Mobile Laboratory improving the data quality of ICOS atmospheric station network

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ICOS (Integrated Carbon Observation System) is a European-wide research infrastructure consisting of high precision long-term network of stations measuring greenhouse gas concentrations in the atmosphere and greenhouse gas fluxes from ecosystems and oceans. ICOS is designed around central facilities, of which main tasks includes provision of calibration gases, standardized data processing, technical support and training, and quality control. As part of the Atmosphere Thematic Centre (ATC), a mobile laboratory (MobileLab), operated by the Finnish Meteorological Institute (FMI), is responsible for atmospheric station audits and internal quality control. The ICOS Atmospheric Station Specifications –document (https://icos-atc.lsce.ipsl.fr/filebrowser/download/27251), composed in conjunction with the atmospheric scientists and maintained by the ATC, provide the guidelines for the MobileLab audits.

The MobileLab is a fully equipped mobile unit visiting 3-4 atmospheric stations per year. The MobileLab instrument repertoire includes state-of-the-art greenhouse gas analysers; Picarro G2401 (CO_2, CH_4 and CO), Ecotech FTIR (CO_2, CH_4, CO and N_2O), and LGR-EP (CO and N_2O); as well as a set of calibration gases. An audit comprises a multi-day station evaluation visit, a cross-check of the calibration gases, and ambient air intercomparison measurements for one to two months. For the audits, the MobileLab uses travelling standard cylinders (TSs) prepared by FMI and calibrated against the laboratory standards (WMO CCL scale) prepared by WMO Central Calibration Laboratory at NOAA (National Oceanic and Atmospheric Administration, USA). Since the preparation of the MobileLab TSs is separated from the ICOS Central Analytical Laboratory (CAL) that normally provides standard gases for the stations, the MobileLab audits are independent from the ICOS CAL gas standards and thus have a nature of an external audit. The stability of the FMI laboratory standards, however, is ensured with regular cross-checks against the ICOS primary standards maintained by CAL. During the audit visits, all the station infrastructure associated to the ICOS atmospheric measurements, including compliancy of meteorological sensors, and professionality of local personnel will be evaluated.

The MobileLab has standard operating procedures for all its operations that ensure reproducible audit visits from station to station, still enabling to adapt the operations to the local specialities. The quality management procedures of the MobileLab have been applied using the ISO 17025 global standard for good laboratory practises and quality management criteria that is also compliant with the ISO 9001 standard, as a guideline. The measurement data from atmospheric stations are centrally processed in the ATC to ensure the data consistency. Data produced by the MobileLab, however, is calculated separately to maintain the independent nature of the MobileLab and at the same time to evaluate the performance of the centralised data processing. During the audit visit, the MobileLab operators monitor the intercomparison measurements and helps the local personnel to improve the measurements. After the audit visit, a report summarising the results and including possible recommendations will be written.

From 2014 onwards, the MobileLab has set up its instrumentation, developed its operating procedures, quality system and reporting, and conducted seven audits. So far, the ICOS atmospheric station network has been under the building stage, but during 2017 the first stations will accomplish the labelling process. Due to the building stage of the atmospheric stations as well of the MobileLab, the frequency of audit visits has remained below the initial plans during these first years of operation. However, the audits performed at the stations with varying level of readiness have proven the high overall level of measurement performance, but also revealed some drawbacks in the chain from measurements to data processing.