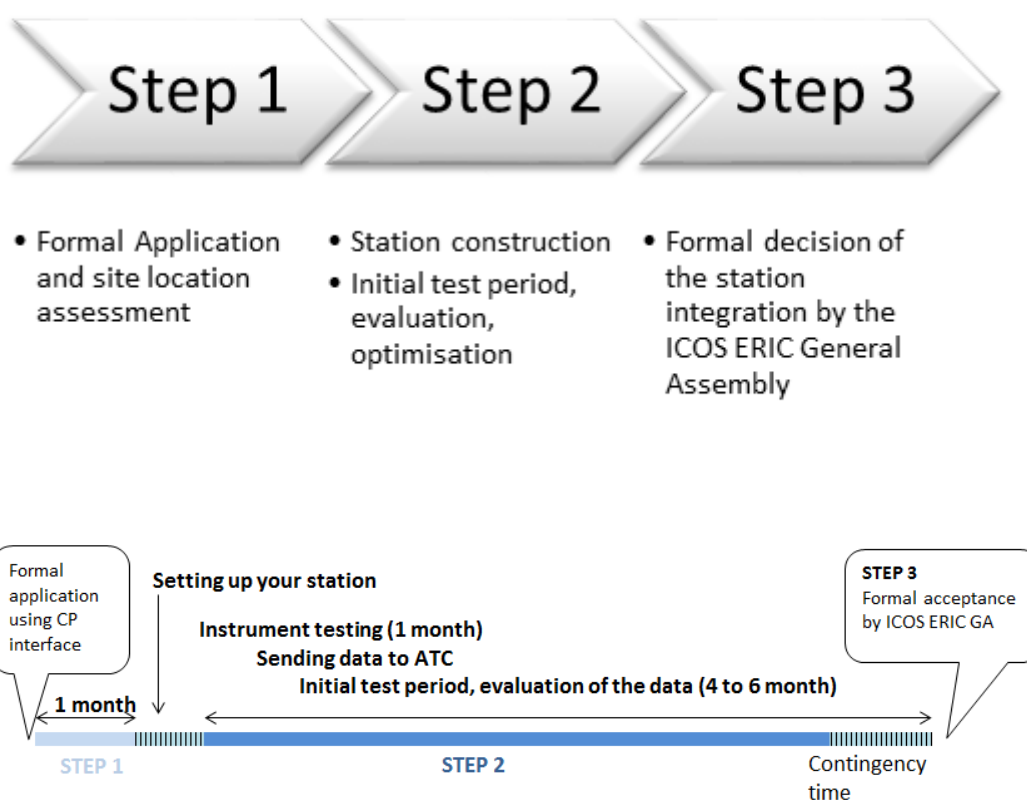


## Executive summary of ICOS ATC Step 2 labelling report for the ICOS class 2 station Puy de Dôme

Executive summary n°: ATC-FR-LA-ES-005-1.0

This document is an executive summary of the ICOS ATC Step 2 labelling report for ICOS class 2 station Puy de Dôme (PUY).

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.



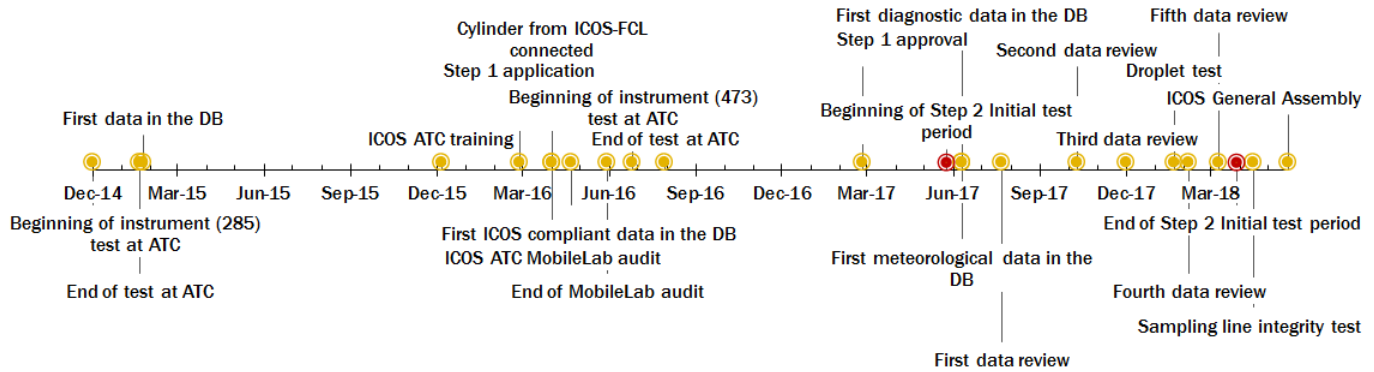
Once the data flow from the station to the ATC is in place, a phase of measurement optimization starts, the so called initial test period. This is done in close collaboration between the station PI and the ATC. This period typically lasts 4 to 6 months to gather enough time-statistics. The period can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



Puy de Dôme is providing ICOS specifications compatible data since 2016-04-15.

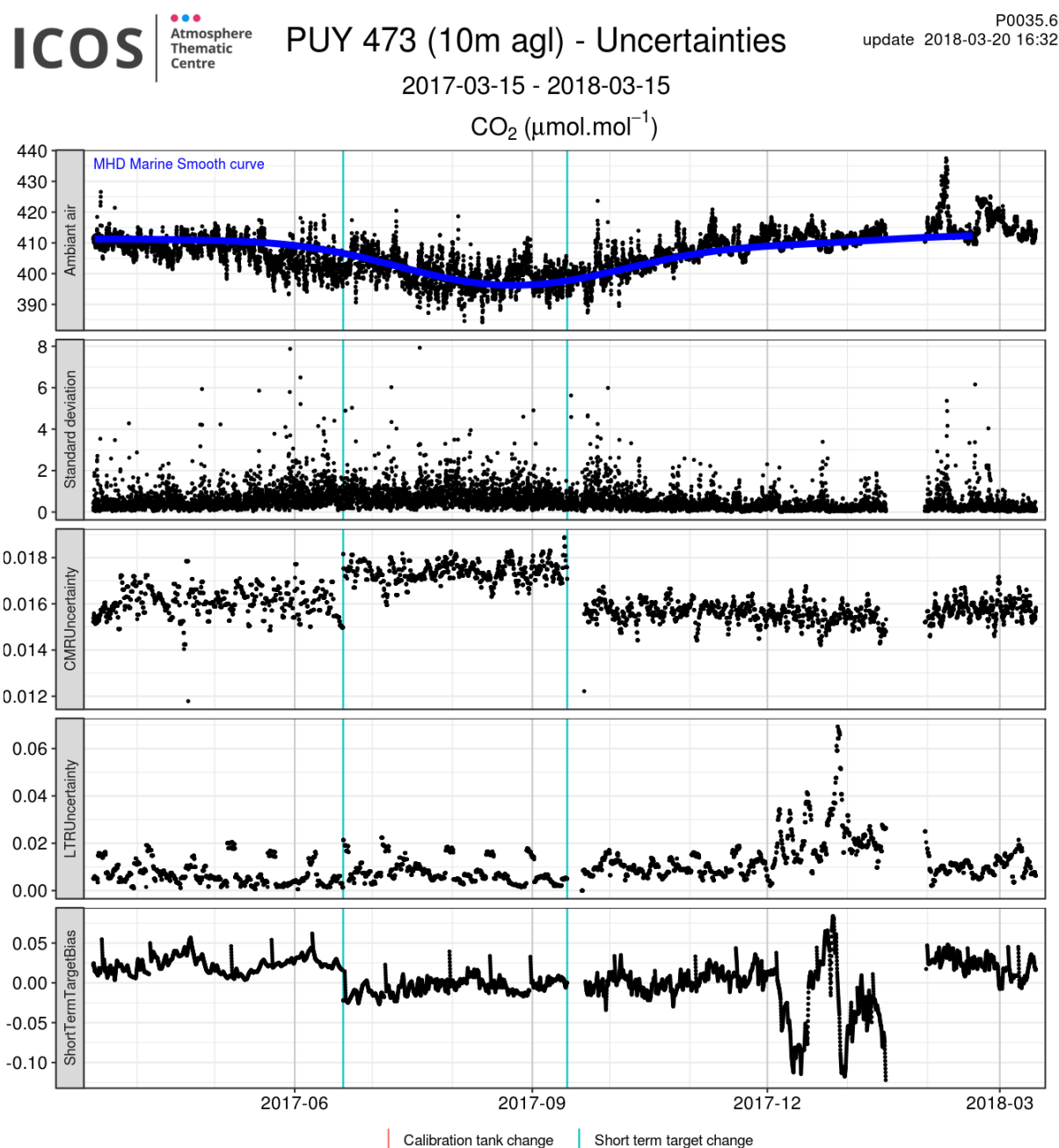
During the initial test period, the data quality has been improved thanks to the collaboration between the PIs and the MLab.

The dryer unit, which caused problems, is not used anymore.

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

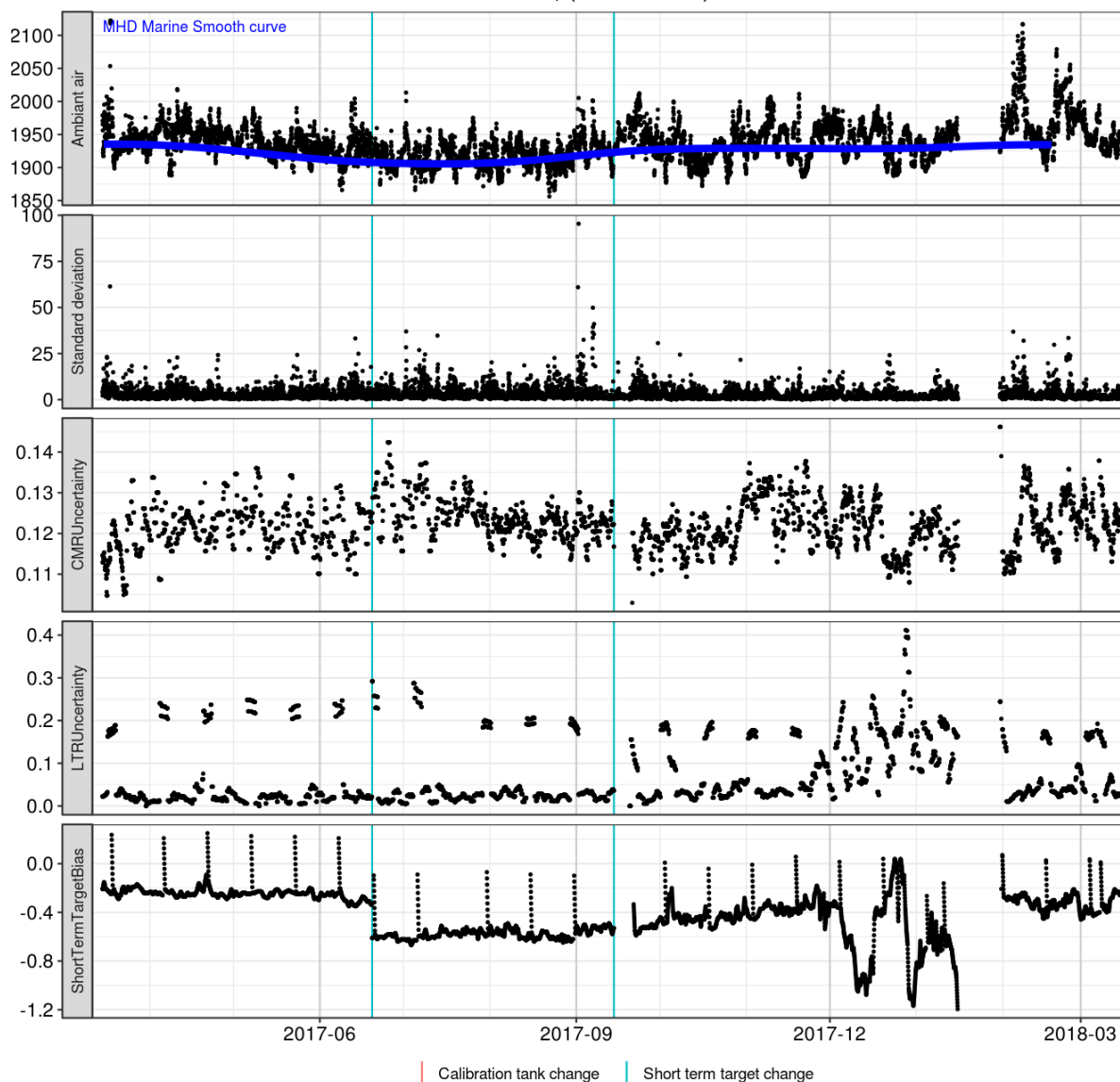
- (\*\*\*, important, -): It is recommended to continue the flagging of raw data on a weekly basis.
- (\*, minor, 2018): Flushing time for calibration and target gases can be decreased to 5 minutes.
- (\*, minor, 2018): It is possible to reduce to three calibration cycles instead of four (keeping the rejection of the first cycle in the ATC configuration)
- (\*\*\*, important, 2018): Despite the short size of the tubing, it is recommended to add a flushing pump to the sampling line to reduce residence time in the sampling tube.

The following graph presents on the first panel the data, CO<sub>2</sub> 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)



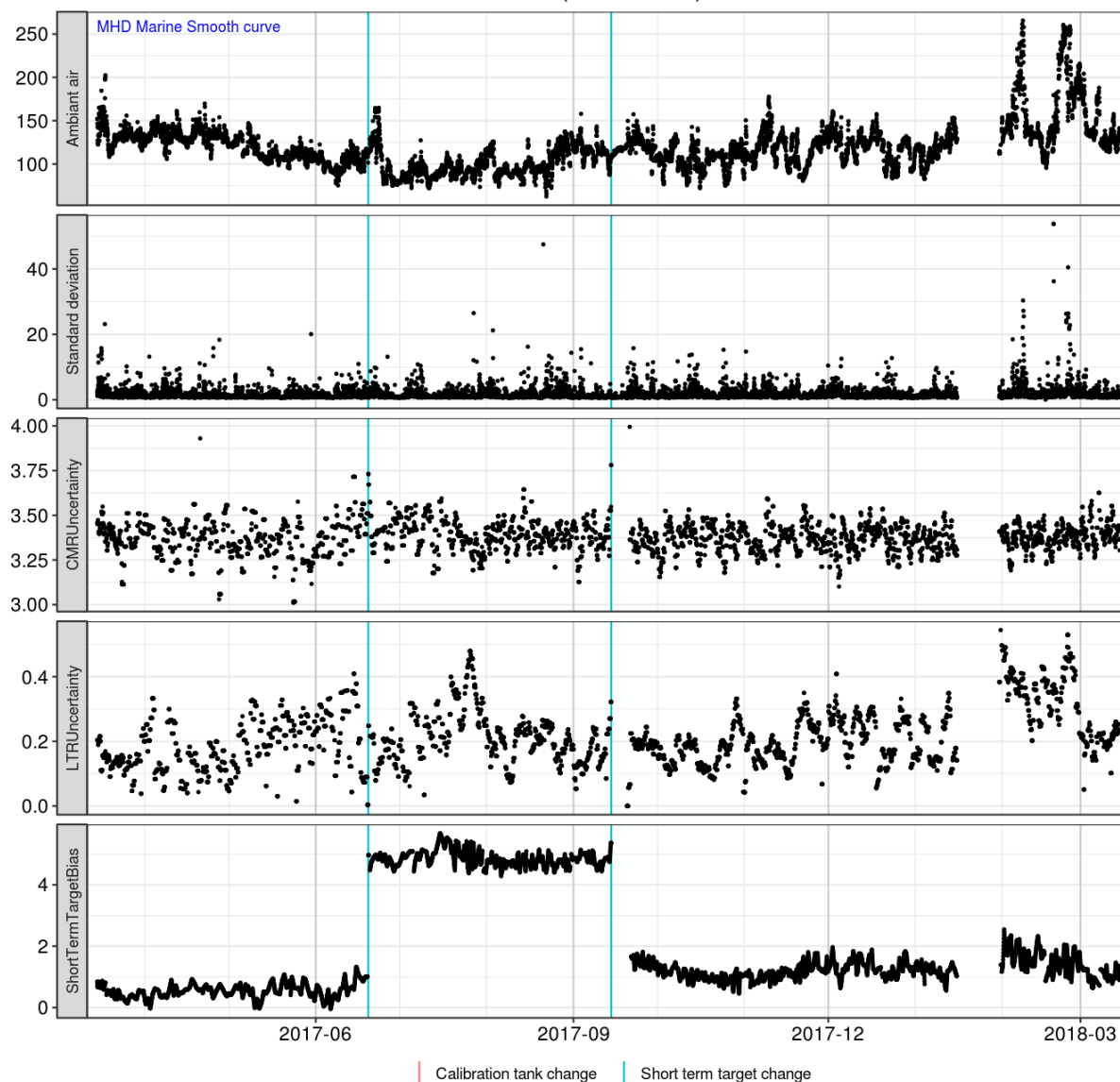
2017-03-15 - 2018-03-15

CH<sub>4</sub> (nmol.mol<sup>-1</sup>)

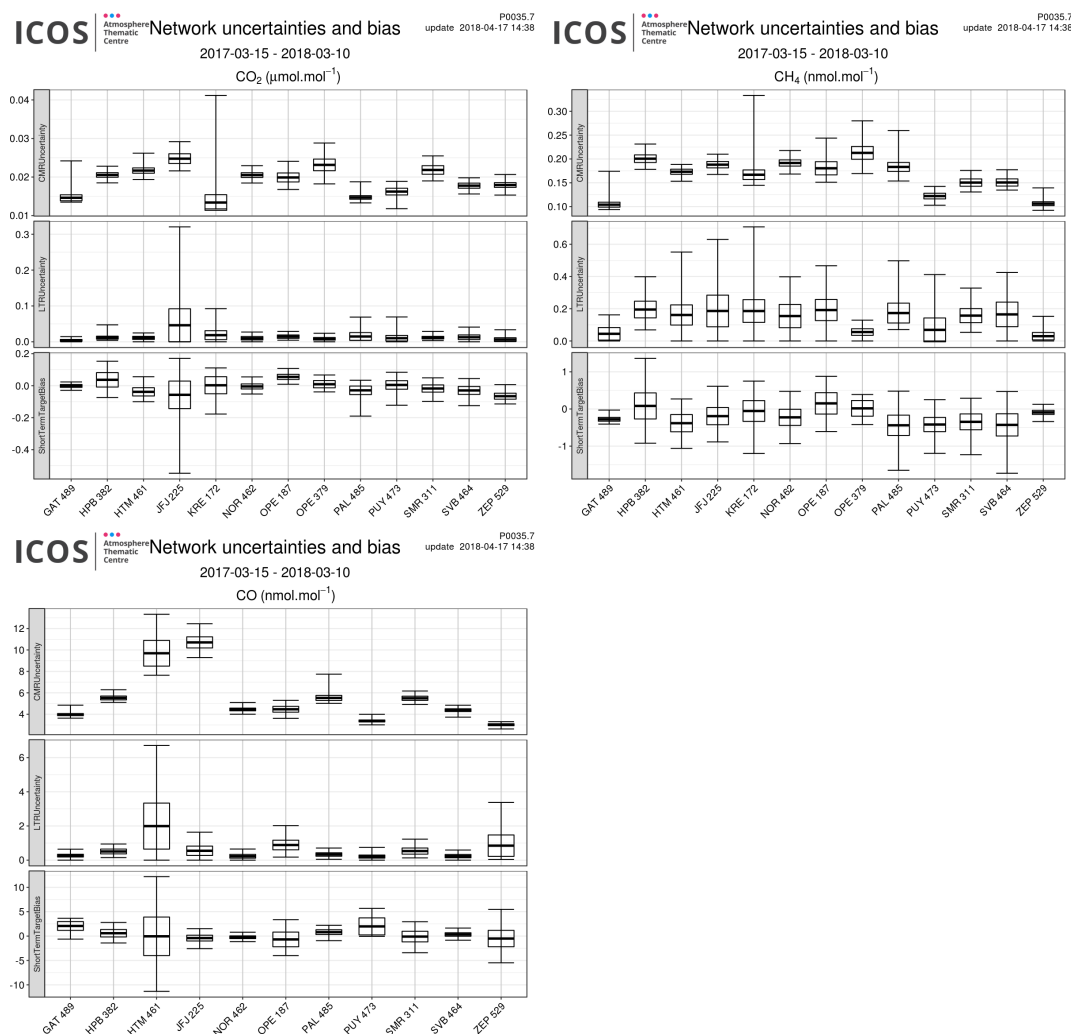


2017-03-15 - 2018-03-15

CO (nmol.mol<sup>-1</sup>)



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



The measurement system has been simplified before entering the test period (no more drier) and the ICOS test period progressed very well. We may expect that measurements according to ICOS protocol will continue well in the future. The Puy de Dôme station is the most southwestern ICOS station in Europe. The data are valuable for estimating emissions and sinks of GHGs in France and surrounding countries. The status of global WMO/GAW station, together with extensive air quality and aerosol measurements, support analysis of anthropogenic and natural emissions, and environmental and meteorological research. Based on the data provided during the initial test period, we recommend that the Puy de Dôme station (PUY) 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-FR-LA-RP-002-1.0
AD3	ICOS ATC Metrology Laboratory Evaluation report for the ICOS instrument 473	ATC-ML-IT-RP-59-2.0
AD4	ICOS ATC Step 2 labelling report for the ICOS station PUY	ATC-FR-LA-RP-005-1.0
AD5	ICOS ATC MLab water correction assessment report	ATC-ML-WC-RP-14-1.1-473
AD6	ICOS ANET Sampling system test report	ANET-FR-SS-RP-006-1.0-PUY
AD7	ICOS ATC station website	<a href="https://icos-atc.lsce.ipsl.fr/PUY">https://icos-atc.lsce.ipsl.fr/PUY</a>

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
- CO<sub>2</sub> 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 CO<sub>2</sub> residuals. These graphs are a measure of the importance of local sources and an indication of averaged direction of potential strong sources/sinks of CO<sub>2</sub>



# ICOS

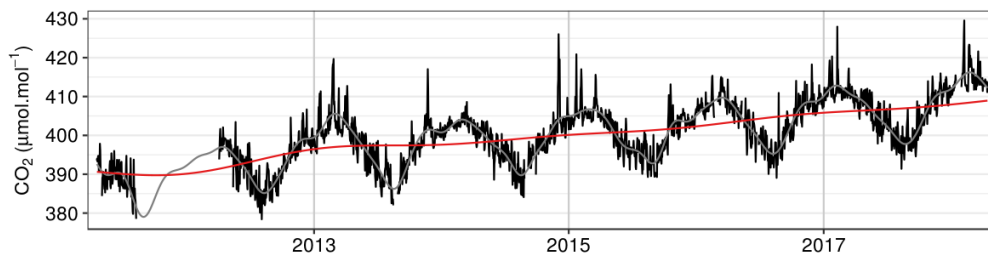
National Network France



Puy de Dôme (PUY), France - CO<sub>2</sub>

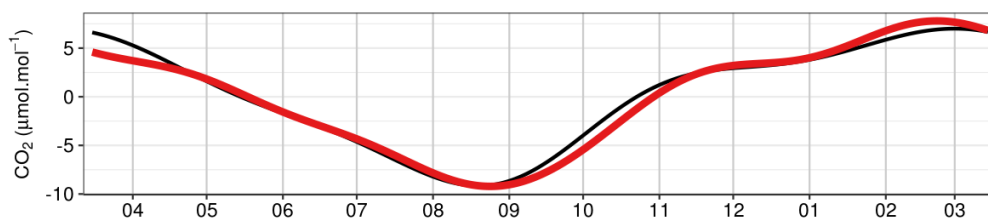
45.7719°N - 2.9658°W, 1465m ASL (10m AGL)

— Daily means — Smoothed curve — Trend curve



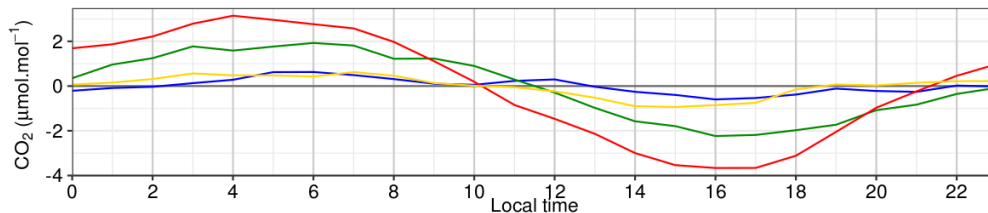
Seasonal cycle

— Mean seasonal cycle (2011-2018) — Seasonal cycle (2017)

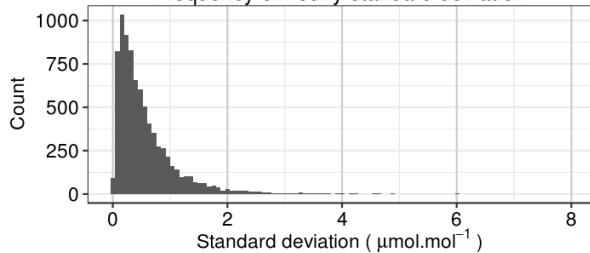


Diurnal cycle (2017)

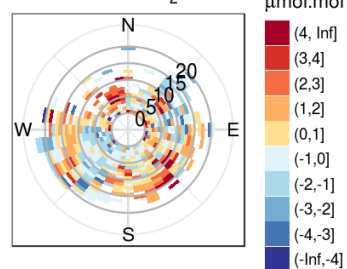
— Winter — Spring — Summer — Autumn



Frequency of hourly standard deviation



Wind rose of CO<sub>2</sub> residuals μmol.mol<sup>-1</sup>





## 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.