1. DODATEČNÉ INFORMACE
K VEŘEJNÉ ZAKÁZCE
ČIDLA TEPLOTY A VLHKOSTI VZDUCHU 2006

I. VEŘEJNÝ ZADAVATEL

Název	**Ústav výzkumu globální změny AV ČR, v. v. i.**
Sídlo	Bělidla 986/4a, 603 00 Brno
IČO	86652079

II. VEŘEJNÁ ZAKÁZKA

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III. DODATEČNÉ INFORMACE

1. Žádost o dodatečnou informaci

„V příloze č.1 kupní smlouvy, jsou dva parametry, které pro aplikaci meteorologickou a výzkumnou v podmínkách České Republiky i Evropských jsou předimenzované.

Jedná se o parametry:

1. Rozsah provozních teplot alespoň: -50°C až 55°C. Námi nabízené řešení švýcarského výrobce Rotronic pracuje v rozsahu od -40°C do 80°C (převodník), měřicí sonda HC2A-S3 dokonce precizně měří v rozsahu -50…100 °C / 0…100 %rh. Vzhledem k teplotním podmínkám na území ČR, celosvětovému množství meteorologických aplikací (mj. i na nejvyšších vrcholech Alp) a spoluprací například s výrobcem Campbell Scientific, tyto sondy dokazují svoji kvalitu a zvládnutí těch nejnáročnějších podmínek. Jsme přesvědčeni, že drobné omezení provozní záporné teploty převodníku na -40°C nemůže ovlivnit celkovou kvalitu této sestavy a převodník můžeme navíc za příplatek doplnit i dalším, nezávislým pasivním snímačem PT100.

2. Krytí alespoň IP66. Naše řešení disponuje ochranou IP65, kdy rozdíl mezi těmito kategoriemi je pouze v tlaku vody přímo stříkající na zařízení. IP65 plně splňuje podmínky použití zařízení ve venkovních podmínkách a vzhledem k nutnosti kompatibility s radiačními kryty, předpokládáme jejich užití v kombinaci s těmito kryty nepřipouští vzniku podmínek pro využití ochrany IP66.“

1. Dodatečná informace

Vzhledem k tomu, že požadovaná čidla jsou určena pro zapojení do mezinárodní sítě ekosystémových stanic ICOS (Integrated Carbon Observation System), která stanovuje jednotné technické parametry těchto čidel pro celou Evropu a jejich znění je uvedeno konkrétně na straně č. 3 přílohy č. 1 této 1. Dodatečné informace, je zadavatel povinen i nadále trvat na dodržení technického parametru „Rozsah provozních teplot alespoň: -50 °C až + 55 °C“.

Technický požadavek na stupeň krytí alespoň IP66 je zadavatelem požadován z toho důvodu, že zadavatelem dříve používaná čidla s nižším krytím, měla velmi krátkou životnost při jejich umístění pod korunovou vrstvou na perhumidních lesních stanicích. Vzhledem k tomu, že požadovaná čidla budou umístěna ve velmi podobných podmínkách, zadavatel i nadále trvá na dodržení technického parametru „Krytí alespoň IP66“.

V Brně dne 14. 10. 2020

prof. RNDr. Ing Michal Marek, DrSc., dr. h. c

Digitálně podepsal prof. RNDr. Ing Michal Marek, DrSc., dr. h. c
DN: c=CZ, 2.5.4.97=NTRCZ-86652079, o=Ústav výzkumu globální změny AV ČR, v.v.i., ou=65005032, cn=prof. RNDr. Ing Michal Marek, DrSc., dr. h. c, sn=Marek, givenName=Michal, serialNumber=P43242
Datum: 2020.10.14 14:18:37 +02'00'

prof. RNDr. Ing. Michal V. Marek, DrSc., dr. h. c.

ředitel

Ústav výzkumu globální změny AV ČR, v. v. i.

Příloha č. 1: ICOS Ecosystem Instructions METEOROLOGY

ICOS Ecosystem Thematic Centre

ICOS Ecosystem Instructions

METEOROLOGY

Version: **20170131**

INSTRUCTIONS FOR

METEOROLOGY

Air temperature

Air relative humidity

Air pressure

Wind speed

Wind direction

Backup meteo station

Version	Release date	Summary of changes

The ICOS protocols and the derived Instructions documents can be changed and amended in time, because new methods become available or to improve their clearness. For this reason, it is crucial to keep track of the versions and differences.

ICOS Ecosystem Thematic Centre

ICOS Ecosystem Instructions

METEOROLOGY

Version: **20170131**

CONTENTS

SUMMARY

Several meteorological variables need to be measured at ICOS monitoring stations in order to characterize them, analyse the drivers explaining GHG fluxes, and properly calculate, partition and aggregate these fluxes and their seasonal budgets from eddy covariance (EC) measurements, the storage profile, automatic chambers, etc. This Instruction document deals with all the relevant air characteristics to be measured at ICOS stations, i.e. air temperature (TA), air relative humidity (RH), air pressure (PA), wind speed (WS) and wind direction (WD). Radiations and Precipitations are kept separated in dedicated documents. Furthermore, in order to reduce the occurrence of gaps in meteorological data and to have a reference, ICOS stations have to be equipped with a backup meteorological station in the vicinity of the main one. The steps needed to install, maintain, calibrate the sensors, up to the data collection, processing and submission are described in this Instruction document for the meteorological variables. For the sensors in the backup station that are not described in the present document, the respective Instruction documents must be consulted. The info are contained in the following sections:

- Measurements: in this section the sensors are described, and the steps to perform from the installation to the data collection are illustrated.
- Maintenance and calibration: in this section all the maintenance and calibration guidelines are described, including the general timeline and how to deal with repairs.
- Submission: it is the section related to the data preparation and submission to the ETC. It includes a summary of the submission workflow described in a dedicated document, and lists all metadata and ancillary parameters to be sent to the ETC, and how to submit them.
- Processing: this section is for internal use of the ETC and describes the processing applied to the single variable/info/sample submitted.

It is important to remind that the exact application of the protocol at station level must be also discussed with the ETC in order to reach agreed solutions for specific cases. If a specific part is relevant only for a specific ecosystem or site Class this is also reported in the document.

This Instruction document is based on the following ICOS Ecosystem protocols:

- Rebmann et al. “Flux-Station Site Setup including complementary measurements”

MEASUREMENTS

Sensors and material

Temperature sensors. PT100 or PT1000 resistance thermometers have to be used to measure air temperature (TA). Minimum requirements (class 1/3 DIN):

- Accuracy: ±0.1K at 0°C (sensing probe, excluding screen and data-logging errors)
- Precision: ±0.1K
- Step Response time (or response time): about 20s
- Measuring range: -50°C - +55°C

If for some reasons it is not possible to use such sensors, other electrical thermometers can be deployed, following the indications of WMO (WMO, 2014 – Guide to Meteorological Instruments and Methods of Observation) and in accordance with the ETC. Resistance thermometers with the same requirements must be used also in the backup meteorological station.

Hygrometers. Electrical capacitive hygrometers have to be used to measure air relative humidity (RH). Minimum requirements:

- Accuracy: ±3% RH
- Step Response time (or response time): about 60s
- Measuring range: 5% - 100%

This instrument must be used also in the backup meteorological station.

Barometer. Electronic barometers have to be used to measure air pressure (PA). Minimum requirements:

- Accuracy: ±0.5hPa
- Precision: ±0.5hPa
- Step Response time (or response time): 30 s.

Anemometer (only Class1 sites). Anemometer(s) must be used to measure wind speed (WS) and wind direction (WD). Minimum requirements:

Wind Speed:

- Accuracy: ±0.5 m s-1 for values <= 5 m s-1; ±10% for values >5 m s-1
- Precision: ±0.5 m s-1
- Measuring range: 0 – 75 m s-1
- Distance constant: 5 m

For wind speed, cup or propeller anemometers are possible, as well as sonic anemometers, provided that they respect the minimum requirements. The distance constant, defined as the length of the

column of air that has to blow through the anemometer to reach 63% of its final reaction to a change, is analogue to response time in other instruments.

Wind direction:

- Accuracy: ±5°
- Precision: ±3°
- Measuring range: 0 – 360°
- Response time: 1s

If sonic anemometers are used, they can measure both wind speed and direction. Also some models of cup/propeller anemometers are provided as a combination of a cup or propeller anemometer and a vane anemometer for wind direction measurements. If this is not the case, a separated vane anemometer must be installed at the station together with the cup/propeller anemometer.

Radiation sensors. They are used to measure radiation components at the tower. A pyranometer has also to be installed at the backup meteorological station. See the Instruction document on Radiations for detailed characteristics.

Precipitation sensor. An automatic recording gauge has to be used to measure precipitation at the station. Furthermore, a precipitation sensor must be part of the backup meteorological station. See the Instruction document on Precipitations for detailed characteristics.

Additional material. All the sensors listed above may require some additional material to ensure proper functioning.

Screens, shields and other protection devices: clean screens or shields are mandatory for both resistance thermometers and capacitive hygrometers to protect them from radiation. Both sensors can be placed inside the same screen, which must be a double cylinder white screen with forced ventilation (3 – 7 m s^{-1}). The volume of the screen must be large enough to guarantee air circulation and the insertion of the probes without contact. For the housing only appropriate materials must be used, non-adsorbing or non-desorbing liquid water and water vapour (e.g. plastic materials). See Figure 1 for an example of shielded resistance thermometer and capacitive hygrometer sensors. For the barometer the screen is facultative. A shield is mandatory around some precipitation sensors to protect them from wind: for details see the Instruction document on Precipitations. Protection devices to prevent dirt accumulation on radiation sensors (including the pyranometer at the backup station) could be needed in case of intensive bird impact: refer to the Instruction document on Radiations.

Static pressure head: Facultative to be connected to the barometer to avoid biases from wind gusts, can be commercial or homemade. However, if the sensor is connected with a tube the static pressure head is mandatory, especially when the sensor is installed in a closed room/cabin (see below), in which case the static pressure head must be placed outside the enclosure of the sensor.

Sealed pipe or tube: used to connect the barometer to the static pressure head and bring the air pressure signal to the sensing element.

Ventilation and heating unit: some of the radiation sensors (including the pyranometer at the backup station) must be permanently ventilated or heated. See the Instruction document on Radiations.

Power unit for anemometer: cup/propeller anemometers and/or vane anemometers might be associated to a power unit, depending on the model. Usually the power unit must be put indoor. In this case provide a proper housing to avoid damage from precipitation, wind and other atmospheric events. Follow the recommendations of the producer.

Figure 1. Example of shielded thermometer and hygrometer with forced ventilation (43502 YOUNG). Source WMO Field Intercomparison of Thermometer Screens and Humidity Measuring Instruments, Ghardaïa, 2008-2009, Appendix 1

Instrument setup

Setup

Thermometer and hygrometer. One resistance thermometer and one capacitive hygrometer must be mounted at roughly the same height as the EC system (an offset of 1 m for towers lower than 10 m and of 2 m for taller towers is allowed), and at the same location whenever possible, because their measurements are used in the processing of EC data. For that reason the mast to host the sensors shall be the same as the mast of the EC system. For all the cases where the EC system height needs to be adjusted during the growing season (e.g. fast growing crops), the sensors must be installed such that their height can be changed along with that of the EC system. It is important however to ensure that meteorological sensors do not disturb the EC system in terms of flow distortion, and at the same time that the tower structure is not disturbing the meteorological sensors (e.g. shadowing, thermal interaction). For that, a minimum distance of 1 m must be respected from these two sensors (thermometer and hygrometer) and all the other structures and instruments installed at the tower, including the tower/mast itself. For towers higher than 3 m the minimum distance should be 1.5 m. Deviations from these values can be discussed with the ETC.

Barometer. It is necessary to sample air pressure inside an ideal volume around the EC system not exceeding a horizontal distance of 100 m, and a vertical distance of 10 m. For that reason a barometer can be installed inside this ideal volume, or for higher distances it must be connected to it via a tube. If a tube is used, the static pressure head is mandatory. Care must be taken as usually to avoid disturbances to the other sensors, especially the EC system. Close vibrations can however disturb the barometer, and then interferences with other devices should be avoided.

Anemometer (Class1 stations). Depending on the selected models, one or two anemometers must be installed at the stations to measure both wind direction and speed. Whatever the anemometer(s) selected (Class1 stations only), it (they) must be installed on the main mast or in a mast located close-by. The distance from the mast body must follow the same rules as prescribed for the EC sonic. This means a minimum distance of 85 cm if the maximum section size of the mast is <= 60 cm, otherwise 1.2 times the maximum section size of the tower. However, the maximum distance should be 4 meters (but can be discussed with ETC if higher distance is suggested by the PI). The height must be at least 2 meters above the canopy. Care must be taken that no disturbance is caused to the other instruments installed at the station, especially that no shadowing to the radiation sensors and no distortion of the air flow in the vicinity of the sonic anemometer occur. In the case of sonic anemometers, it is recommended to use heated instruments in cold climates. The heating should be switched on automatically when conditions of low temperatures and high relative humidity occur.

Backup meteorological station. The backup station is composed of a resistance thermometer, a capacitive hygrometer, a pyranometer and a precipitation sensor as described in the previous section. The use of a commercial pre-composed meteo station equipped with the requested sensors must be discussed with the ETC, especially if one or more sensors have a lower accuracy than expected. The backup station has to be installed less than 1 km away from the main (EC) one, and

the sensors must be installed at a height of at least 2.5 m above the surface (except for radiation and precipitation where the setup must follow the one explained in the relative Instructions). The backup station has to be powered independently from the main one, and must be capable of logging data internally. A system of power backup in case of power cut is recommended. If the vegetation of the target ecosystem is tall, an open space (e.g. forest clearing, close-by field) must be found in a ray of 1 km, having a diameter at least 5 times the highest element at the border, and as representative as possible of the above-canopy. If this is not possible, the sensors of the backup station can be installed on the main tower, also above the canopy, provided that they can be powered independently, and that data can be collected in an independent datalogger dedicated only to these sensors.

Mounting of sensors

Thermometers and hygrometers. Install the sensors inside the screen, paying attention to avoid contact between the sensors and the screen (and the sensors between them if installed in the same screen). This is not necessary if the sensors are provided already inside the screen by the producer. The screen can be used as support for the sensors: just fix it to the mast or boom using a proper support. Respect the distances reported above. The same applies for the sensors to be installed at the backup station.

Barometer. Install the barometer at a proper location. If installed far from the EC system (according to the rules reported above), use a tube to bring the air to the sensor, and a static pressure head. If the sensor is installed inside the housing of other instrumentation, also at the ground, following the instructions of the producer, place the static pressure head outside the enclosure. Avoid mechanical vibrations by reducing as much as possible any interference with other devices. Respect the distances reported above.

Anemometer (Class1 stations). Follow the recommendations from the provider. For some models, both the vane and the cup/propeller anemometer can be installed in the same structure. Respect the recommended orientations.

Radiation and precipitation sensors. See the Instruction documents on Radiations and Precipitations for mounting recommendations, also for the backup meteo station.

Data collection

Minimum acquisition frequency is 0.033 Hz (meaning one measurement every 30 s) for all the sensors, except the radiation sensors, which must be acquired at minimum 0.05 Hz (one every 20 s). Different loggers can be deployed, each producing one or more files. One file per acquisition frequency is requested. Both instrument units and physical units must be recorded and archived. Loggers must be synchronised between them and with the logging system of EC data, checking the

time alignment once per day using GPS or NTP. Each file produced by the loggers must include data collected during one day. For the data format refer to the specific Instruction document.

MAINTENANCE

Sensors maintenance

Resistance thermometers and capacitive hygrometers require minimal maintenance. A monthly check is needed to make sure that the radiation shield is clean and free from debris. Cleaning of the probes is not recommended, and must be considered only if excessive dirt contaminates it, using a small very soft brush, that may be wetted with distilled water, if needed. After cleaning, a check of the correct functioning of the probes is needed (see calibration). The wiring should be checked for corroded traits, animal bites, and disruption at least monthly for installation below 10m, at least every 3 months elsewhere.

The barometer can be cleaned with a soft, wet cloth if needed. To clean the static pressure head (if used), disassemble the instrument and follow the instructions of the producer. The wiring should be checked for corroded traits, animal bites, and disruption at least monthly for installation below 10m, at least every 3 months elsewhere.

For Cup/propeller and vane anemometers, follow the instructions from the producers. Once per month check that the rotating parts are freely moving. In case of friction (not smooth rotation, noise) send the instrument to the factory for repairing, or replace it. Also in case of evidence of physical damage, replace the sensors. Some instruments may come with proper means of checking the conditions of the bearings. Bearings and shafts shall never be lubricated if not specifically indicated in the manual. The wiring should be checked for corroded traits, animal bites, and disruption at least monthly for installation below 10m, at least every 3 months elsewhere. In case of sonic anemometer see Turbulent fluxes Instruction document.

Sensors calibration

Field calibrations

In general, field calibration for air meteorological sensors and backup meteo station sensors is not recommended. An exception to this situation is in the case of availability of a redundant sensor of higher accuracy in the vicinity of the standard one, e.g. if provided by the ETC. This sensor should be factory calibrated every one or two years, according to the recommendations of the following section. Field calibration must be however discussed with the ETC. See also the Instruction documents on Radiation and Precipitation. The sensors of the backup station are checked against the corresponding sensors at the main tower by the ETC, and must be sent to the factory for calibration if a significant deviation is found (> 1 sigma).

Factory calibrations

All the sensors except those at the backup station must be recalibrated at the factory/local seller every two years. When sent to the factory for calibration, sensors will undergo a general maintenance and overhaul procedure. An exception is the cup/propeller anemometer and vane anemometer that need factory calibration every year. If the seller of one or more of the selected instruments should not provide factory calibration for them, the field calibration with a redundant sensor as reported in the previous section would become mandatory. In specific cases to be discussed with the ETC, it may be also possible to send the sensors to a certified calibration facility other than the factory/seller. For the sensors at the backup station, the regular comparison with the main sensors is deemed enough to decide on the need for factory calibration/sensor replacement.

Sensors repair and substitutions

Minor damages can be in general easily solved by the technical staff of the station. The information on the repairing must be submitted to the ETC via the BADM system on the same day they are made. Repairing must be done in less than one day, or an ICOS compliant spare sensor must be installed for longer periods as a substitute. In case of change of the instrument, parallel measurements of the old and new sensors should be performed, if possible, for at least two months (ideally one year).

If the damage cannot be repaired, the sensor must be sent to the factory for repairing, or a new/different sensor must be installed, according to the convenience evaluated by the PI. The new metadata must always be submitted as soon as possible and whenever possible in the same day.

SUBMISSION

Data format

All the sensors described in this document are run in continuous mode at ICOS stations. The file format, variable names to be used, their units, the filenames, and other details on the data format and the data submission are reported and explained in the corresponding Instruction documents. Summarizing the content of the format instructions, these are continuous low frequency data organized in daily files, either comma-separated ASCII or binary. One file per acquisition frequency is required. The files must be structured with one record per row and one variable per column. One line in the header file will report the variable labels according to the standard names. The order of the column is in general not prescribed, except the timestamp which must be reported in the first column.

Variables to be submitted using BADM system

Data must be accompanied by fundamental metadata, which are sporadic data to be sent to the ETC using the BADM system. These info must be sent at the time of installation of the station, and each time a change in the setup occurs or an event happens (including calibrations and disturbances). To get the full and updated list of variables refer to the BADM Instruction document. In general however the BADM variables related to the meteorological variables are:

- Variables to describe the sensors used (models, serial numbers, characteristics) using the INST group in the BDAM system.
- Variables to describe the setup of the sensors (positions, acquisition system, file type) using the BM group for the installation and the LOGGER and FILE groups for the acquisition and file characteristics.
- Variables to describe the management and disturbances to the system (calibrations, damages, other problems) using the BM group for the field calibration and disturbances/management while the factory calibrations and firmware upgrade are reported using the INST group.

PROCESSING

The meteorological data after a check for the format are compared with the historical timeseries in order to timely identify possible errors, trends and deviation. Also variables linked and correlated (such main and backup meteorological variables) are constantly checked and compared.