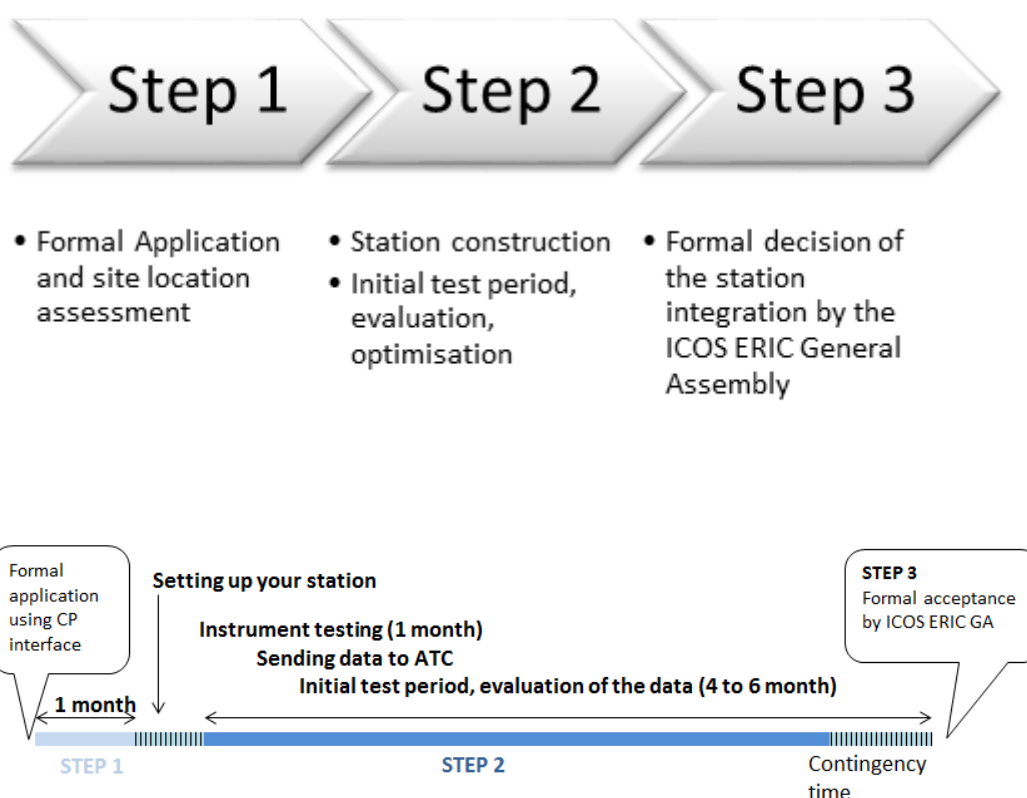


Executive summary of ICOS ATC Step 2 labelling report for the ICOS class 1 station Norunda

Executive summary n°: ATC-SE-LA-ES-004-1.1

This document is an executive summary of the ICOS ATC Step 2 labelling report for ICOS class 1 station Norunda (NOR).

A candidate atmospheric station officially becomes ICOS when it receives the ICOS label. The ICOS Station Labelling is a 3 step process summarized in the graphs below.



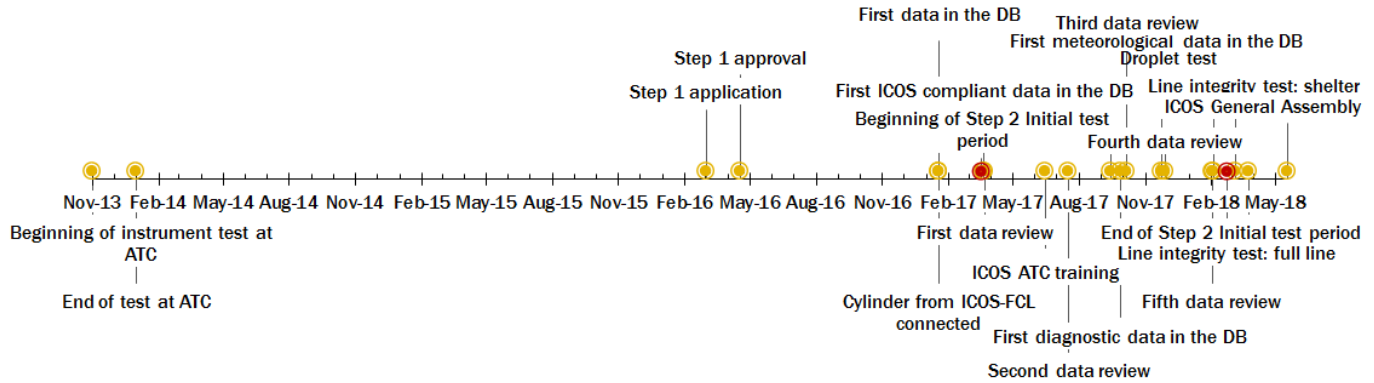
Once the data flow from the station to the ATC is in place, a phase of measurement optimization starts, the so called initial test period. This is done in close collaboration between the station PI and the ATC. This period typically lasts 4 to 6 months to gather enough time-statistics. The period can be prolonged if need be.

During the initial test period, the following metrics have been thoroughly investigated to make sure the measurements were meeting the ICOS specifications and quality standards required:

- Amount of data quality control and validation
- Time of actual measurement vs calibrations
- Optimized stabilization time to flush the sampling system
- Calibration drift and quality control

- Temperature dependence of the instruments
- Meteorological measurements
- Target gas measurements
- Diagnostic parameters
- Measurements uncertainties

The graph below shows the station installation and operation timeline relevant to the ICOS Atmosphere labelling process.



Norunda is providing ICOS specifications compatible data since 2017-04-01.

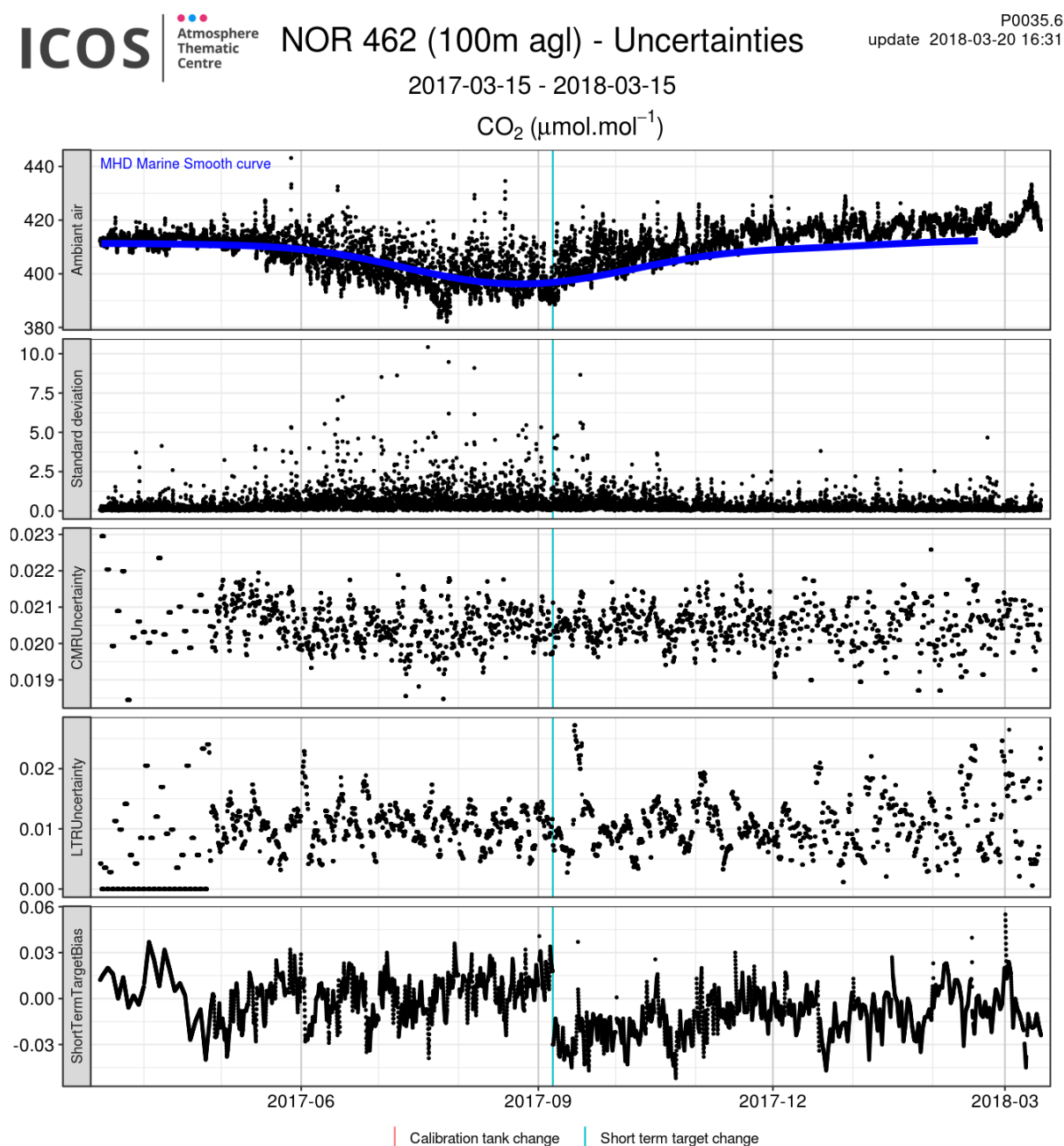
During the initial test period, the data quality has been improved thanks to the collaboration between the PIs and the MLab.

During the initial test period, the intake cups, that can be heated, showed that depending on flowrate and temperature, a CO bias could appear. These cups were replaced with teflon cups to avoid the problem.

At the end of the labelling step 2 initial test period, the following recommendations have been made to the station PIs:

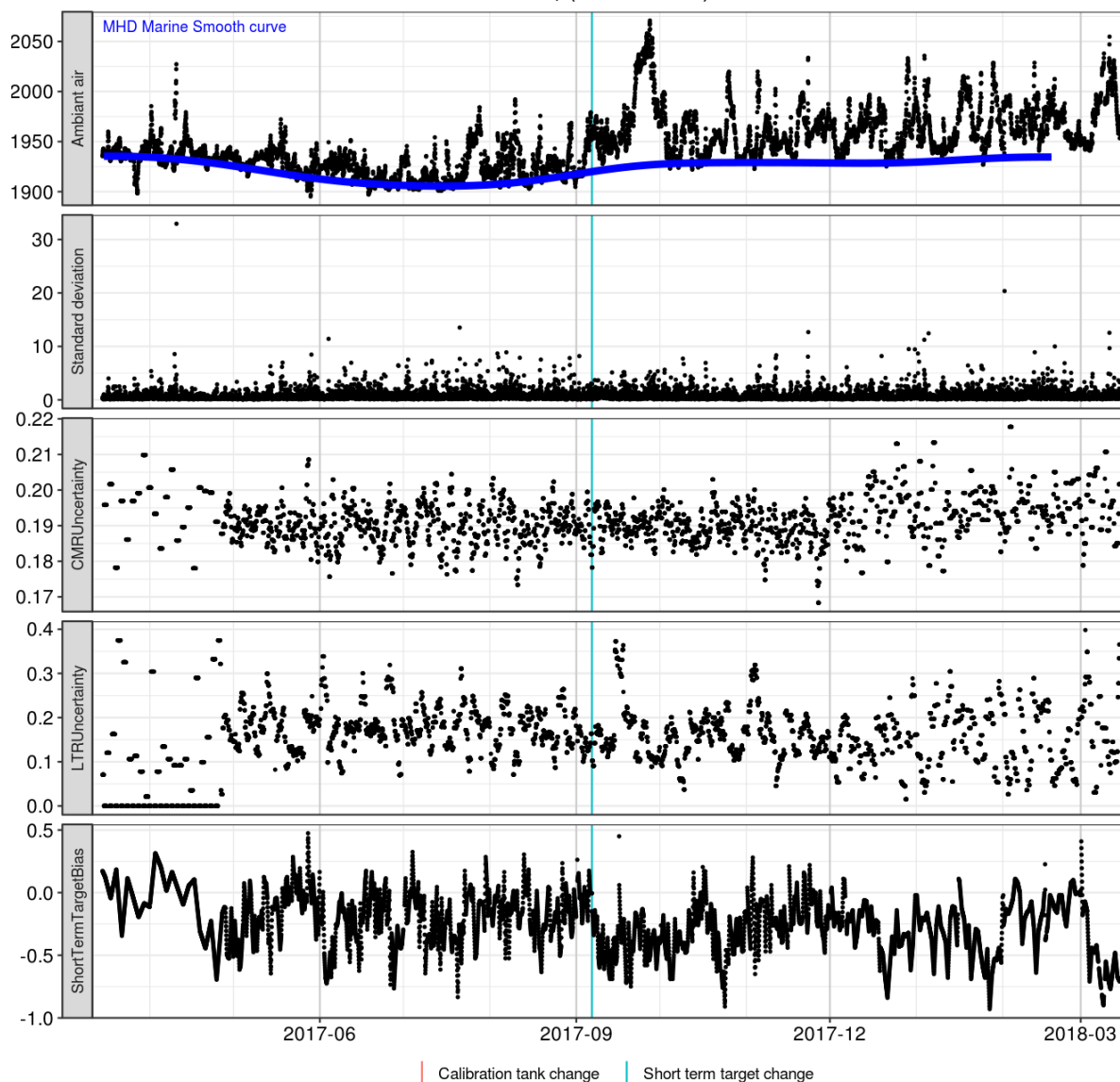
- (**, important, 2018): It is recommended to continue the flagging of raw data on a weekly basis.
- (*, minor, 2018): In the present situation, we recommend keeping 20min with 5min flushing for calibration and 30min with 10min flushing for the targets.
- (*, minor, 2018): In the present situation, we recommend keeping three calibration cycles every two weeks.

The following graph presents on the first panel the data, CO₂ of the station for the period relevant to the ICOS labelling. The four panels below the first one provide the associated uncertainties for different time scales (see glossary for detailed definitions)



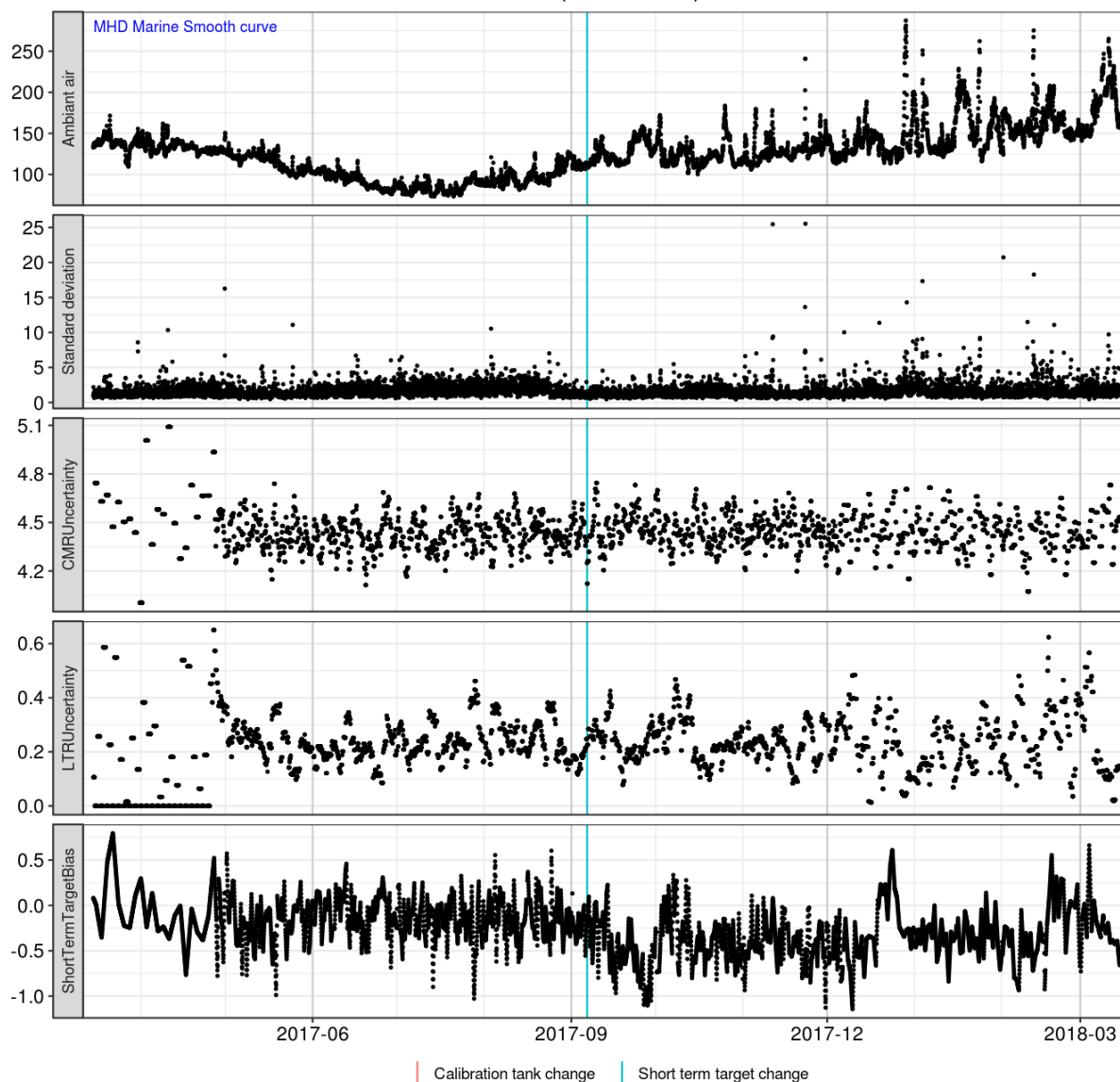
2017-03-15 - 2018-03-15

CH₄ (nmol.mol⁻¹)

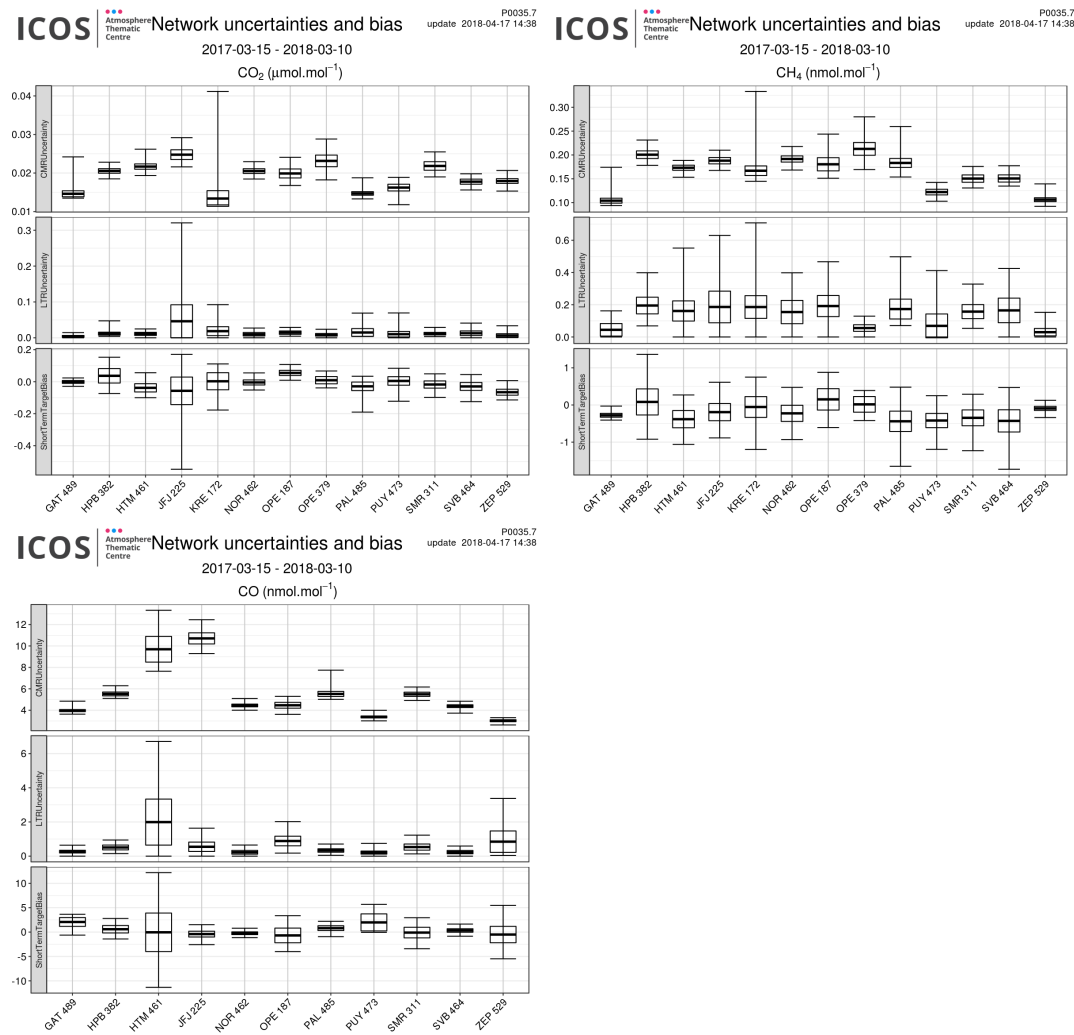


2017-03-15 - 2018-03-15

CO (nmol.mol⁻¹)



The figure below shows a summary of the uncertainties linked to the measurements put in perspective with the other candidate or actual ICOS stations.



Based on the data provided during the initial test period, we recommend that the Norunda station (NOR) is labelled as part of the ICOS Atmospheric Network.

For more information, you can consult these documents:

ID	Associated documents	Reference
AD1	ICOS atmospheric station specifications	ATC-GN-GN-SP-1.28
AD2	ICOS step 1 report	ATC-SE-LA-RP-003-1.0
AD3	ICOS ATC Metrology Laboratory Evaluation report for the ICOS instrument 462	ATC-ML-IT-RP-002-2.0
AD4	ICOS ATC Step 2 labelling report for the ICOS station NOR	ATC-SE-LA-RP-004-1.1
AD5	ICOS ATC MLab water correction assessment report	ATC-ML-WC-RP-02-1.0-462
AD6	ICOS ANET Sampling system test report	ANET-SE-SS-RP-002-1.0-NOR
AD7	ICOS ATC station website	https://icos-atc.lsce.ipsl.fr/NOR

The next page aims at giving a first partial identity card to the actual station measurements. From top to bottom is shown:

- Site photo + station general name/location information
- CO₂ daily measurements overlaid with linear trend and seasonal cycle
- Seasonal cycle, diurnal cycle and vertical profiles (by seasons)
- Hourly standard deviation together with a wind rose of CO₂ residuals. These graphs are a measure of the importance of local sources and an indication of averaged direction of potential strong sources/sinks of CO₂



ICOS

National Network Sweden

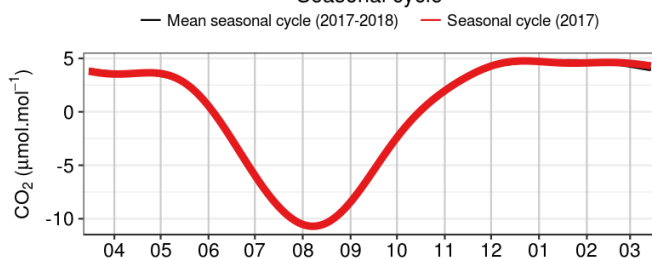
Norunda (NOR), Sweden - CO₂
60.0864°N - 17.4794°W, 46m ASL (100m AGL)



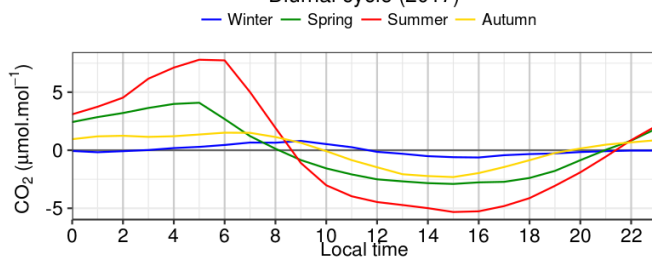
— Daily means — Smoothed curve — Trend curve



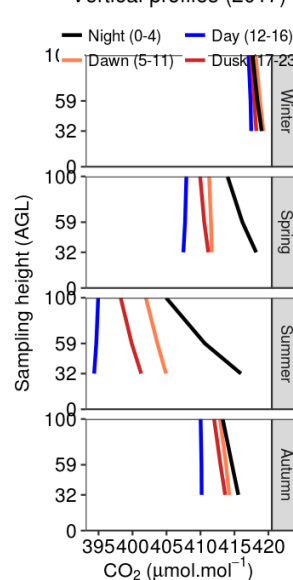
Seasonal cycle



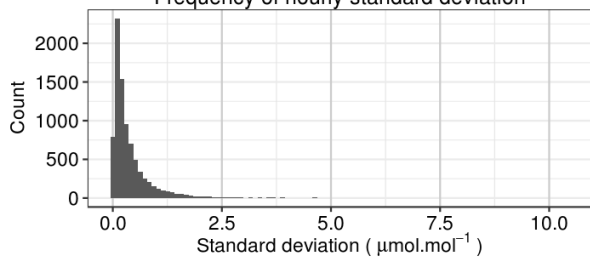
Diurnal cycle (2017)



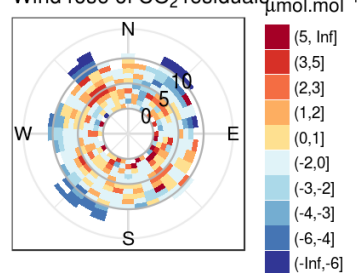
Vertical profiles (2017)



Frequency of hourly standard deviation



Wind rose of CO₂ residuals



List of abbreviations and glossary

ATC: Atmospheric Thematic Center

CMR: Continuous Measurement Reproducibility

CP: Carbon Portal

ICOS: Integrated Carbon Observation System

ICOS-FCL: ICOS Flask and Calibration Laboratory

LTR: Long-Term Repeatability

Calibration: As detailed in the ICOS specifications, three to four standard gases (known concentrations calibrated at the ICOS-FCL) are measured one after the other at least four times for 30 min each calibration sequence (each set of the three to four cylinders measurement is hereafter called a cycle). Usually the first cycle is used to flush the calibration lines. Then the calibration function using a linear fit is calculated.

CMR: In the MLab, the continuous measurement repeatability is evaluated with the standard deviation of the continuous measurements of a cylinder over 24 hours. Using the station data, the CMR is calculated using regular but not continuous measurements of the short term target gas. We calculate the moving monthly average of the standard deviations of raw data over 1 min intervals.

Long term target: gas with known concentrations (calibrated at the ICOS-FCL) that is measured on a monthly basis to insure data quality continuity through the different short term target changes

LTR: In the MLab, a target gas is measured for 30 min bracketed by around 5 hours of wet ambient air over 72 hours of total measurements. For each measure, only the last 10 min are averaged. The long-term repeatability is then expressed through the standard deviation of these averaged measures. Using the station data, we calculate the moving standard deviation of the averaged short term target measurement intervals over 3 days as in the MLab.

Short term target: gas with known concentrations (calibrated at the ICOS-FCL) that is measured frequently (two to three times a day) to follow short term instrument variability.