ICOS SWEDEN Annual Report 2015

ICOS National Network Sweden

Lunds Universitet

Göteborgs Universitet

Stockholms universitet

SLU

Polarforskningssekretariatet
Swedish Polar Research Secretariat

Vetenskapsrådet

The Board of ICOS Sweden endorsed this Annual Report on 10 February 2016. The plan is complemented by other documents from ICOS Sweden, including the Operational Plans for 2015 and 2016, and the Strategic plan 2012-2014 (from 2012) and Strategic plan 2016-2020 (from 2016).

Contents

1. Introduction to ICOS Sweden

ICOS - Integrated Carbon Observation System - is a new European research infrastructure for quantifying and understanding the greenhouse gas balance of the European continent and of adjacent regions. The infrastructure is built up as a collaboration of nationally operated measurement stations in 9+ European countries. ICOS Sweden is the Swedish contribution to this European effort. An ERIC (European Research Infrastructure Consortium) 'ICOS ERIC' has been established as a legal entity for ICOS data release as well as the coordination and integration of the whole research and measurement infrastructure, ICOS Research Infrastructure (RI), that includes the national networks, the measurement station assemblies and the central facilities.

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.

ICOS Sweden will be fully integrated with and play an important role in the pan-European ICOS (ICOS RI). ICOS Sweden will also provide data, and compile information on greenhouse gas exchange of typical northern ecosystems to the research community as well as Swedish stakeholders. ICOS Sweden will furthermore provide test sites for national inventory systems and sites and databases for advanced research.

A description of ICOS RI status and progress can be found at the website http://www.ICOS-infrastructure.eu/. A list of ICOS Sweden personnel can be found in Appendix 1. In Appendix 2, the measurement variables and instruments/systems used in ICOS Sweden are listed. Appendix 3 contains a list of the acronyms and abbreviations mentioned in the report.

2. Status of ICOS Sweden at the end of 2015

The building up of the organization and management as well as of the measurement stations and systems is about to be finalized. ICOS Sweden has, for most of the measurement systems, become fully operational during 2015.

The installation and deployment of equipment and control systems at the ecosystem stations are finalized except for the chamber systems. The expected delivery of data to Ecosystem Thematic Center (ETC) from the other stations has been delayed due to changed requirements from the central facility. We are now waiting for approval to send in data in connection to the labelling process. The atmospheric systems are fully operational for most parts and the ^{14}C samples are being sent in to the Central Analytical Laboratory. However, data submission to the Atmospheric Thematic Center (ATC) has not yet started due to delays at the ATC. Furthermore, the flask sampling systems are not yet available from the Central Facilities. The Ocean station is running, and in the process of being updated to the ICOS RI requirements. There is presently an ongoing discussion at the Ocean Thematic Center (OTC) to define the labelling of the stations before the

process will start during 2016. Figure 1 illustrates the development status of the ICOS Sweden measurement stations when it comes to delivery of data and information to the Central Facilities.

The buildup of the ICOS Sweden organization and its functions is finished except for the full implementation of the User's Group and continued establishment of links to the Central Facilities. The ICOS ERIC was established in November 2015 and further development of the links to ICOS RI will take place during early 2016. The funding application for the next financing period was submitted to Swedish Research Council (SRC) during spring 2015 and the decision by SRC was announced in late December. The adjustments to the new conditions will be made during early 2016.

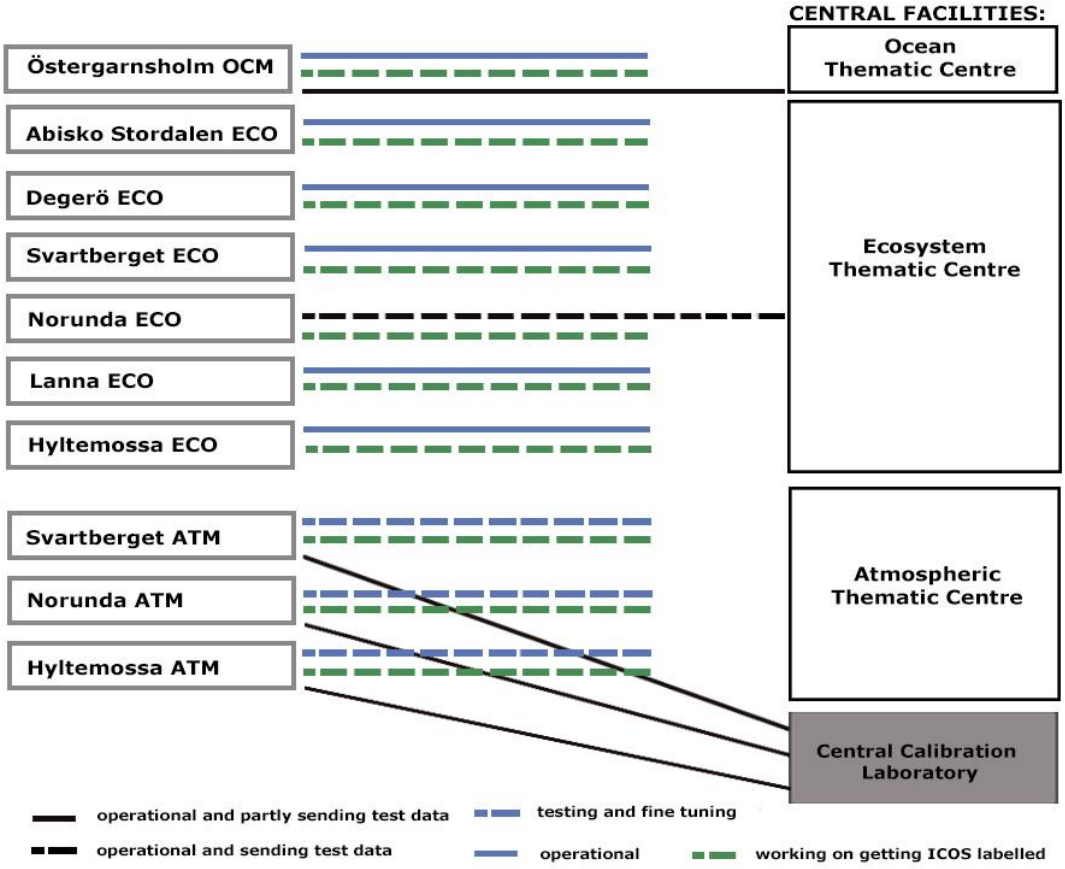

Figure 1. *The development status for the delivery of data and information to the Central Facilities from the ICOS Sweden measurement stations. Upper lines at all stations – development status for data delivery. Lower green lines – status on getting ICOS labelled.*

The activities for ICOS Sweden during 2015 are related to milestones (Table 1) in order to identify actions needed and to reveal the progress of the infrastructure. Compared to what was planned in the Operational plan for 2015 (endorsed by the board in late 2014) the following milestones have not been reached:

- Some of the instrument installations at the ecosystem and atmospheric stations due to delay of the decisions at the ICOS RI level.
- The grid power installation for Östergarnsholm as there may be other solutions for the provision of electricity to the site.
- The measurement protocols are not yet completely finalized at ICOS RI level and thus the routines at the sites are not fully adapted.
- The startup of the User's group has been postponed.
- Becoming ICOS labelled stations. ICOS RI and the Central Facilities are not ready to verify the stations yet. The labelling procedure has been decided upon and the process will start in early 2016.

Table 1. *ICOS Sweden milestones for the building up and management of the research infrastructure. Dotted lines mark the years when the milestone is active. The pink color shows start year and the blue color identifies the year when the milestone is finalized. In-between years are marked with yellow color. Table continues on the next page.*

				PHASE	2010	2011	2012	2013	2014	2015	2016-onwards
1.				**Initiation phase**							
	1.1.			***Building up of ICOS Sweden organization:***	====	========	========	========	========	========	========
		1.1.1		*Establishing the ICOS Sweden management structure*	-----	----------	----------	----------	----------	----------	----------
			1.1.1.1.	Establishing the Coordination Office	-----						
			1.1.1.2.	Appointing the Board		----------					
			1.1.1.3.	Establishing the ICOS Sweden consortium and verifying the measurement stations	-----	----------					
			1.1.1.4.	Establishing the Station Coordination Group		----------					
			1.1.1.5.	Appointing the SAC			----------				
			1.1.1.6	Establishing the User Group				----------	----------	----------	----------
			1.1.1.7.	Establishing links to ICOS RI	-----	----------	----------	----------	----------		
		1.1.2.		*Development of the strategy and planning*	-----	----------	----------				
			1.1.2.1.	Strategic plan development and formalizing the operational plans	-----	----------	----------				
		1.1.3.		*Formalizing the reporting and dissemination*	-----	----------	----------				
			1.1.3.1.	Formalizing the annual reporting incl key numbers and economic outcomes		----------	----------				
			1.1.3.2.	Creating an outreach strategy	-----	----------					
	1.2.			***Building up of the field sites and measurement systems:***	====	========	========	========	========	========	========
		1.2.1.		*Building masts and labs*	-----	----------	----------	----------	----------		
		1.2.2.		*Employing staff and appointing Station Pis*	-----	----------	----------	----------	----------		
		1.2.3.		*Installing the instrumentation at the sites: ecosystem, atmospheric and ocean measurement systems*	-----	----------	----------	----------	----------	----------	----------
		1.2.4.		*Forming the routines at the measurement stations*	-----	----------	----------	----------	----------	----------	----------
			1.2.4.1.	Routines for the measurements and measurement protocols						----------	----------
			1.2.4.2.	Safety and rules at the stations	-----	----------	----------	----------	----------	----------	----------
			1.2.4.3.	Routines for access to stations and identification of the ICOS domain			----------	----------	----------	----------	----------
2.				**Testing phase**							
	2.1.			***Follow up of measurement routines and fine tuning***				========	========	========	========
		2.1.1.		Ecosystem measurement data				----------	----------	----------	----------
		2.1.2.		Atmospheric measurement data					----------	----------	----------
		2.1.3.		Ocean measurement data						----------	----------
	2.2.			***Startup sending data to the thematic centres***					----------	----------	----------
		2.2.1.		Ecosystem measurement data					----------	----------	----------
		2.2.2.		Atmospheric measurement data					----------	----------	----------
		2.2.3.		Ocean measurement data						----------	----------
	2.3.			***Becoming ICOS labelled stations***							========
		2.3.1.		Ecosystem sites							----------
		2.3.2.		Atmospheric sites							----------
		2.3.3.		Ocean sites							----------

Table 1 (continued). *ICOS Sweden milestones. Continued from previous page.*

				PHASE	2010	2011	2012	2013	2014	2015	2016-onwards
3.				**Operational phase**							
	3.1.			***Management of the organisation***		========	========	========	========	========	========
		3.1.1.		*Reoccurring revision of the strategy and planning*				----------	----------	----------	----------
			3.1.1.1.	Production and revision of steering documents		----------	----------	----------	----------	----------	----------
			3.1.1.2.	Board revision and endorsements		----------	----------	----------	----------	----------	----------
			3.1.1.3.	SAC supevision and advice				----------	----------	----------	----------
		3.1.2.		*Evaluation and reporting*			----------	----------	----------	----------	----------
			3.1.2.1.	Biannual follow up of key numbers					----------	----------	----------
			3.1.2.2.	Annual reporting			----------	----------	----------	----------	----------
			3.1.2.3.	SRC evaluations and renewed applications			----------			----------	----------
		3.1.3.		*Conduction of outreach activities and dissemination*			----------	----------	----------	----------	----------
			3.1.3.1.	Annual workshop				----------	----------	----------	----------
			3.1.3.2.	Seminars, homepage, media activities		----------	----------	----------	----------	----------	----------
			3.1.3.3.	External courses and field visits		----------	----------	----------	----------	----------	----------
			3.1.3.4.	User group interaction						----------	----------
			3.1.3.5.	Dissemination - reports and papers						----------	----------
		3.1.4.		*Consortium agreement revision and renewal*					----------	----------	----------
		3.1.5.		*Cooperation activities*			----------	----------	----------	----------	----------
			3.1.5.1.	ICOS RI MSA meetings, workshops and conferences					----------	----------	----------
			3.1.5.2.	Cooperation with other projects			----------	----------	----------	----------	----------
		3.1.6.		*SCG management meetings*		----------	----------	----------	----------	----------	----------
	3.2.			***Management of sites, systems and measurements***		========	========	========	========	========	========
		3.2.1.		*Monitoring measurements at the sites*					----------	----------	----------
		3.2.2.		*Service, maintenance and update of systems*					----------	----------	----------
		3.2.3.		*Revision of work routines and protocols*						----------	----------
		3.2.4.		*Follow up of safety and rules at the stations*						----------	----------
		3.2.5.		*Storing and long-time archiving of data and metadata*						----------	----------
		3.2.6.		*Delivery of data to CFs including quality verification*						----------	----------
		3.2.7.		*Staff education and development*		----------	----------	----------	----------	----------	----------
			3.2.7.1.	*Staff participation in external and internal courses*		----------	----------	----------	----------	----------	----------
			3.2.7.2.	*Staff internal information and knowledge exchange*		----------	----------	----------	----------	----------	----------
		3.2.8.		*Service to ancillary project and data users*					----------	----------	----------

3. Building up and management of the measurement stations and systems

ICOS Sweden operates, up to the end of 2015, ten measurement stations in total, of which six are ecosystem stations and three are atmospheric stations and one is an ocean station (Fig. 2). The three atmospheric stations are co-located with three of the ecosystem stations. The ocean station Östergarnsholm, run by Uppsala University, became an ICOS Sweden station in 2015.

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. The stations are run by the consortium partners Lund University, University of Gothenburg, Swedish University of Agricultural Sciences, Uppsala University, Stockholm University, and the Swedish Polar Research Secretariat. Each partner has employer's liability for the personnel at its station(s) and is represented by a Station Principal Investigators (SPI) in the Station Coordination Group (SCG) of ICOS Sweden and in the ICOS RI Measurement Station Assembly (MSA) (see Chap. 4.1).

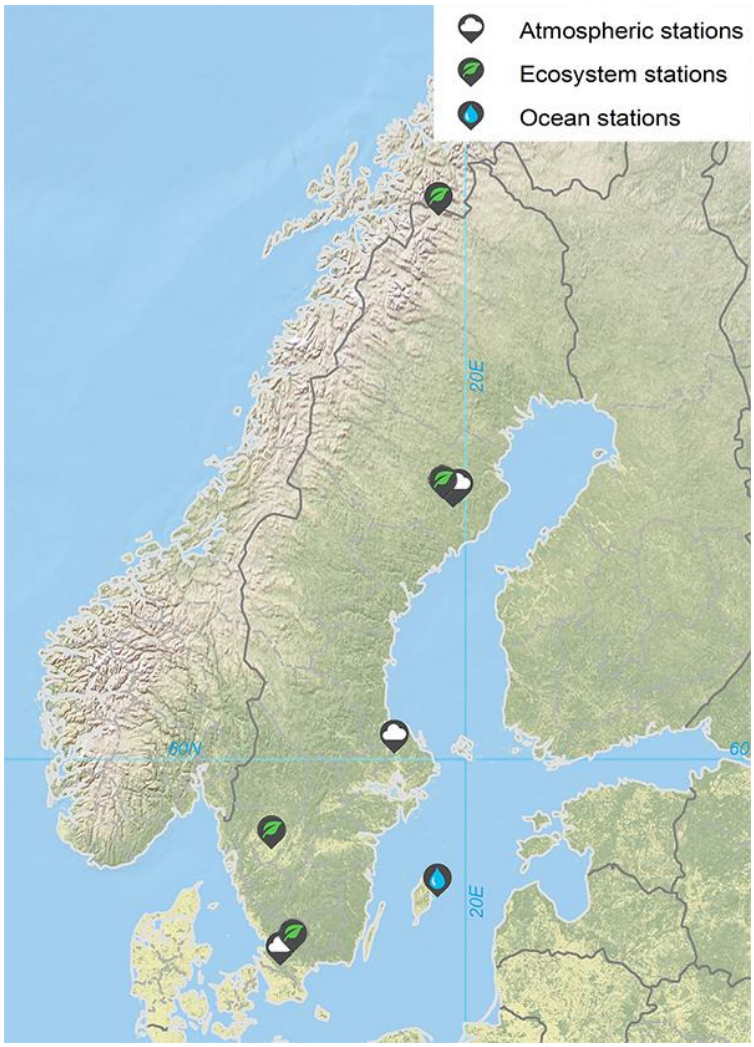

***Figure 2**. Location of the ICOS Sweden measurement stations. The colors indicate the dominant land cover: forest (dark green), wetlands (brown), agricultural land (light green), water bodies (light blue), barren/alpine vegetation (gray) and built-up areas (red).*

3.1 The measurement stations

Below, the measurement stations are described, followed by a summarized description of the progress during 2015 and a list of actions taken during this time.

3.1.1 Abisko-Stordalen ecosystem station

The Stordalen subarctic wetland, consists of a fen/palsa/lake complex. The site is a protected natural wetland (unmanaged) which for the last 30 years has served as study area for a large number of national and international researchers as well as a favorite location for field courses and students. The location in Stordalen is well suited for studies of climate change effects in the Arctic and sub-Arctic region because a mean annual temperature of 0°C in the Abisko region makes the permafrost and associated ecosystems highly responsive to any changes in temperatures. Being the northernmost of all ICOS ecosystem stations, it represents an extreme site both within ICOS and Europe.

The station has been operational since spring 2013, with improvements implemented during summer and autumn and providing continuous, high quality data since New Year 2014, with little downtime in the data stream. The setup in Stordalen does in all major aspects comply with the ICOS standards, and the few deviations will be adjusted during the coming year.

Especially during summer season, a large number of researchers are using Stordalen for field experiments, and ICOS has provided data and logistic assistance to seven national and 17 international projects in the past year. Courses and excursions have visited the site during longer or shorter periods in 2015. Groups from local gymnasiums as well as Umeå University has paid shorter visits to the site and a group of 15-20 students from US NSF Research Experience for Undergraduates program conducted field studies during the full month of July.

The ICOS staff in Abisko hosted a common ICOS technician meeting at Abisko Research station with visits to Stordalen during spring 2015.

Station PIs are Thomas Friborg and Patrick Crill; research engineers, 1.5 FTE, are Per Marklund and Niklas Rakos. The station is operated by the Swedish Polar Research Secretariat at the Abisko Scientific Research Station.

3.1.2 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. The site is located in a cold temperate humid climate.

Extension to the measurement cabin (the 'Igloo') was delivered during spring, and during the autumn, preparations were made for rebuilding the Igloo next spring. Problems with water entering profile intakes were solved during the autumn, by adding a rain-protection and changing the alignment of the tubes. The precipitation gauge leveling need to be checked/adjusted more often than expected, the base fundament are still not stable. During the summer, a vegetation

inventory was performed and a practical guideline produced according to the ICOS protocol for mire inventories.

About 15 projects are currently active in utilizing the ICOS Degerö infrastructure. In addition, numerous projects are utilizing data from Degerö through the FLUXNET/European Eddy Covariance database. New projects during 2015 include studies on root productivity both in general within the footprint and in response to various experimental treatments; studies on the mire Hg-mass balance; studies on nitrogen fixation in plant various plant communities distributed over the mire. Several ongoing studies aiming at resolving the partitioning of the CO_2 production and emission have continued during the year. Another five papers have been published 2015 from the site. The personnel at the station have served these projects with routine maintenance and expert support.

Local newspaper (Västerbottenskuriren) publishes a full page about the ICOS stations at Vindeln Field station pointing to the ongoing Climate-meeting in Paris.

The station is run by the Swedish University of Agricultural Sciences in their role as a consortium partner of ICOS Sweden. Personnel resources correspond to 1.5 FTE involving the research engineers Jörgen Sagerfors, Tomas Hörnlund, and the Station PI Mats Nilsson.

3.1.3 Svartberget combined ecosystem and atmospheric station

ICOS-Svartberget is located in the Svartberget Experimental Forest, Vindeln. The experimental forest covers 1076 hectares of boreal forest land and governs a manifold of research activities since 1923. A reference monitoring program of climate and water is active since 1980. ICOS-Svartberget site is situated on a moraine slope covered mainly by Scots pine (60%) and Norway spruce (40%), in the center of a well-investigated sub-catchment with long-term hydrological measurement. The sub-catchment is part of the larger Krycklan catchment area. A wide range of ancillary data is available at ICOS-Svartberget and invites to collaborative research in field.

The forest is about 110 years old with a mean height around 20 m. Some cleaning were done in 1962, otherwise the stand is undisturbed except for unavoidable influences by installation of research infrastructures and instrument. The ICOS ecosystem instrumentation was in place during 2013, most of the measurements started in June 2013.

After repair and calibration of the Li7200 gas analyzer system in January, the control-box was malfunctioning and had to be sent back for another repair. Fortunately, we have a spare system within ICOS Sweden that was replacing the original system during this period. Phenological webcams were installed, above the forest and below forest canopy, which were in operation in July. As part of the biometric description of the forest site, cooperation with the Swedish national forest inventory and Department of Forest Resource Management, SLU, was initiated and LIDAR-based inventory will be used. During 2015, the site has been visited for detailed on ground inventories directed for the LIDAR-based inventory model. Also, the major part of the field staff (around 50 people) of Swedish forest inventory visited the site during an excursion in October.

The 150 meters mast was installed in October 2011 and the instrument house built during the winter 2011-2012, ready to move into during the spring 2012. The atmospheric station basic installation were completed and in operation during the spring 2015. Still calibration gases and additional equipment (boundary layer LIDAR and flask-sampler) are to be installed. A gas intake in the profile system is not functioning properly, and quite some effort has put into resolving the problem. At present, the tubing appears as the most suspicious candidate, and the tube package has been dig up out of the ground for closer inspection. Work on preparing the instrument house for installation of calibration and reference gas tubes has been done, as well as safety inspection of climbing equipment and rescue practice in the tower. The mast elevator system has been rebuilt, where the motor were placed on ground instead of in the top of the mast.

About 25 national and international research projects are running at the site. Most of these projects are related to water chemistry and stream hydrology, but also some projects dealing with atmospheric polyaromatic compounds, below-ground phenology, ICOS instrument development (ICOS-INWIRE) as well as new project started late 2015 that study carbon sink at forest landscape scale. Data from the site has been delivered to researchers, about five deliveries during 2015, with ground water data, soil moisture data and various meteorological variables.

Local newspaper (Västerbottenskuriren) published a full page about the ICOS stations in Vindeln pointing to the then ongoing Climate-meeting in Paris.

Personnel resources correspond to 2 FTEs involving research engineers Holger Tülp, Pernilla Löfvenius and Tomas Hörnlund, as well as the Station PI Mikaell Ottoson Löfvenius.

3.1.4 Norunda combined ecosystem and atmospheric station

The Norunda station 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, with an existing infrastructure in terms of tower, electricity, buildings etc. The forest is already more than 110 years old. The future of the forest surrounding the tower is under negotiation with the forest owner. The existing equipment for the Ecosystem Station was installed by In Situ Instrument AB in 2012.

In 2015, the equipment has been in routine operation. The instruments and sensors have been checked daily by the personnel. The digital logger (ISDL) that was developed by In Situ Instrument AB still does not fulfil standards as expected and causes problems from time to time. The LI-7200 gas analyser by LI-COR Inc broke also this year, which was the third time in a row. Fortunately, the ICOS Sweden spare analyser could be used while our own was sent for repair. We are also still running another flux system, installed in 2007, in parallel. This non-ICOS system has run practically continuously. This year we learned from comparison of those two systems, that water vapour signals from the ICOS LI-7200 analyser is frequently heavily dampened. This occurs after rainy periods and during morning hours. The exact reason has not been identified yet. The carbon dioxide signals are, however, good. Hopefully a major improvement will appear now after the installation (November 2015) of a newly developed intake tube. That tube is shorter, has a smaller rain cap and is heated.

The core of the Atmospheric Station is the accurate measurement of CO, CO_2, CH_4 and H_2O concentrations. The system based on a Picarro gas analyser was installed in July 2014 by our technicians and it is running well. A minor problem was that the pump to Picarro broke. We switched to another type of pump that we have good experience of. This change was acceptable according to the Picarro company. The standard procedure includes measurements at three levels. This procedure was interrupted during the winter for two weeks for a study of different tubing designs. This study was a part of ICOS INWIRE project. The standard tubing is insulated and also heated. We installed two additional tubes up to the highest 100 m level. One tube was "naked" and the other just insulated. The three tubes from the same height were connected to the Picarro system and had to deliver equal results. However, as could be expected, water vapor concentrations deviated from each other from time to time. This caused also some deviations in the other concentrations, for which reason is still under investigation. In May 2015, a ^{14}C-sampler was set into operation. The first set of samples has been sent to University of Heidelberg for analysis.

For many years we have had an ancillary project where fluxes are measured on a nearby clear cut, about 500 m from the ICOS tower. Fluxes are calculated from turbulence and gradient measurements in small towers. The birch trees had become so tall that the applicability of the method became questionable. This year, the birches were removed and those measurements can continue for some time.

The station is operated by Lund University, as part of its commitments as a partner of ICOS Sweden. Personnel resources correspond to 2 FTEs involving research engineers Anders Båth and Irene Lehner. The Station PI is Meelis Mölder.

3.1.5 Östergarnsholm ocean station

The Östergarnholm ocean station is located in the Baltic Sea, about 4 km east of Gotland. The measuring site at Östergarnsholm has been running since 1995. It is a land-based 30 m tower situated on the southern tip of a very small, flat island.

The flux of some quantity measured at a certain height is influenced by the surface conditions at a certain distance upwind; this area of influence is called the flux footprint. The flux foot-print of the tower measurements is shown to represent marine conditions for the right wind directions.

In addition to the tower measurements several buoys in the water continuously measure temperature, pCO_2 salinity and oxygen. In 2015 we also deployed a thermistor chain for temperature and salinity profile in the water, a water sampling program has also been initiated. The data from the station is used to study various aspects of air-sea

interaction including atmospheric mixing, sea surface friction and in particularly air-sea gas exchange and the Baltic Sea carbon cycle. During the last year particular effort have been on using the data for developing remote sensing algorithms for sea surface CO_2 concentration and air-sea CO_2 flux. The station is included in the ICOS program since the beginning of the year and there has been a continuous work to update the instrumentation and station to ICOS standard.

During 2015, 8 papers were published using data from this site. The annual Swedish ICOS workshop was held in Visby and we made a field trip to the site with approximately 60 participants.

Station PI is Anna Rutgersson, personnel resources correspond to 1.0 FTE and includes mainly Station Engineer Marcus Wallin, but also Hans Bergström, Erik Sahlée and Erik Nilsson.

3.1.6 Lanna ecosystem station

Lanna is the most northern agricultural sites within ICOS-Europe (58°20.43'N 13°6.14'E) operated by GU and is located on the SLU research station which has been in operation since 1929. ICOS Lanna is thus operated in close cooperation with SLU. The station is set on clay soil and representative for the most dominate cereal production in Sweden.

The Marie Sklodowska Curie Initial Training Network "Nitrous Oxide Research Alliance" (NORA) has been active at the station. The main aim of NORA is to develop interdisciplinary approaches to reduce N_2O emissions from European agriculture and wastewater treatments, and to educate a new generation of researchers to tackle the nitrogen issues. The Nora project consists of eleven full partners and three associated partners – both industrial and academic institutions – across Europe. ^{15}N tracing experiments were used to investigate which microbial processes are the sources of N_2O from soils used for cereal cropping and permanent grassland as a part of an European wide transect study. Visiting researchers used Lanna for training in using automatic chamber systems for continuous measurements of N_2O emissions and testing of a novel field robot for N_2O emission measurements.

Other projects were focused on identifying options to reduce fertilizer nitrogen losses by closing the nitrogen budget in arable fields. The project has combined stable isotope (15N) with in situ N2O flux measurements, using micrometeorology and automatic chamber techniques, permanent monitoring of leaching N losses and measurements of NH3 losses upon fertilization.

During 10th to 13th May 2015 a workshop on N_2O and trace gas emissions ("Gas flux measurements in terrestrial ecosystems -state of the art and emerging technologies") was held at the University of Gothenburg (UGOT). The networks of ICOS Sweden and the Swedish Infrastructure for Ecosystem Research (SITES) supported the workshop. The Lanna station was used to demonstrate different measuring techniques and equipment's. In total 62 attendees from 13 European countries as well as from the US participated in the workshop and five companies providing equipment for trace gas and atmospheric measurements were represented.

The station is operated by University of Gothenburg, a consortium partner in ICOS Sweden. Personnel resources correspond to 1.5 FTEs involving research engineers Per Weslien and Bengt Liljeblad, as well as Station PI Leif Klemedtsson.

3.1.7 Hyltemossa combined ecosystem and atmospheric station

Hyltemossa is a combined ecosystem and atmospheric station located in Skåne, southern Sweden. The site is placed in a temperate, maritime climate with monthly average temperatures for January around 0°C and 20°C for July. Annual average temperature is around 8°C. Spring months are the driest while summer months are the wettest with total annual precipitation of around 800 mm.

The ICOS activities are centered on a 150 m tall tower. The site around the tower is dominated by Norway spruce (Picea abies) with a small fraction of birch trees (Betula sp.) and single occurrence of Scots pine (Pinus sylvestris). Understory vegetation is sparse. The forest floor is mainly covered by mosses.

The forest is owned and managed by Gustafsborg Säteri AB (www.gustafsborg.se). The management turnover rate is 50 years, with an estimated growth of 34 m within 100 years. After clear cut, the site was replanted in 1983 with 3300 trees per hectare. At the present time the forest stand is 19 m tall and holds around 190 m^3 per hectare (excluding branches, stumps and roots).

The ICOS site was established in 2014 and started high quality ecosystem measurements in January 2015. The gas concentration measurements for the atmospheric station started in February and the ^{14}C sampling started during the summer. The atmospheric station is still missing anemometer measurements, which will start in the beginning of 2016. At the end of 2015, the intake tube for the infrared gas analyzer in the flux system was upgraded with filter and heating in campaign organized by ICOS RI.

Hyltemossa experienced problems with the gas profile measurements. The intake tubes were sucking water into the system during rain events and were redesigned to solve the problem. There were also problems with the logger recording data from the flux system. There were hang-ups and the logger is produced artificial spikes when the anemometer heating was turned on. During the summer the tower started creating a very loud and disturbing noise that made the neighbors complain. As the noise was produced only occasionally, at strong winds only from certain directions, lots of time and effort was spent on finding the source. It has now been verified that the elevator railing caused the noise and a temporal solution was to tape it. The railing will have to be redesigned and the company that installed the railing is working on the problem.

Hyltemossa is a newly established site. However, two projects have already started. One is placed on nearby the clearcut, focusing at energy and greenhouse gases exchange. The second project concerns measurements of the incoming and outgoing light spectra to improve remote sensing measurements. Preparations started for a third project which will integrate Hyltemossa with the Aerosol Group at Lund University.

An open house event was organized for the public, especially people living in the vicinities, and owner and personnel at Gustavsborgs Säteri, the owner of the forest, to increase awareness about the site. The station was also visited by researchers from some departments at Lund

University. Information about ICOS was published in a few newspapers and an interview with the Director about ICOS Sweden was recorded by SVT1 at the Hyltemossa site.

The station is operated by Lund University, being a partner of ICOS Sweden. Personnel resources correspond to 2 FTEs involving research engineers Michal Heliasz, who is also the Station PI, and Tobias Biermann.

3.2 Development phase of the measurement stations and systems

The buildup of measurement stations and systems was finalized at the end of 2015 and ICOS Sweden has, for most of the measurements systems, become fully operational during 2015.

All ecosystem stations are instrumented according to the ICOS RI requirements except for the chamber measurements and the systems are now fine-tuned and in operation. Delivery of data from the Norunda ecosystem station to the ETC has started. However, this is merely test data and the operational submission of data will start once the labelling process has started in 2016. The chamber systems for the forest sites are delayed due to the need for special design in Nordic climates. A workshop on chamber designs took place in January 2015 but the final design of the chamber system is still under development.

The atmospheric instrumentation is installed at all atmospheric sites. The flask sampling systems are however not yet in place due to delays from the ICOS RI Central Facilities. The purchase of the spectro radiomenters is also delayed as the requirements form ICOS RI is not yet delivered and we have now decided upon another system that will be purchased in early 2016. The procurement of the LIDARs (laser based distance measurements of boundary layer height) for the atmospheric sites is ongoing. The delay is due to the need of clarification on the requirements from ICOS RI and the possibilities to enable expansion of the systems in order to suite other projects including aerosol measurements. After different options had been evaluated, ICOS Sweden decided on installing the more advanced LIDARs that are expandable.

The Ocean station is running, and in the process of being updated (including more stable power supply and improved precipitation and radiation systems). A water sampling program was initiated during 2015 and is now being evaluated. There is an ongoing discussion at the Ocean Thematic Center (OTC) to define the labelling of the stations before the labelling will start during 2016. Data are not yet delivered to the OTC, but data for CO_2 in the water is being delivered to the SOCAT database.

ICOS Sweden has, concerning building up and management of the measurement stations and systems, in principle concluded the initiation phase and entered the operational phases. The timing for being operational for all parts of the systems is now highly dependent on the development of ICOS RI and the Thematic Centers as we now are awaiting finalized protocols for data and metadata acquisition and for instructions and procedures to submit data operationally to the Thematic Centers.

3.2.1 Actions taken 2015

Numbers within [ ] indicate milestones, as defined in Table 1.

- During 2015, continuous data from Norunda, with its metadata, has been submitted as an evaluation data set for ETC to standardize its procedures. The submission from the other stations was expected to start during the year but the newly set procedure for the labelling of the stations by ICOS RI requires that the data is delivered accordingly. The labelling process will start up in early 2016. [2.2.1]

- ICOS Sweden arranged a workshop in January to decide on design of the automatic chambers for Nordic forest environments that are supposed to be installed at the ecosystem forest sites. We have had contact with a company is Switzerland that is running a similar system and with a Swedish company that could start producing them. However the production has not yet started.[1.2.3, 3.1.5]
- The atmospheric installations of the gas concentration measurements is finalized and integrated with the 3-level profile systems at the three ATM sites. The testing and the quality control of the data have started. [1.2.3, 2.1.2]
- The sampler for ^{14}C was procured and installed during the year. The testing and quality control of the ^{14}C measurements was found satisfactory and the data delivery to The Central Analytical Laboratory has started. However, the laboratory has not yet decided on the production of the automatic flask sampler so the installation of the sampler is delayed. [1.2.3, 2.1.2, 2.2.2]
- The procurement of the LIDAR systems was started but has been postponed due to the need of clarification on the requirements from ICOS RI as well as on the possibilities to enable expansion of the systems in order to suite other projects including aerosol measurements. [1.2.3]
- The Östergarnsholm station has been working on getting harmonized with the ICOS RI requirements. A water sampling program was initiated during 2015 and is now being evaluated. Data are not yet delivered to the OTC, but data for CO_2 in the water is being delivered to the SOCAT database. [1.2.3, 2.2.3]
- Development of ecosystem measurement protocols for all type of measurements, continuous automatic as well as manual, has been under work within ICOS RI during the year. Most of the protocols are finally decided upon and we have gone through them and started to adjust our own procedures to make sure that they fulfill the ICOS requirements. [1.2.4, 3.2.3]
- We have organized staff meetings to follow up on the measurement protocols and the engineers working at the measurement stations have had meeting to discuss work procedures and security issues. [3.2.3, 3.2.7]
- The work on documenting the "ICOS domain" for all ecosystem sites has continued using footprint analyses. These analyses are now the base for the evaluation. [1.2.4]
- All stations need to be approved and labelled by the Thematic Centers and we expected this to be possible during 2015. However, the labelling process was decided upon in late 2015 and will not start before 2016. [2.3]
- The compilation of descriptions of all non-ICOS research activities that are ongoing inside the domains is continuously updated and we have provided service and support these ancillary projects at the station. [1.2.4, 3.2.8]
- As the ICOS RI Carbon Portal is not yet operational, we have made data available directly to users upon request.[3.2.8]
- Our ambition was to decide on a system for data archiving, to set up routines for archiving, and to start implementing them during the year. However this issue has to be clarified within ICOS RI before we can take any final decisions. [3.2.5]
- The ICOS Sweden personnel have participated in workshops and other types of meetings organized by the ICOS RI Head Office and Thematic Centers. These were two MSA meetings for each station type (ATM, ECO, OCM). All Ecosystem Station PIs and the Director and the Data manager also attended a general ETC (Ecosystem Thematic Center) meeting in Todi. ICOS Sweden arranged to international workshops for the measurement protocols concerning the storage term and the chamber measurements. [3.1.5]
- The ICOS Sweden director has participated in ISIC meetings, CWG (contract working group) meetings and has been appointed to be a delegate in the ICOS RI General Assembly for Sweden. [3.1.5]

- We had problems with measurement failure and break down for some key instruments as reported in the annual report 2014 and this was followed up with a plan for replacements and/or complementary spare instruments during 2015. However, we have to wait for the outcome of the financing for the coming five-year period before any final decisions can be taken. [3.2.2]
- Cooperation activities: The stations were visited by Campbell Sci. and Picarro. These companies produce the type of specialized instruments used in ICOS. [3.1.5]

4. Building up and management of the ICOS Sweden organization

4.1 The ICOS Sweden Organization

During the last six years, the ICOS Sweden management structure has been built up and now consists of a Board and Scientific Advisory Committee, a Coordination Office and Director, the consortium partners and a Station Coordination group. Below, the different bodies and their duties are described, followed by a summarized description of the progress up to the end of 2015 and a list of actions taken during the year.

4.1.1 The ICOS Sweden Board

The ICOS Sweden Board members are Sanna Sorvari (Chair; Finnish Meteorological Institute (FMI), Marianne Lilliesköld (Swedish Environmental Protection Agency), Joakim Langner (Swedish Meteorological and Hydrological Institute SMHI), Gunilla Svensson (Stockholm University) Benjamin Smith (Lund University), and Hans Winsa (Sveaskog). The Board is responsible for the overall strategic and financial monitoring and shall promote development, operation and management. The Board has also to decide on the focus and objectives for the collaboration between the different partner organizations that constitute ICOS Sweden. The Board meets the Scientific Advisory Committee (SAC) at the annual workshop to discuss strategic issues.

4.1.2 The Scientific Advisory Committee (SAC)

The members of the Scientific Advisory Board are Professor Beverly Law (Oregon State University, USA), Professor Monique Leclerc (University of Georgia, Georgia, USA), Professor Ernst-Detlef Schulze (Max Planck Institute for Biogeochemistry, Jena, Germany) and John Moncrieff (University of Edinburgh, Edinburgh, UK). John Moncrieff became a new member during 2015. The SAC contributes with scientific advice, establishes external links, and acts as ambassadors in general. SAC participates in the annual workshop and, in conjunction to the workshop, meets the Board to discuss strategic issues.

4.1.3 Coordination Office (CO)

The ICOS Sweden Coordination Office is hosted by Lund University. It consists of a Director (Anders Lindroth), two part time Scientific Coordinators (Jutta Holst (50%) and Maj-Lena Linderson (50%) and a Measurement System Coordinator (Meelis Mölder, 25%). The Director decides on all day-to-day scientific, technical and administrative issues of the research infrastructure. The Director also serves as Sweden's national Focal Point to ICOS RI. The CO supervises the activities at the stations as well as the instruments and systems functioning. It acts as an intermediary between the Board and the rest of the organization and assists the Board in organizing meetings, taking minutes and compiling documents for progress follow up, revisions and endorsements. The CO coordinates the renewal of applications and agreements as well as the internal communication and common outreach activities.

4.1.4 Consortium partners and Station Principal Investigators (SPIs)

A Station Principal Investigator is appointed for each of the operative ICOS Sweden stations. Responsibilities, tasks, and duties for the SPIs include organizing and managing the activities at their respective measurement station and to perform the data quality checks in conjunction to the data submission to the Thematic Centers. The SPIs participate in the ICOS RI MSAs as representatives of ICOS Sweden. They also contribute to applications and reporting, including the strategic development of ICOS Sweden, and act as intermediary between their respective partner and the CO. The SPIs promote outreach activities specific for their site e.g. courses and field visits. The list of SPIs includes Tomas Friborg and Patrick Crill (Abisko-Stordalen), Mats B. Nilsson (Degerö), Mikaell Ottosson Löfvenius (Svartberget), Meelis Mölder (Norunda), Anna Rutgersson (Östergarnsholm), Leif Klemedtsson (Lanna), and Michal Heliasz (Hyltemossa).

4.1.5 Station Coordination Group (SCG)

The Station Coordination Group is made up of the Station Principal Investigators, as representatives for their respective consortium partner, and is headed by Prof. em. Sune Linder. The group coordinates the activities at the different sites and resolves various technical and practical issues and is a forum for discussions on the management and development of the research infrastructure. The SCG has regular phone/internet meetings, which are complemented by occasional site visits, when needed.

4.1.6 Users' Groups

In the early stage of the buildup of ICOS Sweden, the plan was to set up a Users' Group and a Stakeholder's group. The Users' Group should promote contacts with members of the scientific user community, who are tentatively interested in using research sites and measurement data of the national RI. The Stakeholders' Group aimed at promoting contact with representatives of authorities and organizations that are potentially interested in using the synthesized data products of ICOS RI. Because ICOS RI is not yet fully operational and ICOS Sweden's activities are just starting, it was decided to join the two contact groups into one single user group open to stakeholders as well as site and data users. Guy Schurgers, University of Copenhagen is appointed as chair with the aim of leading the work with identifying and enrolling members to the group and further defining its objectives and work procedures. To start with, the enrollment will be concentrated on scientific users of the data and of the sites. The stakeholder community will be approached once ICOS Sweden is operational and there are data products to display to illustrate the usefulness of the data.

4.2 Development phase of the organization and its management

The buildup of the ICOS Sweden organization and its functions is finished except for the full implementation of the User's Group and the continued establishment of links to the Central Facilities. The ICOS RI MSA started in 2014 and the ICOS Sweden representatives are appointed (Director and SPIs). Six MSA meetings have taken place during 2015. The ERIC (European Research Infrastructure Consortium) was established in November 2015 and further development of the links to ICOS RI will take place during early 2016. The work with enrolling members to the User's Group and to further define its objectives and work procedures has not yet started due to the intensive work on finalizing the buildup of the measurement stations. This will be a task for the coming year.

The funding application for the next funding period was due in spring 2015. The application for funding from VR for the next four + four year period was submitted to SRC in spring 2015. The decision from SRC arrived on 17 December with a substantially reduced budget and a financing period of five years. Adaptation to the new budget and negotiations with the consortium partners will takes place in early 2016.

4.2.1 Actions taken 2015

Numbers within [] indicate milestones, as defined in Table 1.

- The application for renewed funding was submitted to the Swedish Research Council (SRC) in spring 2015. At the end of the year, the SRC decision was announced. The application was approved but the funding period was changed to five years and the budget was reduced to almost 50% of what was applied for. The consequences of this reduction are dealt with during early 2016. [3.1.2]
- The Coordination Office has, together with the Board, the SAC and the SCG, further developed the updated strategic plan (period 2016-2020) that started in 2014. Due to the late funding decision SRC delayed the submission time of the next year's budget and operational plan until 31 May. [3.1.1,3.1.2]
- The identification and enrollment of members to the User's Group was postponed due to the signals from SRC on cut downs in the funding for the coming five year period. [1.1.1, 3.1.3]
- We have arranged monthly internal information meetings via phone or internet and field visits to stations. [3.2.7]
- We also arranged several SCG meetings via phone or internet. In early 2015, the meetings were focused on the SRC application for the coming five year period. [3.1.6, 3.2.7]

- ICOS Sweden has continued disseminating information and support education efforts through seminars, courses, field visits, media contacts, and through the ICOS Sweden homepage. [3.1.3]
- The annual ICOS Sweden workshop was organized by Uppsala University and took place in August. The meeting focused on carbon fluxes of open waters and oceans, and included field visits to the Östergarnsholm measurement station. Around 60 persons attended the meeting. The Advisory Committee and Board were invited to the workshop and also had their annual discussion and advice meeting. [3.1.3]
- ICOS Sweden has taken several initiatives to cooperation between ICOS Sweden and projects like the Arctic infrastructure network INTERACT and ICOS-INWIRE, and has continued the tradition of a strong Nordic collaboration on greenhouse gas studies, especially through the new Research Infrastructure Network for Nordic Atmospheric and Earth System Science – Nordic ENVRI. [3.1.5]
- ICOS Sweden has worked on a strategy for community building and investigates funding and collaboration opportunities. In conjunction to this we have announced interest in participating in discussions on collaboration with other infrastructures, mainly SITES and ACTRIS [3.1.5]
- We have continued to encourage applications from ICOS-external researchers aiming at setting up new projects at the stations and support already ongoing activities. Among others, a new KAW-project (Knut och Alice Wallenbergs Stiftelse) will be established at Svartberget. [3.2.8]
- To stress the societal use of the data and thus attract the interest of stakeholders, data and synthesis products to show would be needed. ICOS Sweden has the ambition to initiate analyses of greenhouse gas budgets for Sweden and is involved in a MISTRA-initiative together with researchers at Lund University. [3.1.5]
- We have also participated in a cooperation initiative where ICOS Sweden, the climate research centre at Stockholm University, Bolin Center, LUCCI (Linné research environment at Lund University) and SMHI have applied for a competence center within the Vinnova academic and industrial cooperation activities. [3.1.5]
- ICOS Sweden have been active producing press releases, advertisements, e.g. in connection to the Almedalen week, arranged open house days, researcher station visits and other arrangements to attract projects. [3.1.3]

5. Comments on economy and the deviation from the budget for 2015

A summary of the financial outcomes for 2015 for all sites and the common equipment investments are given in Table 2 below. It should be noted that this is a liquidity budget, using incomes and expenses and no depreciation costs, which means that the difference between the total incomes and total expenses represent the amounts available. The accumulated assets correspond to the accumulated amount available since 2010, following the contributions by SRC and the partners in the consortium agreement.

Table 2. *Financial outcomes 2015 for each partner and in total (kSEK). For acronyms, see Appendix 4.*

	LU	GU	SLU	PFS	UU	SU	Common equipment	Total
Incomes								
Incomes SRC	4,882	1,079	2,568	1,371	1,404	0	0	**11,304**
Co-financing	3,165	1,051	1,400	480	928	300	0	**7,324**
Sum	8,047	2,130	3,968	1,851	2,332	300	0	**18,628**
Expences								
Salaries	4,008	1,148	2,369	1,033	1,167	210		**9,938**
Consumables	945	290	659	200	382			**2,476**
Travel	182	144	227	42	93	30		**717**
Infrastructure	829	1,258	384	95	112		0	**2,679**
OH	1,592	698	1,052	446	491	55	0	**4,334**
Sum	7,555	3,538	4,691	1,815	2,245	300	0	**20,145**
Total outcomes	492	-1,408	-723	36	87	0		**-1,517**
Accumulated assets	**4,080**	**-257**	**1,741**	**702**	**87**	**0**	**10,847**	**17,200**

The preliminary outcome for 2015 follows well the budgets for each partner except for the less than expected infrastructure investments. This is because the purchase of some of the instruments has been postponed to 2016. These postponed purchases are also the reason for the large total accumulated asset of ICOS Sweden. The planned investments are: Three LIDARs for the atmospheric stations, Gill anemomenters and NDVI measurement instruments for the ecosystem sites, dendrometers and flux chambers for the forest sites, and spare instruments (gas analysers, pCO_2 sensors and radiometers).

6. Key numbers

ICOS Sweden has identified a list of key numbers that should be reported annually and used to evaluate the performance and usefulness of the infrastructure (Table 3). The key numbers are explained in the table or described in the following text. Targets for the key numbers have not yet been established. For key number 1 and 2, the targets will be set once the ICOS RI requirements are ready. For the other key numbers, the goals will be developed during 2016.

Table 3. *Key numbers for evaluation of the ICOS Sweden infrastructure.*

Key No	Performance	Key number description
1.	84, see text	Percentage of uptime of measurements for key variables such as fluxes and concentrations flagged with the highest quality.
2.	71, see text	Percentage of uptime of backup meteorological variables to be used for gap filling.
3.	51	Number of national research projects at the different sites.
4.	20	Number of international research projects (projects with a foreign PI) at the different sites.
5.	Not compiled	Volume (amount of funding) of research projects.
6.	17	Number of users of ICOS Sweden data.
7.	Not applicable	Volume of data retrieval of ICOS data products (provided by ICOS Carbon Portal) from ICOS Sweden sites.
8.	8	Number of peer review publications (in preparation and/or published) where data from ICOS Sweden sites are used.
9.	Not applicable	Number of citations for all peer review publications where data from ICOS Sweden sites are used.
10.	Not applicable	Number of other scientific publications where data from ICOS Sweden are used.
11.	5	Number of popular science publications related to ICOS Sweden/non-scientific visitors to ICOS Sweden sites..
12.	8	Number of appearances in public media.
13.	3 / 41	Number of undergraduate courses and number of participants.
14.	8 / 160	Number of graduate courses and number of participants.
15.	44	Number of course days at the different sites.
16.	>10	Number of undergraduate theses using data or sites.
17.	10	Number of graduate theses using data or sites.
18.	6	Number of meetings/conferences/workshops organized by ICOS Sweden.
19.	See text	No of stakeholders.
20.	See text	Impact on society and industry.

Number of non-scientific visitors to the sites: approx. 100

Key number 1 and 2, the percentages of uptime of measurements of key variables and backup meteorological variables are important measures connected to data accessibility and each key variable should be presented separately. These are illustrated in Figure 4.

Key number 7, volume of data retrieval of ICOS RI data products (provided by ICOS Carbon Portal) from ICOS Sweden sites, is not applicable this year as the Carbon Portal has not yet started delivering data.

Key number 9 and 10 concerns ICOS labelled data delivered through the Carbon Portal. As the portal has not yet started delivering data, the key numbers are not applicable yet. Figure 3 illustrates number of publications referring to ICOS related data that does is not ICOS labelled.

Key number 18 is an indicator of how well ICOS Sweden can interact with the wider scientific and stakeholder communities.

Key numbers 19 and 20 relates to the required reporting in the SRC agreement: "Infrastructure importance for direct societal interests" and "Infrastructure importance for trade and industry and commercial use". As ICOS Sweden has not fully entered the operational phase, this can only be described in general terms, without specification of actual number of users outside the scientific community. However, there have been regular visits and meetings by the Forest Agency at Svartberget. Also, several industrial partners work at the site and makes regular visit including SKB, HydroResearch, and several forest companies. The instrument producing companies Picarro and Campbell Sci also visited the sites during the year. More information about potential impact on society and industry can be found in the strategic plan.

Other issues required in the annual reporting according to the agreement with SRC that not included here: number of patents and scientific breakthroughs as they are not applicable for the infrastructure.

Some of the key numbers are not yet applicable as ICOS RI and ICOS Sweden has not fully entered the operational phase. However, the interest of users for the type of data produced at ICOS Sweden is illustrated by the number of academic users at the ICOS Sweden sites (Table 4) and by the number of publications referring to ICOS-related data from the sites (Figure 3). Interests of users have been research related to greenhouse gas (GHG) exchange, hydrological processes, and climate change.

Table 4. *Number of academic users of data, measured at sites within ICOS Sweden since 2005. Numbers include (i) data requests from sites that now belong to ICOS Sweden via the European Fluxes Database Cluster, (ii) projects which are in direct relation to ICOS and (iii) data requests addressed to ICOS Sweden directly.*

Year	Number of Data Users		
	international	national	total
2005	3	0	3
2006	19	0	19
2007	4	0	4
2008	14	9	23
2009	38	2	40
2010	45	6	51
2011	21	1	22
2012	36	2	38
2013	64	1	65
2014	50	17	67
2015	63	42	105

As can be seen from table 4 and figure 3, there is an increasing trend of research interest within this topic.

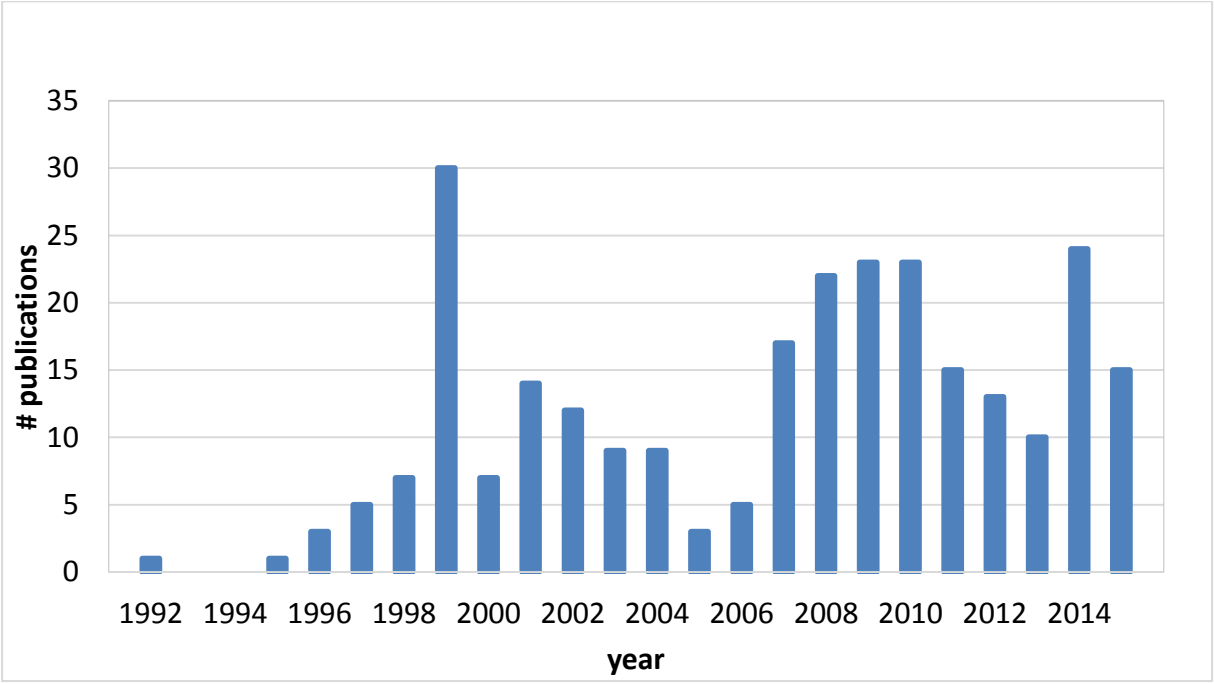

Figure 3. *Number of peer-reviewed and popular science publications referring to ICOS-related data measured at sites that now belong to ICOS Sweden.*

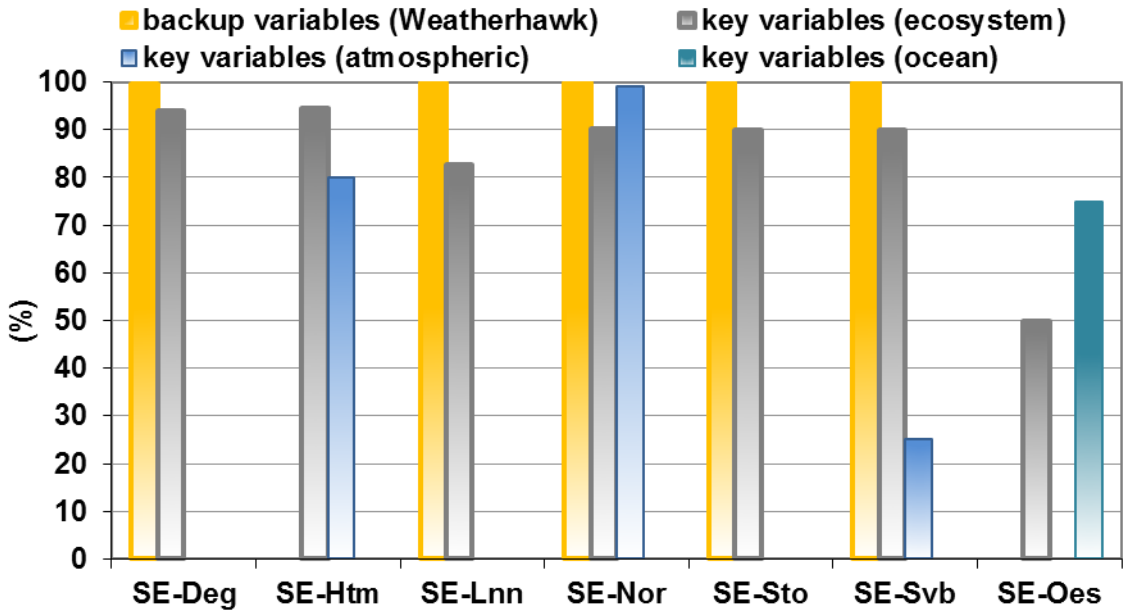

Figure 4. *Bar plot showing the percentage of days with high data quality (>80% data per day available) for backup meteorological variables and for key variables for the ecosystem, atmospheric and ocean stations. Key variable for the ecosystem stations are turbulent fluxes from the eddy covariance systems. Key variables for the atmospheric stations are concentrations of GHG at three levels, Key variables for the ocean station is pCO_2 (CO_2 concentration). Note: This figure was produced on 11 December. All stations in ICOS Sweden are shortened with the prefix SE. Deg is Degerö, Htm is Hyltemossa, Lnn is Lanna, Nor is Norunda, Sto is Abisko-Stordalen, Svb is Svartberget and Oes is Östergarnsholm.*

The uptime statistics for the backup systems for meteorological variables and the key variables have improved since the previous year (Figure 4). No statistics for the backup system can be provided for Hyltemossa and Östergarnsholm, as it has not been installed at these sites yet. The eddy covariance data coverage at the ecosystem sites where higher than 80% at all sites except for Lanna, where lower uptime of the N_2O analyser caused a slightly lower data coverage for this key variable. Measurements for the atmospheric stations was initiated at all three sites during 2015 (Hyltemossa: February 2015, Svartberget: October 2015). Ongoing power supply problems caused an overall low data coverage at the ocean site Östergarnsholm. Measures are already taken to provide a more reliable power supply in future.

Appendices

Appendix 1: List of personnel during 2015

Total amount of FTEs: 13.3

Coordination Office:

Anders Lindroth, director, 50%
Maj-Lena Linderson, scientific coordinator, 50%
Jutta Holst, scientific coordinator, 50%
Meelis Mölder, measurement system coordinator 25%
Susanna Olsson, communication officer 20% from 1 September
Björn Eriksson, System manager, 20%

Measurement stations:

Abisko-Stordalen:

Robert Holden, research engineer, 100% up to summer 2015
Per Marklund, research engineer, 100% from summer 2015
Niklas Rakos, research engineer, 50%
Thomas Friborg, station PI, 20%
Patrick Crill, station PI, 10%

Degerö and Svartberget:

Jörgen Sagerfors, research engineer, 80%
Holger Tülp, research engineer, 100%
Pernilla Löfvenius, research engineer, 40%
Tomas Hörnlund, research engineer, 20%
Mikaell Ottosson Löfvenius, station PI, 50 %
Mats Nilsson, station PI, 20%

Norunda:

Irene Lehner, research engineer, 100%
Anders Båth, research engineer, 75%
Meelis Mölder, station PI, 15%

Östergarnsholm:

Anna Rutgersson, station PI, 35%
Marcus Wallin, research engineer, 50%
Erik Nilsson, research engineer, 45%
Hans Bergström, research engineer, 5%

Lanna:

Per Weslien, research engineer, 75%
Bengt Liljeblad, research engineer, 25%
Leif Klemedtsson, Station PI, 35%

Hyltemossa:

Tobias Biermann, research engineer, 100%
Michal Heliasz, station PI, research engineer, 100%

Appendix 2: List of measured variables and instruments/systems

Ecosystem stations

Continuous measurements		Forest	Wetland	Agriculture
Turbulent fluxes	CO_2	1	1	1
	H_2O	1	1	1
	CH_4	-	1	-
	N_2O	-	-	1
	Momentum	1	1	1
	Sensible heat	1	1	1
Radiative fluxes	Incoming short-wave	2	2	2
	Outgoing short-wave	1	1	1
	Incoming long-wave	1	1	1
	Outgoing long-wave	1	1	1
	Net Radiation	Combination of 4 components	Combination of 4 components	Combination of 4 components
	Incoming PAR	2	2	2
	Diffuse incoming PAR	1	1	1
	Outgoing PAR	1	1	1
	PAR below canopy	16	-	-
	Spectral reflectance	1	1	1
Soil fluxes	Soil heat flux	4	4	4
	Soil CO_2 efflux	6	-	-
State variables	Air temperature profile	14-15	5	5
	CO_2 profile	14-15	5	5
	CH_4 profile	14-15	5	5
	Relative humidity	1	1	1
	Wind speed/direction	Flux sonic, SE-Nor: 14	Flux sonic	Flux sonic
	Soil temperature profile	4x5	4x5	4x5
	Soil moisture profile	4x5	4x5	4x5
	Ground water level	1-4	4	-
	Ground height	-	1	-
	Snow depth	1	1	1
	Precipitation	1	1	1
	Tree trunk surface temperature	48	-	-
	Canopy IR temperature	1	1	1
	Backup meteorological station	1	1	1
Imaging	Above canopy phenological cam	1	1	1
	Below canopy phenological cam	1	0	0
Periodic measurements	Green area index	x	x	x
	Aboveground biomass	x	x	x
	Leaf chemical analysis	x	x	x
	Litterfall	x		
	C and N export/import	x		x

Atmospheric stations				
		Svartberget	Norunda	Hyltemossa
Continuous measurements	CO_2, CH_4, H_2O, CO	3	3	3
	Wind speed/direction	1	1	1
	PBL height	Not yet	Not yet	Not yet
	Meteorological parameters	Ecosystem station	Ecosystem station	Ecosystem station
Periodic measurements	Sampling for radio carbon ^{14}C	1	1	1
	Flask sampling: SF_6, N_2O, O_2, N_2, C-14, Rn-222 + other isotopes	1	1	1

Ocean station		
Continuous measurements		Östergarnsholm
Turbulent fluxes	CO_2	1
	H_2O	1
	CH_4	-
	N_2O	-
	Momentum	1
	Sensible heat	1
Radiative fluxes	Incoming short-wave	2
Water measurements	Temperature profile	4
	Salinity profile	4
	Surface CO_2	1
	Surface Oxygen	1
State variables	Air temperature profile	5
	CO_2 profile	4
	H_2O profile	4
	Wind profile	5
	Relative humidity	1
	Precipitation	1
Periodic Water sampling	Nitrogen	x
	Phosphorous	x
	Silica	x

Appendix 3: List of abbreviations and acronyms

ICOS RI (European level)

ATC – Atmospheric Thematic Center
ATM – Atmospheric stations
CAL – Central Analytical Laboratory
CP – Carbon Portal
ECO –Ecosystem stations
ETC – Ecosystem Thematic Center
ERIC – European Research Infrastructure Consortium
ESFRI - European Strategy Forum on Research Infrastructures
HO – Head office
ICOS RI – Integrated Carbon Observation System Research Infrastructure
ICOS PP – ICOS Planning Project (sometimes also Preparatory Phase)
ISIC – ICOS Stakeholder Interim Council
OCM – Ocean stations
OTC – Oceanic Thematic Center

ICOS Sweden

CO – ICOS Sweden's Coordination Office
SAC – ICOS Sweden's Scientific Advisory Committee
SCG – ICOS Sweden's Station Coordination Group
SPI – ICOS Sweden Station Principal Investigator

ICOS Sweden partners

LU – Lund University
GU – Gothenburg University
SU – Stockholm University
SLU – Swedish University of Agricultural Sciences
PFS - Swedish Polar Research Secretariat

Other infrastructures and organizations

ACTRIS - Aerosols, Clouds, and Trace gases Research Infrastructure network (http://www.actris.net)
ANAEE – Analysis and Experimentation on Ecosystems (www.anaee.com)
GMES - Global Monitoring for Environment and Security (now called Copernicus, http://www.copernicus.eu)
DEFROST – A Nordic Centre of Excellence with the aim to understand how climate change induced changes in the cryosphere influence the ecosystem/geosphere processes which directly affect climate (http://www.ncoe-defrost.org)
INTERACT – International Network for Research and Monitoring in the Arctic (http://www.eu-interact.org)

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NORDFROST - A Nordic researcher network supporting the study of greenhouse gas and energy exchange in sub-arctic and arctic ecosystems (http://www.nateko.lu.se/nordfrost)

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

SITES – Swedish Infrastructure for Ecosystem Research (http://www.fieldsites.se/)

Other

CWG – contract working group

GHG – greenhouse gas

NORA – The Marie Sklodowska Curie Initial Training Network ”Nitrous Oxide Research Alliance”

SMHI –Swedish Meteorological and Hydrological Institute

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