High-precision datasets from monitoring stations based on eddy covariance measurements: what six years of quality evaluation process of ICOS ecosystem stations have to tell

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ICOS (Integrated Carbon Observation System) is a Research Infrastructure aiming at getting a deeper understanding of the European Carbon balance by means of a network of monitoring stations, based on eddy covariance (EC) technique, spread out all over the European Continent, and continuously expanding. The Ecosystem Thematic Centre (ETC) coordinates the activities of ecosystem stations to ensure high-precision datasets and standardisation. The so-called Labelling procedure is made of two steps, conceived to guide the candidate stations to get the official ICOS label: the Step 1 is focused on the sensors’ setup and is structured as a discussion between the ETC and the station teams, while the Step 2 concerns the practical build-up of the station and the data evaluation. For stations with the stricter standards (so-called Class 1 and Class 2), some quality tests on the data are included: one on the EC data quality, two on the representativeness of the measured EC fluxes and one on the representativeness of the ancillary plots.

Currently 58 of 86 candidate stations completed the labelling procedure, of which 30 Class 1 and 2. The more common fixes agreed in Step 1 are changes in sonic orientation and height or location, to better deal with fetch and canopy inhomogeneities. In Step 2, apart from increasing the signal resolution and fixing some metadata, a further correction of the location/height of the sensors led to solving the remaining problems. Overall, two thirds of the stations passed the three EC tests at the first try (all the wetlands, 74% of the forests, 33% of the crops), pointing at the efficiency of the Step 1 evaluations, while the remaining ten didn’t pass one or more of the two other EC tests, testifying that some issues are only discoverable from proper data analysis. About one third of the stations didn’t pass the ancillary representativeness test, all of them over forests: the most common solution was to add or move one or more plots.

The results support the common knowledge that more complex ecosystems - not uniform canopy
geometries, fast growing vegetation - are more likely to be affected by some data quality issue. This constitutes a crucial warning to researchers and technicians in the direction of properly considering the station characteristics when planning its setup and sampling design, as well as continuously checking the data produced, to ensure the production of high-precision datasets.