between RG and the SC, the director prepares the reporting documents for the SC and the stämman.

Operational Management

The operational management oversees the daily business at the stations with the main goal of delivering high quality data to ICOS RI. This comprises the main task for the SRC funded national infrastructure. For this task, the stations are to a large part directed by ICOS RI. The operational management group is led by the director who is supported by administrative staff: a part time (5%) scientific secretary (Irene Lehner), a part time (25%) economist (Heléne Holmström), and part time (5%) administrative support (Yvonne Kedström). The SPIs are responsible for the daily management, data quality control, data reporting and coordination of scientific issues at the site level. The SPIs are also members of the respective ICOS MSAs (Atmosphere, Ecosystem, Ocean). During 2016, a Scientific and Technical Station Support Module for technical and data support of the stations and users have been added to the infrastructure. 1 FTE is divided into three part time personnel: Michal Heliasz (20%), Meelis Mölder (40%), and Jutta Holst (40%). The costs for the module are shared between the ecosystem and atmosphere station hosts.

Appendix C: The ICOS Sweden measurement stations

ICOS Sweden operates eleven measurement stations in total: six ecosystem stations, three atmospheric stations, and two ocean stations. The three atmospheric stations are co-located with three of the ecosystem stations. The locations of the measurement stations have been chosen with the main aim to cover typical Swedish conditions, while at the same time considering a broader Nordic context as well as the European perspective.

Abisko-Stordalen Ecosystem Station

The Abisko-Stordalen subarctic mire, consisting of a palsa/bog/fen complex, is of large interest to many national and international researchers and there are a number of ongoing activities including flux measurements by different groups. The mire area is located very close to the 0°C isotherm and represents a very dynamic part of the sub-arctic region. The station is operated by the PFS at the Abisko Scientific Research Station and is located about 10 km east of Abisko. Personnel resources correspond to 1.2 FTE involving the research engineers Niklas Rakos, Alexander Meire, Erik Lundin, and Annika Kristoffersson. SPI is Erik Lundin.

Degerö Ecosystem Station

The Degerö station is situated on a minerogenic oligotrophic boreal mire covering 6.5 km² in the Kulbäcksliden research park at Vindeln Experimental Forests, located in a cold temperate humid climate, about 60 km west of Umeå. The station is run by SLU. Personnel resources correspond to 1.25 FTE involving the research engineers Giuseppe De Simon, Per Marklund, Pernilla Löfvenius, and the SPI Mats B. Nilsson.

Svartberget combined Ecosystem and Atmosphere Station

The Svartberget site is located in a mixed boreal pine/spruce forest within the Vindeln Experimental Forests which are situated in Vindeln, 60 km west of Umeå. The station is operated by SLU. Personnel resources correspond to 2.35 FTE involving the research engineers Paul Smith, who also is SPI for the Atmosphere Station, Pernilla Löfvenius, Rowan Messmann, Giuseppe De Simon, and the ecosystem SPI Matthias Peichl.

Norunda combined Ecosystem and Atmosphere Station

Norunda is located in a mixed boreal pine/spruce forest about 30 km north of Uppsala. The station is the oldest flux site in Sweden, established in 1994. The station is operated by LU. Personnel resources correspond to 2.35 FTE involving the research engineers Anders Båth, Irene Lehner, as well as the SPI Meelis Mölder and Co-SPI Natascha Kljun as permanent staff.

Östergarnsholm Fixed Ocean Station with Marine Flux Tower

The site Östergarnsholm is located at the small island Östergarnsholm situated 4 km east of Gotland in the Baltic Sea. The island is very flat and for selected wind sectors representing well the open sea, i.e. marine conditions. The site has been running since 1995 and has been included as an ICOS Sweden station on 1 January 2015. The station is run by UU and personnel resources correspond to 0.95 FTE involving research engineer Panagiotis Stagianos and the SPI Anna Rutgersson. Hans Bergström, Erik Sahlée, and Erik Nilsson are also involved in the operational work.

Mycklemossen Ecosystem Station

Mycklemossen mire station is located within the Skogaryd Research Catchment which is situated in a part of the country with high levels of nitrogen deposition, about 15km north-west Trollhättan. The measurements enable determination of the net ecosystem carbon balance. The station is operated by GU. In the current phase, the personnel resources are covered by the research infrastructure project SITES. SPI is Per Weslien.

Hyltemossa combined Ecosystem and Atmosphere Station

The Hyltemossa site is located in southernmost Sweden, about 60 km north-east of Lund, in a young temperate spruce forest around 30 years old. The station is operated by LU. Personnel resources correspond to 2.35 FTE involving the research engineers Michal Heliasz, who is also the SPI, Tobias Biermann, and Thomas Holst as well as Co-SPI Natascha Kljun as permanent staff.

M/S Tavastland: SOOP Ocean Station

SMHI runs a ferrybox on the SOOP M/S Tavastland, who traffics the Baltic Sea one week (Lubeck-Oulu-Kemi-Lubeck) and one week the North Sea (Lubeck-Zeebrugge-Tilbury-Lubeck) on a constant schedule. Measurements on M/S Tavastland are operated by SMHI. The SPI is Anna Willstrand Wranne, who also runs the station as research engineer together with Kristin Andreasson (total 0.6 FTE). Scientifically responsible for the measurements on M/S Tavastland is Irene Wåhlström.

Appendix D: List of abbreviations and acronyms

ACTRIS Sweden – Aerosols, Clouds, and Trace gases Research Infrastructure network

ATC – ICOS Atmosphere Thematic Center

AS – Atmosphere station

CAL – Central Analytical Laboratory

CF – Central facilities (ETC, ATC, OTC and CAL)

CP – Carbon Portal

ES – Ecosystem station

ETC – ICOS Ecosystem Thematic Center

ERIC – European Research Infrastructure Consortium

ESFRI - European Strategy Forum on Research Infrastructures

EUMETNET – Network of European Meteorological Services

FTE – full-time equivalent

GHG – greenhouse gas

GU – Gothenburg University

ICOS – Integrated Carbon Observation System

LU – Lund University

MSA – Monitoring Station Assembly

NordSpec – research network for spectral data collection

OS – Ocean station

OTC – ICOS Oceani Thematic Center

PFS – Swedish Polar Research Secretariat

RG – ICOS Sweden Reference Group

RI – Research Infrastructure

SAG – ICOS Sweden Scientific Advisory Group

SC – ICOS Sweden Steering Committee

SITES – Swedish Infrastructure for Ecosystem Research

SLU – Swedish University of Agricultural Sciences

SMHI – Swedish Meteorological and Hydrological Institute

SOOP – Ship of Opportunity

SRC – Swedish Research Council (in Swedish VR – Vetenskapsrådet)

UU – Uppsala University