ICOS Ecosystem Station Labelling Report

Station: FI-Sii (Siikaneva)

Viterbo (Italy), Antwerp (Belgium), Bordeaux (France), October 25th 2017

Description of the Labelling procedure

The Step2 procedure has the aims to organize the building the station in accordance with the ICOS Instructions, to establish the link with the ETC, and to validate all the data formats and submission. Furthermore, it involves also defining the additional steps needed after the labelling to complete the station construction according to the station Class. During the Step2 a number of steps are required and organized by the ETC in collaboration with the PI.

Preparation and start of the Step2

The station started the Step1 of the labelling on April 14th 2016 and got the official approval on August 28th 2016. The Step2 started officially on February 27th 2017 with a specific WebEx between the ETC members and the station team members where the overall procedure was discussed and explained.

Team description

The station PI has to describe the station team and provide the basic information about the proposed station using the BADM system. The submission is done using a specific ICOS interface.

Sampling scheme implementation

The sampling scheme is the distribution of points in the ecosystem where a number of measurements must be done. It is composed by two different type of sampling locations: the Sparse Measurement Plots (SP) that are defined by the ETC following a stratified random distribution on the basis of information provided by the PI and the Continuous Measurement Plots (CP) where continuous measurements are performed.

Measurements implementation

The measurement of a set of variables must be implemented in the Step2 labelling phase. The compliance of each proposed sensor and method is checked by the ETC and discussed with the PI in order to find the optimal solution. In case for specific reasons it is not possible to follow the ICOS agreed protocols and Instructions an alternative solution, equally valid, is defined and discussed also with the MSA if needed.

Once the sensors and methods are agreed the station Team has to implement the measurements using calibrated sensors, submit the metadata to the ETC and start to submit data Near Ream Time for the continuous measurement. Also vegetation samples must be collected and shipped to the ETC chemical laboratory in France. The list of variables to be implemented during Step2 is reported in Table 1. Adaptation of the table to specific ecosystem conditions are possible and always discussed with the PI and the MSA.

In addition to the variables reported in Table 1 there is an additional set of measurements that are requested and that must be implemented after the labelling in the following 1-2 years. For all these variables (in particular for the soil sampling) an expected date and specific method to be used is discussed and agreed before the end of the Step2 process.

Group	Variable
EC fluxes CO2-LE-H	Turbulent fluxes Storage fluxes
Radiations	SW incoming LW incoming SW outgoing LW outgoing PPFD incoming PPFD outgoing
Meteorological above ground	Air temperature Relative humidity Air pressure Total precipitation Snow depth Backup meteo station
Soil climate	Soil temperature profiles Soil water content profiles Soil heat flux density Water table depth
Site characteristics	History of disturbances History of management Site description and characterization
Biometric measurement	Green Area Index Aboveground Biomass
Foliar sampling	Sample of leaves Leaf Mass to Area Ratio
Additional variables for Class1 stations	
Radiation	SW/PPFD diffuse
Meteorological	Precipitation (snow)
Biometric measurement	Litterfall

Table 1 – Variables requested for Step2

<u>Data evaluation</u>

Stations entering Step2 have been already analyzed during Step1 of the labelling but the optimal configuration and the possible presence of issues can be checked only looking to the first data measured. For this reason a number of tests will be performed on the data collected during the Step2 (NRT submissions, that can be integrated if needed by existing data) and the results discussed with the PI in order to find the best solution to ensure the maximum quality that is expected by ICOS stations. Four tests are performed:

Test 1 - Percentage of data removed

During the fluxes calculation the raw data are checked by a number of and some of them will lead to data exclusion and gaps. It is be calculated the number of half hours removed by these QAQC filters and the target value is to have less than 40% of data removed. If the test fails, an in depth analysis of the reasons is performed in order to find solutions and alternatives.

Test 2 – Footprint and Target Area

The Target Area is the area that we aim to monitor with the ICOS station. The test will analyze the estimated contribution area for each half hour using a footprint model (Klijun et al. 2015) and check how many records have a source contribution coming mainly from the target area. The target is to have at least 70% of measurements that are coming mainly (70% of the contribution) from the Target Area. If the test fails, a discussion with the PI is started in order to find solutions and alternatives, in particular changing the measurement height or wind sectors to exclude.

Test 3 – Data Representativeness in the Target Area

The aim is to identify areas that are characterized by different species composition or different management (and consequently biomass and density) and analyze, using the same footprint model (Kljun et al. 2015), the amount of records coming from the different ecosystem patches, checking their representativeness in terms of day-night conditions and in the whole analysed period. The target is to get, for the main ecosystem types, at least 20% of the data during night and during day and also distributed along the period analysed. If not reached, a discussion with the PI is started in order to find solutions and alternatives, e.g. changing the measurement height or wind sectors to exclude.

Test 4 – CP Representativeness in the Target Area

The CPs must be as much as possible representative of the Target Area and this will be checked on the basis of the results of the site characterization, in particular in relation to species composition, biomass and management. The target is to have the percentage of the two main species and their biomass in the CP not more that 20% different respect to the measurements done in the SP plots. In case the CPs proposed do not represent a condition present in the Target Area they are relocated or one or more additional CPs can be added.

Station Description

FI-Sii, called Siikaneva, is a Class 2 ICOS station located in Southern Finland, with coordinates in WGS84 system: Latitude 61.83265°N, Longitude 24.19285°E, at a quote of 160 m asl and an UTC offset of +02. It is a fen belonging to an oligotrophic peatland massif of 1300 ha with few isolated ombrotrophic bogs. Vegetation is characterized by sedges (e.g. Carex limosa, C. rostrata, etc) and continuous Sphagnum moss cover (e.g. Sphagnum papillosum). In addition, dwarf shrubs of Andromeda polifolia and Betula nana are common. Vegetation can be divided into five community types (from drier to wetter): hummock, Eriophorum vaginatum lawn, C. rostrata lawn, C. lasiocarpa lawn, and hollow. Figure 1 shows the fen with the tower hosting the main instrumentation.

Figure 1 - FI-Sii instrumentation over the fen.

Team description

The staff of the site has been defined and communicated in March. It includes in addition to the PI, the CO-PI, the Manager and the technical-scientific staff. Below the summary table of the Team members is reported.

MEMBER_NAME	MEMBER_INSTITUTION	MEMBER_ROLE	MEMBER_MAIN_EXPERT
Eeva-Stiina Tuittila	University of Eastern Finland	PI	BIOMASS

Timo Vesala	University of Helsinki	CO-PI	
Janne Levula	University of Helsinki	MANAGER	
Ivan Mammarella	University of Helsinki	SCI-FLX	
Pasi Kolari	University of Helsinki	DATA	
Heikki Laakso	University of Helsinki	TEC-FLX	
Teemu Matilainen	University of Helsinki	TEC-FLX	

Table 2 - Description of team members roles at FI-Sii

Spatial sampling design

For the spatial sampling scheme design the FI-Sii team proposed, in addition to the Target Area (TA) and an area to be excluded from sampling (EA), a set of continuous measurement points (CP). Fig XX shows the spatial extent and position of such points, in relation to the actual site area. The total TA surface was 10.54 Ha and the total EA surface was 0.38 Ha.

Figure 2: Map of proposed spatial features for FI-Sii

The whole area excluded from the placement of sparse measurements plots (SP-I) comes from the sum of the EA as uploaded by the PI, the CP areas and a 10 m buffer around the TA border so as to ensure SP-I centers to be at least 10 m far from any borders.

In addition to the CPs, the Team proposed a grid of pre-existing plots to be used as SP-I plots. These plots have been used in the past for vegetation mapping and the Team would use these points for further investigations in ICOS. After the effective area (SA in Figure 2) have been partitioned into 10 geographically compact, randomly generated sub-areas of equal size, 20 SP-I locations were randomly extracted (2 within each sub-area). These sampled locations were compared to the proposed ones in order to verify which of the proposed points could replace a sampled location. The rationale was that, to be accepted, a proposed point must be at maximum 20 m far from a sampled point. This approach did not modify the random nature of the design. In Figure 3 a representation of the proposed and sampled SP-I locations is reported, with the definitive locations highlighted. 19 (out of 20) locations were accepted as replaceable, the distances between the couples of points ranged between 1.9 and 16.9 m.

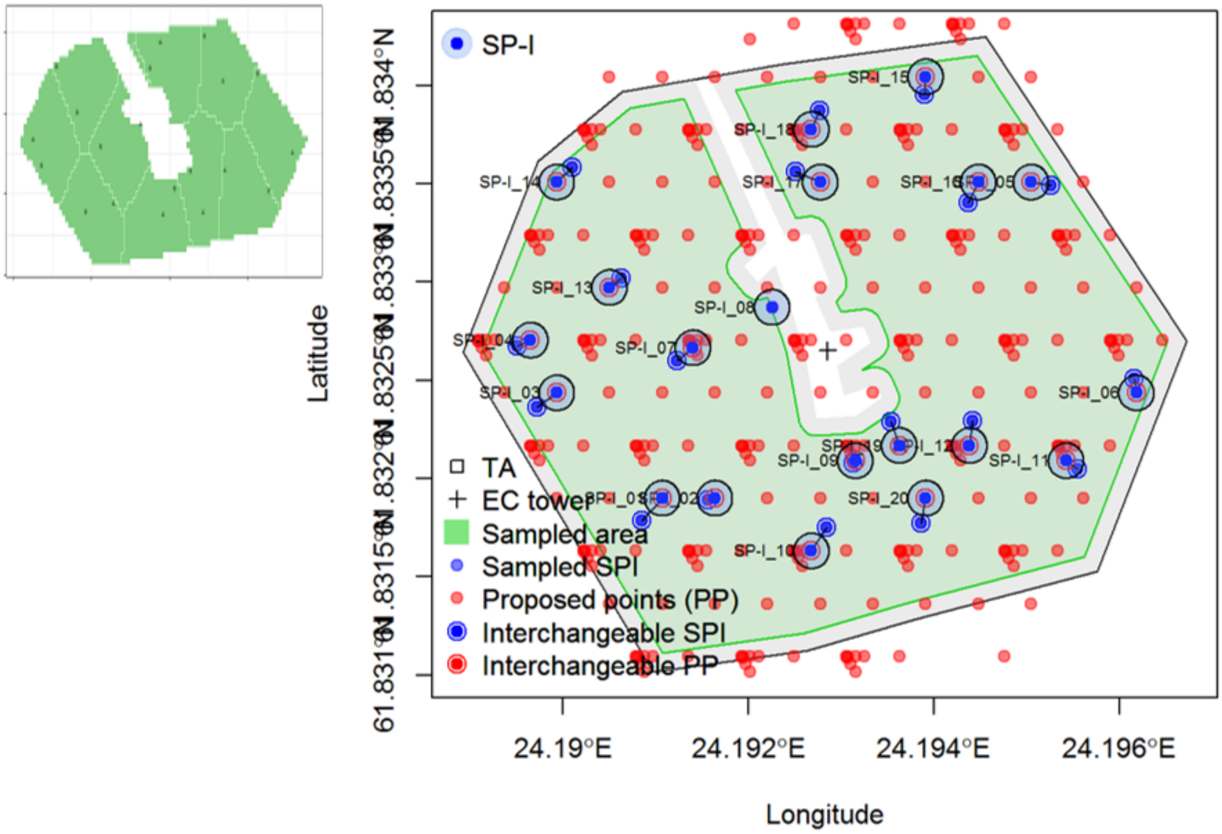


Figure 3: Location of proposed and randomly sampled sampling points. Interchangeable points are highlighted and connected. The box at the top-left corner shows the stratification of the TA into 10 sub-areas of equal size and the respective SP-I sampled locations.

The actual location of the sampling points that the Station Team performed in the field, correctly matched with the proposed design, and such points coordinates are currently definitive and used for specific vegetation and soil samplings (see Figure 7 of the Spatial heterogeneity characterization Section).

Station implementation

Eddy covariance:

FI-Sii station was mounting ICOS compliant sensors for eddy covariance (EC) measurements (ultrasonic anemometer Gill HS and infrared gas analyser LICOR LI-7200, Tab. 3) since February 2016. The sensors have been calibrated more than 2 years ago, but have been unused for a period: it has been agreed to postpone the calibration for maximum 1 year. The sonic anemometer is the reference point of the station, has been oriented towards South (180 degrees from N) and located at 3 m above the ground, in agreement with the ETC.

Model	Serial Number	Measurement height (m)	Eastward Distance (m)	Northward Distance (m)
LI-COR LI-7200	72H-0633	3	0	0
Gill HS-50	H140707	3	0	0

Table 3 - Description of sensors for turbulent measures. The sonic anemometer is the reference point

For what it concerns the storage measurement, given the specific EC measurement height at the site (3 m), the Station Team proposed that storage flux measurements could not be necessary at their site. They prepared and submitted to ETC a preliminary document reporting the results of a test conducted at FI-Sii in August 2016. Measurements were obtained using three LICOR 7000 CO2/H2O analysers. The sampling heights were 0.6 m, 1.6 and 3.0 m, and the flow rates varied between 3.5 - 4 l min-1. The storage flux was calculated using profile measurements as described in an ICOS protocol. In addition, the storage was also determined using data from the 3 m level only. ETC discussed about the experimental results reported in this document and, accordingly, the first impression was that the installation of the storage system (profile) was actually not needed at FI-Sii. For a definitive decision, ETC asked a week of measured data so as to double-check this decision. According to it, and to the document previously sent by the Team, ETC agreed and decided that the profile system is not needed at FI-Sii.

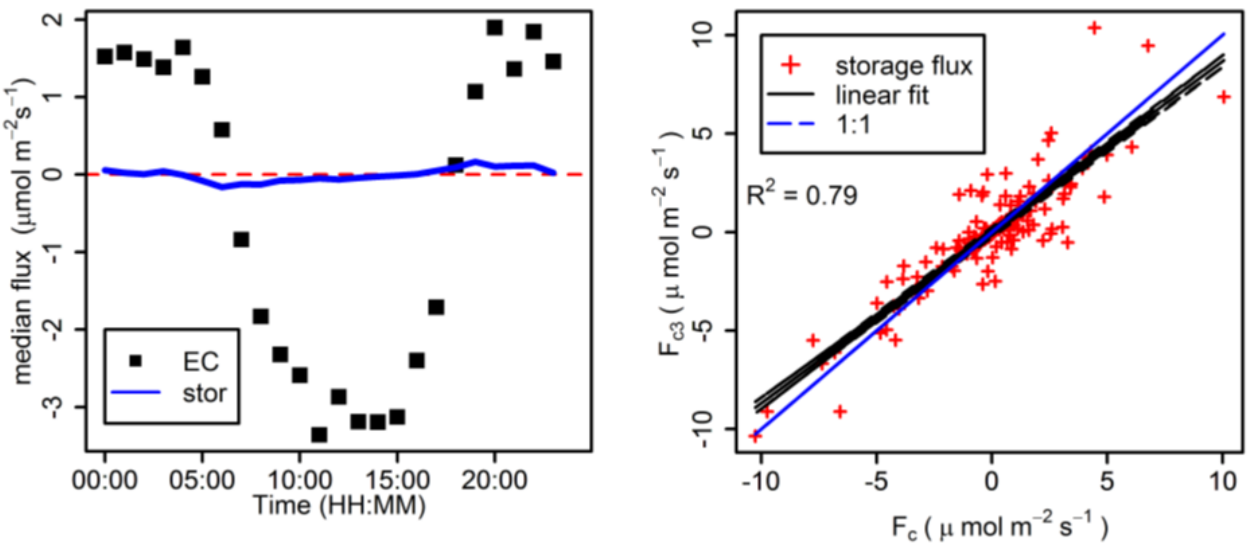


Figure 4: Left panel: median diurnal cycles of the CO2 storage flux (blue solid line) compared to the CO2 EC flux (black squares). Right panel: one-point storage flux (Fc3) against 3 levels profile storage flux (Fc).

Radiations:

For short- and long-wave radiation measurements the Team proposed the use of Kipp&Zonen CNR4 four component radiometer. It is composed by pyranometer and pyrgeometer pairs, one sensor facing upward, the other facing downward, it is ICOS compliant and will be used in combination with CNF4 Ventilation and heating unit. For photosynthetically active radiation measurements the Team proposed the LI-190 (LI-COR) quantum sensor. This sensor is ICOS compliant and has been installed at the site (factory calibration on 2015/12).

MODEL	SN	HEIGHT	EASTWARD_DIST	NORTHWARD_DIST	VARIABLE_H_V_R
Kipp&Zonen CNR4	120928	3	0	7	SW_IN_1_1_1
					LW_IN_1_1_1
					SW_OUT_1_1_1
					LW_OUT_1_1_1
Li-Cor LI-190R	Q101529	3	0	7.5	PPFD_IN_1_1_1
Li-Cor LI-190R	Q101530	3	0	7.5	PPFD_OUT_1_1_1

Table 4 - Description of sensors used for radiation measurements at FI-Sii

Precipitation:

For total precipitation the Team proposed and installed the weighing gauge OTT Pluvio2 (OTT Hydromet) which is compliant with ICOS requirements. For snow depth measurements the ICOS compliant sonic ranging depth sensor SR50ATH-L (Campbell Sci.) will be used.

MODEL	SN	HEIGHT	EASTWARD_DIST	NORTHWARD_DIST	VARIABLE_H_V_R
OTT Pluvio2	385929	1.5	-4.5	4.5	P_3_1_1
Campbell SR50A	7028	1.16	0	10	D_SNOW_1_1_1

Table 5 - Description of sensors used for precipitation measurements at FI-Sii

Air temperature, relative humidity and air pressure

The sensors selected by the PI for air temperature (TA) and relative humidity (RH) are Rotronic MP102H equipped with HygroClip HC2-S3 and in combination with a RS-24T active ventilation shield. These sensor and shield are ICOS compliant. The barometer used for measuring air pressure, a Young 61302V model, is also ICOS compliant.

MODEL	SN	HEIGHT	EASTWARD_DIST	NORTHWARD_DIST	VARIABLE_H_V_R
Rotronic MP102H	61380919_2	3.25	0.5	8	TA_1_1_1
Rotronic MP102H	61380919_1	3.25	0.5	8	RH_1_1_1
Young 61302V	BPA0009495	1.45	-4	5	PA_1_1_1

Table 6 - Description of sensors used for air meteo measurements at FI-Sii

<u>Backup meteorological station</u>

The backup meteorological station has independent power and logging capacity from the main sensors. It is made of ICOS compliant sensors (Tab. 7). It was installed at about 65 m from the main tower after that the ETC did not accept the proposal of using the meteorological data of the station FI-Hyy, located about 5 km away, because too far.

MODEL	SN	HEIGHT	EASTWARD_DIST	NORTHWARD_DIST	VARIABLE_H_V_R
Rotronic MP102H	61543725_2	1.5	-25	60	TA_2_1_1
Rotronic MP102H	61543725_1	1.5	-25	60	RH_2_1_1
Middleton SK-08	3032	2	-25	60	SW_IN_2_1_1
PREC-TipBucGauge	125035	1.5	-24.7	60	P_2_1_1

Table 7 - Description of sensors used in the backup station at FI-Sii

<u>Soil temperature, soil water content, soil heat flux and water table depth</u>

The station team has installed five soil meteo plots, which is in agreement with the ICOS requirement for mires of having at least one soil plot in each of the plant community types that are identified in the target area. At FI-Sii, four plant community types are identified (+ the type ‘pools’). See further below.

The sensor set-up in each of the soil plots is shown schematically in Figure M_1. The selected sensor models and measurement depths are compliant with the ICOS requirements for mires, except on the two points below. These points were discussed between the station team and the ETC and a decision was taken.

<u>Exception 1</u>: The sensors of the proposed Delta-T PR2/4 probe for measurements of soil water content (SWC) have a reported measurement accuracy of 0.06 m^3 m^{-3} under factory calibration. This is less than the minimum required accuracy of 0.05 m^3 m^{-3} defined in the ICOS Instructions.

<u>Decision:</u> The ETC accepts the probe on the condition that the sensors are given a soil-specific calibration, which will increase their measurement accuracy to an acceptable level. The station team has agreed with ETC to perform this calibration in spring 2018.

Exception 2: The set-up deviates on two points from the prescribed measurement depths. Firstly, the second SWC sensor and third soil temperature (TS) sensor are installed at 15 cm instead of the prescribed 10 cm. Secondly, the fourth SWC sensor (at 35 cm) and the matching TS sensor (at 45 cm) are not installed at the same depth, while they should be.

Decision: The ETC accepts these two deviations from the prescribed measurement depths. The rationale for this decision is that it is practically difficult to avoid using profile probes for the TS and SWC profiles in mire soils, and that within the limited range of profile probes with ICOS compliant sensors available on the market, the majority of these probes have fixed sensor distances. Therefore it can for mire stations be difficult to fully reproduce the profiles prescribed in the Instructions. Furthermore, the deviations from the prescribed measurement depths are rather small. Firstly, having the sensors installed at 15 cm - while 10 cm is prescribed, and this for the calculation of soil heat fluxes from the temperature gradient, as a "back up" method for the flux plate method - is less ideal than at 10 cm, but not an insurmountable issue when it comes to the calculation of soil heat fluxes. Secondly, as regards the depth difference between the matching SWC and TS sensors, this difference is only 10 cm (35 vs 45 cm). Since, further, the three uppermost sensors above are installed at agreeing depths (5 cm, 15 cm, and 25 cm), the ETC can live with this deviation.

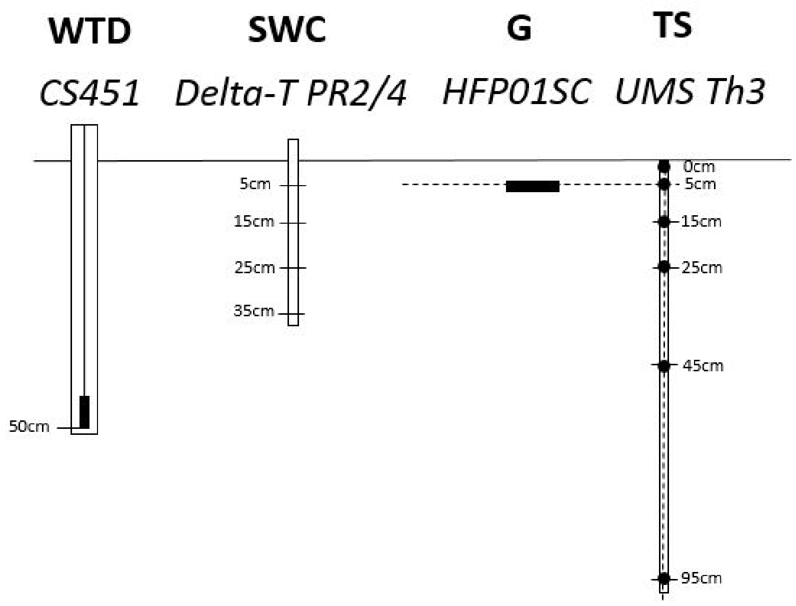


Figure 5: Schematic overview of the installed sensors in each soil plot. The sensor models are given in italics. WTD = water table depth; SWC = volumetric soil water content, G = soil heat flux density, and TS = soil temperature.

MODEL	SN	HEIGHT	EASTWARD_DIST	NORTHWARD_DIST	VARIABLE_H_V_R
UMS TH3	451_1	0	-12.7	42	TS_1_1_1
UMS TH3	451_2	-0.05	-12.7	42	TS_1_2_1
UMS TH3	451_3	-0.15	-12.7	42	TS_1_3_1

UMS TH3	451_4	-0.25	-12.7	42	TS_1_4_1
UMS TH3	451_5	-0.45	-12.7	42	TS_1_5_1
UMS TH3	451_6	-1.35	-12.7	42	TS_1_6_1
UMS TH3	449_1	0	-6.7	9	TS_2_1_1
UMS TH3	449_2	-0.05	-6.7	9	TS_2_2_1
UMS TH3	449_3	-0.15	-6.7	9	TS_2_3_1
UMS TH3	449_4	-0.25	-6.7	9	TS_2_4_1
UMS TH3	449_5	-0.45	-6.7	9	TS_2_5_1
UMS TH3	449_6	-1.35	-6.7	9	TS_2_6_1
UMS TH3	450_1	0	-5.7	2	TS_3_1_1
UMS TH3	450_2	-0.05	-5.7	2	TS_3_2_1
UMS TH3	450_3	-0.15	-5.7	2	TS_3_3_1
UMS TH3	450_4	-0.25	-5.7	2	TS_3_4_1
UMS TH3	450_5	-0.45	-5.7	2	TS_3_5_1
UMS TH3	450_6	-1.35	-5.7	2	TS_3_6_1
UMS TH3	452_1	0	-0.2	-2	TS_4_1_1
UMS TH3	452_2	-0.05	-0.2	-2	TS_4_2_1
UMS TH3	452_3	-0.15	-0.2	-2	TS_4_3_1
UMS TH3	452_4	-0.25	-0.2	-2	TS_4_4_1
UMS TH3	452_5	-0.45	-0.2	-2	TS_4_5_1
UMS TH3	452_6	-1.35	-0.2	-2	TS_4_6_1
UMS TH3	448_1	0	11.3	-27	TS_5_1_1
UMS TH3	448_2	-0.05	11.3	-27	TS_5_2_1
UMS TH3	448_3	-0.15	11.3	-27	TS_5_3_1
UMS TH3	448_4	-0.25	11.3	-27	TS_5_4_1
UMS TH3	448_5	-0.45	11.3	-27	TS_5_5_1
UMS TH3	448_6	-1.35	11.3	-27	TS_5_6_1
Delta-T PR2/4	011-009_1	-0.05	-13.3	42	SWC_1_1_1
Delta-T PR2/4	011-009_2	-0.15	-13.3	42	SWC_1_2_1
Delta-T PR2/4	011-009_3	-0.25	-13.3	42	SWC_1_3_1
Delta-T PR2/4	011-009_4	-0.35	-13.3	42	SWC_1_4_1

Delta-T PR2/4	011-007_1	-0.05	-7.3	9	SWC_2_1_1
Delta-T PR2/4	011-007_2	-0.15	-7.3	9	SWC_2_2_1
Delta-T PR2/4	011-007_3	-0.25	-7.3	9	SWC_2_3_1
Delta-T PR2/4	011-007_4	-0.35	-7.3	9	SWC_2_4_1
Delta-T PR2/4	011-005_1	-0.05	-6.3	2	SWC_3_1_1
Delta-T PR2/4	011-005_2	-0.15	-6.3	2	SWC_3_2_1
Delta-T PR2/4	011-005_3	-0.25	-6.3	2	SWC_3_3_1
Delta-T PR2/4	011-005_4	-0.35	-6.3	2	SWC_3_4_1
Delta-T PR2/4	011-006_1	-0.05	-0.8	-2	SWC_4_1_1
Delta-T PR2/4	011-006_2	-0.15	-0.8	-2	SWC_4_2_1
Delta-T PR2/4	011-006_3	-0.25	-0.8	-2	SWC_4_3_1
Delta-T PR2/4	011-006_4	-0.35	-0.8	-2	SWC_4_4_1
Delta-T PR2/4	012-005_1	-0.05	10.7	-27	SWC_5_1_1
Delta-T PR2/4	012-005_2	-0.15	10.7	-27	SWC_5_2_1
Delta-T PR2/4	012-005_3	-0.25	10.7	-27	SWC_5_3_1
Delta-T PR2/4	012-005_4	-0.35	10.7	-27	SWC_5_4_1
Hukseflux HFP01SC-05	4535	-0.05	-13	42	G_1_1_1
Hukseflux HFP01SC-05	4537	-0.05	-7	9	G_2_1_1
Hukseflux HFP01SC-05	4538	-0.05	-6	2	G_3_1_1
Hukseflux HFP01SC-05	4536	-0.05	-0.5	-2	G_4_1_1
Hukseflux HFP01SC-05	4534	-0.05	11	-27	G_5_1_1
Campbell CS451	20010875	-0.5	-13	43	WTD_1_1_1
Campbell CS451	20010862	-0.5	-7	10	WTD_2_1_1
Campbell CS451	20010861	-0.5	-6	1	WTD_3_1_1
Campbell CS451	20010930	-0.5	-0.5	-3	WTD_4_1_1
Campbell CS451	20010854	-0.5	11	-26	WTD_5_1_1

Spatial heterogeneity characterization

As requested, the station team has in the summer of 2017 carried out a detailed vegetation survey at all 100 second-order Sparse Measurement (SP-II-order) points and at all 15 Continuous Measurements Plots (CPs) that the team has selected in the target area. The vegetation survey data comprise visual estimates of percentage cover at species level. The data were successfully submitted to ETC. The data from the SP-II-order points were fed into the Two-Way Indicator Species Analysis (TWINSPAN) software in order to classify the SP-II-order points on the basis of their species composition, and to characterize with this classification the target area in terms of the main plant community types. Four plant community types were distinguished on the basis of the TWINSPAN output: hummock, *Eriophorum* lawn, *Carex* lawn, and hollow. Figure M_2 shows the relative proportion of the SP-II-order points per plant community type. Figure M_3 shows the distribution of the SP-II-order points around the EC tower per community type; also the CPs are shown on the map.

Note: The team has installed in total 15 CPs in the target area. This is a sufficient amount of CPs, since the Instructions request for Class 2 stations in mires 'a minimum of 10 CPs if three or more plant community type are distinguished in the target area'.

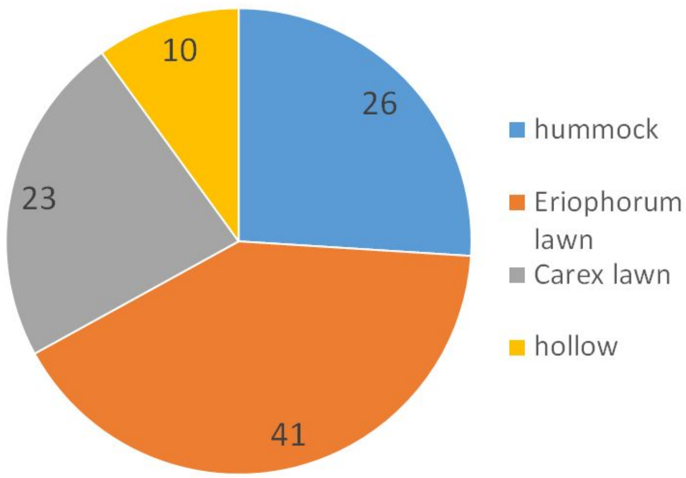


Figure 6: The number of SP-II-order points per plant community type, based on the output of the TWINSPAN software.

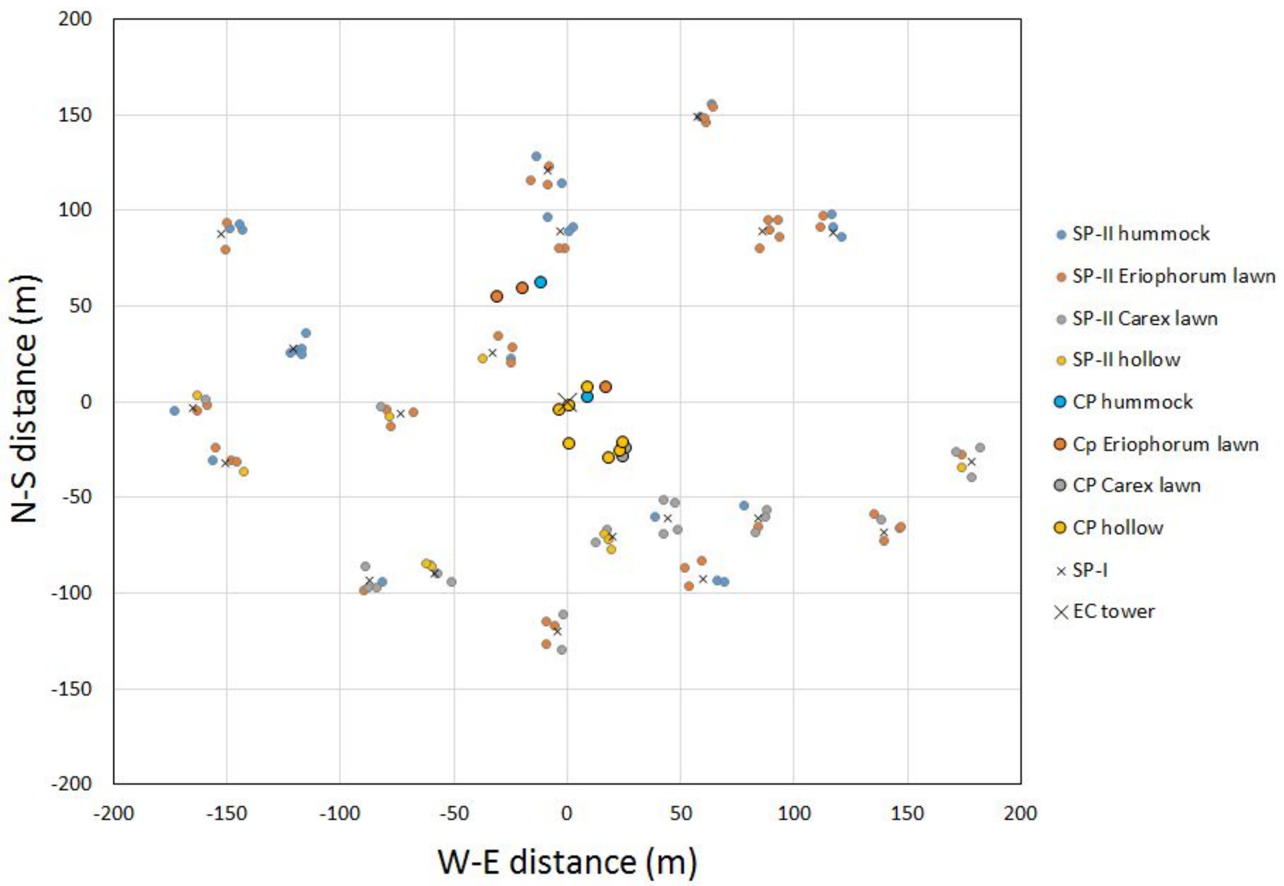


Figure 7: Distribution of the SP-II-order points (SP-II) per plant community type around the eddy covariance (EC) tower. Also shown are the CPs per plant community type and the SP-I-order points (SP-I).

Green Area Index

Throughout the 2017 growing season, the station team has collected Green Area Index (GAI) measurements on the main moss, herbaceous, and dwarf shrubs species in the 15 installed CPs. The GAI of mosses was measured once in May with the prescribed visual estimation method. The GAI of herbs and dwarf shrubs was measured five times throughout the season with the prescribed modified Vascular Green Area method. The team collected much more measurements than strictly required for the second step of the labelling phase. All GAI data were successfully submitted to the ETC. As an example, Figure M_4 shows measured GAI for the main species in plot CP_02.

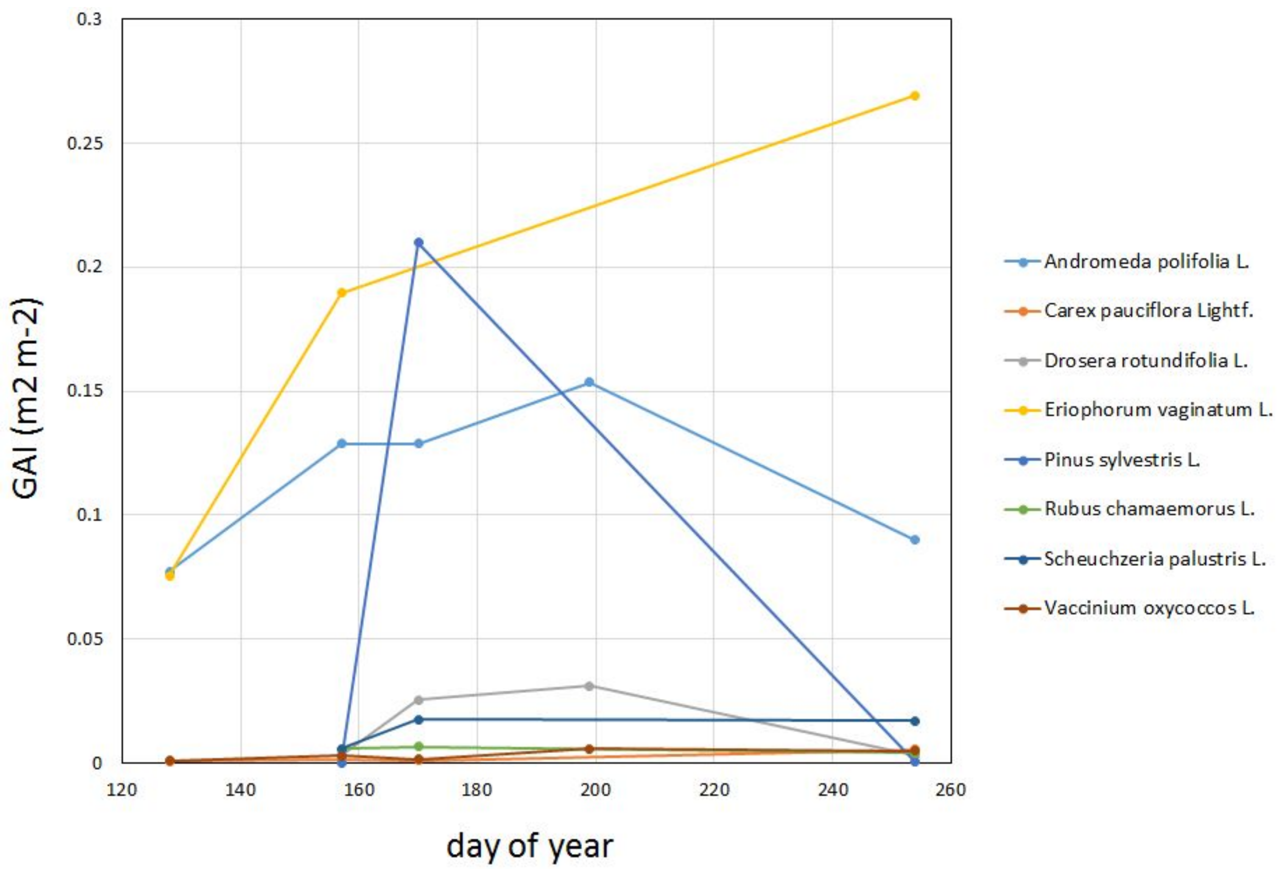


Figure 8: Green Area Index (GAI) measured on the main species in plot CP_02.

Aboveground biomass

Throughout the 2017 growing season, the station team has collected measurements of green Aboveground biomass (AGB) on the main herbaceous and dwarf shrubs species in the 15 installed CPs. Because green AGB is measured with the same method as GAI, applying empirical area-to-biomass ratios, the AGB measurements were collected at the same temporal frequency as the GAI measurements (= five times). The team collected much more measurements than strictly required for the second step of the labelling phase. All green AGB data were successfully submitted to the ETC. The station team did not yet submit data for woody AGB of dwarf shrubs, since measurements to calibrate the prescribed modified point intercept method still are to be processed this autumn. The ETC is aware of this and agreed with the station team to submit these AGB data once available. The ETC has in the meantime been given the raw point intercept data already collected (= number of needle hits).

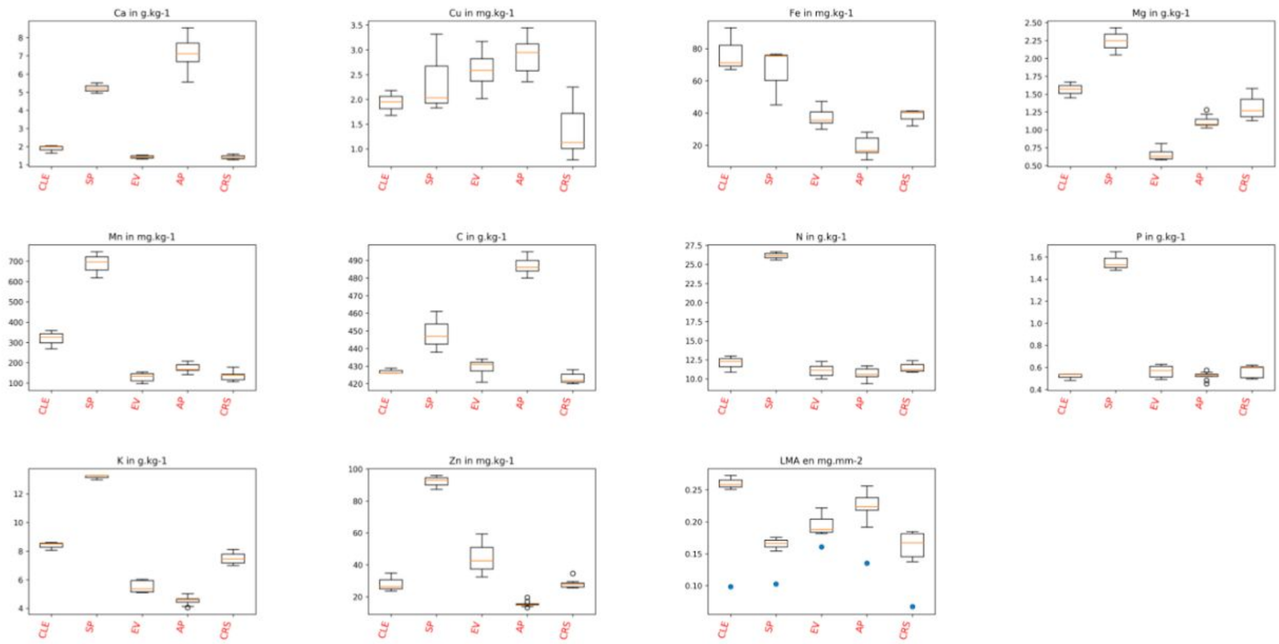
Vegetation sampling and analysis

The foliar samples for the determination of the leaf mass-to-area ratio and the nutrient analysis were collected by August 18th and the related instructions for area and dry mass determinations as well as for leaf packaging were applied correctly. The sample were split among five species for accounting for the species diversity at this site. The quality control for these data consists in systematic comparison with (i) previous analysis results, irrelevant for the present labelling, and

(ii) literature data and databasis such as TRY (references below). At this stage the procedure is not achieved entirely since the reference metadata of those could not be retrieved completely. The quality control procedure will be continued therefore and achieved within weeks.

However the results obtained in terms of average values and precision (shown below) are consistent with the current literature data and considered acceptable. There is a discrepancy between data obtained from the TRY databasis for the LMA results (systematically underestimates) but due to the lack of related metadata (e.g. the drying temperature, date of sampling etc.) no conclusion can be drawn thus far.

Foliar Analyses for station FI-Sii, 2017-08-18



CLE = Carex lasiocarpa Ehrh. SP = Scheuchzeria palustris L. EV = Eriophorum vaginatum L. AP = Andromeda polifolia L. CRS = Carex rostrata Stokes
Data from TRY-db (https://www.try-db.org/TryWeb/Home.php)

Figure 9: Boxplots of nutrient mass per g dry mass of leaves of five main species at the Siikaneva site (FI-Sii) and leaf mass-to-area ratio (LMA). Each plot gives the distribution and median value of the sample per species. The number of replicates is as follows: Carex L : *n*=3; Carex r. : *n*=7, Eriophorum v.: *n*=8 Andromeda p.: *n* = 9; Scheuchzeria p.: *n*=2. Leaves samples were collected by August 18th 2017 using a sampling scheme compliant with the ICOS instructions. Blue dots give values obtained from the TRY databasis.

Reference of the TRY databasis.
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Data check and test

Data quality analysis (Test 1)

On the basis of the current state of scientific knowledge, the quality control (QC) procedure aims to verify that at least 60% of half-hourly values in a given temporal window (e.g. 3 months) are of the highest quality possible. This means that the total percentage of missing and removed data after the QC filtering do not exceed the 40% threshold value.

The QC procedure involves a sequential filtering of half-hourly flux data flagged by severe and moderate quality (Vitale et al, *in prep*). A severe flag is assigned (i) when flux originates from wind sectors to exclude; (ii) in case of instrument malfunction as provided by sonic anemometer (SA) and gas analyser (GA) diagnostics; (iii) when flux is out of its physical range; (iv) when stationary and integral turbulence conditions are not satisfied following the quality flag policy by Mauder and Foken (2004, qc flag 2) based on the combination of the quality assessment tests by Foken and Wichura (1996); (v) when the maximum covariance between vertical wind speed and CO_2 concentrations occurs at implausible time lag respect to the eddy covariance system setup; (vi) in case of anomalous values of the spectral correction factor.

A moderate flag is assigned (i) when stationary and integral turbulence conditions are only partly satisfied (i.e. flag 1 of quality policy by Mauder and Foken, 2004), and (ii) in case of failure of one of statistical tests proposed by Vickers and Mahrt (1997) to detect any instrument malfunction. Flux data flagged with severe quality are directly discarded, whereas those with moderate quality are removed only if they are also identified as outlier.

Concerning FI-Sii site, the testing period involves raw data sampled in 2017 from June 8th to September 14th. Of 4656 expected half-hourly files for NEE fluxes, 67.1% were retained after the QC filtering procedure as illustrated in Figure 10. In particular, 13.7% of raw files were missed, 14.1% of calculated fluxes were discarded because flagged by severe quality, while an additional 5.1% of them were discarded because identified as outliers and flagged by moderate quality. Being the percentage of missing data equal to 32.9% and below the 40% threshold value, we conclude that FI-Sii site reaches the minimum requisite expected for the Step 2 of the labelling.

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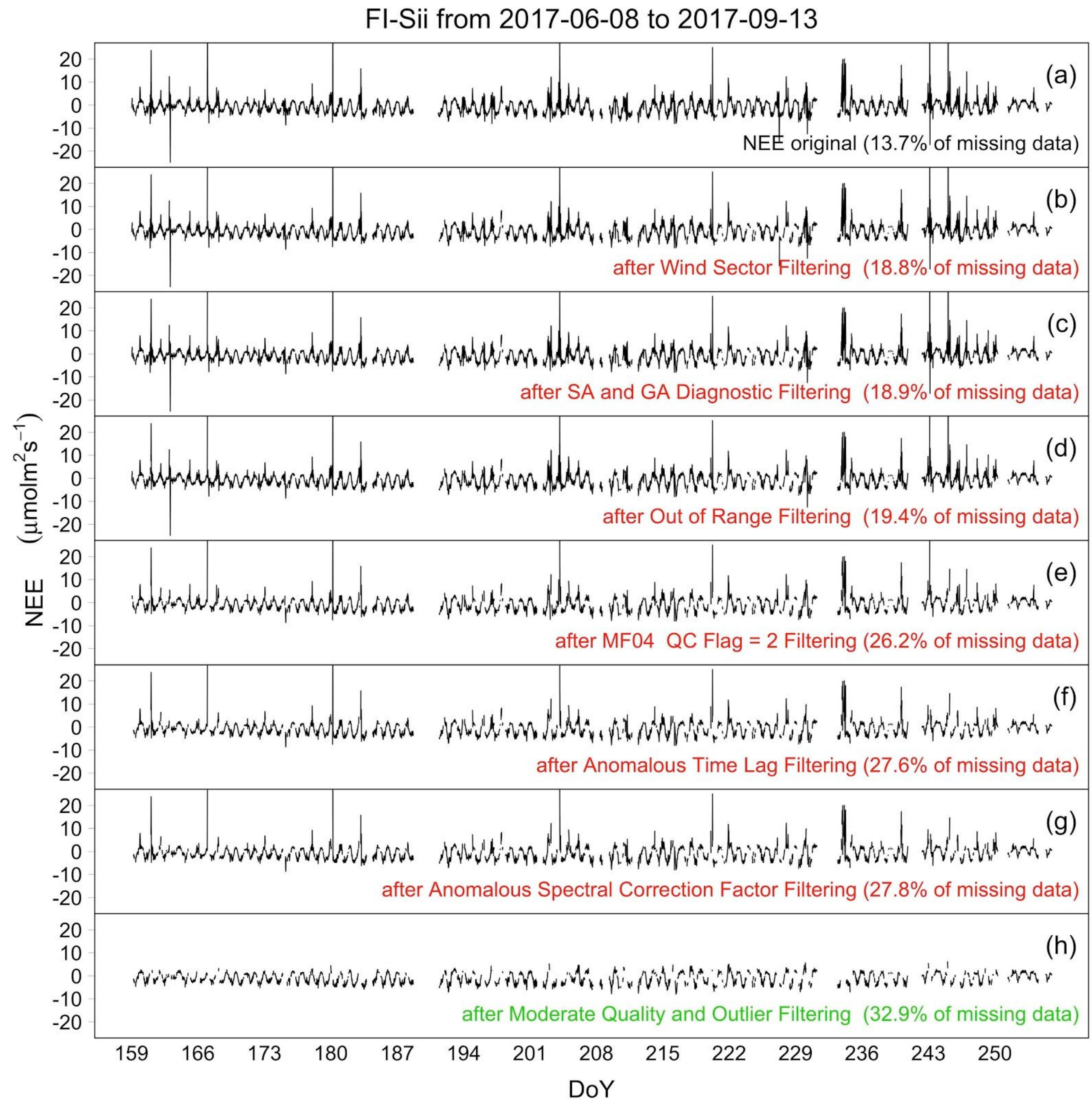

Figure 10: Sequential filtering of Net Ecosystem Exchange (NEE) sampled at FI-Sii from 2017/06/08 to 2017/09/13 according to the quality control procedure. The original half-hourly flux time series is exhibited in the top panel. Panels b-g display the severe quality flag filtering due to: wind sectors to exclude; diagnostics provided by sonic anemometer (SA) and gas analyser (GA); out of physical range check; Mauder and Foken (2004, MF04) quality policy (flag=2); anomalous time lag of the cross-correlation function estimated between vertical wind speed and CO_2 concentrations; anomalous spectral correction factor check. Bottom panel displays the retained high-quality NEE time series after the additional filtering due to moderate quality flags (mainly related to Mauder and Foken (2004) quality policy (flag=1) and Vickers and Mahrt (1997) statistical tests) combined with the outlier detection procedure.

Footprint analysis (Test 2)

The test aimed to evaluate if half-hourly flux values are effectively representative of the target area was performed on 3 months of data, after QA/QC filtering procedure (previous Section). The model of Klijun et al. (2015) has been used to obtain the 2-dimensional flux footprint for each half-hour which, having been georeferenced, was compared to the TA spatial extent. Results showed that basically the 100 % of the whole data have a cumulated contribution of at least 70 % from the Target Area, and this holds also for daytime and nighttime conditions.

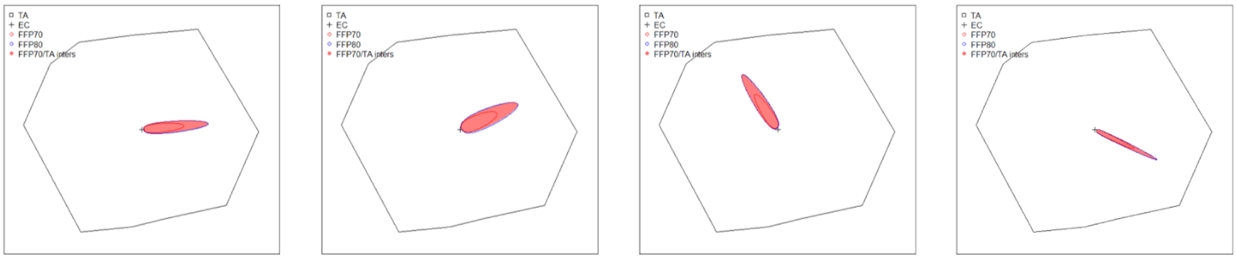

Figure 11: exemplary representation of 70% and 80% footprint contribution at FI-Sii during 4 representative half-hours.

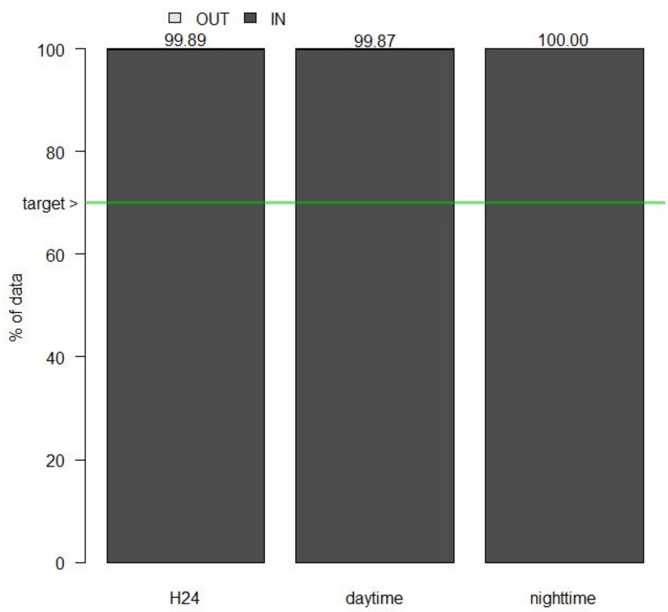

Figure 12: test results showing the percentage of half-hours with a footprint cumulated contribution of 70% from the target area. The target value is that the 70% of data must hold this condition.

Data representativeness analysis (Test 3)

At FI-Sii the spatial heterogeneity characterization revealed a well mixed distribution of plant community types which prevented the definition of homogeneous areas. As a consequence, two land cover typologies (LCT) have been defined according to the vegetation structure, estimated comparing the vegetation map and the high resolution image submitted by the station PI. Given the specific species distribution (the TA does not contain sensible vegetation discontinuities), this empirical approach can be accepted. The two defined LCT are shown in Figure 13

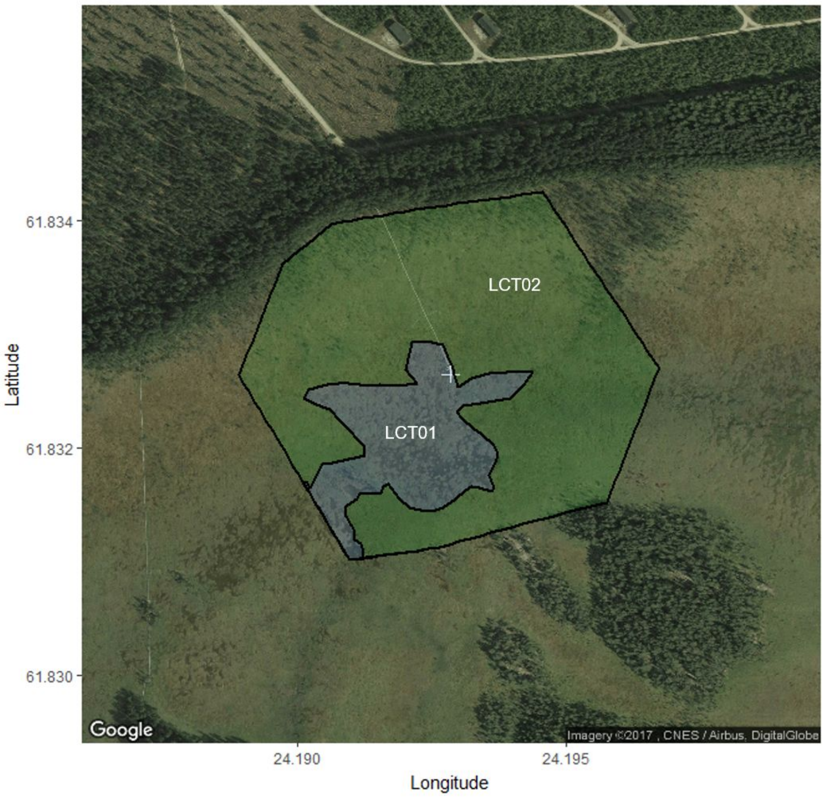

Figure 13: Spatial extent of the two land cover typologies (LCT) defined into the target area of FI-Sii.

The half-hourly 2-D footprint estimations were used to quantify the amount of records coming from the different LCT, checking their representativeness in terms of day-night conditions and in the whole analysed period. The target is to get for each representative LCT, at least 20% of the data during the whole period and considering day/night separately with 70% of cumulated contribution. The figure below (Figure 13) shows some exemplary results of the intersection between the half-hourly footprint and the LCT.

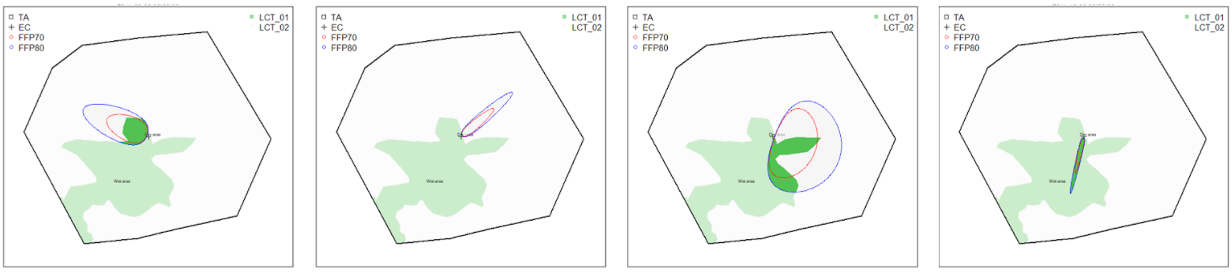

Figure 13: exemplary results of the intersection between half-hourly footprints and the LCT at FI-Sii.

The numerical analysis showed that both LCT are sufficiently sampled (i.e. more than 70% of the flux contribution) in more than 20% of the data and considering both the whole analysed period (3 months) and day and night separately (Figure 14).

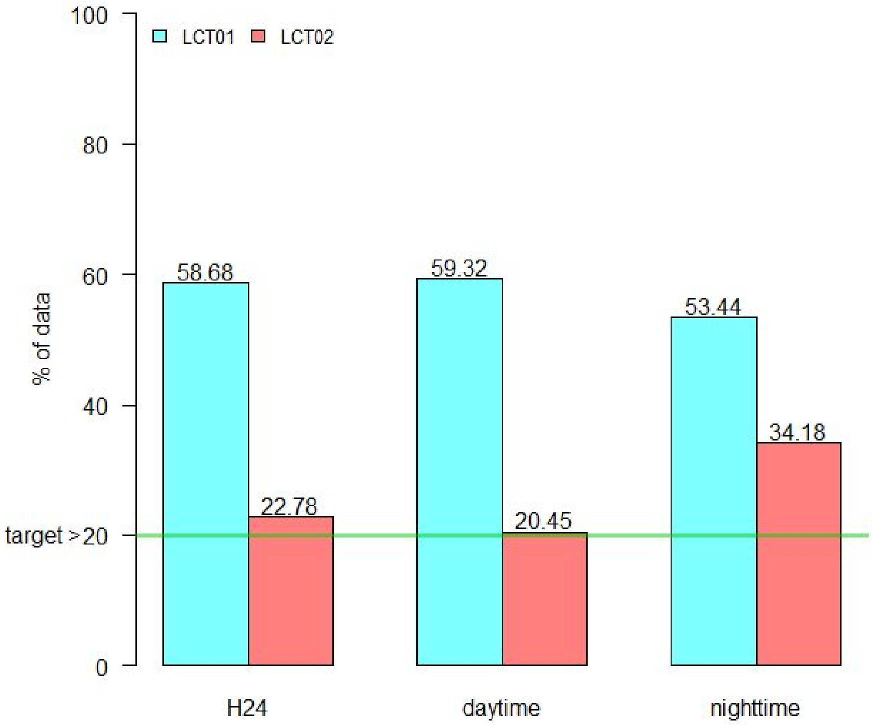

Figure 14: statistics for the spatial analysis of the representativeness of the two LCT defined for FI-Sii. The target is to get at least 20% of the data with at least 70% of contribution from each LCT.

Continuous Measurement Plot representativeness (Test 4)

The representativity of the 15 CPs installed in the target area was first tested with respect to the target area as a whole. This test involved comparing the species composition of the 100 SP-II-order points and the 15 CPs in terms of the scaled abundance of the two main field layer species (*Andromeda polifolia L.; Eriophorum vaginatum L.*) and the main moss species (*Sphagnum papillosum Lindb.*). Scaled abundance is the measured percentage cover converted into the following six abundance categories: 0% = 0, 0-2% = 1, 2-5% = 2, 5-10% = 3, 10-20% = 4, >20% = 5. This conversion was done to remove the confounding effect of very high cover values. The test confirmed that for the above-mentioned three species the abundance was within the +/- 20% limits defined by ETC for this representativity test (see Figure X). While this test only remotely indicates that the group of CPs is generally representative for the target area as a whole, a second - and for mire stations a scientifically more relevant - test was carried out to evaluate whether each selected CP is representative for the plant community type it is supposed to represent. This test involved feeding the CPs along with the SP-II-order points in the TWINSPAN software the same algorithm used to define the PCTs on the basis of the vegetation data collected at the SP-II-order points.) and then verifying that it classifies each CP into the target group of plots. The outcome of this test was positive.

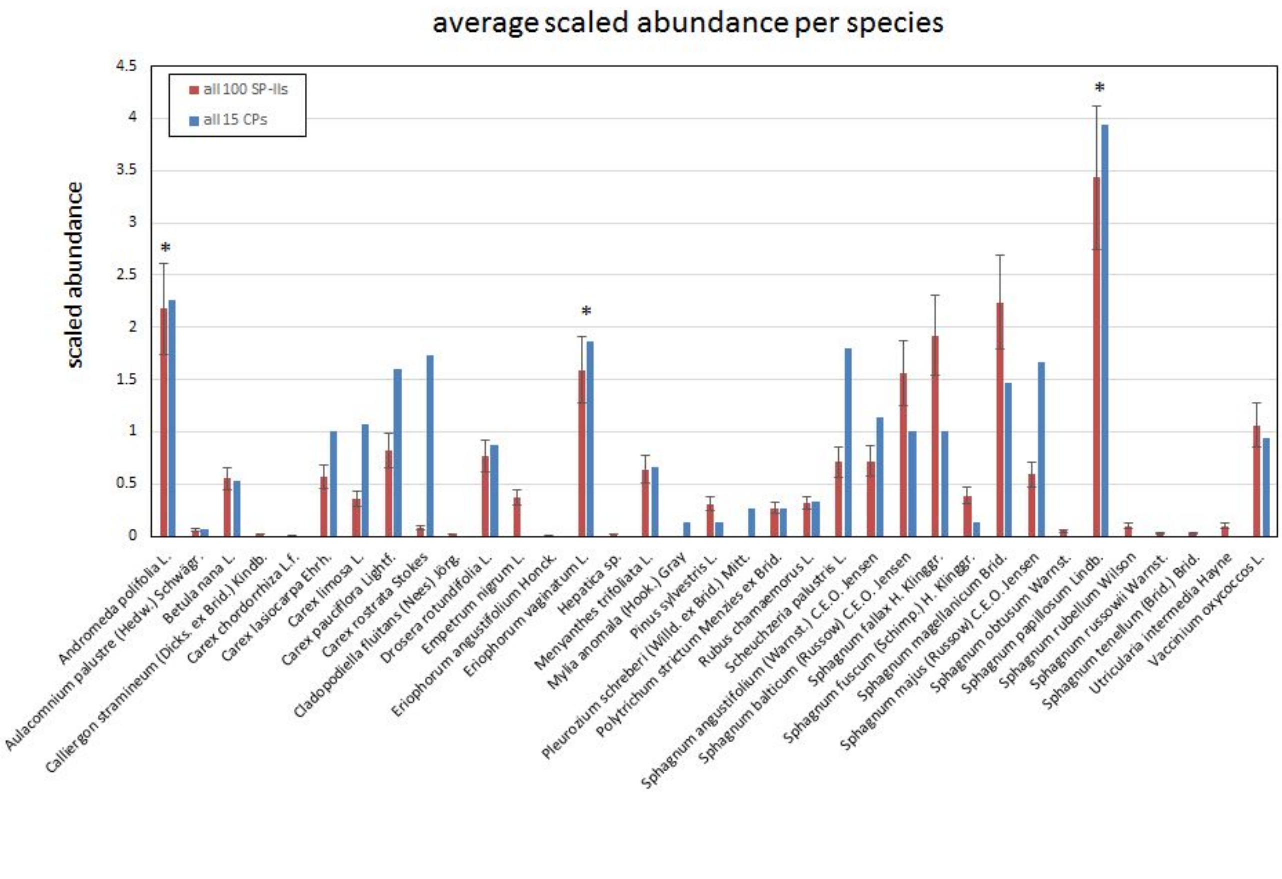

Figure 15: The average scaled abundance per species for all second-order Sparse Measurement plots (SP-IIs; red bars) and all continuous plots (CPs; blue bars). The error bars show +/-20%. The asterisks indicate the two main species in the field layer (*Andromeda polifolia L.* and *Eriophorum vaginatum L.*) and the main moss species (*Sphagnum papillosum Lindb.*).

Near Real Time data transmission

The station is submitting to the ETC compressed ASCII files in NRT transmission for EC data, and uncompressed ASCII files for BM data since September 18th 5 pm. The number of expected EC files until October 22nd is 1646. The total number of file received is 1589, i.e. 96.5%. The acquisition strategy is based upon a dedicated software developed by the station team, running on PCs. The synchronisation of the time-series will be tested in the next weeks. The files are ICOS compliant, after some modifications requested by the ETC on the format.

Plan for remaining variables

Soil sampling

The FI-Sii soil sampling for the determination of the organic carbon and nitrogen soil stocks (0 - 1m) will be challenging but we expect a tight collaboration with the station team for solving the problems expected in organic soils, and specifically mires. The sampling is planned in Spring 2018.

Labelling summary and proposal

On the basis of the activities performed and data submitted and after the evaluation of the station characteristics, the quality of the data and setup, the compliance of the sensors and installations and the team capacity to follow the ICOS requirements for ICOS Ecosystem Stations we recommend that the station Siikaneva (FI-Sii) is labelled as ICOS Class2 Ecosystem station.

Dario Papale, ETC Director

October 25th 2017