ICOS SWEDEN - user statistics 2018

Key numbers for the annual reporting of the infrastructure activities

“Special conditions for contributions to the national infrastructure - ICOS Sweden”, The Swedish Research Council’s (SRC's) Director General, March 21, 2016.

The Integrated Carbon Observation System Sweden, ICOS Sweden[1] is a part of the pan-European distributed research infrastructure ICOS[2] that promotes fundamental understanding of carbon cycle, greenhouse gas (GHG) budgets and perturbations and their underlying processes by providing consistent and persistent measurement data from *in situ* networks. The overall aim of ICOS Sweden is to produce harmonized, high quality data on GHG exchanges, atmospheric concentrations and their defining state variables within typical Swedish ecosystems (both terrestrial and marine) and regions. These activities are critical to enable quantification of the Swedish GHG balance and the feed backs of these ecosystems to a changing climate. Swedish ICOS stations contribute data that are critical for a continental scale understanding of the GHG balance of Europe. This document contains a description of how infrastructure and its activities are organized in order to achieve these aims.

ICOS Sweden is fully integrated and plays an important role in the pan-European ICOS (ICOS RI). ICOS Sweden provides 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. The ICOS Sweden activities have been organized in five modules: module 1: organization and leadership, modules 2 to 4 for the Ecosystem, Atmosphere and Ocean stations and module 5 for the Technical and scientific expertise and support.

ICOS Sweden and its data products is an infrastructure which is open to everyone. As research infrastructure, it is meant to be used by scientists to address different research questions. By organizing open door events or preparing easy to understand teaching material, it can even reach out to the general public to arouse interest and enlarge knowledge on ecosystem related climate issues. Elaborated products will be available for all the interested social stakeholders such as citizens, decision makers and media.

ICOS Sweden stations are used as destination of excursions and field courses at different levels and attracted by this 139 scientific visitors during 2018.

Scientific users of the infrastructure are researchers using the data produced by the measurement stations to address their research question. The data downloads of near real time and final quality controlled data sets has via the Carbon Portal has increased to 15781 during 2018, compared to 59 data requests by direct mail contact.

Scientific users of the ICOS Sweden infrastructure are also researchers coming to the stations adding installations or taking samples to answer their specific research question. During 2018, 54 project PIs were active at the ICOS Sweden stations.

[1] www.icos-sweden.se
[2] www.icos-ri.eu

The users of ICOS infrastructure divide into two partially overlapping classes, data users and users of the physical station infrastructure. Again the data and the sites will be available to all.

The academic users of ICOS data can be divided into three main groups. 1) Modelers working with both bottom-up and top-down type models from different disciplines, e.g., soil science, ecophysiology, biogeochemistry, hydrology, meteorology, climate science, atmospheric science. 2) Remote sensing (RS) community that is interested in ground truth data for validation of different RS products. 3) Researchers synthesizing empirical data from different types of ecosystems and climatic regions in order to understand the processes regulating exchange of matter and energy between ecosystems and the climate system.

Users taking advantage of the physical access to the measurement stations benefit from station infrastructure, including laboratory space, technical support, power supply, internet and other services, and high quality auxiliary data provided by ICOS Sweden. These users perform on site research consisting of measurement programs that are in addition to the ongoing ICOS measurement program. They, in turn, benefit directly from the context of the long term ICOS measurements.

Today, the ICOS Sweden community consists of more than 1400 scientists from at least 16 countries (since 2016), who participate in ICOS Sweden related work and operations. They design, build and operate ICOS stations and use and process ICOS data while integrating it into their own scientific research topics. The ICOS RI can thus be regarded as being **co-designed** by its users. They publish scientific papers in high-impact journals, make presentations at international workshops and conferences, and develop novel measurement methods that may become operational within ICOS in future. National users (71%) are hosted by all major research institutions of Sweden.

ICOS Sweden data and stations are also used in education at all levels from high school to research training. This and public information days follow the aim to increase the public awareness, interest, and knowledge of climate change issues. Large numbers of the general public (non-scientific users) have been and will be reached; for example, since 2016, more than 300 non-scientific users showed interest in the RI by e.g. visiting the sites. Table 1 comprises the summary of the key numbers since the start of the 2nd ICOS Sweden funding period 2016. The results are analyzed in more detail below.

Table 1. Summary of the key numbers for the annual reporting of the infrastructure activities.

year	general key numbers	Site visitors and project Pis					Data Users				
	number of peer-reviewed publications	international		national			international		national		
		male	female	male	female	unknown	male	female	male	female	unknown
2016	44	140	129	337	270	0	49	33	18	7	60
2017	64	48	12	100	197	56	4	5	12	16	1186
2018	60	15	13	72	69	2	8	7	29	15	15781

Physical Users of the infrastructure

The motivation for users that come in person to the ICOS Sweden RI facilities is broad. It starts from the general public that is attracted by e.g. open-door days or programs for school children. ICOS Sweden facilities are also used for education at university level during excursions and field courses. Last but not least, national and international scientists use ICOS Sweden stations for their own research project related field work. Table 2 includes the updated numbers for each group of physical users.

Table 2. User numbers for project PIs, Scientific visitors (site visitors through field courses and excursions) and General public visitors (general public and school children).

year	Project PIs		Scientific visitors		General public visitors
	male	female	male	female	not divided by gender
2016	50	19	355	277	245
2017	40	14	166	227	21
2018	42	12	72	67	32

Since there were no larger international conferences during 2018, the share of international physical users is only 7%, the majority (144 counted users) of physical users had a national background. For approx. 20% of the users, it is not known whether their site visit was motivated nationally or internationally. Figures 1 and 2 show the distribution of origin for national (Fig. 1) and international (Fig. 2) users during 2018 as far as known.

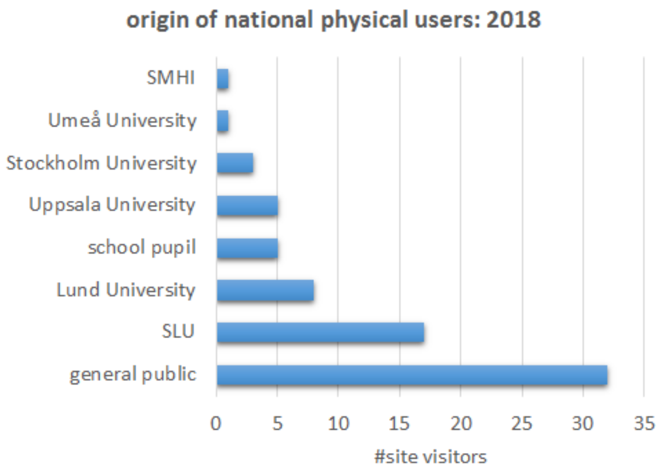

Fig. 1: Origin of national project PIs and visitors of the ICOS Sweden facilities in 2018. SLU: Swedish University of Agricultural Sciences.

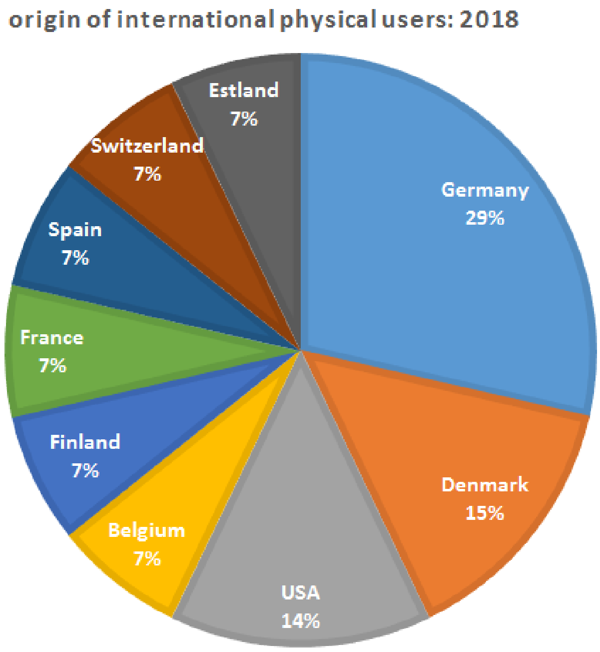

Fig. 2: Origin of international project PIs and visitors of the ICOS Sweden facilities in 2018.

For the statistics on the number of physical users on subject area, only the research projects related to ICOS Sweden stations have been analyzed. During 2018, the background of the majority (83%) of the physical users was within Geo- and Environmental sciences (SCB code 105). Physical users related to atmospheric sciences (aerosol measurements) accounted for roughly 10% at ICOS Sweden sites during 2018 (SCB code 103). The remaining 7% can be found in Agricultural Science and Forestry (SCB code 401).

Due to the co-location of the Svartberget/Degerö sites in the Krycklan area, hydrological motivated projects were dominating in previous years; however, during 2018 the share of carbon budget related research projects increased significantly. The spectrum of science questions investigated at the marine station (module 3) is broad. It attracts scientists from atmospheric physics and atmospheric chemistry as well as scientists with marine research questions.

Users of the data produced by the infrastructure

Data produced at ICOS Sweden facilities is of interest for scientists nationally and internationally. During 2018, the amount of data requests from the ICOS Carbon portal, where all data are available under a Creative Commons Attribution 4.0 International License, as well as data requests from compiled data products like the NOAA Observation package (ObsPack) increased to more than 15800. No personal data is gathered from users downloading data via the Carbon Portal, however, the country of origin is derived from the users IP number for the whole period since end 2017 to today (2019-02-13, Fig 3).

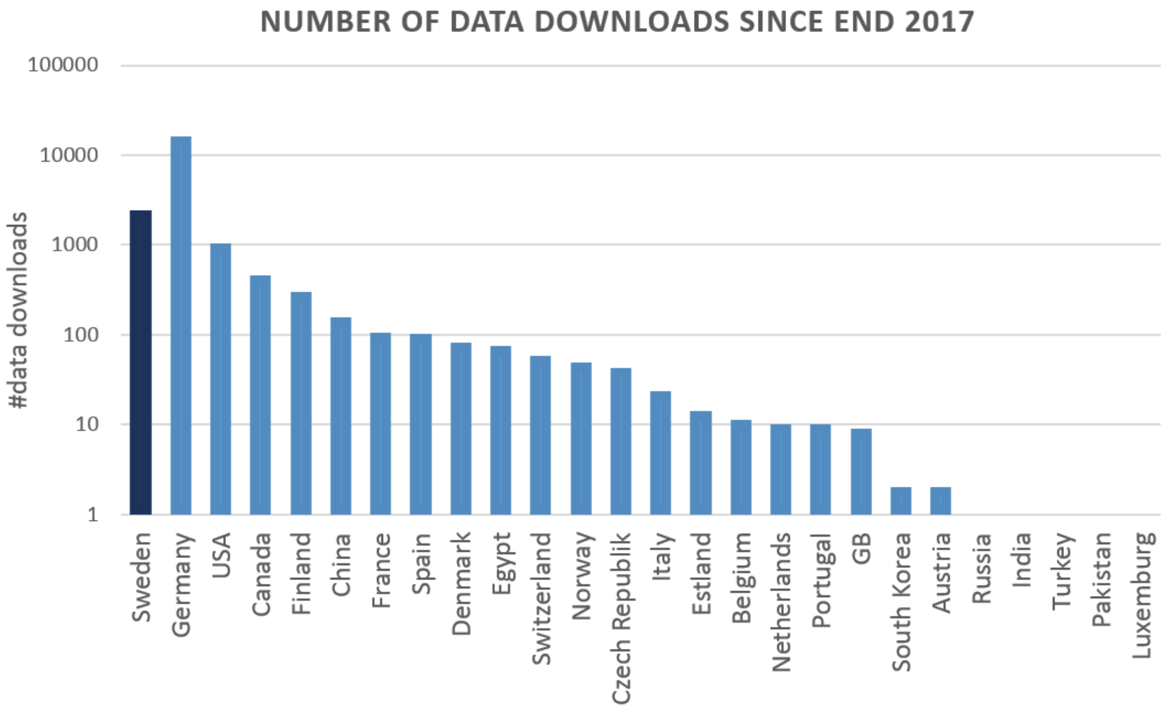

Fig. 3: Origin of international data users of the ICOS Sweden data products since 2017 (level 1 to 3); data downloads from the ICOS Carbon Portal.

Since the data flow from the stations to the ICOS Thematic Centres and to the Carbon portal has not yet been fully established for all Thematic Centres, data from ICOS Sweden stations are available as ICOS Sweden data through the Carbon Portal but also through direct contact with the station Scientific Principle Investigators or the ICOS Sweden data manager. Statistics on gender distribution (Table 1) as well as origin of data users (Fig. 4 and 5) is purely based on data requests via the direct contact.

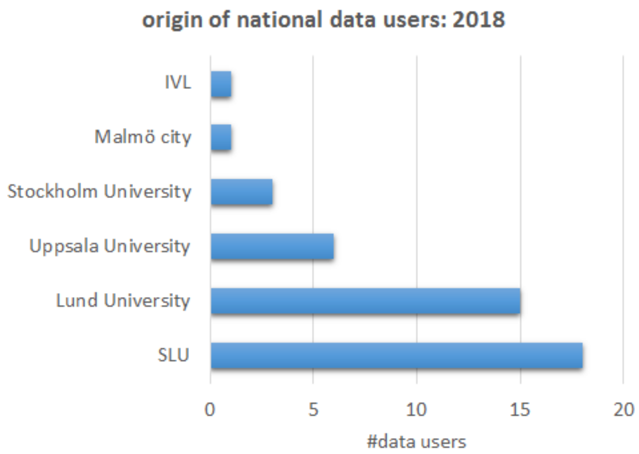

Fig. 4: Origin of national data users of the ICOS Sweden data products in 2018; data requests via direct contact. IVL: Swedish Environmental Research Institute SLU: Swedish University of Agricultural Sciences

77% of the data requests via direct contact came from Swedish institutions. Data products from ICOS Sweden stations are also used for educational purposes at undergraduate and graduate level, reaching out to a number of students in environmental sciences, forestry and physical geography. In 2018, ICOS Sweden contributed with data products from ICOS Sweden stations to the "Weather and Climate" module of the National Resource Centre for Physics Education which is aimed at being a resource for teachers from preschool to high school level.

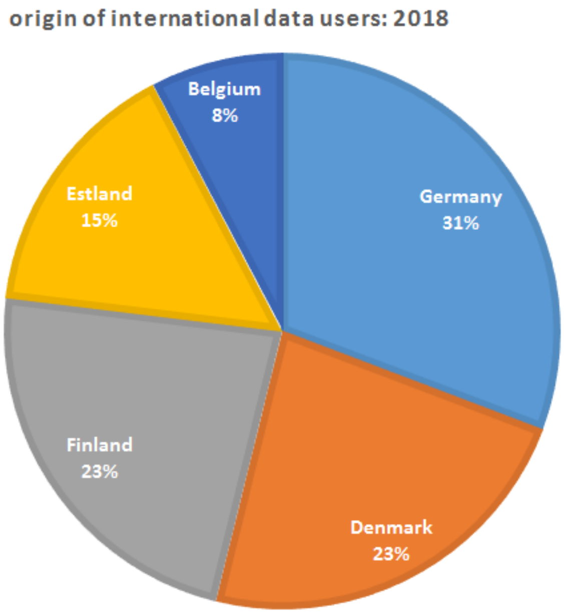

Fig. 5: Origin of international data users of the ICOS Sweden data products in 2018; data requests via direct contact.

Citation statistics for peer-reviewed publications related ICOS Sweden stations

The full list of peer-reviewed scientific publications published in 2018 that the ICOS Sweden infrastructure has contributed to through data measured at the stations or support of field research at the stations is included in Appendix A. Google scholar was used to compile the citations related to publications since 2014 (Table 3). The full publication list of included papers is available on www.icos-sweden.se.

Table 3. Citation statistics on publications related to ICOS Sweden stations and ICOS Sweden activities (2019-02-13). The full publication list of included papers is available on www.icos-sweden.se.

	Since 2014
Total number of publications	239
Citations	3010
h-index	27
I10-index	90

Appendix A – List of peer-reviewed scientific publications that the infrastructure has contributed to with data, pure infrastructure or technical support: 2018

- Alekseychik, P., I. Mammarella, A. Lindroth *et al.*, 2018: Surface energy exchange in pristine and managed boreal peatlands. *Mires and peat*, 21, 14. 10.19189/MaP.2018.OMB.333
- Ameli, A.A. & J.R. Craig, 2018: Semi-analytical 3D solution for assessing radial collector well pumping impacts on groundwater-surface water interaction. *Hydrology Research*, 49, 17-26.
- von Buttlar, J., Zscheischler, J., Rammig *et al.*, 2018: Impacts of droughts and extreme-temperature events on gross primary production and ecosystem respiration: a systematic assessment across ecosystems and climate zones, *Biogeosciences*, 15, 1293-1318, https://doi.org/10.5194/bg-15-1293-2018.
- Campeau, A., K. Bishop, M.B. Nilsson *et al.*, 2018: Stable carbon isotopes reveal soil-stream DIC linkages in contrasting headwater catchments. *JGR-Biogeosciences*, 123(1):149-167, DOI:10.1002/2017JG004083
- Denfeld, B. A., Klaus, M., Laudon *et al.*, 2018: Carbon dioxide and methane dynamics in a small boreal lake during winter and spring melt events. *Journal of Geophysical Research: Biogeosciences*, 123, 2527-2540.
- Dengel S., A. Graf, T. Grünwald *et al.*, 2018: Standardized precipitation measurements within ICOS: rain, snowfall and snow depth: a review. *International Agrophysics*, 32:607-617
- Du Toit, A., 2018: Permafrost thawing and carbon metabolism. *Nature Reviews Microbiology* 16, 519
- Emerson, J.B., S. Roux, J.R. Brum *et al.*, 2018: Host-linked soil viral ecology along a permafrost thaw gradient. *Nature Microbiology* 3:870-880
- Faiola, C. L. , Buchholz, A., Kari, E. *et al.*, 2018: Terpene Composition Complexity Controls Secondary Organic Aerosol Yields from Scots Pine Volatile Emissions. *Scientific Reports*, 8, Article number: 3053
- Franz, D., M. Acosta, N. Altimir *et al.*, 2018: Towards long-term standardised carbon and greenhouse gas observations for monitoring Europe's terrestrial ecosystems: a review. *International Agrophysics*, 32:439-455
- Gielen B., M. Acosta, N. Altimir *et al.*, 2018: Ancillary vegetation measurements at ICOS ecosystem stations. *International Agrophysics*, 32:645-664
- Gutiérrez-Loza, L., M.B. Wallin, Sahlée E., Nilsson E., Bange H.W., Kock A. and A. Rutgersson, 2018: Measurement of air-sea methane fluxes in the Baltic Sea using the eddy covariance method. *In revision*
- Hodgkins, S.B., C.J. Richardson, R. Dommain *et al.*, 2018: Tropical peatland carbon storage linked to global latitudinal trends in peat recalcitrance. *Nature Communications*, 9, 3640
- Hufkens K., F. Gianluca, E. Cremonese *et al.*, 2018: Assimilating phenology datasets automatically across ICOS ecosystem stations. *International Agrophysics*, 32:677-687
- Järveoja, J., M.B. Nilsson, M. Gažovič, P.M. Crill & M. Peichl, 2018: Partitioning of the net CO_2 exchange using an automated chamber system reveals plant phenology as key control of production and respiration fluxes in a boreal peatland. *Global Change Biology*, 24, 3436-3451
- Jocher, G., J. Marshall, M.B. Nilsson *et al.*, 2018: Impact of canopy decoupling and subcanopy advection on the annual carbon balance of a boreal Scots pine forest as derived from eddy covariance. *JGR-Biogeosciences*, 123(2):303-325, DOI:10.1002/2017JG003988
- Jurevics, A., Peichl, M., Egnell, G., 2018: Stand Volume Production in the Subsequent Stand during Three Decades Remains Unaffected by Slash and Stump Harvest in Nordic Forests. *Forests*, 9(12), 770; https://doi.org/10.3390/f9120770
- Kaisermann, A., J. Ogée, J. Sauze, S. Wohl, S.P. Jones, A. Gutierrez & L. Wingate, 2018: Disentangling the rates of carbonyl sulfide (COS) production and consumption and their dependency on soil properties across biomes and land use types. *Atmos. Chem. Phys.*, 18:9425-9440, DOI:10.5194/acp-18-9425-2018
- Kovalets, I., R. Avila, M. Mölder, S. Kovalets & A. Lindroth, 2018: Verification of a one-dimensional model of CO_2 atmospheric transport inside and above a forest canopy using observations at the Norunda research station. *Boundary-Layer Meteorol.*, 168(1):103-126, DOI:10.1007/s10546-018-0340-z
- Kuhn, M., E.J. Lundin, R. Giesler, M. Johansson & J. Karlsson, 2018: Emissions from thaw ponds largely offset the carbon sink of northern permafrost wetlands. *Scientific Reports*, 8, 9535
- Laudon, H. & R.A. Sponseller, 2018: How landscape organization and scale shape catchment hydrology and biogeochemistry: insights from a long-term catchment study. *Wiley Interdisciplinary Reviews: Water*, 5, e1265
- Ledesma, J.L.J., M.N. Futter, M. Blackburn *et al.*, 2018: Towards an improved conceptualization of riparian zones in boreal forest headwaters. *Ecosystems*, 21(2):297-315, DOI:10.1007/s10021-017-0149-5

- Leufen, L. H. & Schädler, G., 2018: Calculating the turbulent fluxes in the atmospheric surface layer with neural networks. *Geosci. Model Dev. Discuss.*, https://doi.org/10.5194/gmd-2018-263
- Lindroth, A., J. Holst, M. Heliasz *et al.*, 2018: Effects of low thinning on carbon dioxide fluxes in a mixed hemiboreal forest. *Agricultural and Forest Meteorology*, 262:59-70
- Loustau D., N. Altimir, M. Barbaste *et al.*, 2018: Sampling and collecting foliage elements for the determination of the foliar nutrients in ICOS ecosystem stations. *International Agrophysics*, 32:665-676
- Malhotra, A., T.R. Moore, J. Limpens & N.T. Roulet, 2018: Post-thaw variability in litter decomposition best explained by microtopography at an ice-rich permafrost peatland. *Arctic, Antarctic, and Alpine Research*, 50, e1415622
- Martinez, M.A., B.J. Woodcroft, J.C.I. Espinoza *et al.*, 2018: Discovery and ecogenomic context of a global Caldiserica-related phylum active in thawing permafrost, *Candidatus* Cryosericota phylum nov., *Ca.*Cryosericia class nov., *Ca.* Cryosericales ord. nov., *Ca.* Cryosericaceae fam. nov., comprising the four species Cryosericum septentrionale gen. nov. sp. nov., *Ca.* C. hinesii sp. nov., *Ca.* C. odellii sp. nov., *Ca.*C. terrychapinii sp. nov. *Systematic and Applied Microbiology*, 42(1):54-66, DOI:10.1016/j.syapm.2018.12.003
- Menegat, A., P. Milberg, A.T.S. Nilsson, L. Andersson & G. Vico, 2018: Soil water potential and temperature sum during reproductive growth control seed dormancy in Alopecurus myosuroides Huds. *Ecol Evol.*, 8:7186-7194, DOI:10.1002/ece3.4249
- Meredith, L.K., K. Boye, C. Youngerman, M. Whelan, J. Ogée, J. Sauze & L. Wingate, 2018: Coupled biological and abiotic mechanisms driving carbonyl sulfide production in soils. *Soil Syst.* 2018, 2(3):37, DOI:10.3390/soilsystems2030037
- Nemitz E., I. Mammarella, A. Ibrom *et al.*, 2018: Standardisation of eddy-covariance flux measurements of methane and nitrous oxide. *International Agrophysics*, 32:517-549
- Nicolini, G., M. Aubinet, C. Feigenwinter *et al.*, 2018: Impact of CO_2 storage flux sampling uncertainty on net ecosystem exchange measured by eddy covariance. *Agricultural and Forest Meteorology*, 248:228-239
- Nilsson, E., H. Bergström, A. Rutgersson *et al.*, 2018: Evaluating humidity and sea salt disturbances on CO_2 flux measurements. *Journal of Atmospheric and Oceanic Technology*, 35/4:859-875, DOI:10.1175/JTECH-D-17-0072.1
- Op de Beeck M., B. Gielen, L. Merbold *et al.*, 2018: Soil-meteorological measurements at ICOS monitoring stations in terrestrial ecosystems. *International Agrophysics*, 32:619-631
- Osterwalder, S., J. Sommar, S. Åkerblom *et al.*, 2018: Comparative study of elemental mercury flux measurement techniques over a Fennoscandian boreal peatland. *Atmospheric Environment*, 172, 16-25
- Palace, M., C. Herrick, J. DelGreco *et al.*, 2018: Determining subarctic peatland vegetation using an Unmanned Aerial System (UAS). *Remote Sensing*, 10:1498, DOI:10.3390/rs10091498
- Pavelka M., M. Acosta, R. Kiese *et al.*, 2018: Standardisation of chamber technique for CO_2, N2O and CH_4 fluxes measurements from terrestrial ecosystems. *International Agrophysics*, 32:569-587
- Peichl, M., M. Gažovič, I. Vermeij *et al.*, 2018: Peatland vegetation composition and phenology drive the seasonal trajectory of maximum gross primary production. *Scientific Reports*, 8:8012
- Qiu, C., D. Zhu, P. Ciais *et al.*, 2018: ORCHIDEE-PEAT (revision 4596), a model for northern peatland CO_2, water, and energy fluxes on daily to annual scales. *Geosci. Model Dev.*, 11:497-519, DOI:10.5194/gmd-11-497-2018
- Rebmann C., M. Aubinet, H. Schmid *et al.*, 2018: ICOS eddy covariance flux-station site setup: a review. *International Agrophysics*, 32:471-494
- Siewert, M.B., 2018: High-resolution digital mapping of soil organic carbon in permafrost terrain using machine learning: a case study in a sub-Arctic peatland environment. *Biogeosciences*, 15, 1663-1682
- Singleton, C.M., C.K. McCalley, B.J. Woodcroft *et al.*, 2018: Methanotrophy across a natural permafrost thaw environment. *The ISME Journal*, 12, 2544
- Sponseller, R.A., M. Blackburn, M.B. Nilsson *et al.*, 2018: Headwater mires constitute a major source of nitrogen (N) to surface waters in the boreal landscape. *Ecosystems*, 21, 31-44
- Sprenger, M., D. Tetzlaff, J. Buttle *et al.*, 2018: Storage, mixing, and fluxes of water in the critical zone across northern environments inferred by stable isotopes of soil water. *Hydrological Processes*, 32, 1720-1737
- Sprenger, M., D. Tetzlaff, J. Buttle *et al.*, 2018: Measuring and Modeling Stable Isotopes of Mobile and Bulk Soil Water. *Vadose Zone J.* 17:170149. doi:10.2136/vzj2017.08.0149
- Tang, J., A.Y. Yurova, G. Schurgers *et al.*, 2018: Drivers of dissolved organic carbon export in a subarctic catchment: Importance of microbial decomposition, sorption-desorption, peatland and lateral flow. *Science of the Total Environment*, 622:260-274

- Tiwari, T., Sponseller, R.A., Laudon, H., 2018: Extreme Climate Effects on Dissolved Organic Carbon Concentrations during Snowmelt. *Journal of Geophysical Research: Biogeosciences*, 123/4, 1143-1144, https://doi.org/10.1002/2017JG004272
- Tor-ngern, P., Oren, R., Palmroth et al., 2018: Water balance of pine forests: Synthesis of new and published results. *Agricultural and Forest Meteorology*, 259, 107-117. doi.org/10.1016/j.agrformet.2018.04.021
- Trubl, G., H.B. Jang, S. Roux *et al.*, 2018: Soil viruses are underexplored players in ecosystem carbon processing. *MSystems* 3:e00076-18, DOI:10.1128/msystems.00076-18
- Wang, M., G. Schurgers, H. Hellén, F. Lagergren & T. Holst, 2018: Biogenic volatile organic compound emissions from a boreal forest floor. *Boreal Environment Research.*, 23:249-265
- Wang, S., Lu, X., Cheng, X. *et al.*, 2018: Limitations and Challenges of MODIS-Derived Phenological Metrics Across Different Landscapes in Pan-Arctic Regions. *Remote Sens.* 10(11), 1784; https://doi.org/10.3390/rs10111784
- Wik, M., J.E. Johnson, P.M. Crill *et al.*, 2018: Sediment characteristics and methane ebullition in three subarctic lakes. *Journal of Geophysical Research: Biogeosciences* 123:2399-2411
- Woodcroft, B.J., C.M. Singleton, J.A. Boyd *et al.*, 2018: Genome-centric view of carbon processing in thawing permafrost. *Nature*, 560, 49
- Wu, L., T. Hristov & A. Rutgersson, 2018: Vertical Profiles of Wave-Coherent Momentum Flux and Velocity Variances in the Marine Atmospheric Boundary Layer. *Journal of Physical Oceanography*, 48, 625-641