ICOS Ecosystem Station Labelling Report

Station: DE-RuS (Selhausen Juelich)

Viterbo (Italy), Antwerp (Belgium), Bordeaux (France), April 29th 2019

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 5th July 2016 and got the official approval on 28th August 2016. The Step2 started officially on 17th March 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 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 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 Groundwater level
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

Data evaluation

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 using a footprint model (Klijun et al. 2015) the estimated contribution area for each half hour and 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 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

The station Selhausen Juelich, with ICOS code DE-RuS, is a crop site having Latitude 50.8659070173 °N and Longitude 6.4471447044 °E, an elevation of 103.2 m above sea level and an offset respect to the Coordinated Universal Time (UTC) equal +01. The site is located in the catchment of the river Rur, between the cities of Düren and Juelich. The climate is maritime temperate with a Mean Annual Temperature of 10 °C and a Mean Annual Precipitation of 698 mm. The field has a size of 9.7 ha, a slope of about 0.3°, and is surrounded by fields with the same type of crop rotation, occasionally including additional crops such as rapeseed, potatoes, maize oat and white mustard.

Figure 1 - The DE-RuS tower

Team description

The staff of the site has been defined and communicated in March 2017 and updated at later date. It includes in addition to the PI, the Manager and the technical staff. Below the summary table of the Team members is reported.

MEMBER_NAME	MEMBER_INSTITUTION	MEMBER_ROLE	MEMBER_MAIN_EXPERT
Marius Schmidt	Research Centre Juelich, IBG3: Agrosphere	PI	MICROMET
Alexander Graf	Research Centre Juelich, IBG3: Agrosphere	MANAGER	MICROMET
Judith Mattes	Research Centre Juelich, IBG3: Agrosphere	TEC-ANC	BIOMASS
Odilia Esser	Research Centre Juelich, IBG3: Agrosphere	TEC-ANC	BIOMASS
Daniel Dolfus	Research Centre Juelich, IBG3: Agrosphere	TEC	LOGISTIC

Table 2 - Description of team members roles at DE-RuS

Spatial sampling design

For the spatial sampling design at DE-Rus, the Station Team (ST) proposed in addition to the Target Area (TA), 1 areas to be excluded from sampling (EA). 5 continuous measurement points (CP) were submitted and after verifying their compliance, the respective areas were excluded from the surface available for sampling. Figure 2 shows the extent and position of such spatial features in relation to the actual site area in addition to the randomly sampled first order sparse measurement plots SP-I.

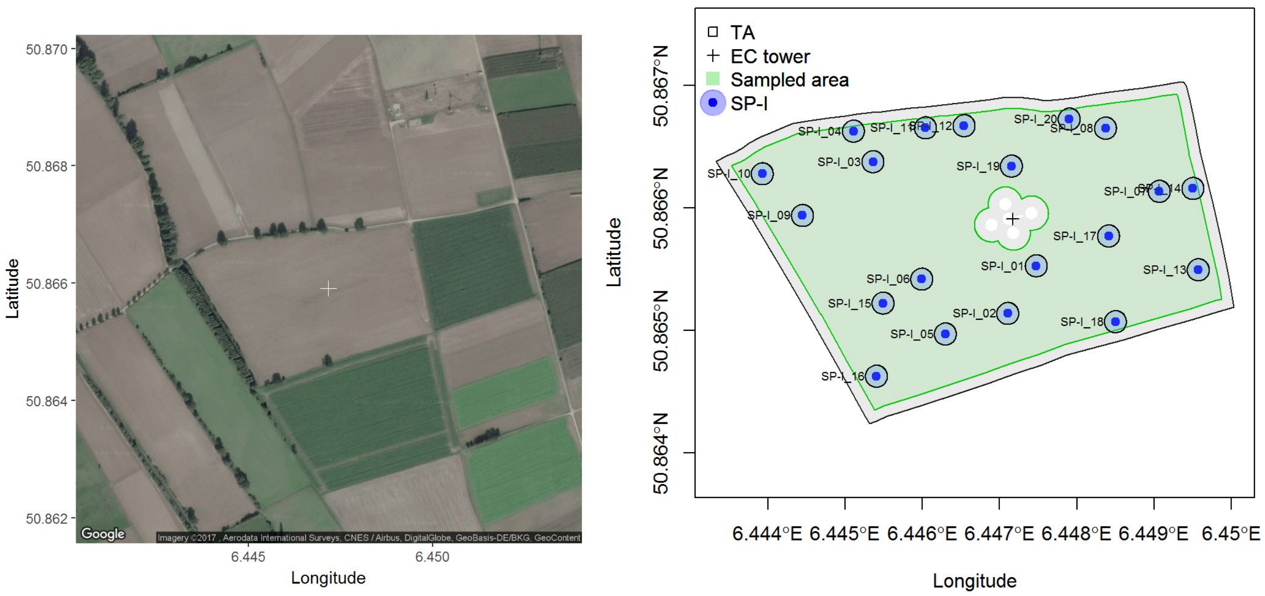


Figure 2: Aerial map of DE-Rus (*left* panel) and proposed spatial features according to the reported target area (TA), exclusion area (EA), continuous plots (CP) and ICOS requirements (*right* panel). Note that the CP areas have been excluded from the sampled area. The TA surface is: 9.64 Ha while EA surface is 31.27 m2 (CP areas excluded).

The check on the coordinates of points positioned and mapped in the field has been performed and all points were accepted, i.e. their coordinates match with the randomly extracted values.

Station implementation

Eddy covariance:

EC System		
MODEL	GA_CP-LI-COR LI-7200	SA-Gill HS-50
SN	72H-0452	H000235
HEIGHT (m)	2.63	2.67
EASTWARD_DIST (m)	-1.14	-1.3
NORTHWARD_DIST (m)	-0.682	-0.78
SAMPLING_INT	0.05	0.05
LOGGER	8	8
FILE	1	1
GA_FLOW_RATE	15	-
GA_LICOR_FM_SN	FM1-0412	-
GA_LICOR_AIU_SN	AIU-1043	-
SA_OFFSET_N	-	237
SA_WIND_FORMAT	-	U, V, W
SA_GILL_ALIGN	-	Spar
ECSYS_SEP_VERT	-0.04	
ECSYS_SEP_EASTWARD	0.16	
ECSYS_SEP_NORTHWARD	0.098	
ECSYS_WIND_EXCL		
ECSYS_WIND_EXCL_RANGE		

The EC system is installed since August 2016. While the IRGA has been recently factory calibrated (20171023), the sonic anemometer requires a new factory calibration, which was planned by the PI for January 2019. However this is not done according to the BADM: the PI agreed in planning a calibration for the sonic during the dormant season 2019-2020. The sonic orientation corresponds to that proposed by the station team and accepted by the ETC. The station height is slightly bigger (2.67 m instead of 2.4): this was due to an adaptation from the previous setting to the ICOS rules.

The station team was asked to update the firmware of the SmartFlux2, and/or to update this info in the BADM using the correct variables, which was promptly done.

Some changes of flow-rates happened in time at the station, and the station team added some missing info in the BADM in collaboration with the ETC. Also, the harvesting time was added to the BADM

<u>*Storage*</u>: as a crop station, and with an EC measurement height of 2.4 m, DE-Rus is in the category where the necessity to perform continuous profile measurements is subject to a test measurement (measurement height between 2 and 4 m). In this respect, it was agreed with the ETC during action 5 to provide experimental data to evaluate the use of the storage measurement at the site. A ≥ 48-hour continuous measurement performed during full development of the year's crop (sugar beet) and the warmest 25-percentile of the year, starting on 21 August 2017 were provided to ETC. Despite the sampling approach used at DE-Rus was not the one suggested in ICOS (storage instruction), a detailed description of the system, corroborated by a scientific publication, allowed ETC to ascertain the robustness and reliability of the method, and data were thus accepted.

The test results confirmed that a difference between storage fluxes estimated from the profile and those by only one point (et the EC height) of at least 10% with the storage flux and higher than 2 µmolm2s-1, was verified only in the 5% to 8% of the data (according to the considered temporal window). Given that the threshold set in ICOS is 10%, ETC agreed that the storage system is not needed at the DE-Rus station. In addition, there were no cases in which the difference was > 5 µmol m-2 s-1 (ICOS threshold 5 %). A comparison of storage fluxes as measured by the profile and by one point is reported in the Fig. 3.

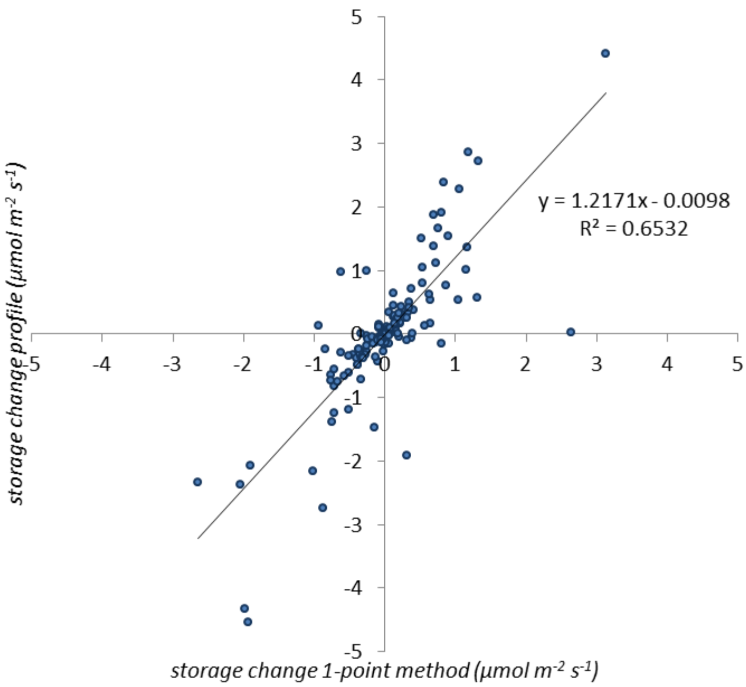


Fig. 3: comparison of storage fluxes as measured by the profile and by one point at DE-Rus.

Radiations:

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
RAD-4C-KZCNR4	121124	2.6	2.84	-2.19	SW_IN_1_1_1
					SW_OUT_1_1_1
					LW_IN_1_1_1
					LW_OUT_1_1_1
LI-COR LI190	100278	2.57	2.74	-1.99	PPFD_OUT_1_1_1
LI-COR LI190	100680	2.57	2.74	-1.99	PPFD_IN_1_1_1
Delta-T BF5	23102	2.6	2.84	-2.19	PPFD_IN_1_1_2
					PPFD_DIF_1_1_1
Kipp&Zonen CMP21	120903	2.54	2.27	0.96	SW_IN_1_1_2

SW and LW will be measured by the CNR4 (*Kipp&Zonen*) equipped with the CNF4 ventilation unit (sent to *Kipp&Zonen* for a factory calibration during the week 11-15 June 2018). For diffuse radiation it has been agreed to use the BF5 (as exception) for the acquisition of the ratio diffuse/total to scale the measurements of the CMP21 (*Kipp&Zonen*) pyranometer (secondary sensor). PPFD will be measured by LI-190 (*LI-COR Inc.*)

Precipitation:

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
OTT Hydromet Pluvio2	31078865	1	164.24	324.78	P_2_1_1
Campbell Scientific SR50AH	9308	1.46	162.51	325.46	D_SNOW_2_1_1

Total precipitation will be measured by the Pluvio2 (*Ott Hydromet GmbH*) weighing gauge (installed at the backup meteo station), shielded by a 260-952 Alter-Type windscreen (*NovaLynx*). Snow depth will be measured by the SR50A (Campbell Scientific), installed at the backup meteo station.

Air temperature, relative humidity and air pressure

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
Rotronic HC2-S3	20041923	2.58	1.85	0.6	TA_1_1_1
					RH_1_1_1
CS106	L4530206	0.5	1.98	0.73	PA_1_1_1
Windsonic75	17150043	2.75	1.98	0.73	WD_1_1_1
					WS_1_1_1

The sensor for TA and RH (HC2-S3, Rotronic AG) is ICOS compliant, as it is the PTB110 (a.k.a. CS106), Vaisala, for PA measurements. Calibration is expired for the HC2-S3 and the PTB110, but the PI communicated a plan to send both to the factory for calibration between December 2018 and January 2019. The PI has availability for spare sensors to cover the gaps in this period. In addition to the mandatory sensors, the station is also provided with a wind sensor for measuring wind speed and direction.

Backup meteorological station

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
Rotronic HC2S3	20073088	2.58	161.48	324.67	TA_2_1_1
					RH_2_1_1
Kipp&Zonen CMP21	120904	2.47	161.62	324.02	SW_IN_2_1_1
Ecotech	831	1	10.86	-1.01	P_1_1_1

The sensors installed at the backup station for TA+RH, P and SW_IN measurements are ICOS compliant. A comparison with the main sensors will be needed to determine the need for calibration.

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

The station team has installed the full set of soil meteo sensors required for a Class 1 cropland station. The sensors are installed at locations in the target area that comply with the ICOS Instructions, ie. one permanent soil plot very near the EC tower and one soil plot in or near each of the four CPs (see Figure 4). The set-up of each soil plot, shown in Figure 5, 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.

MODEL	SN	HEIGHT (m)	EASTWARD_DIST (m)	NORTHWARD_DIST (m)	VARIABLE_H_V_R
Truebner SMT-100	FZJICOS-001-001	-0.01	-1.88	-0.1	TS_1_1_1
Campbell Scientific CS109	JCSL044653	-0.1	-1.88	-0.1	TS_1_3_2
Truebner SMT-100	FZJICOS-001-004	-0.2	-1.88	-0.1	TS_1_4_1 SWC_1_4_1
Truebner SMT-100	FZJICOS-002-001	-0.01	-20.61	1.83	TS_2_1_1 SWC_2_1_1
Truebner SMT-100	FZJICOS-002-002	-0.05	-20.61	1.83	TS_2_2_1 SWC_2_2_1
Truebner SMT-100	FZJICOS-002-003b	-0.1	-20.61	1.83	TS_2_3_1 SWC_2_3_1
Truebner SMT-100	FZJICOS-002-004	-0.2	-20.61	1.83	TS_2_4_1 SWC_2_4_1
Truebner SMT-100	FZJICOS-002-005	-0.5	-20.61	1.83	TS_2_5_1 SWC_2_5_1
Truebner SMT-100	FZJICOS-002-006	-1	-20.61	1.83	TS_2_6_1 SWC_2_6_1
Truebner SMT-100	FZJICOS-003-001	-0.01	-3.34	9.92	TS_3_1_1 SWC_3_1_1
Truebner SMT-100	FZJICOS-003-002	-0.05	-3.34	9.92	TS_3_2_1 SWC_3_2_1
Truebner SMT-100	FZJICOS-003-003	-0.1	-3.34	9.92	TS_3_3_1 SWC_3_3_1
Truebner SMT-100	FZJICOS-003-004	-0.2	-3.34	9.92	TS_3_4_1 SWC_3_4_1
Truebner SMT-100	FZJICOS-003-005	-0.5	-3.34	9.92	TS_3_5_1 SWC_3_5_1
Truebner SMT-100	FZJICOS-003-006	-1	-3.34	9.92	TS_3_6_1 SWC_3_6_1
Truebner SMT-100	FZJICOS-004-001	-0.01	15.62	5.28	TS_4_1_1 SWC_4_1_1
Truebner SMT-100	FZJICOS-004-002	-0.05	15.62	5.28	TS_4_2_1 SWC_4_2_1

Truebner SMT-100	FZJICOS-004-003	-0.1	15.62	5.28	TS_4_3_1 SWC_4_3_1
Truebner SMT-100	FZJICOS-004-004	-0.2	15.62	5.28	TS_4_4_1 SWC_4_4_1
Truebner SMT-100	FZJICOS-004-005	-0.5	15.62	5.28	TS_4_5_1 SWC_4_5_1
Truebner SMT-100	FZJICOS-004-006	-1	15.62	5.28	TS_4_6_1 SWC_4_6_1
Truebner SMT-100	FZJICOS-005-001	-0.01	4.79	-11.12	TS_5_1_1 SWC_5_1_1
Truebner SMT-100	FZJICOS-005-002	-0.05	4.79	-11.12	TS_5_2_1 SWC_5_2_1
Truebner SMT-100	FZJICOS-005-003	-0.1	4.79	-11.12	TS_5_3_1 SWC_5_3_1
Truebner SMT-100	FZJICOS-005-004	-0.2	4.79	-11.12	TS_5_4_1 SWC_5_4_1
Truebner SMT-100	FZJICOS-005-005	-0.5	4.79	-11.12	TS_5_5_1 SWC_5_5_1
Truebner SMT-100	FZJICOS-005-006	-1	4.79	-11.12	TS_5_6_1 SWC_5_6_1
Hukseflux HFP01SC	4364	-0.05	-1.88	-0.1	G_1_1_1
Hukseflux HFP01SC	4365	-0.05	-20.61	1.83	G_2_1_1
Hukseflux HFP01SC	5560	-0.05	-3.34	9.92	G_3_1_1
Hukseflux HFP01SC	4368	-0.05	15.62	5.28	G_4_1_1
Hukseflux HFP01SC	5647	-0.05	4.79	-11.12	G_5_1_1
Decagon Devices CTD-10	1165208116	-6	-1.01	-0.04	WTD_1_1_1

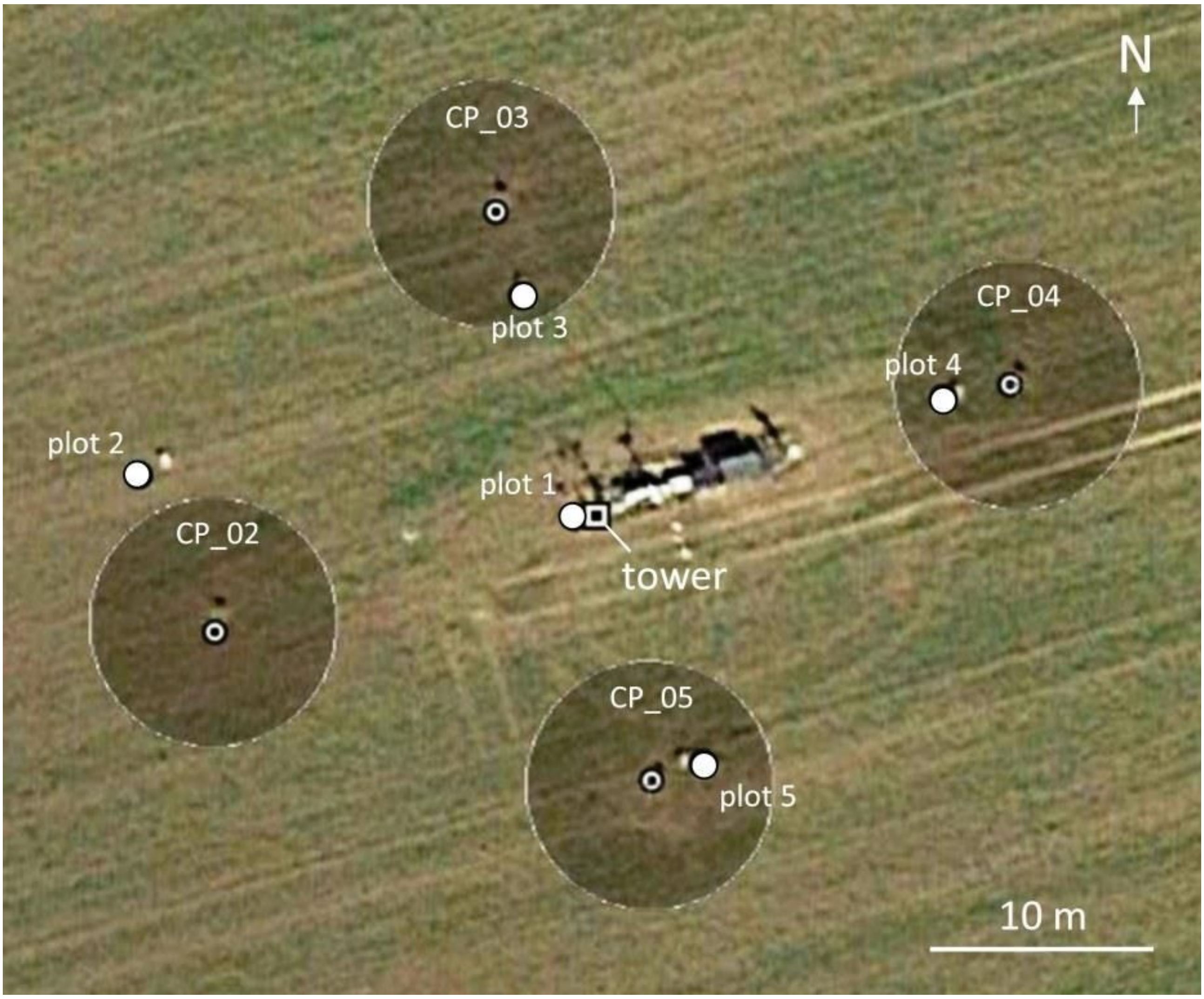


Figure 4: Location of the soil plots around the EC tower (plots 1 to 5). CP = Continuous Measurements plot.

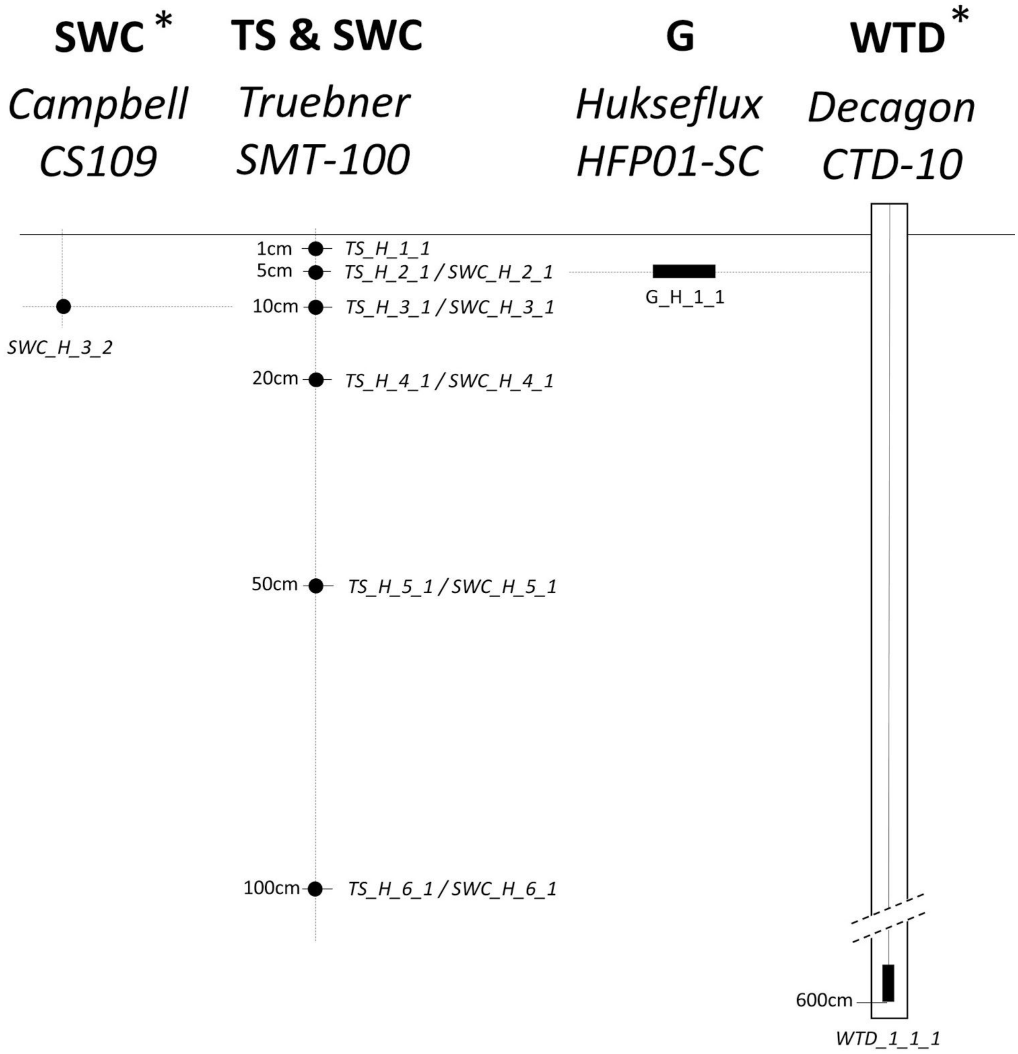


Figure 5: Set-up of the five soil plots. TS = soil temperature, SWC = soil water content, G = soil heat flux density, WTD = water table depth. * only in the permanent soil plot near the EC tower.

Green Area Index

The station team has collected the minimum required number of two sets of GAI measurements in the four CPs installed in their winter wheat crop. These measurements have been done with the ceptometer. A first set of measurements was collected on May 18th 2018, the second set on June 18th 2018. The data have sent to the ETC, where they have been quality-checked and processed (see Figure 6 for results).

The station team furthermore collected out a third set of ceptometer measurements on June 19th 2018 and this at four locations in the target area where the wheat crop was destructively harvested afterwards for direct GAI measurements to compare the ceptometer results with. The ETC and the station PI agreed to reduce to amount of wheat material that had to be harvested from the four plots: instead of harvesting all material from the 5.5m x 1m plots, it sufficed to harvest only the 1st, 4th, and 7th row from the eight rows contained inside the plot. The ETC received and processed all measurements (see Figure 7).

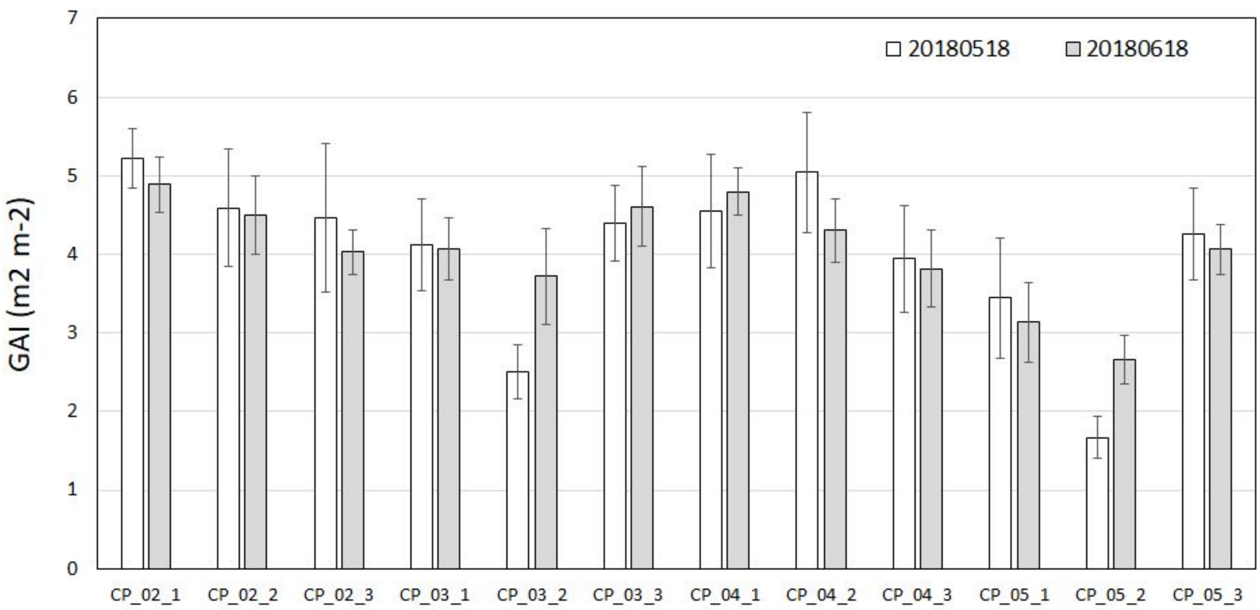


Figure 6: GAI measured with the ceptometer on 18 May 2018 and 18 June 2018 in the four CPs (CP_02 to CP_05). Results are shown for each of the two locations in the CPs where GAI was measured. Error bars indicate the standard deviation to the mean GAI per location, derived from 12 below-canopy measurements per location.

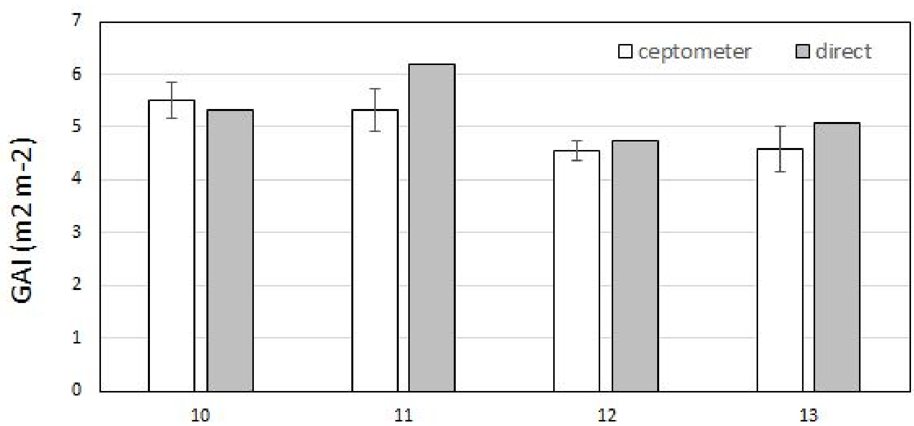


Figure 7: Green Area Index (GAI) measured with the ceptometer and with the direct method on 19 July 2018 at four locations in the target area (named 10 to 13). It should be noted that the direct measurement included 15 to 20% non-green plant area.

Aboveground biomass

The station team collected the minimum required AGB measurements in the four CPs and the 20 SP-I plots on June 18th 2018, i.e. approximately one month before the winter wheat was harvested. The ETC received and processed all measurements (Figure 8).

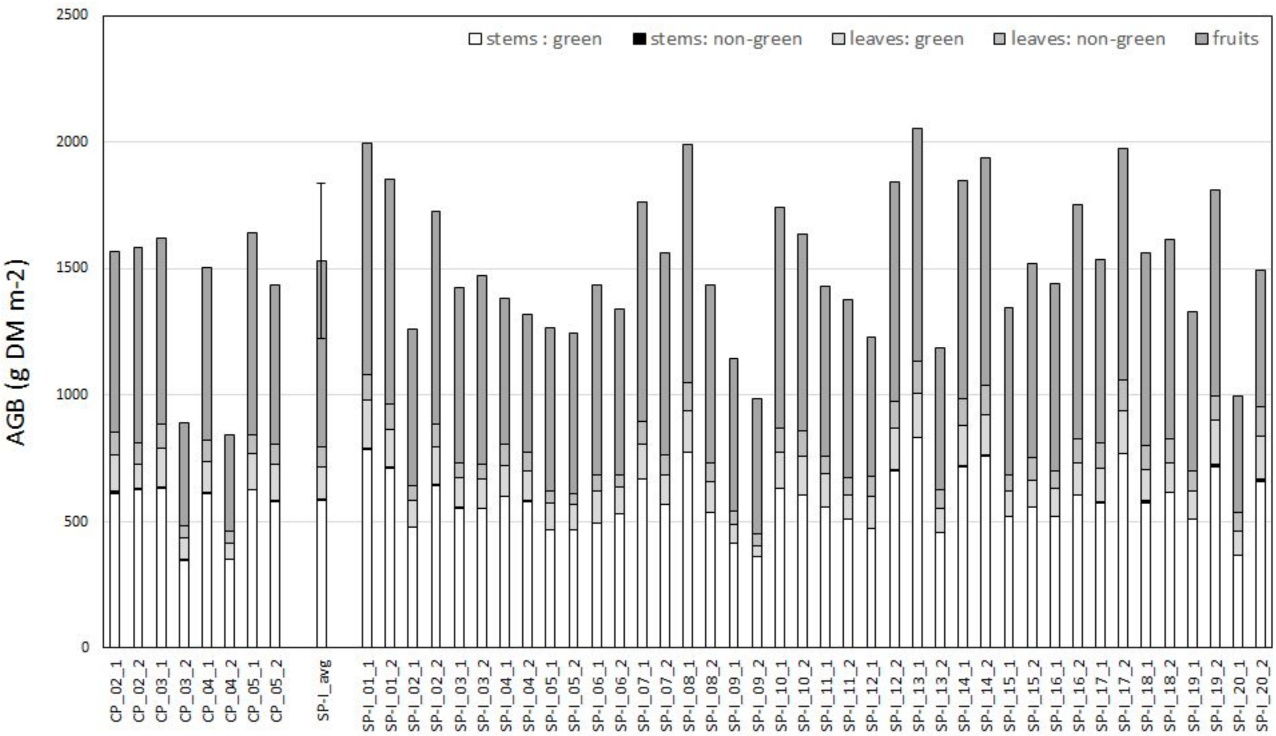
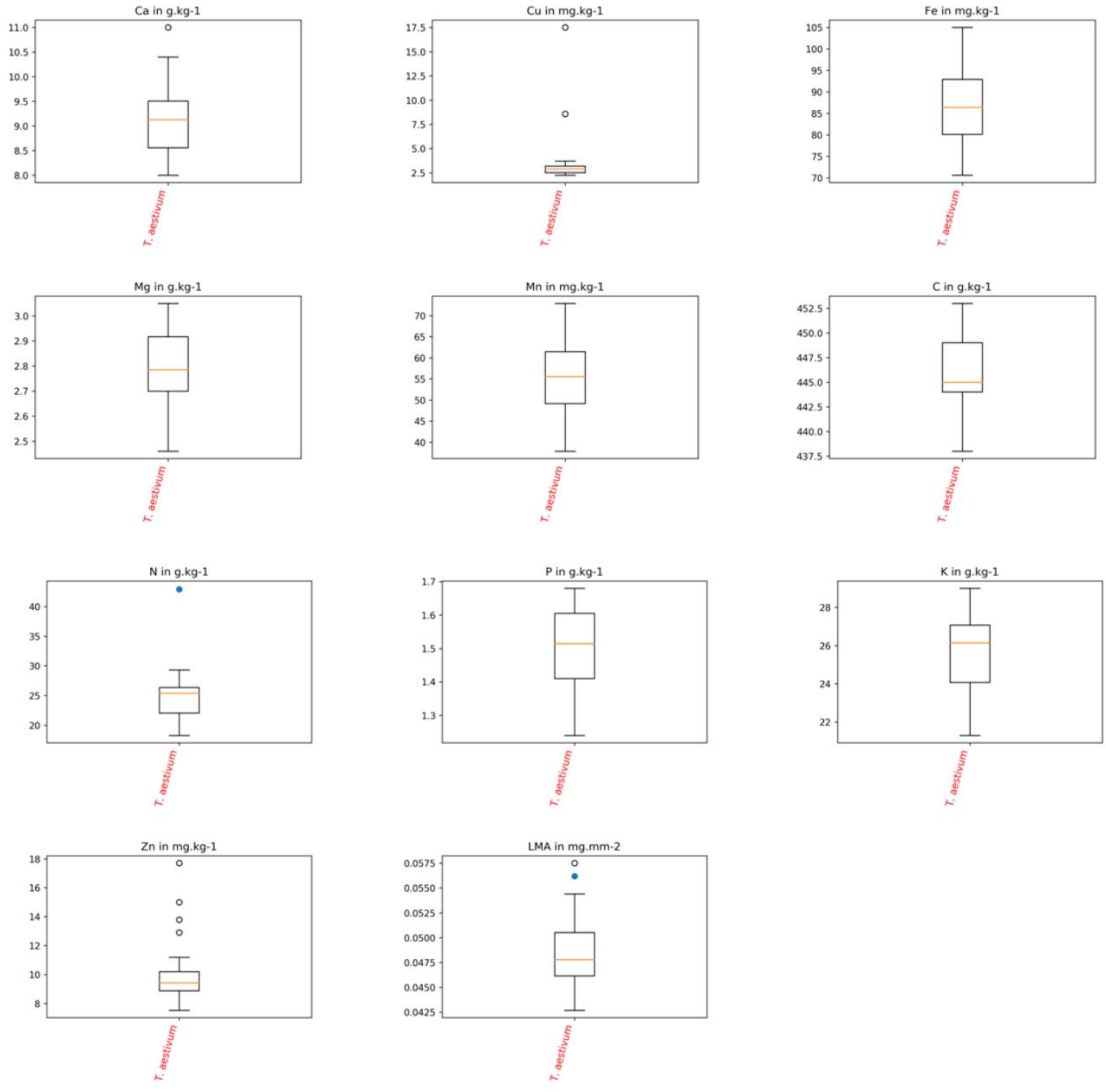


Figure 8: AGB measured on 18 June 2018. Results are shown for each of the two locations per CP and SP-I plot where wheat material was sampled. Error bars on the SP-I average indicate +/- 20% of total AGB. Fruits = grain-filled ears.

Vegetation sampling and analysis

First chemical analysis results and LMA values are shown below as collected from the June 26th 2018 sampling. ETC has no particular comment on the results that are at the low range of expected values (note that the TRY database values of N mass ratio is high and correspond to mature flag leaf with optimal fertilisation).

Foliar Analyses for station DE-RuS, 2018-06-26



Mean value of the ***Triticum aestivum L.*** *from TRY-db Data when available.* (https://www.try-db.org/TryWeb/Home.php)

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 Quality Control (QC) procedures. The requirement expected for the Step 2 of labelling is that the total percentage of missing and removed data after the QC filtering does not exceed the 40% threshold value.

Tests involved in the QC 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); (ii) instruments malfunction as provided by Vickers and Mahrt (1997) statistical tests; (iii) inappropriateness of the spectral correction method as provided by anomalous values of the spectral correction factor; (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 severe, moderate or negligible evidences about the presence of specific sources of systematic error (hereinafter denoted as SevEr, ModEr and NoEr). 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.

Concerning DE-RuS site, the testing period involves raw data sampled from 15th December 2018 to 16th April 2019. Of 5904 expected half-hourly files for NEE fluxes, 58.1% were retained after QC routines as illustrated in Figure 9. In particular, about 1.5% of raw-data was missed, 40.4% of calculated half-hourly fluxes was discarded because affected by SevEr, while an additional 1.5% was discarded because identified as outliers and affected by ModEr. Although the amount of removed data is 1.9% higher than the threshold it must be noted that the period of measurement (winter) is characterized by small fluxes with low signal-to-noise ratio that are also the cause of rejection. With the much higher fluxes (and low S/N) during the growing season we expect that the percentage of data removed will decrease substantially and for this reason we consider the test passed.

References

Foken T and Wichura B (1996) Tools for the quality assessment of surface-based flux measurements, Agric For Meterol, 78, 83-105

Mahrt L (1998) Flux sampling errors for aircraft and towers, J Atmosph Ocean Techn, 15, 416-429

Vickers D and Mahrt L (1997) Quality control and flux sampling problems for tower and aircraft data, J Atmosph Ocean Techn, 14(3), 512-526

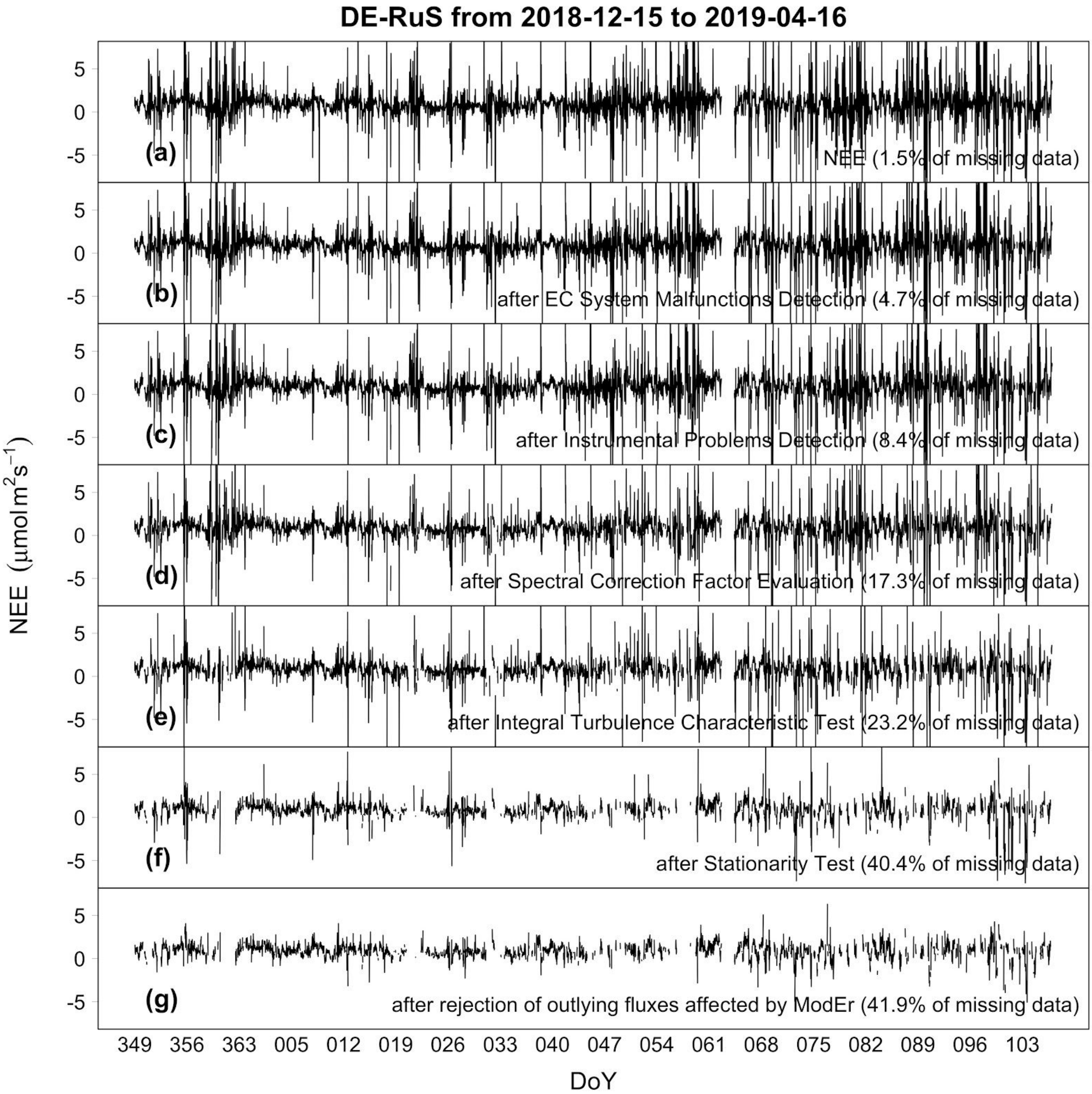


Figure 9: Summary of the quality control tests applied to the Net Ecosystem Exchange (NEE) of CO2 flux collected at DE-RuS site from 2018/12/15 to 2019/04/16. The original half-hourly flux time series is exhibited in the top panel. Panels b-f display the sequential removal of data affected by severe 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) instrumental problems detection; (d) anomalous spectral correction factor (SCF) check; (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 evidences of error.

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 5 months of data, after QC filtering procedure (previous Section) has been achieved. The model by Klijun et al. (2015) has been 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, the 37.4 % of the data was used for the test. Results showed that the 100 % of the whole period data have a cumulative contribution of at least 70 % from the TA (Fig. 10, first bar on the left), and this holds for daytime and nighttime periods too (Fig.10, left panel).

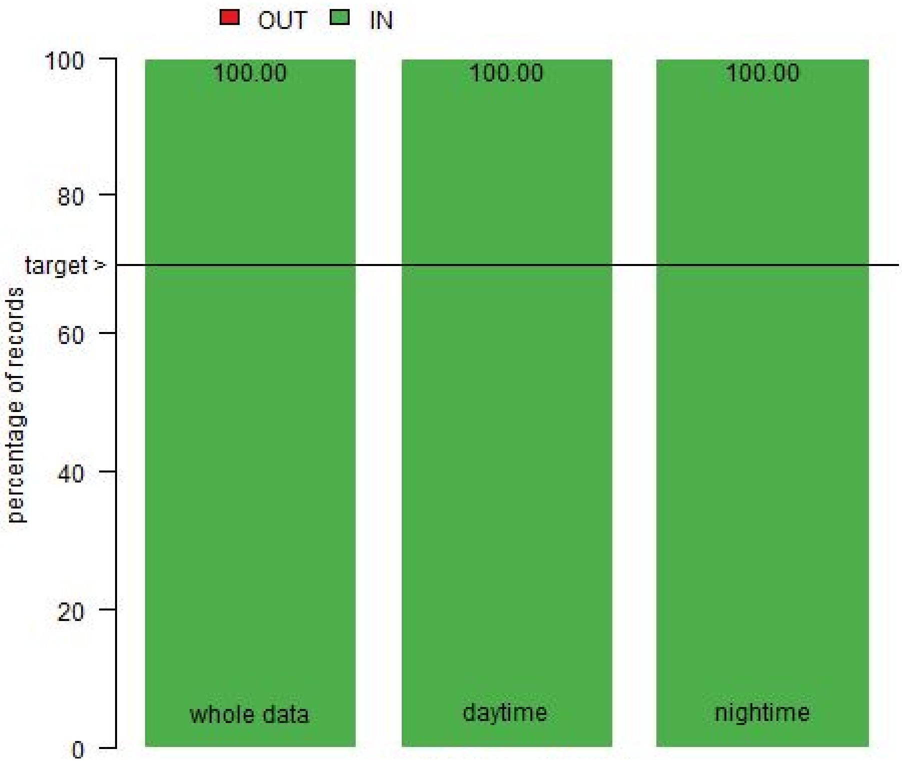


Figure 10: Test results over the whole analyzed period showing the percentage of half-hours with a footprint cumulative contribution of at least 70% from the target area. The target value is that the 70% of data (half-hourly fluxes) must hold this condition.

In addition, the test was performed on 5 sub-periods and results fully confirmed the percentages obtained for the whole period (Fig. 11).

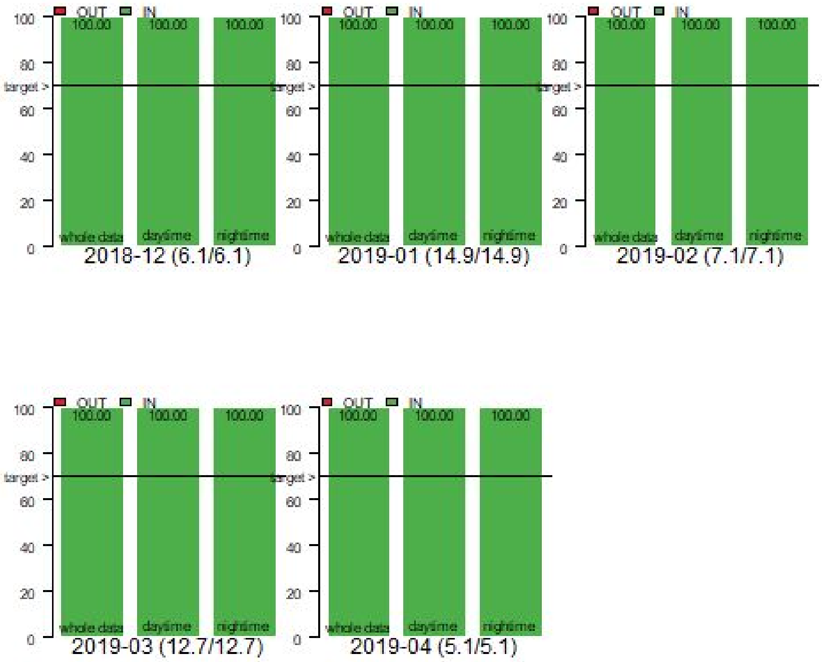


Figure 11: Test results over monthly sub-periods showing the percentage of half-hours with a footprint cumulative contribution of at least 70% from the target area. The target value is that the 70% of data (half-hourly fluxes) must hold this condition.

The footprint climatology for DE-RuS, computed over the period under consideration is reported in Fig. 12, by which it is possible to noticed that the footprint 70% contribution is always included in the TA. According to these results, the test is passed.

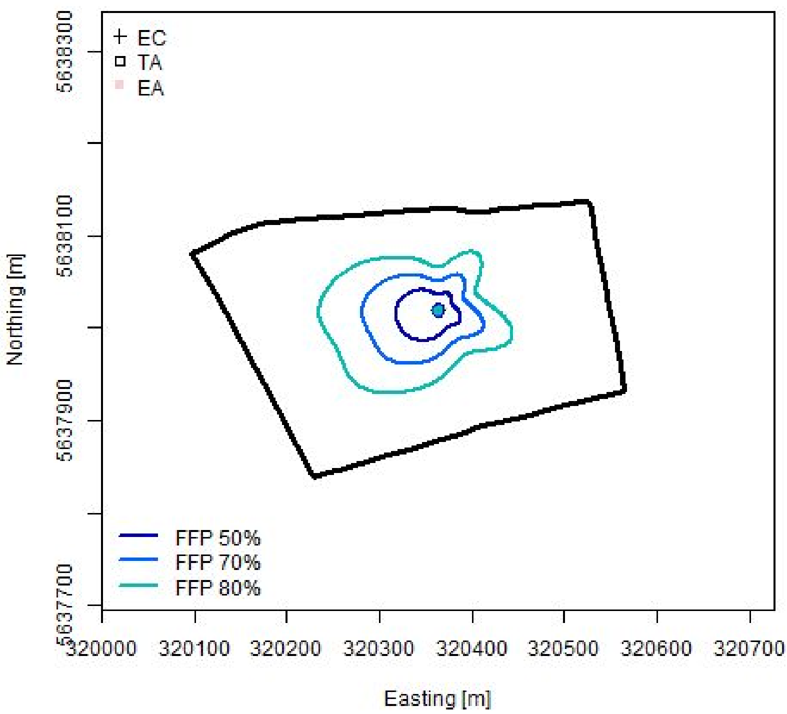


Figure 12: Footprint climatology at DE-RuS in relation to the TA, the different land cover typologies (LCT), the EC tower (EC), and the excluded areas (EA, see the spatial sampling Section). The 50, 70 and 80 % cumulative distribution isopleths are reported.

Data representativeness analysis (Test 3)

This test aimed to evaluate the representativeness of the possible different land cover tipologies inside the Target area (TA).

At DE-RuS the analysis on vegetation (Test 4, Section below) revealed a single vegetation typology. Consequently, the entire TA was considered as homogeneous in terms of vegetation and the Test 3 became unnecessary.

Ancillary plot representativeness (Test 4)

The representativeness of the CPs has been evaluated by comparing each CP with the SP-I plots in terms of the AGB measurements done shortly before the harvest of the wheat crop. As explained in the introductory section of this report, a CP is deemed representative when values are less than 20% different with respect to the target area's average, i.e. the average of the SP-I plots. As can be seen in Figure 13, one CP falls below the formal threshold for acceptance (CP_03), but the average AGB of the CPs is rather close to the average AGB of the SP-I plots and the AGB variability of the CPs is similar to the variability in the SP-I plots. Therefore, we conclude that the CPs were together representative of the target area. Furthermore, mapping of total AGB per plot revealed that there is no obvious spatial trend in crop growth in the target area (Figure 14) and that, hence, the variation in AGB between the SP-I plots is due to random variability in growth conditions in the target area. This is in line with the station team's observations

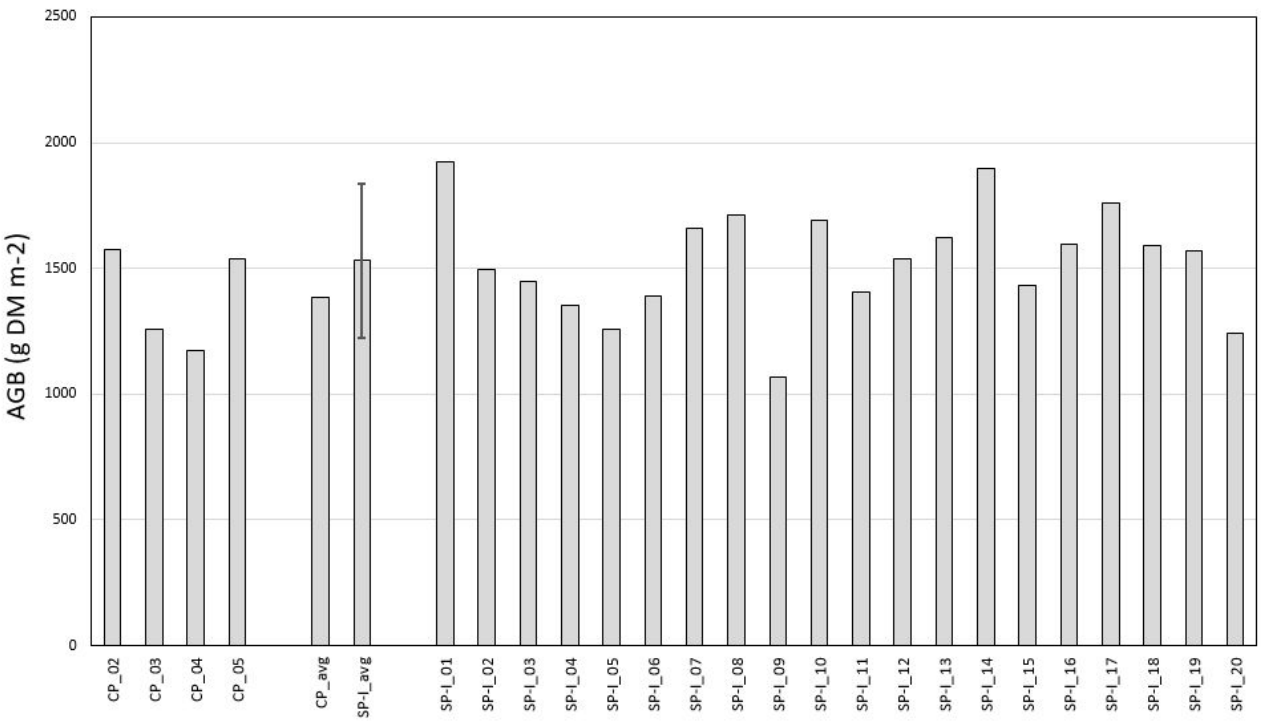


Figure 13: Total AGB per plot (= average of the two harvested locations per plot). Error bars on the SP-I average show the +/- 20% threshold.

Figure 14: Total AGB per plot for the four CPs and the 20 SP-I plots, mapped in the target area. Bubble size scales with total AGB. The square indicates the EC tower location.

Near Real Time data transmission

NRT data transmission of 1 EC and 7 BM files started in July, 17^{th} Some example files previously sent, with some inconsistencies in file name, variable names, timestamp format, file structure, which have been corrected with time, for EC files by switching from Campbell to SmartFlux2 solution. At the same time the PI asked to perform the sync test on the CS data. The ETC gave instruction on how to set up the experiment. The PI sent the sync test data that will be checked soon. However, this is not part of the labelling. The PI asked an exception on the first (and last) timestamps in the file for soil BM files, i.e. starting from 0000 instead of 0001. The ETC rejected this request of exception for consistency. The PI communicated to the ETC that in August the height of the SAT was slightly modified (4 cm). This change is considered negligible by the ETC, and all the files are processed together. An important issue occurred in the acquisition system: a communication problem between the SmartFlux2 and the SAT was causing some EC files to be missing, and other to be incomplete. The cause of the problem was in a connector and solved.

Another issue was found for some BM files, var G_ISCAL, which had incorrect values (-1): the installation of new hardware fixed everything. Also, an issue with the submission of some files was solved by the CP, and another with the sampling interval in the BADM of few variables was fixed by the ETC.

Plan for remaining variables

The first soil sampling operations were planned for the summer 2018 but are presently delayed due to soil drought. No particular problem is expected otherwise at this station.

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 Selhausen Juelich (DE-RuS) is labelled as ICOS Class 1 Ecosystem station.

Dario Papale, ETC Director

April 29th 2019