



# ICOS SWEDEN

## Operational Plan 2025

**ICOS** | National  
Network  
Sweden



Swedish  
Research Council

# ICOS Sweden Operational Plan 2025

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*The ICOS Sweden Steering Committee endorsed this Operational Plan on 2024-11-11 (DNr. STYR 2024/2862). The plan is complemented by other documents from ICOS Sweden, including the Strategic Plan (2025-2028, DNr. STYR 2024/2859) and the Annual Report (2024).*

# ICOS Sweden Operational Plan 2025

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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 the 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 therefore, is 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.

Stations within ICOS RI separate into three 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, only calculated fluxes and processed data must be submitted.

To assure that stations fulfil the requirements set by the ICOS RI measurement protocols, all stations need to pass a three-step labelling process<sup>1</sup> (two steps for Associated Stations). During this process, the stations prove the suitability of the facility and its surrounding, the correctness of the instrumentation, installation as well as functioning of the data transmission. Once the stations have passed this process, they are promoted to the General Assembly to receive label as an ICOS station.

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<sup>1</sup> <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 integrated with and plays an important role in the European ICOS RI. ICOS Sweden has been providing data and helping to compile information on greenhouse gas exchange of typical northern ecosystems to the research community and Swedish stakeholders. Furthermore, ICOS Sweden provides test sites for national inventory systems and databases for advanced research. ICOS Sweden is entering its third phase (2025-28) as research infrastructure of national interest, funded by the Swedish Research Council (SRC, DNo. F2023-00172) 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). The funding will cover the operations at all stations but Östergarnsholm. The funding of the marine station Östergarnsholm is subject to the condition that the Ocean station at Östergarnsholm passes the labelling process before the end of 2028; only in this case the RI can apply to cover the costs for the station for the remaining time of the funding period 2025-28. More information about the organization of the national research infrastructure ICOS Sweden can be found in Appendix B.

### ***Station labelling***

ICOS Sweden became fully operational during 2014. In 2016, the station labelling process 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 every 24 hrs. The latest release by the ATC of quality-controlled data products (Level 2 data) including data from ICOS Sweden stations was in July 2023 and included data until April 2023. These data as well as near real time data (Level 1 data) from the Atmosphere Stations are available for users via the ICOS Carbon Portal (CP)<sup>2</sup>.

All Swedish Ecosystem stations, except the mire station Mycklemossen, which only became an ICOS candidate station in 2020, have passed the labelling process before 2023. Measurements (automatic data sampling and ancillary vegetation data) are ongoing following the instructions of the Ecosystem Thematic Centre (ETC), which are based on the elaborated protocols for Ecosystem Station measurements<sup>3</sup>. Data is automatically transferred to the ETC via the ICOS Carbon Portal. The ETC released the latest Level 2 dataset including data until the end of 2023 in July 2024. The next interim L2 dataset covering the data until the end of the summer 2024 is in preparation. The ETC data products are available through the ICOS Carbon Portal.

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

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<sup>2</sup> [data.icos-cp.eu/portal](https://data.icos-cp.eu/portal)

<sup>3</sup> [www.international-agrophysics.org/infopage/articles/y/2018/pub/1/issue/4](http://www.international-agrophysics.org/infopage/articles/y/2018/pub/1/issue/4)



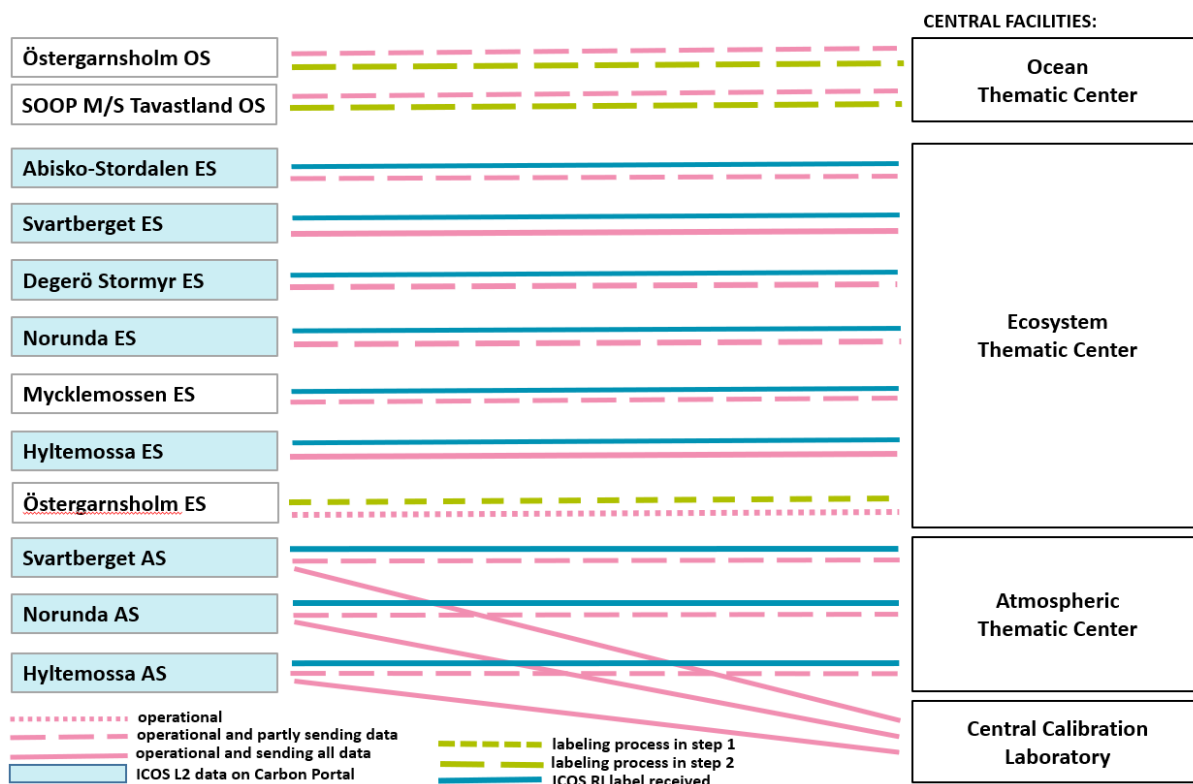
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- The Ecosystem Station Mycklemossen has been labelled as Class 2 Ecosystem station to the ICOS General Assembly in November 2024.
- The Ocean Station SOOP M/S Tavastland returned to the Baltic Sea in the beginning of 2024. Sampling is ongoing since June 2024 after upgrading the system to measure not only CO<sub>2</sub> but also methane (CH<sub>4</sub>). There are some periods of missing data due to ship maintenance in dry dock and other technical difficulties. The available data will be sent to the OTC as soon as it has passed quality control and labeling of the station is completed. The labelling process of the fixed ocean station Östergarnsholm has been delayed due to difficulties with the sensor quality assurance. Various attempts have been made to get around the problem which is caused by the low salinity of the Baltic Sea. In April 2024, OTC deployed a system for parallel sampling at Östergarnsholm. The results from this first campaign look promising and a repetition is scheduled for spring 2025.
- Associated Ecosystem station Östergarnsholm: The question about who will take care and process the data from the eddy-covariance measurements at Östergarnsholm has been unsolved during the last years. During 2024, ICOS Sweden and UU proposed to divide the ICOS operations at Östergarnsholm into a marine part (Class 1 Ocean Station) and an ecosystem part (Associated Ecosystem Station); the proposal was accepted by the SRC, station fees for the associated ES will be taken from the reserved budget at the SRC for the coming funding period. The preparations for the labelling of the Associated ES have started.

The status of all measurement stations in October 2024 is summarized in Fig. 1.

Note, that the data delivery status has been downgraded to “partly sending data” for the Atmosphere Stations (AS) and the mire Ecosystem Stations (ES). This is due to the new N<sub>2</sub>O measurements which have not yet been fully integrated into the systems at the Atmosphere Stations. At the mire ES, the instructions for non-CO<sub>2</sub> flux measurements have been finalised. Though the measurements are not mandatory for Class 2 sites, we see them as essential for our mire stations and thus as part of the full data stream to the ETC.

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**Figure 1.** The development status for the delivery of data and information from the ICOS Sweden measurement stations to the ICOS Central Facilities (status October 2024). Coloured lines – status ICOS labelling. AS – Atmosphere station, ES – Ecosystem station, OS – Ocean station.

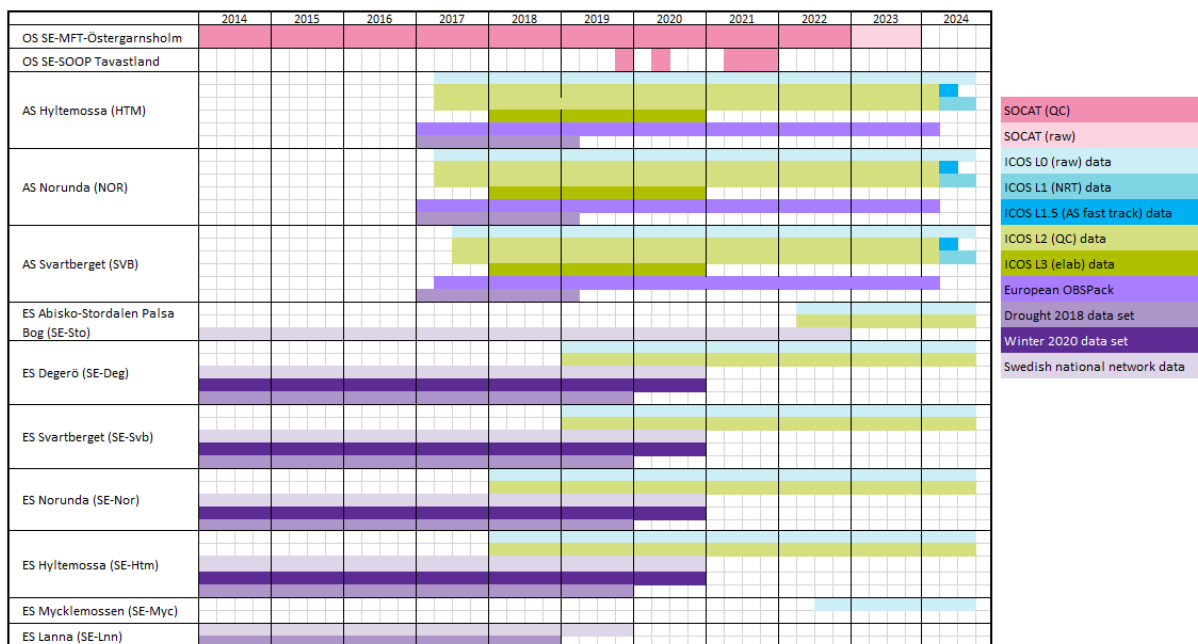
### ICOS Sweden data

Most data from the ICOS Sweden ecosystem network are available and searchable as Swedish National Network data on the ICOS Carbon Portal. In the past, 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. The data sets from these initiatives have been available at the ICOS Carbon Portal since earlier. The processing of pre-labelling data from the Swedish Ecosystem Stations is still on hold and waiting for further instructions.

ATC introduced a new data level to enable faster releases of quality checked and calibrated data. The first release of these so called “fast track” data (data level 1.5) was in October 2024 and covered the period from the last level 2 dataset until end of June 2024.

The status of all data from ICOS Sweden stations is summarized in Fig. 2.

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**Fig 2.** Status of ICOS Sweden data products on the ICOS Carbon Portal on 2024-10-28.

### 3. Planned activities during 2025

#### General

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

For the not yet certified stations, finalising the labelling process including delivery of all data to ICOS RI in operational mode will be the main focus.

The other stations, beside normal operations, will be working on bringing data streams for not yet delivered variables into operational mode.

The main emphasis of outreach activities in 2025 will again be on attracting scientific users to ICOS Sweden data and facilities. The primary goal is to show the benefit of ICOS data for scientific questions. Alongside other initiatives, this will be done by actively contributing to joint efforts by the ICOS community regarding current research questions, and by actively following and contributing to developments in larger European scientific proposals and projects.

We will follow the action points listed in the strategic plan for closer collaboration between the three environmental research infrastructures of national interest (ICOS Sweden, SITES<sup>4</sup> and ACTRIS Sweden<sup>5</sup>) as well as possible new actions emerging from possible directives from the Swedish Research Council which are expected at the end of 2024. As in previous years, the deep involvement in education from school to higher education levels will continue alongside information provision to stakeholders and the general public.

<sup>4</sup> [www.fieldsites.se/en-GB](http://www.fieldsites.se/en-GB)

<sup>5</sup> [www.actris.se/](http://www.actris.se/)

## **Summary of planned activities**

Planned activities divide into 1) measurement stations, systems, and data, 2) management of the organisation, and 3) collaboration and outreach activities. Acronyms are explained in Appendix D.

### **1) Measurements stations, systems, and data**

- At the Atmosphere Stations, teams will continue with the necessary tasks defined in the ICOS RI protocols for atmospheric stations, including regular system tests (more detail in Fig. 3). Concentrations of CO, CO<sub>2</sub>, CH<sub>4</sub>, and H<sub>2</sub>O have been measured at three levels. The lowest level is above the tree tops, the highest at the top of the tower. Wind speed and direction (sonic anemometers), air temperature, and humidity are measured at three levels. The cloud base height is measured at each station. Mandatory system leakage tests of the tubing are performed on an annual basis. The indoor sampling system is tested twice a year. All data (gas concentrations, diagnostic values and meteorological variables) are transferred to the ATC on a daily basis.
- Gas analysers for measuring N<sub>2</sub>O concentrations at the Atmosphere Stations have been purchased in 2023 and delivered in 2024. The implementation of the analysers into the stations will be finalised after a necessary update by the manufacturer Picarro to make the data stream coming from the analyser compatible with the requirements by the ATC.
- Hyltemossa and Norunda Atmosphere Station will continue sending near real time ceilometer data to the EUMETNET project E-PROFILE<sup>6</sup>. In addition, Norunda data is part of a PROBE COST action in collaboration with E-PROFILE. Any new developments in the centralised data processing of ceilometerdata (e.g. possible data processing by ACTRIS RI data centers) will be followed and actions will be taken when needed. Svartberget will start sending ceilometerdata at the end of 2024.
- We will continue to follow 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 being analysed for carbon isotopes. Hyltemossa has been part of the CO2MVS Research on Supplementary Observations project (CORSO) and follows a tighter sampling strategy with one flask per day for potential isotope analysis if the atmospheric conditions are given; Svartberget and Norunda follow the general schedule for flask sampling following the ICOS RI protocol. Changes in the sampling routines are done in consultation with the CRL.
- The Ecosystem Stations will follow the strict schedule to fulfil all tasks defined in the ICOS RI protocols and instructions (Fig. 4). The key component of the continuous measurements are the fluxes of ecosystem relevant trace gases (i.e. CO<sub>2</sub> in forests and CO<sub>2</sub> + CH<sub>4</sub> in mires) and energy (i.e. latent and sensible heat). Furthermore, atmospheric (i.e. air temperature, pressure and humidity, wind, radiation balance components and precipitation) and soil meteorological (i.e. temperature, moisture, ground heat flux and water table level) variables are continuously measured within the footprint of the flux system. All sensors require regular maintenance such as calibration, cleaning, filter replacement, change of desiccants and occasional troubleshooting. In addition to the continuous automatic measurements, periodic manual measurements, and discontinuous

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<sup>6</sup> <https://www.eumetnet.eu/activities/observations-programme/current-activities/e-profile/>

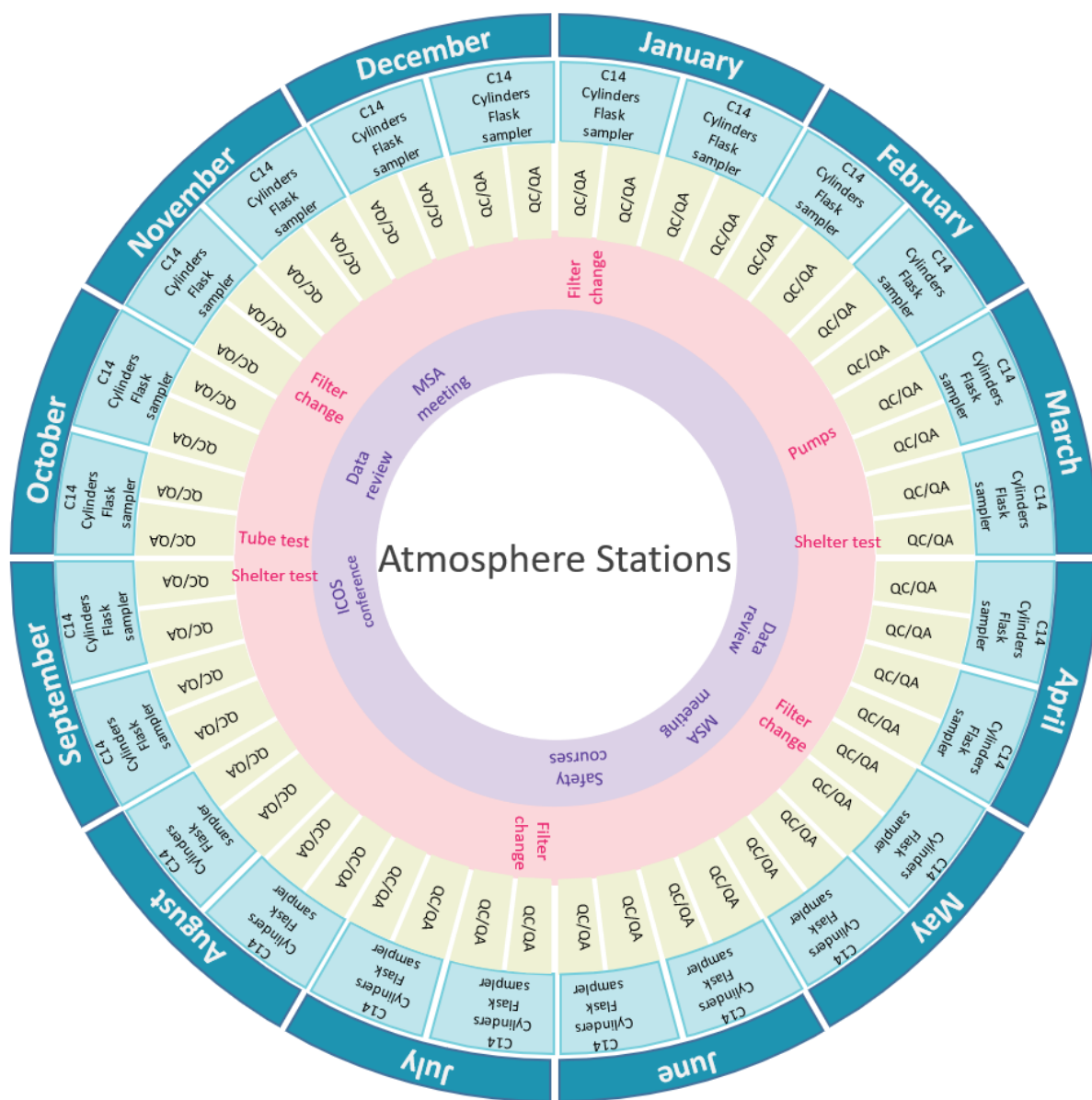
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sampling for analyses are part of the mandatory program to provide necessary information for interpretation and upscaling of continuous measurements. This includes inventories of carbon pools in plant and soil material, as well as periodic measurements of vegetation structural properties, including species composition, tree height and diameter at breast height, as well as phenology cameras and hemispherical canopy images to determine e.g. aboveground biomass and Green Area Index. Leaf and soil samples are sent for chemical analyses of their C and N contents.

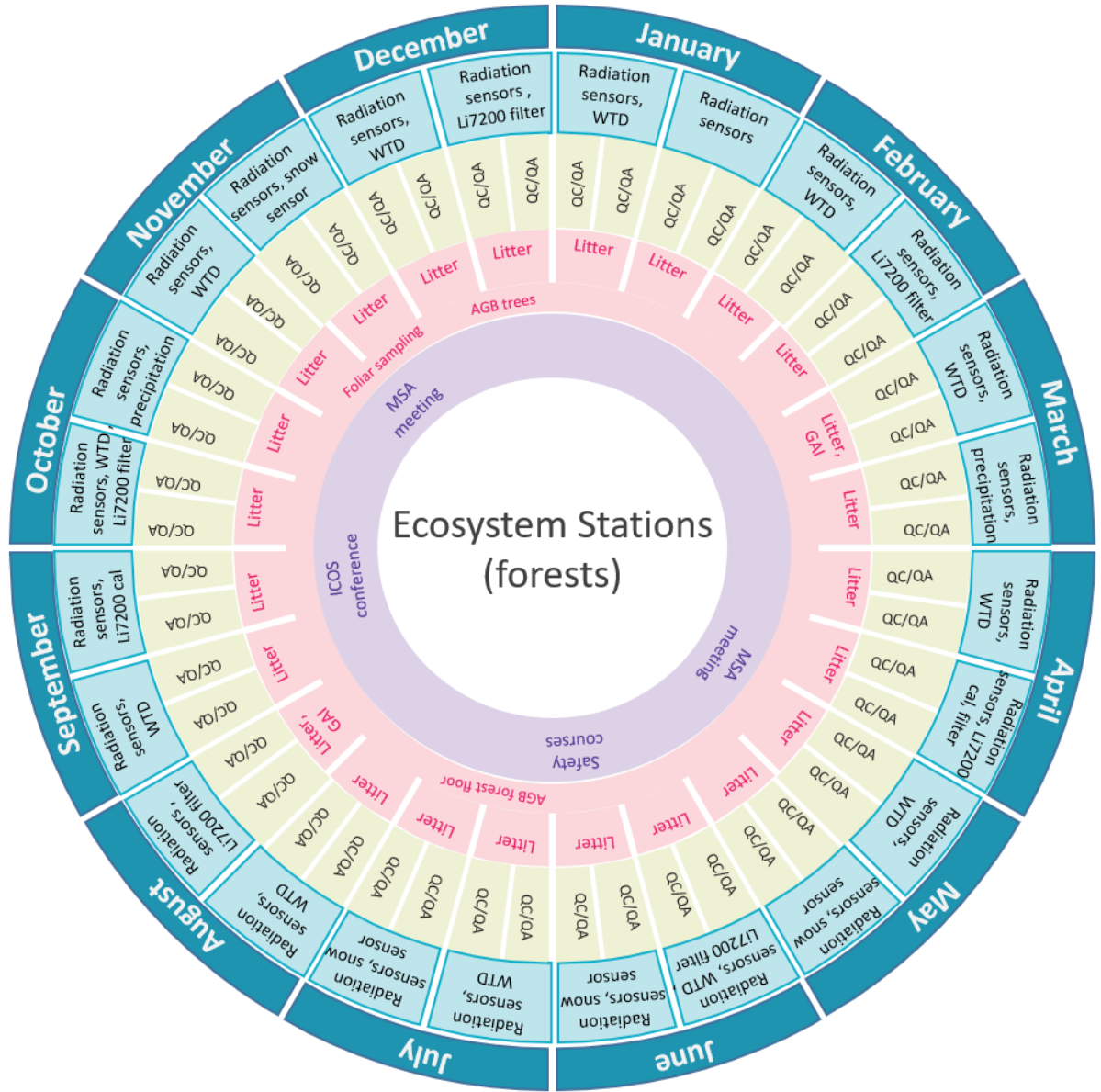
- Östergarnsholm Associated Ecosystem station will with support of the ICOS Sweden support prepare and provide all necessary material for the labelling process to ETC.
- The Ocean Stations Östergarnsholm and SOOP M/S Tavastland, will follow the schedule to fulfil all tasks defined in the ICOS RI protocols (Fig. 5). Both teams will continue to work together with OTC to make progress in the quality assurance for the station labelling.
- We will continue following the development and updates of ETC instructions for all types of measurements, continuous automatic as well as manual, and we will continue working on adapting our routines to ensure they fulfil ICOS requirements.
- Continuous below-canopy photosynthetically active radiation measurements will be used to estimate green area index at the forest sites; the difficult task of taking hemispherical pictures (difficult in terms of matching right season, light and weather conditions) will thus be reduced to twice per year.
- The routines for litter sampling have been adjusted to meet both ICOS RI requirements and possibilities at the stations. Litter includes coarse woody litter, fine woody litter and non-woody litter. Non-woody litter has been sampled in litter traps. To reduce the work load, only the total dry weight has been recorded at Svartberget and at two CPs at Hyltemossa since 2023; at SE-Htm, sorting continued at two CPs. Coarse and fine woody litter will be sampled according to the ICOS protocol in late summer where possible.
- Norunda: The data transfer from the second eddy-covariance mast to ETC will be re-scheduled to 2025.
- Svartberget, Degerö: central in-house (by the ICOS Sweden support) data processing of the additional eddy-covariance system to be able to deliver reliable data during winter will be initiated. Since the system does not comply with the ICOS protocols, data processing will have to be done in house. The discussions with ETC on the practicalities around how to make these data best available and visible for users will be taken up again once the data have been processed.
- Station staff will continue to participate in training and working with the standardized measurement protocols and recommended data practices, arranged by ICOS RI and/or ICOS Sweden. Staff will continue to follow up on health and security checks necessary for their working environment.
- The descriptions of all non-ICOS research activities 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.

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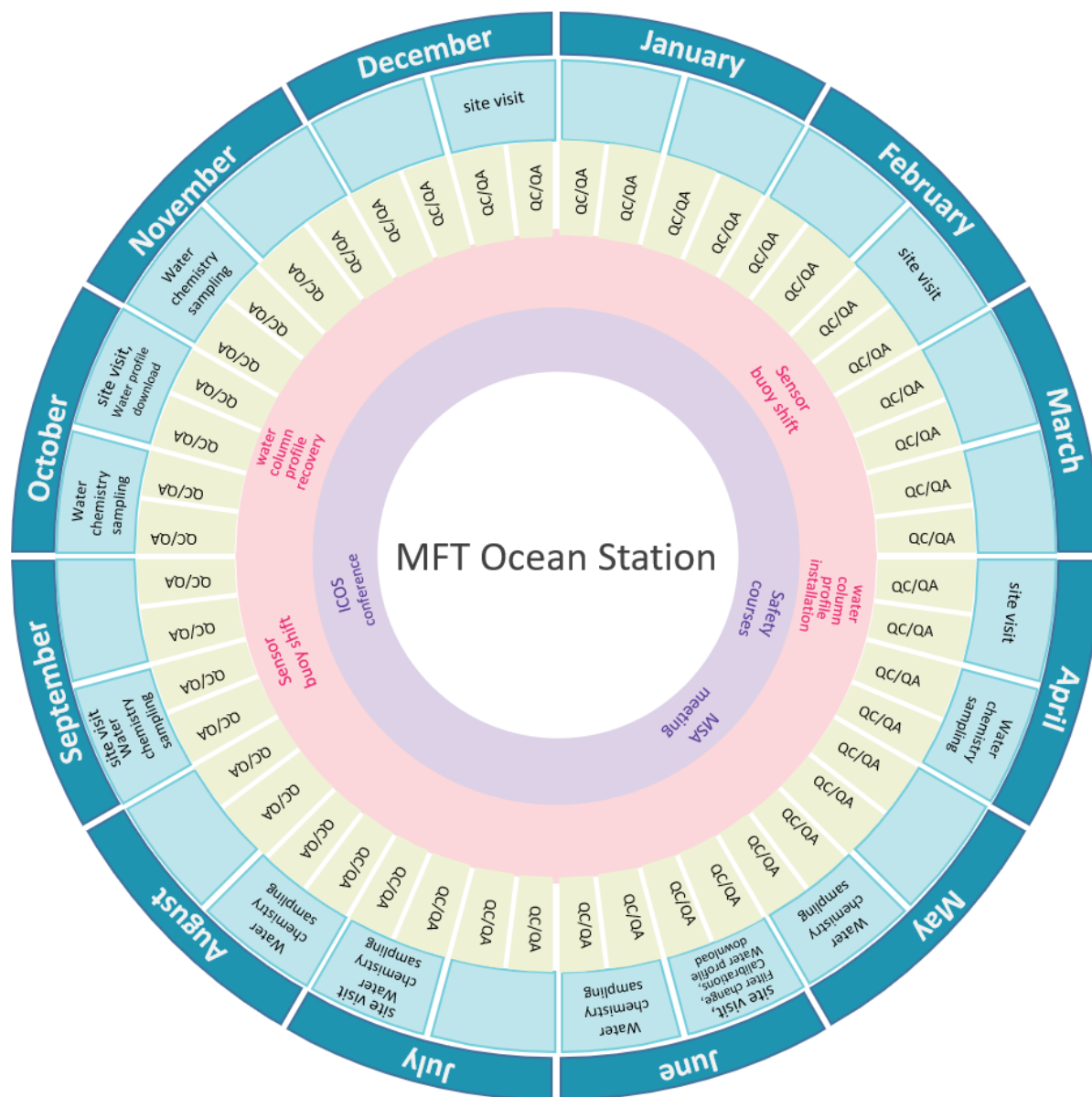
- The ICOS Sweden personnel will participate in workshops and meetings organized by the ICOS ERIC Head Office and Central Facilities as long as funding is available. The SPI will also participate in the ICOS RI MSA meetings.
- There will be ongoing monitoring of the measurements and service, maintenance and update of systems and follow up of safety rules at the stations.
- Monthly meetings of the research engineers will continue, to ensure active information flow about best practices and problems at the stations. An in-person technician meeting is planned for 2025.



**Figure 3:** Scheduled regular tasks at the Atmosphere stations within ICOS RI/ICOS Sweden.



**Figure 4:** Scheduled regular tasks at the Ecosystem stations within ICOS RI/ICOS Sweden.



**Figure 5:** Scheduled regular tasks at the Ocean station SE-MFT-Östergarnsholm within ICOS RI/ICOS Sweden. Tasks for SOOP M/V Tavastland will be added during 2025.

## 2) Management of the organisation

- Tim Arnold will take over as director of the infrastructure from January 2025. The coordinator (current director) will assist the new director with his tasks. As in previous years, the director also acts as national contact point (Focal Point) towards ICOS ERIC.
- The management team will start up the funding period 2025-28 including the update of the consortium agreement (if not finalised in 2024) and any updates regarding Uppsala University as consortium partner.



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- The management team will coordinate the contributions to ICOS RI initiated proposals. The coordination office together with the management team will also prepare the documents for endorsement by the Steering Committee.
- The Steering Committee will revise the ICOS Sweden strategy and follow up on the ICOS Sweden goals and achievements. Together with ACTRIS Sweden and SITES, the Steering Committee will work on building a scientific advisory board.
- For internal communication, we will continue to arrange online meetings every two months for the whole consortium. We will also arrange at least two management team meetings per year, where possible face to face or via internet.
- As in previous years, the coordination office will assist the management teams and act as contact point between the SRC and the RI whenever needed (e.g. proposals for deviations in the contract with the SRC (“särskilda villkor”) and as contact point between the RI and the fund manager (“medelsförvaltare”) LU.
- The management team will proactively meet the needs related to the collaboration with ACTRIS Sweden and SITES.
- The coordination office will prepare all documents needed for the final reporting of the ending current funding period, including the organisation of the auditor’s visits and certificates for LU and SLU.

### **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 homepage<sup>7</sup>, X (former twitter), ResearchGate and LinkedIn).
- During spring 2025 a half-day event celebrating 30 years Norunda and 10 years of ICOS Sweden measurements is planned in Lund. The target audience should cover also groups outside science, but has not yet been finally defined.
- ICOS Sweden will continue to take initiatives on deepening the collaboration between ICOS Sweden and other Nordic infrastructures such as SITES, ACTRIS Sweden and NordSpec<sup>8</sup>.
- ICOS Sweden will continue to encourage applications from researchers looking to set up new projects at the stations.
- ICOS Sweden will support and encourage scientists and stakeholders to make use of data measured at the stations.
- ICOS Sweden will also continue to support ongoing activities at all the sites.
- ICOS Sweden will take part in the upcoming Nordic ICOS Symposium in Denmark in autumn 2025.

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<sup>7</sup> [www.icos-sweden.se](http://www.icos-sweden.se)

<sup>8</sup> [nordspec.nateko.lu.se/home](http://nordspec.nateko.lu.se/home)

## 4. Planned budget 2025

The current funding period (SRC Diary No 2019-00205) is ending at 2024-12-31 and nothing can be accounted to this fund after this date. The deadline for instrument purchase was – after some prolongations because of delivery delays - in April 2024. Unfortunately, not all funds were spent and there will be adjustments in the final payment from the SRC to the RI according to the final reporting. At all stations, salaries and premises costs were higher than budgeted. At the same time, the stations used the expenses for operational drift carefully and did not completely use them at all stations (e.g. reduced travels). The management team will ask the SRC for a cost neutral adjustment of the funds to meet the needs at the stations. A detailed list of the preliminary numbers for the financial outcome for 2024 is available in the document App\_C\_ICOS\_Sweden\_prelimOutcome2024.pdf.

The planned budget for 2025 which is based on the funds for the coming funding period 2025-28 (SRC Diary No 2023-00172) is available in the document App\_D\_ICOS\_Sweden\_budget2025\_2023-00172.pdf.

According to the special terms of the contract between the SRC and ICOS Sweden of the ICOS Sweden Infrastructure Upgrade and Renewal grant (*SRC Diary No 2021-00244*), the acquisition phase and deadline for final reporting was prolonged to April 2024. As for 2019-00205 not all funds could be spent in time and there will be adjustments in the final payment from the SRC to the RI according to the final reporting.

## 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 consists of two pillars: research and measurement infrastructure and ICOS ERIC<sup>9</sup>, a legal entity for ICOS data release, coordination, and integration of the whole system.

ICOS RI (Fig. A1) is coordinated ICOS ERIC. ICOS is one of 28 ERICs. The legal entity of ICOS ERIC has held a Landmark status in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap<sup>10</sup> 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 being funded by different national agencies.

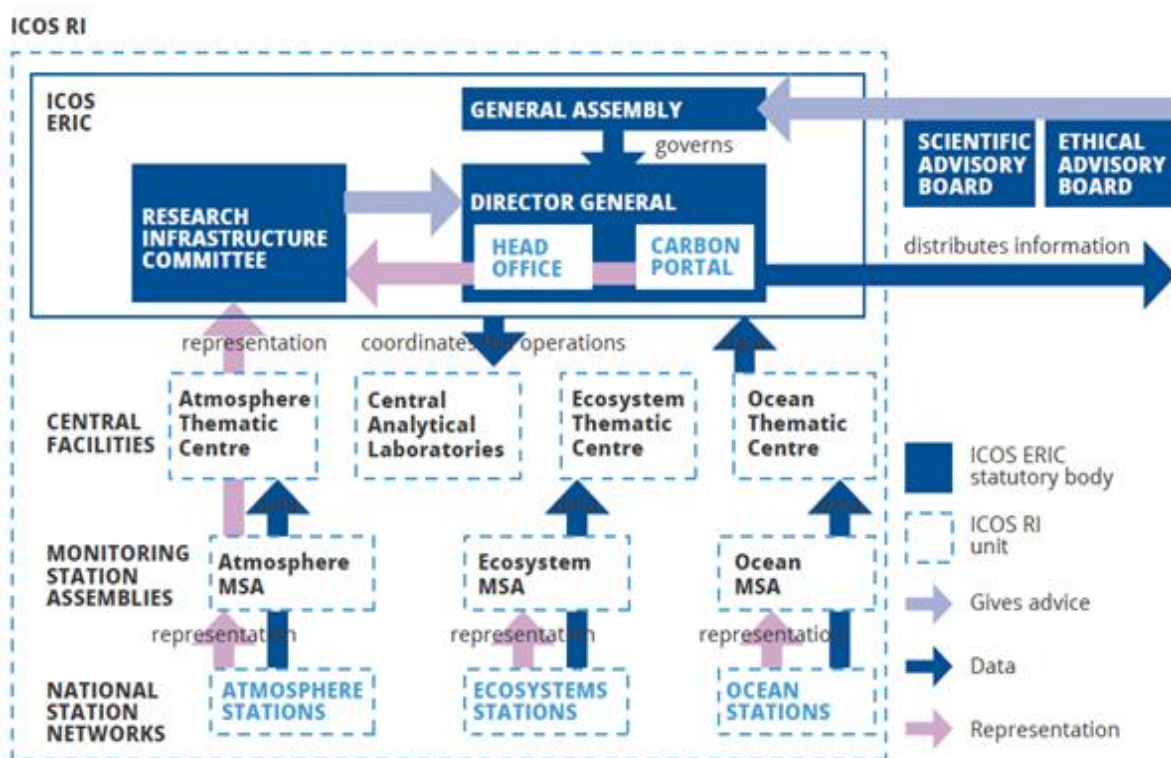


Figure A1. Outline of the ICOS RI organization (ICOS RI, 2021).

<sup>9</sup> [https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures/eric\\_en](https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/our-digital-future/european-research-infrastructures/eric_en)

<sup>10</sup> <https://roadmap2021.esfri.eu/projects-and-landmarks/>

### ***ICOS National Station Networks***

ICOS RI has more than 180 measurement stations in 16 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 46 atmospheric and around 90 ecosystem stations located across Europe. The ICOS Ocean Network covers the North Atlantic and European marginal seas. The ICOS Ocean Observation System includes 27 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 are 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. It is led by the chair Christian Plass-Duelmer from the German Weather Service (DWD).

### ***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 (current Director General of ICOS ERIC: Werner Kutsch; deputy director: Alex Vermeulen, Director of the ICOS Carbon Portal).

### ***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 dialogue with both internal and external scientists. Dedicated researchers from all over the world will contribute to the elaborated products catalogue.

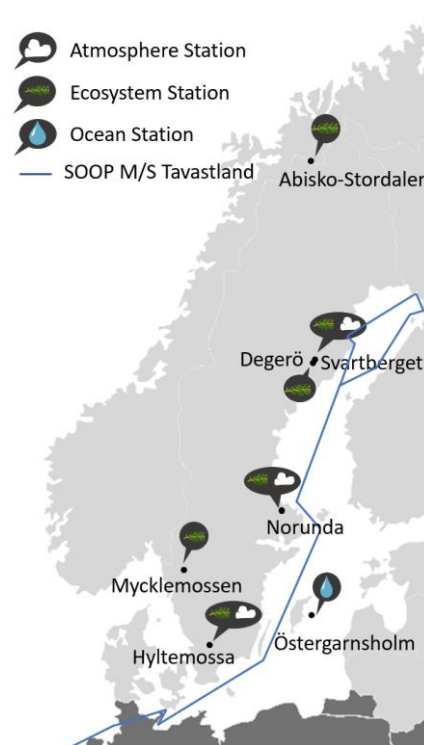
## Appendix B: The ICOS Sweden organization

### *Consortium partners*

ICOS Sweden performs measurements at stations in a transect across Sweden, from Abisko-Stordalen in the north to Hyltemossa in the south (Fig. A2). There are three Atmosphere Stations for measurement of GHGs in the well-mixed boundary layer, six Ecosystem Stations for measurements of GHG exchange 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 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 SOOP M/S Tavastland.

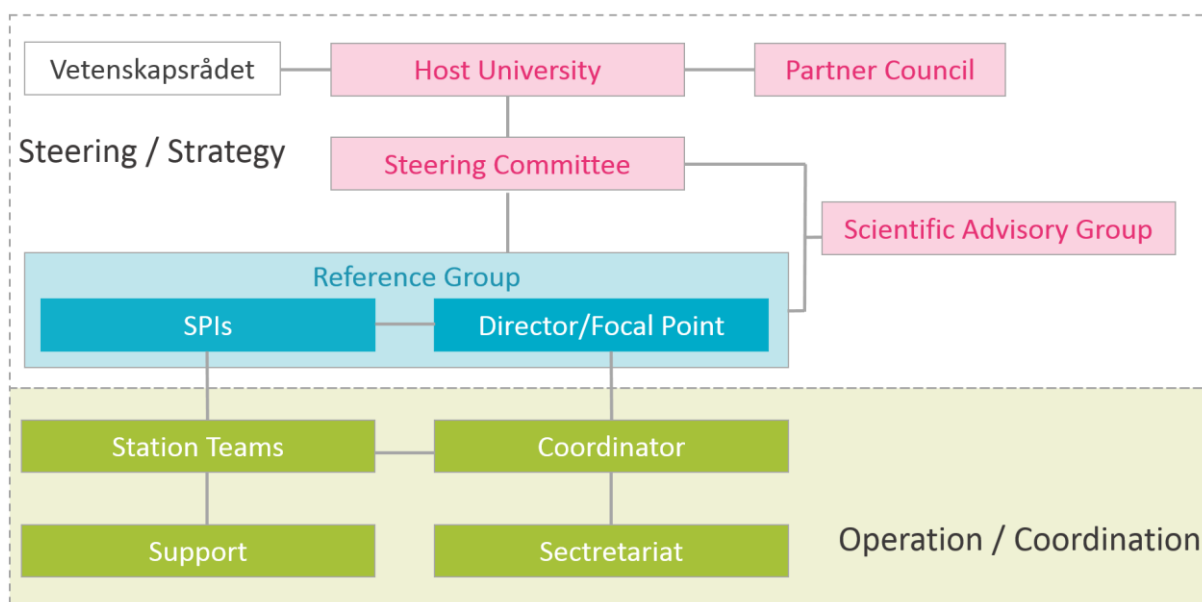


**Fig A2.** Map of the site locations of the observation network of ICOS Sweden.

The organization of ICOS Sweden (Fig. A3) are structured according to the directions given in the original agreement with the Swedish Research Council (SRC) for the funding period 2025-2028.

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 partners' council (PC). The PC is a forum for consultation and agreement between all participating parties: all consortium partners are represented in the PCil that 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 PC, 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 also decides on the focus and objectives for the collaboration between the different partner organizations that constitute ICOS Sweden.

The present SC members appointed on 16 December 2021 until the end of 2024, 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). In 2025, new members will be assigned to the Steering Committee.

**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 meets the SC to discuss strategic issues. Currently, ICOS Sweden does not have an SAG.

### ***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 period 2021-07-01 to 2024-12-31. From 2025-01-01, Tim Arnold will be given the roll as director. Jutta Holst will continue as coordinator of the RI. The director's tasks include planning, leading, and prioritization of ICOS Sweden's operations within the framework of its business plan and budget 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 PC.

### ***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, the stations are to a large part directed by ICOS RI. The operational management group is led by the coordinator who is supported by a part time economist (Heléne Holmström). 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 was added. 1 FTE is divided into three part time personnel: Michal Heliasz, Jutta Holst, and Meelis Mölder. The costs for the module have been shared between the ecosystem and atmosphere station hosts.



## Appendix C: The ICOS Sweden measurement stations

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ICOS Sweden operates twelve measurement stations in total: seven 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 chosen with the 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 great 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 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 (SPI), and Annika Kristoffersson.

### ***Degerö Ecosystem Station***

The Degerö station is situated on a minerogenic oligotrophic boreal mire covering 6.5 km<sup>2</sup> 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 Per Marklund, Pernilla Löfvenius, and the SPI Matthias Peichl.

### ***Svartberget combined Ecosystem and Atmosphere Station***

The Svartberget site is located in a mixed boreal pine/spruce forest within the Vindeln Experimental Forests situated in Vindeln, 60 km west of Umeå. The ICOS Atmosphere and Ecosystem stations are operated by SLU. Personnel resources correspond to 2.35 FTE involving the research engineers Eric Larmanou (AS SPI), Fabio Boschetti, Pernilla Löfvenius, Nataliia Kozii, 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 research station is the oldest flux site in Sweden, established in 1994. The ICOS Atmosphere (SPI: Irene Lehner) and Ecosystem (SPI: Natascha Kljun, Co-SPI: Meelis Mölder) stations are operated by LU. Personnel resources correspond to 2.35 FTE involving the SPIs and the research engineers Anders Båth, Irene Lehner, and Gunnar Bergström.

### ***Östergarnsholm Fixed Ocean Station and Associated Ecosystem Station***

This site is located on 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 since 1 January 2015. The station is run by UU and personnel resources correspond to 0.95 FTE involving a research engineer (John Trytherch) 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 of Trollhättan. The measurements enable determination of the net ecosystem carbon balance. The station is operated by GU. Staff involved include Amelie Lindgren and research engineer Per Weslien (SPI).

***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 ICOS Atmosphere (SPI: Michal Heliasz) and Ecosystem (PI: Michal Heliasz, Co-PI: Natascha Kljun) stations are operated by LU. Personnel resources correspond to 2.35 FTE involving the SPIs as well as the research engineers Michal Heliasz, Tobias Biermann, and Thomas Holst as permanent staff.

***M/S Tavastland: SOOP Ocean Station***

SMHI runs a ferrybox on the SOOP M/S Tavastland, that cruises the Baltic Sea one week (Lubeck-Oulu-Kemi-Lubeck) and the North Sea (Lubeck-Zeebrugge-Tilbury-Lubeck) one week on a constant schedule. Measurements on M/S Tavastland are operated by SMHI. The SPI is Madeleine Nilsson, who runs the station as research engineer together with Irena Draca (total 0.6 FTE).

## Appendix D: List of abbreviations and acronyms

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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, CRL and CAL)  
CP – Carbon Portal  
CRL – Central Radiocarbon Laboratory  
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 Ocean 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