ICOS SWEDEN
Strategic Plan

2021-2024

ICOS National Network Sweden

Lunds Universitet · Göteborgs Universitet · Uppsala Universitet · SLU · Polarforskningssekretariatet · SMHI · Swedish Research Council

ICOS Sweden Strategic Plan 2021-2024

> *This plan is compiled by the ICOS Sweden Coordination Office and is based on discussions with and recommendations by the ICOS Sweden Board, the ICOS Sweden Scientific Advisory Committee and the ICOS Sweden Station Coordination Group. The plan was endorsed by the ICOS Sweden Board on 27 August 2020.*

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Lund University reference number: STYR2020/1362

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1. Scientific and societal framing of the infrastructure

Climate is changing faster at higher latitudes than anywhere else on Earth. Because of Sweden's latitudinal extent and topography, many of our sensitive ecosystems will change too and some are at risk of being damaged irreversibly. Sweden's geography however also provides an opportunity, probably unique world-wide, to study climate system interactions and the impact of climate change on these sensitive ecosystems. ICOS Sweden[1] is essential for the wider ICOS project as it represents a number of important ecosystems at high latitudes including one sub-arctic site.

The existence and mission of ICOS Sweden is determined by the European Union's as well as the Swedish government's strategic investments in research infrastructures. Furthermore, the ICOS Sweden station hosts, mainly Swedish universities, fund at least 50% of the cost for running their respective station, including costs for purchasing and install expensive equipment. The usefulness of the data and sites for science as well as the societal use of the results is thus a prerequisite for the financing of the infrastructure. The development of the scientific and political outlines for research and infrastructures is framing the strategic decisions for ICOS Sweden.

The overall aim of ICOS is to facilitate research to understand the Earth system and to derive applied knowledge that supports 'climate action'. Scientific knowledge on carbon emissions, sinks and trends advances the fulfilment of the UN Sustainable Development Goals and EU Societal Challenges, especially the ones concerning climate change. It also supports efforts to comply with the COP23 Paris Agreement resolutions with its ambitious targets to reduce the anthropogenic impact on the global climate and, for the Swedish case, to comply with the Swedish Climate Policy Framework. The Framework is decided upon by the parliament and aims for a net zero emission of greenhouse gases in 2045 and includes a road map to reach the goal that will be annually evaluated.

ICOS enable, through its long term, standardized and high quality data, better understanding of the annual variations in the greenhouse gas exchange processes that determines the sources and sinks. To quantify these is important for national commitment negotiations in general, and, in Sweden, also as an evaluation tool for the emission roadmap stated in the policy framework. In

[1] ICOS Sweden is the Swedish node in the international Integrated Carbon Observation System Research Infrastructure (ICOS RI) and provides a network of Swedish measurement stations.

combination with other high quality data sources from other ground based measurements and from satellites, ICOS enables estimations of greenhouse gas emissions using atmospheric transport models. The development of such top-down methods will improve the accuracy and usefulness of the current IPCC emission guidelines, based on carbon inventories, for estimating greenhouse gas emissions. Such development requires that the ICOS data is not only of high quality but also interoperable with other environmental measurement systems.

ICOS observations will be an important source for climate policy research in Europe, large cities and regions. Some topics have been identified by ICOS RI to drive the future development of the ICOS observational network: 1) ICOS has the utility for detecting the temporal and spatial variations of the greenhouse gas exchanges between the three earth reservoirs and to understand their drivers and can by this contribute to the detection of trends and the understanding of the drivers in land and ocean sinks. 2) The ICOS network comprises a multitude of ecosystem sites providing long-term data sets for supporting scientists to improve the best practice guidelines for terrestrial ecosystem management between food production, bioenergy and greenhouse gas mitigation. 3) The quantification of greenhouse gas emissions and sinks in urban areas require estimates of emission baselines and changes.

For all these uses, long-term data from a multitude of ecosystems are needed, which is provided by the international ICOS RI, in which ICOS Sweden is a part.

2. Mission

The mission of ICOS Sweden is to make accurate high quality measurements of greenhouse gas concentrations in water, air, and soil as well as surface exchange fluxes of these gases. These are the drivers relevant to surface-atmosphere exchange processes from which we derive understanding of the processes of climate change in this region. All sites within ICOS Sweden are using measurement systems of the same design and adhering to the measurement protocols and quality control procedures decided upon by ICOS RI, the full international body of ICOS. This makes data highly comparable and consistent and such data are keys to developing models and estimation methods for characterizing source/sink distributions from local to global scales and from seasons to decennia, and to assessing and monitoring the effectiveness of mitigation activities. ICOS Sweden as an integral part of ICOS RI will provide such data with a focus on Nordic ecosystems. By being a member of ICOS RI and the ICOS ERIC, ICOS Sweden provides access to

extensive knowledge in the field of greenhouse gas observations from the full European ICOS related measurements and research network. ICOS Sweden will, likewise ICOS RI, develop towards increased collaboration and interoperability with other in-situ environmental networks and satellite measurement programs, in order to widen the research and societal usefulness of the data.

3. Vision

The ICOS Sweden network for greenhouse gas measurements is a world class research infrastructure that provides advanced data, research sites, data, and services from typical northern ecosystems as a basis for enhancing knowledge and informing models of the interactions between land surface processes, including human activities, and the climate system. ICOS Sweden stations are equipped with the best instrumentation available, have well-trained personnel and deliver first class services to scientists using its facilities. ICOS Sweden has a central role in the support of Swedish biogeochemistry research, provide test sites for national inventory systems, and sites and databases for advanced research. ICOS Sweden is fully integrated with and plays an important role in ICOS RI. Furthermore, it collaborates and is interoperable with other environmental in-situ and mobile infrastructures. ICOS Sweden is a key resource for climate impact research, earth system modeling and for supporting climate action.

4. Strategic objectives

The strategy of ICOS Sweden to achieve the goals of the Vision is outlined below.

To perform measurements of highest quality by:

- Following the established ICOS protocols and instructions and contribute to the development of these in collaboration with ICOS RI.
- Ensuring the expertise of the personnel in ICOS Sweden through education at internal workshops and courses on handling of data and instruments.
- Ensuring governance and coordination of ICOS Sweden in order to maintain and strengthen both the internal cooperation and quality of the products, and the external contacts and collaborations.

To develop and optimize the usefulness of the data for research by:

- Identifying possible extension of measurements in to facilitate research within other

disciplines (e.g. boundary layer meteorology, physiological ecology, atmospheric physics and chemistry) and thereby enable better understanding of related physical processes.

- Contributing to development and evaluation of new instruments that have potential for superior measurement capabilities, allowing the network measurement systems to evolve with major shifts in technology.
- Collaborating with other environmental RIs, both in-situ and satellite platforms and working on making ICOS Sweden interoperable with them.
- Observing and assessing needs for measurements in ecosystems/regions complementing the existing ICOS Sweden RI.

To strengthen ICOS Sweden's role in Swedish and international research by:

- Promoting, encouraging, and supporting research utilizing and enhancing ICOS data, e.g. greenhouse gas inverse modelling, at the national or Nordic level, and garnering the results as input to synthesis reports, for example, by providing data for an annual greenhouse gas index and an emission verification system for Sweden.
- Promoting, encouraging, and supporting education utilizing and ICOS, e.g. by contributing to under-graduate and doctoral courses using the data and sites.
- Engaging in dialogue with other national or international observation networks, by arranging and participating in meetings and workshops and by establishing long time collaborations.
- Ensuring high visibility of and accessibility to ICOS Sweden's and ICOS RI's data products by communicating with users to facilitate and encourage their use in high-profile scientific papers.
- Ensuring and strengthening scientific and societal benefits of ICOS Sweden's activities and output through outreach efforts like information meetings, workshops, webinars, and training courses.
- Encouraging other research groups and industry to utilize the sites to develop and test new environmental measurement technologies.

5. Activities

The buildup of the ICOS Sweden organization and its functions is finished except for the full

implementation of the User's Group. All ICOS Sweden atmospheric stations and four ecosystem stations are already certified ICOS stations and the remaining two ecosystem stations, and two marine stations are expected to become certified in late 2020 or 2021. ICOS Sweden Ecosystem station data is available through the ICOS Carbon Portal as ICOS Sweden data from 2014 onwards.

In early 2019, ICOS Sweden received renewed funding for the period 2021-2024. The consortium was increased with a new partner, SMHI, with the ship of opportunity (SOOP) Tavastland as a new ICOS ocean station. Furthermore, the Ecosystem station Mycklemossen, run by University of Gothenburg, replaced the station Lanna. ICOS Sweden now has a good representation of the Swedish natural environment with a north-south profile of terrestrial ecosystem and marine measurements, a north-south profile of atmosphere measurements and an in situ ocean station with a complementary flux and meteorology measurement system.

ICOS Sweden has already built-up collaborations within ICOS RI, e.g. in development projects such as the RINGO internal development project and with other Environmental Research Infrastructures (ENVRIs). ICOS Sweden has over the years arranged annual workshops to promote the use of ICOS Sweden data and, since last year, started the Nordic ICOS symposiums together with the other Nordic ICOS RIs as the main information campaign.

Over the coming four-year period (2021-2024), there are three activities that we will focus on in order to fulfil the objectives:

- Maintaining the scientific and technical expertise of the personnel and promoting highest quality of the station equipment (Ch. 5.1).
- Continue fostering collaboration and interoperability with other in-situ environmental measurement networks and satellite programs (Ch. 5.2).
- Continue stimulating scientific studies and modelling efforts aiming at increasing the knowledge on carbon emissions, sinks and trends to enable evaluation of the Swedish emission targets (Ch. 5.3).

The objectives will be described in more detail below.

5.1 Maintaining the scientific and technical expertise of the personnel and promoting highest quality of the station equipment

ICOS Sweden is both a national research resource and a partner of the international ICOS Research Infrastructure. To fulfil our obligations towards the international body, we will continue

engaging qualified technical personnel and PIs (Principal Investigators) at our sites. We will see to that they always will be updated on the quality and improvements of the measurements and systems by encouraging participation in meetings, courses, and education. We will also continue our internal support functions of scientific and technical expertise concerning measurement systems.

To fulfil our aims concerning the quality of the network and its management, as well as to strengthen the role of the consortium partners in the scientific development of the RI and connection to the partner universities, we will continue to engage scientific expertise with a high research profile from all consortium partners. These scientific experts are also essential for the outreach and collaboration activities and they will participate by initiating national and international collaborations and research activities, and through other outreach efforts.

In order to fulfil our obligations to ICOS RI and maintain the quality of our network, we will continuously follow and participate in ICOS RIs development of the instrumentation and protocols, e.g. by participation in research and development projects initiated by ICOS ERIC. The routines for external projects at the sites will be further developed and we will setup a data policy for the use of non-ICOS data.

Gender equality is sought in all areas of the RI and will be taken into account in dissemination activities of the RI, e.g. by supporting project and researcher presentations on the homepage and oral presentations at ICOS meetings and conferences. Diversity and gender balance issues are considered for project prioritization. Data usage as such is however openly available and not controlled for gender equality. In the coming years we will monitor gender distribution and take action where needed.

Renewal of the instrumentation and possible extensions of the measurements will also be identified in the light of possible changes in the research community needs of data and information to address societal challenges. This also includes reoccurring evaluations of the importance of the already existing individual stations for the future development of the full network and its usefulness.

5.2 Foster collaboration and interoperability with other in-situ environmental measurement networks and satellite programs

At the international level, ICOS RI aims at being the European pillar of a global greenhouse gas

observation system. ICOS RI has this clear role in the European Research Area and the ensemble of European Environmental Research Infrastructures (ENVRIs) and acts in this role towards GCOS and other global organizations and networks such as UNFCCC, WMO, UNESCO, UNEP, and GEO. ICOS also cooperates with similar research infrastructures in other regions, and thus, actively supports global integration of research on greenhouse gases and the carbon cycle.

ICOS Sweden collaborates and will continue collaborating with other national and international in situ ENVRIs active in Sweden such as SITES, ACTRIS, eLTER, AnaEE and NordSpec. The aim is to co-locate measurements and make the systems interoperable in order to widen the use of the data, e.g. for earth system modelers, that needs a number of variables from a specific site to validate and constrain their models. ACTRIS is on the Swedish roadmap for RIs and will apply for funding in early 2021. The Swedish Research Councils (SRCs) council for RIs (RFI) identified ACRTIS and the cooperation and co-location of ICOS and ACTRIS measurements as being of high scientific value.

Furthermore, the interoperability with satellite data e.g. the European Commission program Copernicus is a prerequisite for the integration of ICOS into a global observational system and for enabling top-down approaches to assess the greenhouse gas cycles, sources and sinks. Such approaches require measurements from ground-based stations or aircrafts and remote sensing data. In the aim of widening the use of the data, evaluation of the possible extension of new measurements within the ICOS Sweden measurement program, as well as technical development of the instruments, is taken into account.

5.3 Stimulating scientific studies and modelling efforts aiming at increasing the knowledge on carbon emissions, sinks, and trends to enable evaluation of the Swedish emission targets

All ICOS Sweden stations are expected to be certified ICOS stations by latest in the end of 2021. Data and elaborated products based on our stations will be delivered through the ICOS Carbon Portal from the date of certification. Outreach activities directed towards the scientific community will be increasingly important for ICOS Sweden. To ensure ICOS' long-term contributions, ICOS Sweden will mainly target information on the usefulness of ICOS Sweden for Swedish research towards the funders - the SRC and the station hosting universities and institutions. Activities will include further development of a user group and continued outreach activities as workshops, webinars, news-letters and information meetings. ICOS Sweden will, for the development of the outreach efforts towards the scientific community, follow the

recommendations and suggestions from the ICOS ERIC Science Plan that will be delivered in late 2020.

The main task is to approach and motivate the funders even though industry and authorities will also be targeted. Scientific and societal usefulness and relevance will be addressed by compiling data and synthesis products. This will be done by ICOS RI and the ICOS Carbon Portal. ICOS Sweden may need to work on adapted material for national use. Showcases on how ICOS Sweden data can be used to improve the understanding of ecosystem functioning, carbon budgets and trends in greenhouse gas concentrations will be identified and featured. An example of a such showcase is the 2018 drought initiative that ICOS RI supported through its community including ICOS Sweden. We expect more of such initiatives to come in the future. Furthermore, ICOS Sweden will actively promote research contributing to improvements of the carbon emission accounting and development of adequate methods to evaluate the Swedish emission roadmap stated in the Swedish Climate Policy Framework. Ongoing research using ICOS Sweden and ICOS RI data will be compiled and spread through outreach channels mentioned above.

6. Evaluation of the outcome

The outcome of the activities will be quantified in line with the required key numbers from the SRC and adapted to the suggested key performance indicators in the ICOS RI Impact report 2018 that also will be updated in the coming years. The ICOS Sweden key numbers to report to SRC are already set in the agreement 2021-24 but will be revised in spring 2021 to identify complementary key numbers useful for internal evaluation.

7. Revision of the Strategic Plan

The Strategic Plan will be revised annually.

Appendix 1: List of abbreviations and acronyms

ICOS (European level)

ATC – Atmosphere Thematic Center
AS – Atmosphere station
CAL – Central Analytical Laboratory
CP – Carbon Portal (www.icos-cp.eu)
ES –Ecosystem station
ETC – Ecosystem Thematic Center
ERIC – European Research Infrastructure Consortium
ENVRI – Environmental Research Infrastructure
ESFRI - European Strategy Forum on Research Infrastructures
HO – Head office
ICOS RI – Integrated Carbon Observation System Research Infrastructure (www.icos-ri.eu)
ICOS Sweden – Swedish node of the ICOS RI (www.icos-sweden.se)
OS – Ocean station
OTC – Ocean Thematic Center
RINGO - Readiness of ICOS for Necessities of Integrated Global Observations (www.icos-cp.eu/observations/projects/ringo)
SOOP – ship of opportunity

ICOS Sweden

CO – ICOS Sweden's Coordination Office
SAC – ICOS Sweden's Scientific Advisory Committee
PI – ICOS Sweden Station Principal Investigator
SE – ICOS Sweden Consortium Partner Scientific Expert

ICOS Sweden partners

LU – Lund University (host)
GU – Gothenburg University
PFS - Swedish Polar Research Secretariat
SLU – Swedish University of Agricultural Sciences
SMHI – Swedish Meteorological and Hydrological Institute
UU – Uppsala University

Other infrastructures and organizations

ACTRIS the European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases (www.actris.eu)

AnaEE – Analysis and Experimentation on Ecosystems, offers access to experimental platforms on terrestrial and aquatic ecosystems across Europe (www.anaee.com)

Copernicus, European Commission programme (www.copernicus.eu)

eLTER - the Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure (www.lter-europe.net/elter)

GMES - Global Monitoring for Environment and Security (now called Copernicus, www.copernicus.eu)

NordSpec - a research network for spectral data collection, inspired by SpecNet (nordspec.nateko.lu.se)

SITES – Swedish Infrastructure for Ecosystem Science, a national infrastructure for ecosystem research (www.fieldsites.se/)

Other

COP23 – 23rd annual Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change (https://unfccc.int/process-and-meetings/conferences/un-climate-change-conference-november-2017/sessions-of-negotiating-bodies/cop-23)

GCOS – Global Climate Observing System (gcos.wmo.int)

GEO – Group on Earth Observations (www.earthobservations.org)

IPCC – Intergovernmental Panel on Climate Change (www.ipcc.ch)

SRC – Swedish Research Council (in Swedish VR – Vetenskapsrådet, www.vr.se)

UNEP – United Nations Environment Program (https://www.unenvironment.org/)

UNESCO – United Nations Educational, Scientific and Cultural Organization (en.unesco.org)

UNFCCC – United Nations Framework Convention on Climate Change (unfccc.int)

WCRP – World Climate Research Programme (www.wcrp-climate.org)

WMO – World meteorological organization (public.wmo.int)