ICOS Ecosystem Station Labelling Report

Station: SE-Myc (Mycklemossen)

Italy, Belgium, France, October 9th 2024

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 also involves 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 September 27th 2021 and got the official approval on June 17th 2021. The Step2 started officially on June 18th 2021 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 types of sampling locations: the Sparse Measurement Plots (SP) that are defined by the ETC following a stratified random distribution based on 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 specific reasons make it impossible to follow the ICOS agreed protocols and Instructions an alternative solution, equally valid, is defined and discussed with the MSA if needed.

Once the sensors and methods have been agreed upon the station Team has to implement the measurements using calibrated sensors, submit the metadata to the ETC and start to submit data Near Real 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 is 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 upon before the end of the Step2 process.

<table>
<tr><th>Group</th><th>Variable</th></tr>
<tr><td>EC fluxes CO2-LE-H</td><td>Turbulent fluxes
Storage fluxes</td></tr>
<tr><td>Radiations</td><td>SW incoming
LW incoming
SW outgoing
LW outgoing
PPFD incoming
PPFD outgoing</td></tr>
<tr><td>Meteorological above ground</td><td>Air temperature
Relative humidity
Air pressure
Total precipitation
Snow depth
Backup meteo station</td></tr>
<tr><td>Soil climate</td><td>Soil temperature profiles
Soil water content profiles
Soil heat flux density
Groundwater level</td></tr>
<tr><td>Site characteristics</td><td>History of disturbances
History of management
Site description and characterization</td></tr>
<tr><td>Biometric measurement</td><td>Green Area Index
Aboveground Biomass</td></tr>
<tr><td>Foliar sampling</td><td>Sample of leaves
Leaf Mass to Area Ratio</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Additional variables for Class1 stations</td></tr>
<tr><td>Radiation</td><td>SW/PPFD diffuse</td></tr>
<tr><td>Meteorological</td><td>Precipitation (snow)</td></tr>
<tr><td>Biometric measurement</td><td>Litterfall</td></tr>
</table>

Table 1 – Variables requested for Step2

Data evaluation

Stations entering Step2 have already been analyzed during Step1 of the labelling but the optimal configuration and the possible presence of issues can be checked only by 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 will be 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. The number of half hours removed by these QAQC filters will be calculated 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 will check how many records have a 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 ecosystems, checking their representativeness in terms of day-night conditions and in the period analyzed. 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, in particular 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 than 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

The Mycklemossen site (ICOS code SE-Myc) is located in south-west Sweden approximately 80 km north of Gothenburg. Its coordinates in the WGS84 system are Latitude 58.36503 °N, Longitude 12.1694 °E. The elevation is 93 m above sea level and the UTC offset is +01. Mycklemossen is a hemi-boreal, oligotrophic bog and has a catchment area of approximately 0.59 km^2, the climate is temperate maritime with a Mean Annual Temperature of 7 °C, a Mean Annual Precipitation of 1052 mm and a Mean Annual Radiation (incoming shortwave) of 112 W m^{-2}, the days when the ground is covered by snow are on average 50 per year.

The vegetation is fairly homogeneous across the mire which is made up of a mosaic of drier hummocks and wetter hollows. The hummocks are dominated by *Eriophorum vaginatum* (L.) and dwarf shrubs such as *Calluna vulgaris* (L.) Hull and *Erica tetralix* (L.), whereas the hollows are characterized by different Sphagnum species, mainly *Sphagnum rubellum* Wilson, *Sphagnum fallax* H.Klinggr. and *Sphagnum austinii* Sull., and *Rhyncospora alba* (L.) Vahl. Towards the centre of the mire, conditions are drier and the vegetation is more forest-like, with a sparse tree layer dominated by *Pinus sylvestris* (L.), and more dwarf shrubs such as *Vaccinium uliginosum* (L.), *Vaccinium myrtillus* (L.)and *Vaccinium vitis-idaea* (L.).

Figure 1: the SE-Myc station

Team description

The staff of the site has been defined in May 2021, and subsequently updated. It includes in addition to the PI, the technical-scientific and affiliated staff. Below the summary table of the actual Team members is reported.

MEMBER_NAME	MEMBER_INSTITUTION	MEMBER_ROLE	MEMBER_MAIN_EXPERT
Per Weslien	University of Gothenburg	PI	MICROMET
Jutta Holst	Lund University	DATA	DATAPROC
Amelie Lindgren	University of Gothenburg	ADMIN	DATAPROC

Table 2 - Description of the actual team members roles at SE-Myc

Spatial sampling design

For the spatial sampling design at SE-Myc, the Station Team proposed, in addition to the Target Area (TA), 10 areas to be excluded from sampling (EA), Figure 2 left panel. In addition, 8 Continuous measurement points (CP) were proposed. Given that the mire is not accessible, making it impossible to visit the SP-I locations, it has been agreed with ETC to position 100 additional sampling points in a systematic design along the boardwalk paths (Figure 2 right panel). These sets of points have been checked and agreed, and are now the definitive sampling location at the site.

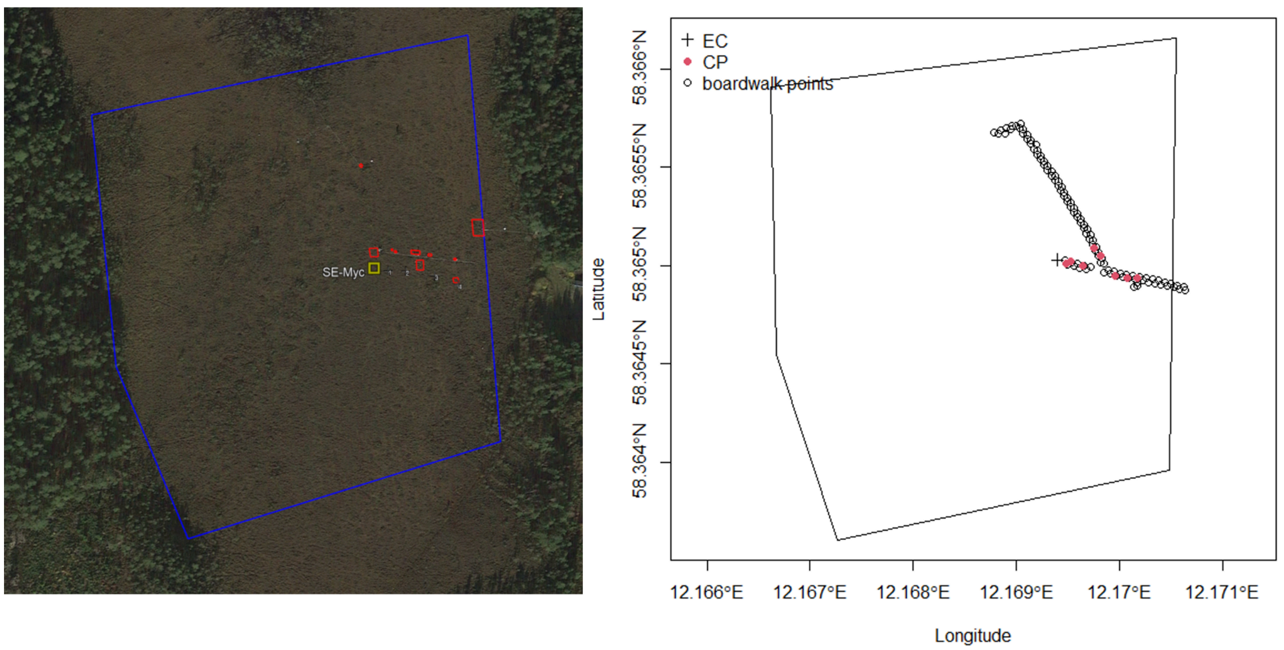

Figure 2: *Left panel:* aerial map of SE-Myc and proposed target area (TA, blue) and exclusion areas (EA, red). *Right panel*: CP points (red) and 100 sampling points (black) systematically placed along the boardwalk paths.

Station implementation

Eddy covariance:

EC System		
MODEL	GA_CP-LI-COR LI-7200RS	SA-Gill HS-50
SN	72H-1105	H231505
HEIGHT (m)	2.2	2.2
EASTWARD_DIST (m)	0.14	0
NORTHWARD_DIST (m)	-0.01	0
SAMPLING_INT	0.05	0.05
LOGGER	1	1
FILE	1	1
GA_FLOW_RATE	12	-
GA_LICOR_FM_SN		-
GA_LICOR_AIU_SN	AIU-2356	-
SA_OFFSET_N	-	270
SA_WIND_FORMAT	-	U, V, W
SA_GILL_ALIGN	-	Axis
ECSYS_SEP_VERT	-0.07	
ECSYS_SEP_EASTWARD	0.19	
ECSYS_SEP_NORTHWARD	-0.01	
ECWEXCL	90	
ECWEXCL_RANGE	20	

The ICOS EC sensors (Gill HS 50 and LI-7200RS) are in place at the station since the end of 2021. The calibration of the IRGA is valid till mid 2024, while a spare, calibrated sonic (till end of 2025) is installed for replacement of two other sensors that needed repair. The location, height and orientation of the sonic is in line with what agreed during the step1 by the PI and the ETC.

In the Step 1 it was made a point of the effect of the forest edge and possible perturbation of turbulence, with the availability of the station team to perform measurement campaigns with a set of sonics and gas analyzers. As the quality test is passed (see below) the ETC considers this campaign not needed at the moment. However, this could change in the case of future issues in the data, or also if the station team is willing to go deeper on that point: the ETC is available for directions and fruitful discussion. The station team is committed to update the firmware of the LI7200 in the coming weeks.

Storage: considering the EC system height (2.2 m) and the local vegetation characteristics, it has been agreed that the storage system (profile) is not needed.

Radiations:

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
RAD_4C-K&Z CNR4	120871	6	25.7	-13.5	SW_IN_1_1_1
					SW_OUT_1_1_1
					LW_IN_1_1_1
					LW_OUT_1_1_1
RAD_PAR-LI-COR LI190R	Q105602	6	25.7	-12.9	PPFD_IN_1_2_1
RAD_PAR-DeltaT BF5	24/09	6.2	26.4	-5.2	PPFD_IN_2_1_1
					PPFD_DIF_1_1_1
RAD_PAR-LI-COR LI190R	Q105514	6	25.7	-12.9	PPFD_OUT_1_1_1

The station team proposed the CNR4 (Kipp&Zonen) 4-way radiometer as the main sensor to measure incoming/outgoing shortwave and longwave radiation used with the CNF4 ventilation unit. PPFD incoming and outgoing will be measured with a pair of LI-190/R (Li-Cor) quantum sensors. A BF5 (Delta-T) will be used to measure diffuse radiation which needs to be rescaled according to ETC recommendation.

Precipitation:

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
PREC-Lambrecht 1518x	860777.0016	1	32	-6.2	P_1_1_1
SNOW-Campbell SR50x	4577	1.72	15.7	1.8	D_SNOW_1_1_1

For the precipitation measure, the 15188 weighing gauge (Lambrecht) will be used together with a compliant wind-shield (Alter type). Snow depth will be measured with the SR50 (Campbell) sonic distance sensor.

Air temperature, relative humidity and air pressure

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
RHTEMP-Rotronic HC2(A)-S	20662042	2.3	26.2	-5.2	TA_1_1_1
					RH_1_1_1
PRES-Vaisala PTB210	H2220004	1.2	24.5	-5	PA_1_1_1

The station team initially proposed a non fully ICOS-compliant sensor for TA, RH: Rotronic HC2-S3, as for TA the range is narrower than ICOS requirements (i.e. lowest limit at -40°C instead of -50°). The station team informed the ETC that the minimum temperature registered on site during the last 10 years is -24 °C, and the one registered at the closer meteorological station active since 30 years is -20.6 °C: for that reason the ETC considers very unlikely that the temperature could go below -40 °C for a significant period of time, and accepted the HC2-S3. For PA, Vaisala PTB210 was proposed, which is ICOS compliant. The station team is working to install a static pressure head. The installation of these sensors was done following ICOS standards. The height and horizontal distance of these sensors from the EC system are compliant with the ICOS Instructions. The calibration of the TA-RH / PA sensors will last till November 2024 and January 2025 respectively. At the station a profile of TA was also proposed, to be installed with the gas profile. However, the latter is not needed (see section above), then also the TA profile is not requested. If in the future the station team will reconsider adding it, they will inform the ETC and compile the required metadata in the BADM system. The profile will be reported in the BADM as soon as installed. For the calibration of the PA, the same scheme used in the other SE stations will be applied, that is using a spare sensor common to the whole ICOS SE, calibrated every 2 years, to be compared against for one month every year. The air temperature measured by the sensor used to correct the snow depth measurements is provided. This additional data will be processed by the ETC.

Backup meteorological station

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
TEMP-Campbell SR50 AT	TA_4577	1.72	15.7	1.8	TA_2_1_1
RHTEMP-Vaisala HMP155	F2650016	2.2	2.5	26	TA_3_1_1
					RH_2_1_1
PREC-EML SBS500(H)	174904	1	31.5	-6.2	P_2_1_1
RAD_SW-K&Z CMP21	120946	6.2	26.1	-5.2	SW_IN_2_1_1

The backup station at SE-Myc is composed of sensors measuring TA, RH, P, SW_IN. The models proposed are Vaisala HMP155A, Campbell Sci. SBS500H and Kipp & Zonen CMP21, respectively. All of them are compliant. Also, a separate ventilated Young/Campbell 43347 Pt1000 sensor was proposed (not ICOS compliant, but OK as additional sensor): if the station team will go on with this purpose, this data will be processed by the ETC, provided that the station team names them in the header files, and in the BADM, by using ICOS labels. The TA sensor of the SR50 AT instrument (snow depth) is also collected. The system has a separate (CR3000) logger and separate battery pack @140Ah. However, the 24V heating of the SBS500H (and Lambrecht) rain gauges currently runs via a 220AC/24DC power supply: this is accepted by the ETC. The power provided to the backup station is expected to be enough to avoid gaps all over the year: the station team committed to enlarge the battery package if this will be needed. The need for calibration of the backup sensors will be established by comparison with the main sensors.

Soil temperature, soil water content, soil heat flux density and water table depth

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
SWCTEMP-Campbell SoilVUE10	2229	-0.05	8.5	-4.2	SWC_1_1_1
SWCTEMP-Campbell SoilVUE10	2229_2	-0.1	8.5	-4.2	SWC_1_2_1
SWCTEMP-Campbell SoilVUE10	2229_3	-0.2	8.5	-4.2	SWC_1_3_1
SWCTEMP-Campbell SoilVUE10	2229_4	-0.3	8.5	-4.2	SWC_1_4_1
SWCTEMP-Campbell SoilVUE10	2229_5	-0.4	8.5	-4.2	SWC_1_5_1
SWCTEMP-Campbell SoilVUE10	2229_6	-0.5	8.5	-4.2	SWC_1_6_1
SWCTEMP-Campbell SoilVUE10	2230	-0.05	14.7	-4.7	SWC_2_1_1
SWCTEMP-Campbell SoilVUE10	2230_2	-0.1	14.7	-4.7	SWC_2_2_1
SWCTEMP-Campbell SoilVUE10	2230_3	-0.2	14.7	-4.7	SWC_2_3_1
SWCTEMP-Campbell SoilVUE10	2230_4	-0.3	14.7	-4.7	SWC_2_4_1
SWCTEMP-Campbell SoilVUE10	2230_5	-0.4	14.7	-4.2	SWC_2_5_1
SWCTEMP-Campbell SoilVUE10	2230_6	-0.5	14.7	-4.7	SWC_2_6_1

SWCTEMP-Campbell SoilVUE10	2113	-0.05	33.3	-8.3	SWC_3_1_1
SWCTEMP-Campbell SoilVUE10	2113_2	-0.1	33.3	-8.3	SWC_3_2_1
SWCTEMP-Campbell SoilVUE10	2113_3	-0.2	33.3	-8.3	SWC_3_3_1
SWCTEMP-Campbell SoilVUE10	2113_4	-0.3	33.3	-8.3	SWC_3_4_1
SWCTEMP-Campbell SoilVUE10	2113_5	-0.4	33.3	-8.3	SWC_3_5_1
SWCTEMP-Campbell SoilVUE10	2113_6	-0.5	33.3	-8.3	SWC_3_6_1
SWCTEMP-Campbell SoilVUE10	2232	-0.05	40.2	-9.6	SWC_4_1_1
SWCTEMP-Campbell SoilVUE10	2232_2	-0.1	40.2	-9.6	SWC_4_2_1
SWCTEMP-Campbell SoilVUE10	2232_3	-0.2	40.2	-9.6	SWC_4_3_1
SWCTEMP-Campbell SoilVUE10	2232_4	-0.3	40.2	-9.6	SWC_4_4_1
SWCTEMP-Campbell SoilVUE10	2232_5	-0.4	40.2	-9.6	SWC_4_5_1
SWCTEMP-Campbell SoilVUE10	2232_6	-0.5	40.2	-9.6	SWC_4_6_1
TEMP-Campbell CS10X	JCSL059987_1	-0.01	8.5	-4.2	TS_1_1_1
TEMP-Campbell CS10X	JCSL059987_2	-0.05	8.5	-4.2	TS_1_2_1
SWCTEMP-Campbell SoilVUE10	2229_7	-0.05	8.5	-4.2	TS_1_2_2
TEMP-Campbell CS10X	JCSL059987_3	-0.1	8.5	-4.2	TS_1_3_1
SWCTEMP-Campbell SoilVUE10	2229_8	-0.1	8.5	-4.2	TS_1_3_2
SWCTEMP-Campbell SoilVUE10	2229_9	-0.2	8.5	-4.2	TS_1_4_1
SWCTEMP-Campbell SoilVUE10	2229_10	-0.3	8.5	-4.2	TS_1_5_1
SWCTEMP-Campbell SoilVUE10	2229_11	-0.4	8.5	-4.2	TS_1_6_1
SWCTEMP-Campbell SoilVUE10	2229_12	-0.5	8.5	-4.2	TS_1_7_1

TEMP-Campbell CS10X	JCSL059987_4	-0.01	14.7	-4.7	TS_2_1_1
TEMP-Campbell CS10X	JCSL059987_5	-0.05	14.7	-4.7	TS_2_2_1
SWCTEMP-Campbell SoilVUE10	2230_7	-0.05	14.7	-4.7	TS_2_2_2
TEMP-Campbell CS10X	JCSL059987_6	-0.1	14.7	-4.7	TS_2_3_1
SWCTEMP-Campbell SoilVUE10	2230_8	-0.1	14.7	-4.7	TS_2_3_2
SWCTEMP-Campbell SoilVUE10	2230_9	-0.2	14.7	-4.7	TS_2_4_1
SWCTEMP-Campbell SoilVUE10	2230_10	-0.3	14.7	-4.7	TS_2_5_1
SWCTEMP-Campbell SoilVUE10	2230_11	-0.4	14.7	-4.7	TS_2_6_1
SWCTEMP-Campbell SoilVUE10	2230_12	-0.5	14.7	-4.7	TS_2_7_1
TEMP-Campbell CS10X	JCSL059987_7	-0.01	33.3	-8.3	TS_3_1_1
TEMP-Campbell CS10X	JCSL059987_8	-0.05	33.3	-8.3	TS_3_2_1
SWCTEMP-Campbell SoilVUE10	2113_7	-0.05	33.3	-8.3	TS_3_2_2
TEMP-Campbell CS10X	JCSL059987_9	-0.1	33.3	-8.3	TS_3_3_1
SWCTEMP-Campbell SoilVUE10	2113_8	-0.1	33.3	-8.3	TS_3_3_2
SWCTEMP-Campbell SoilVUE10	2113_9	-0.2	33.3	-8.3	TS_3_4_1
SWCTEMP-Campbell SoilVUE10	2113_10	-0.3	33.3	-8.3	TS_3_5_1
SWCTEMP-Campbell SoilVUE10	2113_11	-0.4	33.3	-8.3	TS_3_6_1
SWCTEMP-Campbell SoilVUE10	2113_12	-0.5	33.3	-8.3	TS_3_7_1
TEMP-Campbell CS10X	JCSL059987_10	-0.01	40.2	-9.6	TS_4_1_1
TEMP-Campbell CS10X	JCSL059987_11	-0.05	40.2	-9.6	TS_4_2_1
SWCTEMP-Campbell SoilVUE10	2232_7	-0.05	40.2	-9.6	TS_4_2_2

TEMP-Campbell CS10X	JCSL059987_12	-0.1	40.2	-9.6	TS_4_3_1
SWCTEMP-Campbell SoilVUE10	2232_8	-0.1	40.2	-9.6	TS_4_3_2
SWCTEMP-Campbell SoilVUE10	2232_9	-0.2	40.2	-9.6	TS_4_4_1
SWCTEMP-Campbell SoilVUE10	2232_10	-0.3	40.2	-9.6	TS_4_5_1
SWCTEMP-Campbell SoilVUE10	2232_11	-0.4	40.2	-9.6	TS_4_6_1
SWCTEMP-Campbell SoilVUE10	2232_12	-0.5	40.2	-9.6	TS_4_7_1
SOIL_H-Hukseflux HFP01SC	7877	-0.05	8.5	-4.2	G_1_1_1
SOIL_H-Hukseflux HFP01SC	7878	-0.05	14.7	-4.7	G_2_1_1
SOIL_H-Hukseflux HFP01SC	7879	-0.05	33.3	-8.3	G_3_1_1
SOIL_H-Hukseflux HFP01SC	7880	-0.05	40.2	-9.6	G_4_1_1
WTD-Campbell CS45X	200012214	-1	8.5	-4.2	WTD_1_1_1
WTD-Campbell CS45X	200012221	-1	14.7	-4.7	WTD_2_1_1
WTD-Campbell CS45X	200012227	-1	33.3	-8.3	WTD_3_1_1
WTD-Campbell CS45X	200012230	-1	40.2	-9.6	WTD_4_1_1

The station team has installed the full set of soil meteo sensors required for a Class 2 mire station with two plant community types distinguished in the target area (hummocks and hollows): four soil plots have been installed in the target area, i.e. two plots in each community type (see Figure 3). The set-up of each soil plot, shown in Figure 4, is compliant with the ICOS Instructions in terms of sensor models, number of sensors and sensor depths. The station team has furthermore submitted all requested metadata on the installed sensors.

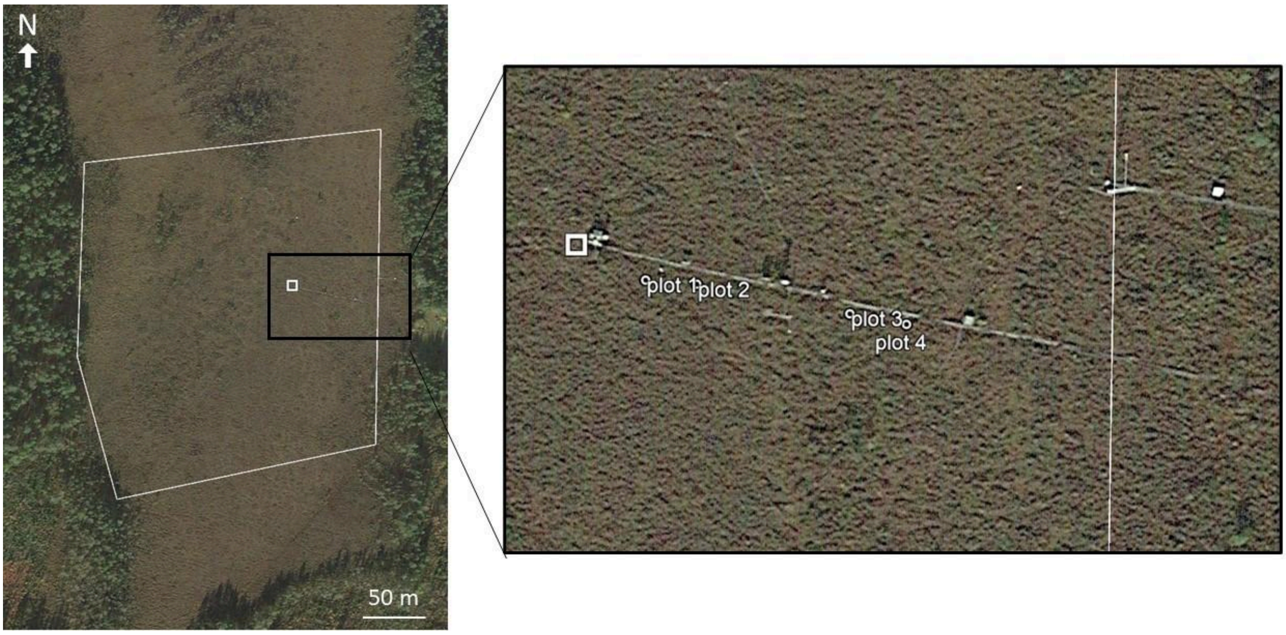

Figure 3: Location of the four soil plots in the target area (plots 1 to 4). The white square shows the location of the EC tower.

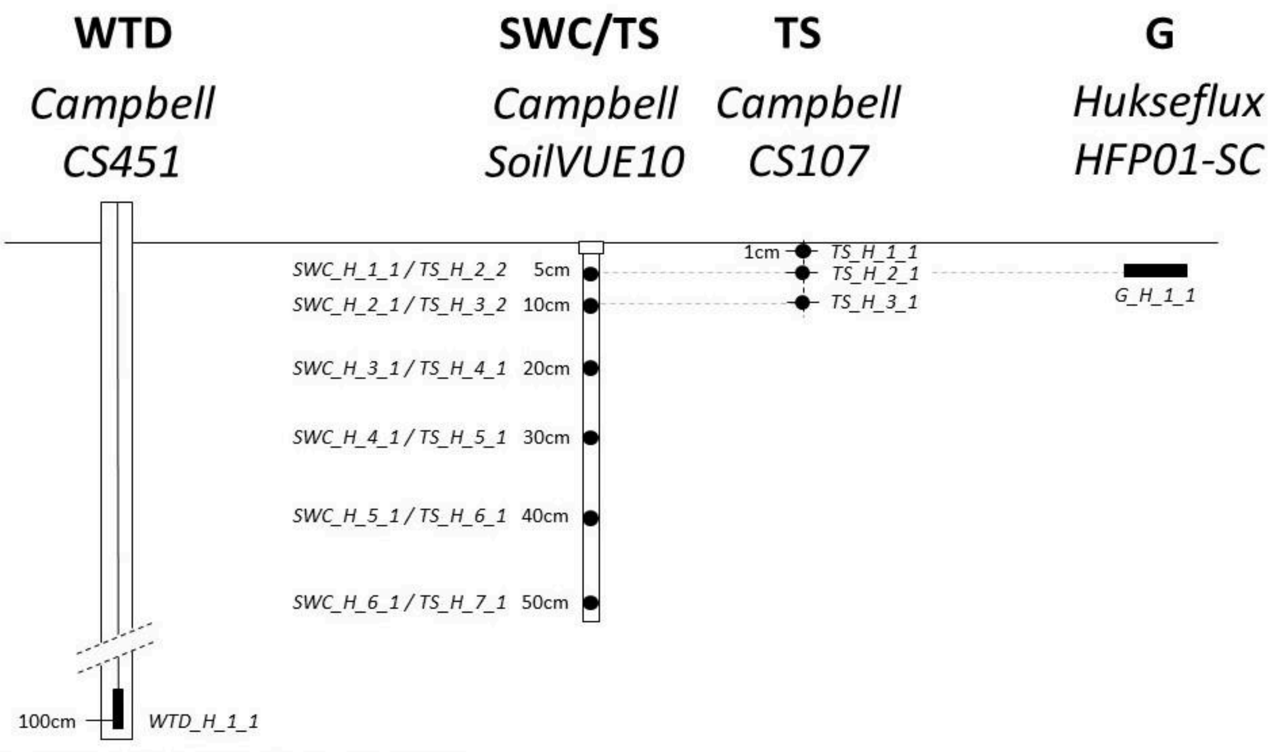

Figure 4: Set-up of the four soil plots. WTD = water table depth, SWC = soil water content, TS = soil temperature, and G = soil heat flux density.

Spatial heterogeneity characterization

The station team has collected in August 2024 all the measurements required for the characterization of the vegetation in the target area. These measurements comprise species cover records at 100 plots located along a system of boardwalks in the target area. The measurements are summarized in Figures 5a and 5b. The ETC carried out a TWINSPAN cluster analysis on these data to classify the 100 plots into groups that correspond with the plant community types (PCTs) that can potentially be distinguished in the target area. In a first division, TWINSPAN identified a group of 51 plots dominated by species that prefer drier conditions and a group of 49 plots dominated by species that prefer wetter conditions. These groups correspond with the hummock and hollow microforms in the target area. The TWINSPAN classification and a visual classification carried out by the survey team in the field matched for 84 out of the 100 plots, while the majority of the 16 mismatched plots were defined as borderline cases in either or both of the classifications. Figure 6 shows the distribution of the survey plots in the target area.

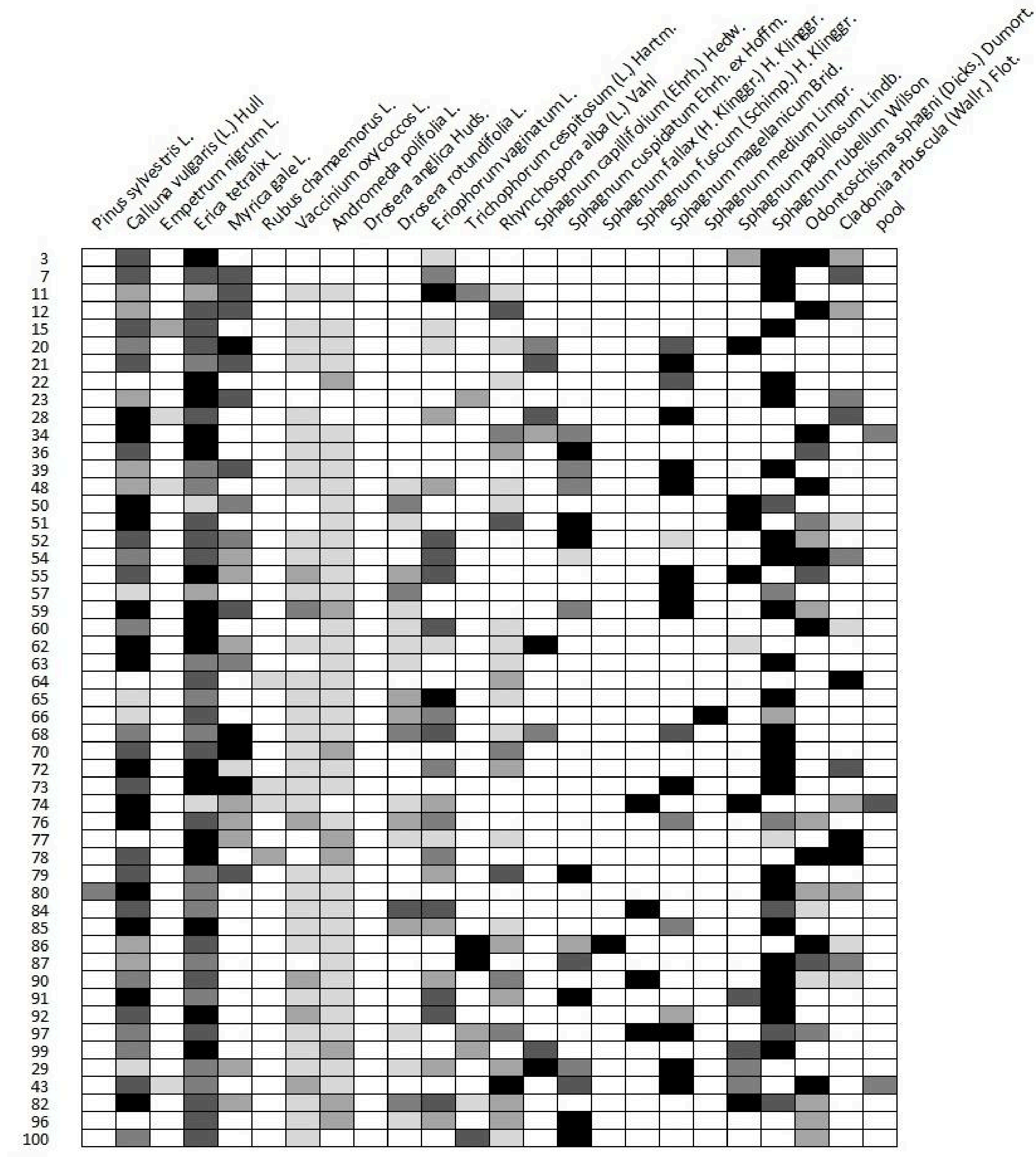

Figure 5a: Species cover in the 51 plots corresponding with hummock microforms. Grayscale colors indicate the following cover classes, which were used in the TWINSPAN analysis: not observed (white), 0.1-2%, 2.1-5%, 5.1-10%, 10.1-20%, and >20% (black). The far left column displays the plot IDs.

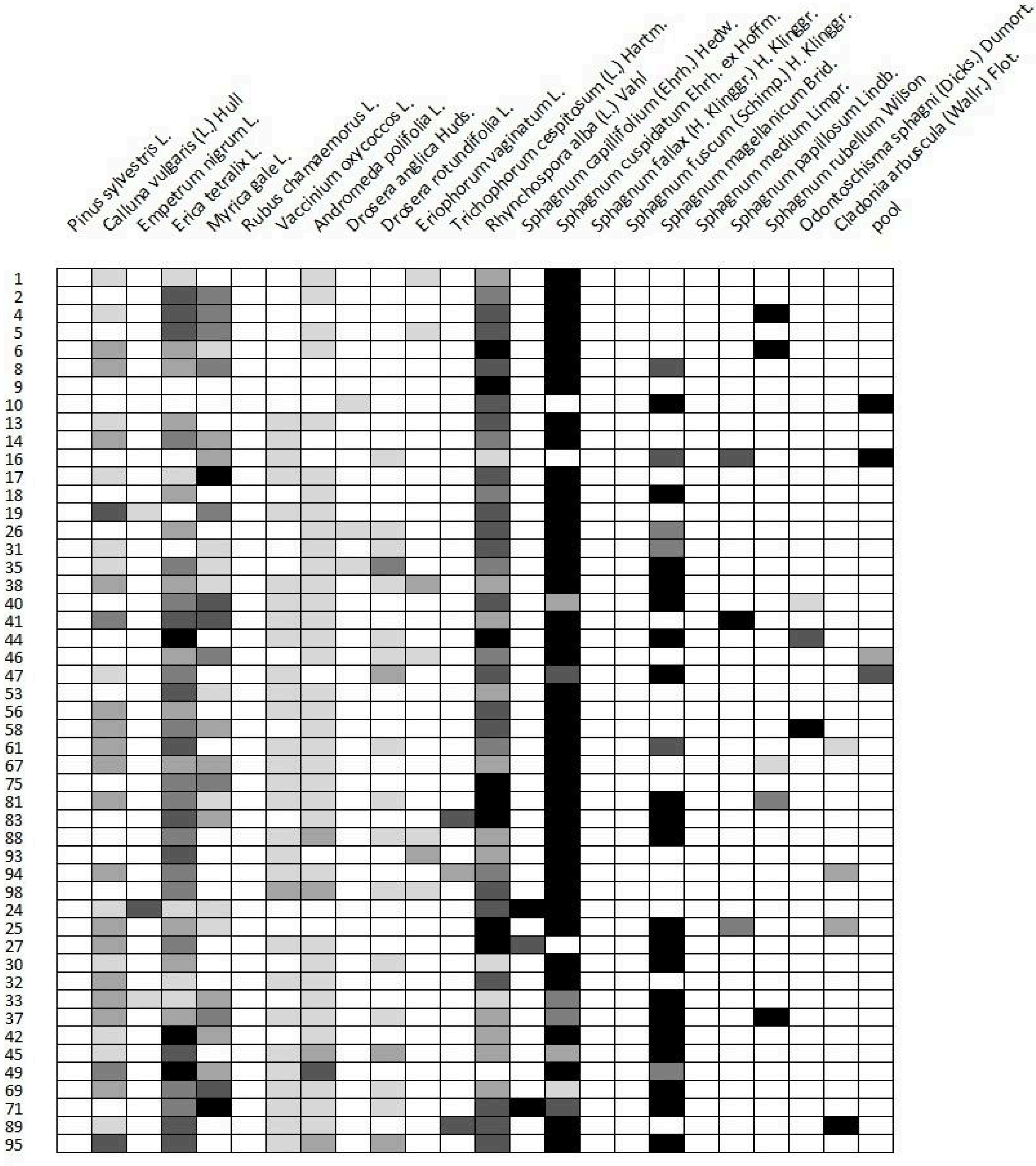

Figure 5b: Species cover in the 49 plots corresponding with hollow microforms. Grayscale colors indicate the following cover classes, which were used in the TWINSPAN analysis: not observed (white), 0.1-2%, 2.1-5%, 5.1-10%, 10.1-20%, and >20% (black). The far left column displays the plot IDs.

Figure 6: Distribution of the 100 plots along the boardwalks in the target area: white = hummock plots, gray = hollow plots. The white square shows the location of the EC tower.

Green Area Index

The station team has collected and submitted the GAI data requested as part of the step 2 labelling requirements. These data include measurements on herbaceous and dwarf shrub species, done with the modified Vascular Green Area method in all eight installed Continuous Measurements Plots (CPs) (Figure 7). The ETC has quality-checked the data.

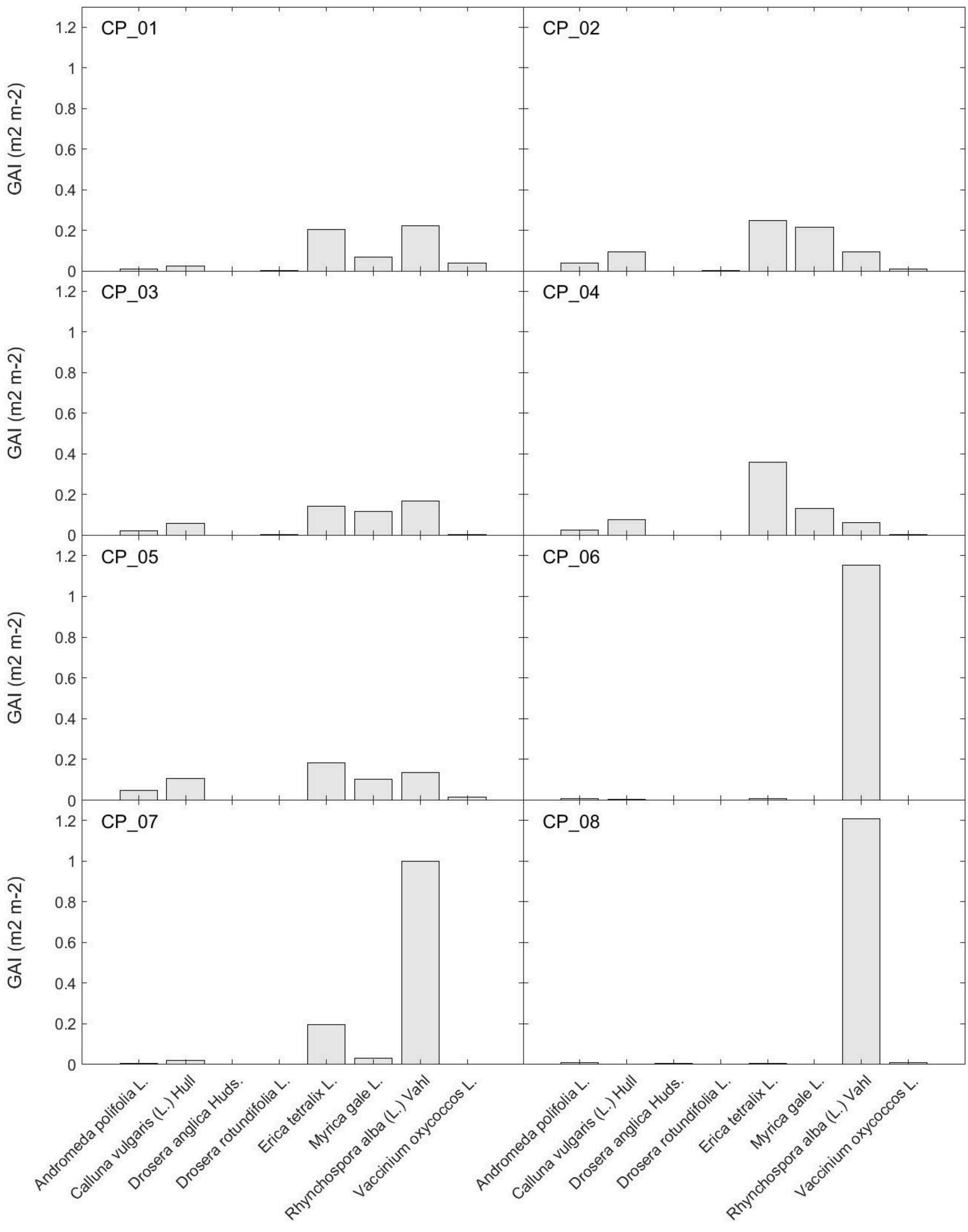

Figure 7: Green Area Index (GAI) measured on the herbaceous and dwarf shrubs species in the eight CPs.

Vegetation sampling and analysis

The vegetation has not been sampled at the site yet. However, in order to speed up the labeling processes, an exception has been agreed with the ETC: the leaves will be sampled and sent to the leaf sample analysis in spring 2025 as soon as the phenology allows for it.

Data check and test

Data quality analysis (Test 1)

The test aims at quantifying the availability of NEE half-hourly data after the application of the data cleaning procedure described in Vitale et al. (2020) and implemented in the RFlux R software package (Vitale et al., 2019). The requirement expected for the Step 2 of labelling is that the total percentage of missing and removed data does not exceed the 40% threshold value.

Tests involved in the procedure aim at detecting NEE flux estimates contaminated by the following sources of systematic error: (i) EC system malfunction occurring when fluxes originate from unrepresentative wind sectors or evidenced by diagnostics of sonic anemometer (SA) and gas analyzer (GA); instruments malfunction detected by (ii) low signal resolution and (iii) structural changes tests as described in Vitale et al. (2020); (iv) lack of well developed turbulence regimes (Foken and Wichura, 1996); (v) violation of the stationary conditions (Mahrt, 1998). By comparing each test statistic with two pre-specified threshold values, flux data are identified as affected by strong/severe (SevEr), weak/moderate (ModEr) or negligible (NoEr) evidences about the presence of specific sources of systematic error. Subsequently, the data rejection rule involves a two-stage procedure: in the first stage half-hourly fluxes affected by SevEr are directly discarded, whereas, in the second stage, those affected by ModEr are removed only if they are also identified as outliers.

The period under test was from 20220415 to 20220714, in which 4368 half hourly files were expected, and 4264 ICOS-compliant files were received, resulting in 104 files missing or not compliant. For NEE, 2769 valid data remained after the overall cleaning procedure. 26 data were discarded due to the lack of storage data; 1369 records were discarded due to severe evidence of error, and 76 identified as outliers. This corresponds to 36.61% of data discarded and missing. This test is considered **passed**, as the total is well below the established 40% threshold: the ETC recommends the PI to pay attention to avoid as much as possible gaps in the timeseries, in order to reduce at maximum the initial percentage of missing data, corresponding in this period to 2.52%. See Figure 8 below for more details.

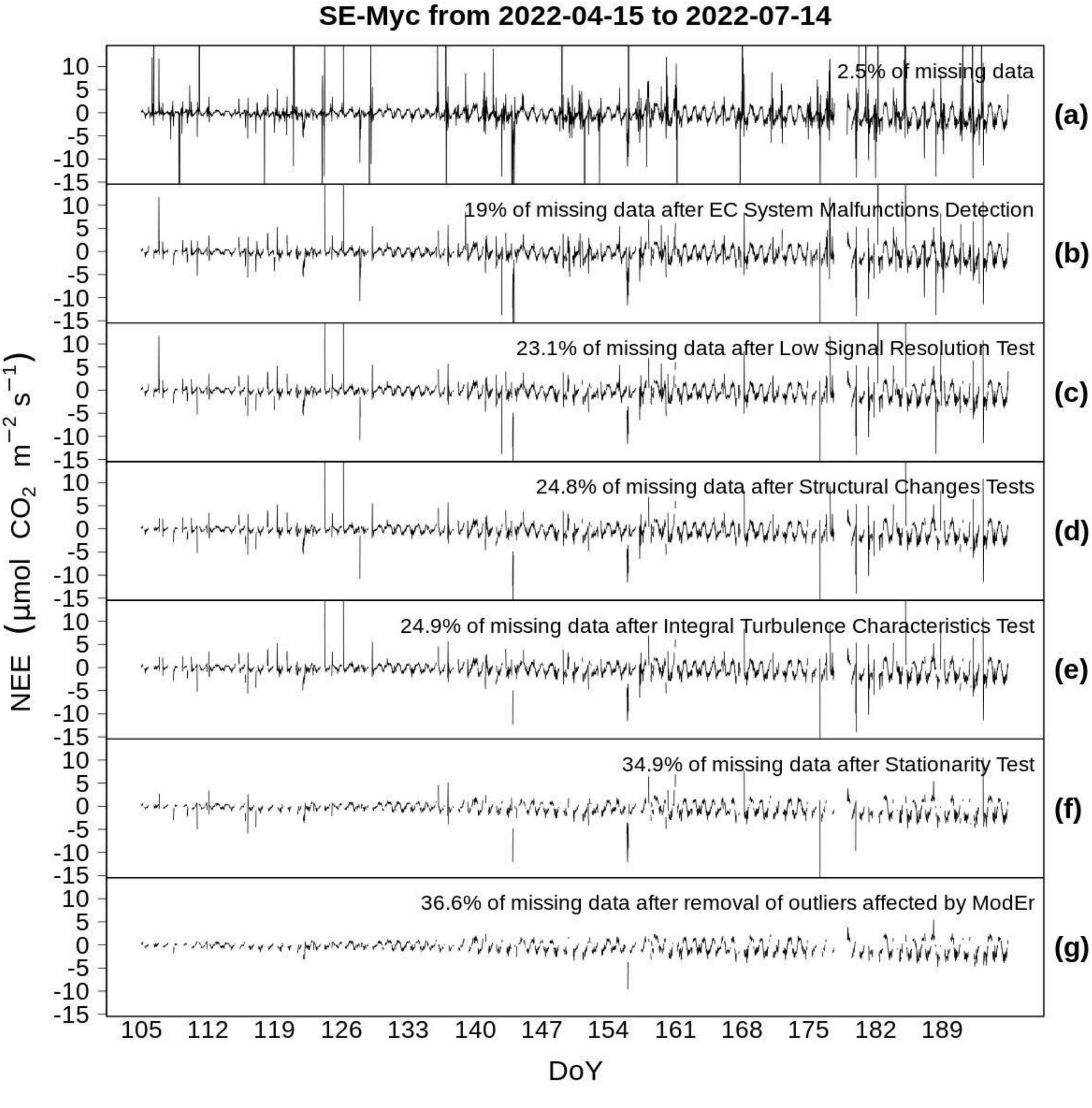

Figure 8: Summary of the data cleaning procedure applied to the Net Ecosystem Exchange (NEE) of CO2 flux collected at SE-Myc station from 20220415 to 20220714. The original half-hourly flux time series is exhibited in the top panel. Panels b-f display the sequential removal of data affected by severe evidences of error according to the following criteria: (b) wind sectors to exclude and diagnostics provided by sonic anemometer (SA) and gas analyser (GA); (c-d) instrumental problems detection; (e) integral turbulence characteristics test (ITC, Foken and Wichura, 1996); (f) stationarity test by Mahrt (1998). Bottom panel displays the time series of retained high-quality NEE after the additional removal of outlying fluxes affected by moderate evidence of error.

References

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Vitale D, Fratini G, Bilancia M, Nicolini G, Sabbatini S, Papale D (2020) A robust data cleaning procedure for eddy covariance flux measurements, Biogeosciences, 17, 1367–1391. https://www.biogeosciences.net/17/1367/2020/bg-17-1367-2020.html, doi = 10.5194/bg-17-1367-2020.

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LI-COR Biosciences: EddyPro 7.0.4: Help and User's Guide, LI-COR Biosciences, Lincoln, Nebraska USA, www.licor.com/EddyPro, 2019.
Fratini, G., & Mauder, M. (2014). Towards a consistent eddy-covariance processing: an intercomparison of EddyPro and TK3. Atmospheric Measurement Techniques, 7(7), 2273-2281.
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Footprint analysis (Test 2)

The test aims to evaluate whether half-hourly flux values are sufficiently representative of the target area (TA) or not. It was performed on about 3 months (92 days) of QC filtered data (see previous Section). The model by Klijun et al. (2015) was used to obtain the 2-dimensional flux footprint for each half-hour, which was compared to the TA spatial extent.

After the QC procedure and additional filtering according to footprint model requirements, 49.5 % of the data was used for the test.

Results showed that 100 % of the data have a cumulative contribution of at least 70% from the TA (Figure 9, leftmost bars block). The test was also performed on 4 sub-periods of similar length and results confirmed the percentages obtained on the whole dataset (Figure 9).

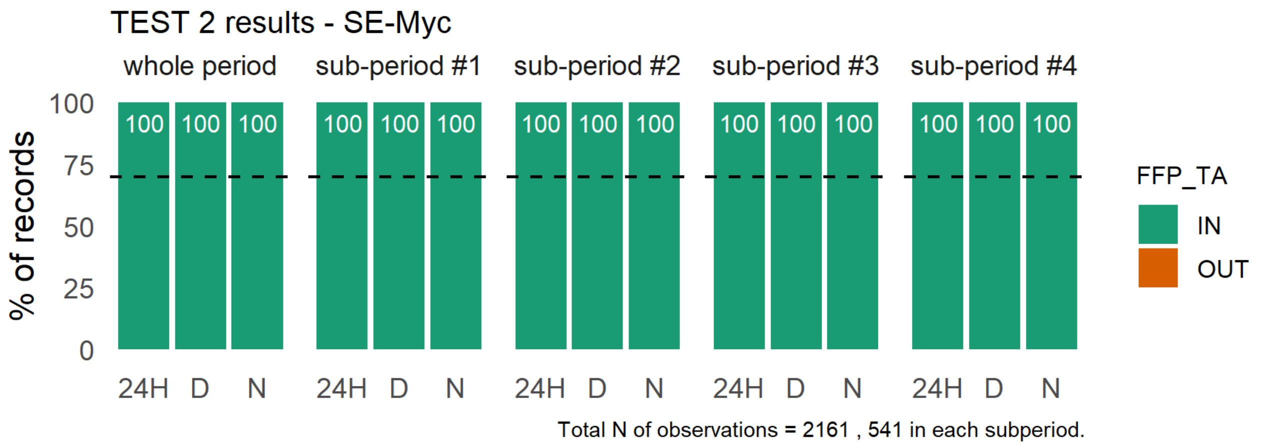

Figure 9: Test 2 results obtained over the whole period (leftmost block) and sub-periods, showing the percentage of half-hours with a footprint cumulative contribution of at least 70% from the target area. The target value (dashed horizontal line) is that 70% of data (half-hourly fluxes) must hold this condition. The analysis was done considering both the whole day ('24H') and daytime and nighttime separately ('D' and 'N' respectively).

The footprint climatology for SE-Myc, estimated over the period under consideration is reported in Figure 10, by which it is possible to notice that both 70% and 80% footprint cumulative contribution is always included in the TA. According to these results, the test is considered as passed.

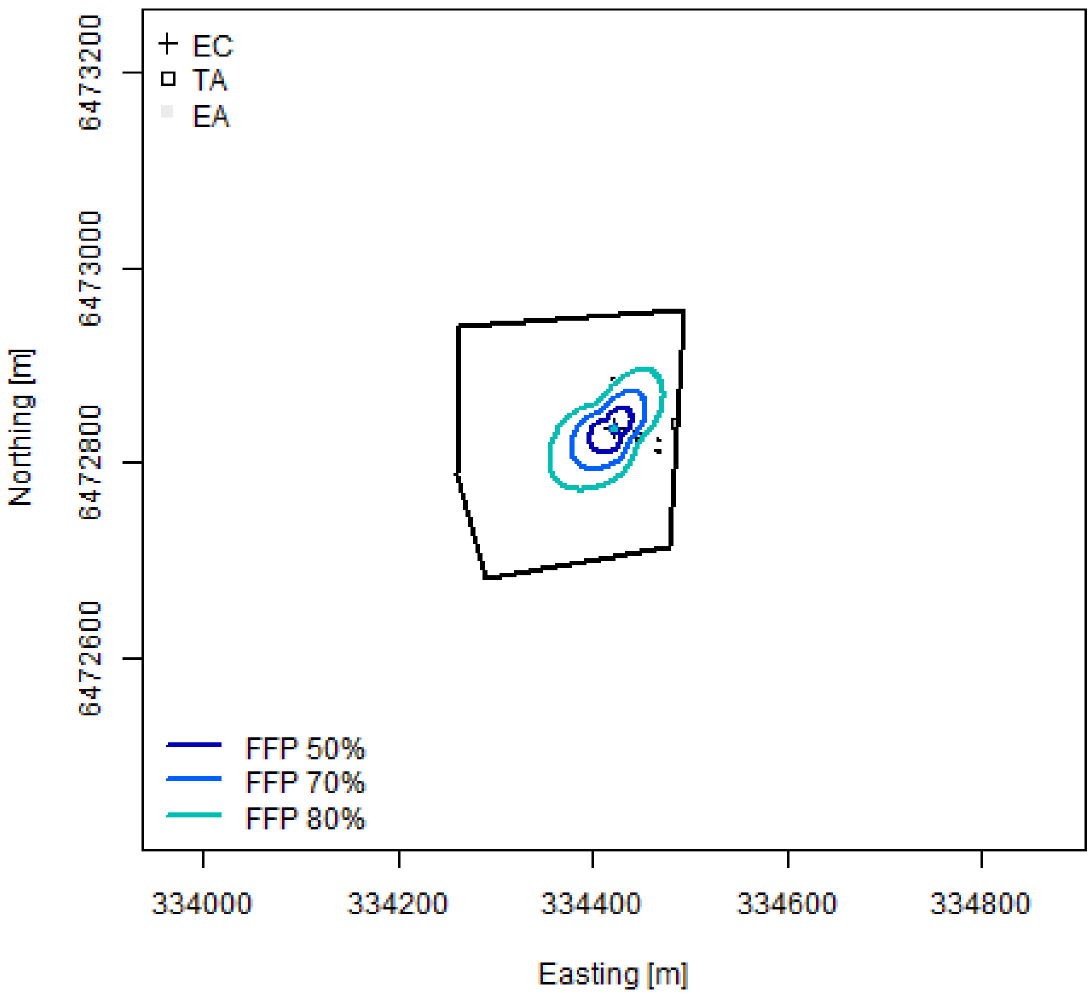

Figure 10: Footprint climatology at SE-Myc in relation to the TA, the EC tower (EC), and the excluded areas (EA, see the spatial sampling Section). The 50, 70 and 80 % cumulative contribution isopleths are reported.

Data representativeness analysis (Test 3)

According to the spatial heterogeneity characterization, the target area (TA) includes just one land cover typology (LCT, hummock-hollow mosaic), so test 3 is not of relevance.

Ancillary plot representativeness (Test 4)

The station team has collected in the summer of 2024 all the measurements needed for the ancillary plot representativity. These measurements comprise species cover records at eight candidate Continuous Measurements Plots (CPs), as well as at 100 survey plots for site characterization. For mire stations such as SE-Myc, it is not the standard test described in the Introductory section of this report that is applied here. Instead, each candidate CP is checked by running the same TWINSPAN cluster analysis as ran for the classification of the 100 survey plots into groups corresponding with PCTs, but now with the candidate CP included in the input data set. It is then checked if the TWINSPAN algorithm assigns the CP to the PCT it is meant to represent.

The outcome of the test was positive for all CPs, as they were all assigned to the PCT they are meant to represent: five CPs in hummocks and three CPs in hollows.

- hummock: CP_01, CP_02, CP_03, CP_04, CP_05,
- hollow: CP_06, CP_07, CP_08

Figure 11 shows the locations of the CPs in the target area.

Figure 11: Locations of the eight CPs in the target area: white = hummock CP, gray = hollow CP. Due to the inaccessibility of the mire, the CPs are installed along boardwalks. The white square shows the location of the EC tower.

Near Real Time data transmission

The station team is using a Campbell Scientific CR6 logger to collect EC data, some Campbell Scientific CR1000, CR1000X and CR3000 loggers for BM data, and a Campbell Scientific CR1000 logger for ST data. The EC files are in ASCII format, as well as the BM files. The acquisition programme of the EC file is the same for all the SE stations, then the sync test is not needed. The EC files got the green light on 20210927. Their submission started right after. BM files L03_F01 and L03_F02 got the green light on 20230608, BM file L03_F03 on 20230918.

Plan for remaining variables

Soil sampling

It has been agreed with the ETC that soil will be sampled in 2025. The period will be discussed together with the ETC.

<u>Eddy covariance:</u> The station team is committed to update the firmware of the LI7200 in the coming weeks.

<u>Leaves sampling</u>: leaves will be sampled and sent to the leaf sample analysis in spring 2025 as soon as the phenology allows for it

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 Mycklemossen (SE-Myc) is labelled as ICOS Class2 Ecosystem station.

Dario Papale, ETC Director

October 9th 2024