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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation and optimization of ICOS atmospheric station data as part of the labeling process" *by* Camille Yver-Kwok et al.

Anonymous Referee #3

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This work describes the specific workflow and quality assurance processes within the ICOS network. The authors did a wonderful job composing a well written, comprehensive paper about the difficulties and challenges faced in the world of high-quality greenhouse gas observations. I think this work is a substantial contribution to the knowledge base and scientifically very important. Everyone in the field relies on intercomparable high-quality long-term observations but is rare to see papers that clearly describe and outline the hard work that lies behind them. I especially appreciate that the examples given in the paper include times where problems were found and solved, as well the realistic description of timeframes when setting up a new site. It is the lived reality in the field and will hopefully be educational to both users of the ICOS data as

well as groups interested in setting up long-term observation stations. While the quality of the paper is generally high, there are some inconsistencies in the use of language mainly the interchangeable use of site names and abbreviations. Some of the parameters mentioned in the text and/or in figures have no clear explanation of how they were derived. The figures contain a lot of vocabulary and abbreviations that are probably useful within ICOS but can be confusing for the casual reader (tank and instrument numbers) without additional explanation. A lot of the figures also use very small fonts that can only be read by zooming and will not be legible in print outs at all. The colour in the figures is generally not suitable for colour-blind individuals (a lot of red and green with the same saturation levels). The descriptions of the figures in both the text and figure legends are very perfunctory even for some of the more complex figures

Specific Comments: While the introduction gives a brief overview of greenhouse gas measurements and observation networks what the data is used for but lacks information about why we need such high-quality greenhouse gas observations and the benefits of the labelling process for the end-user of the data product.

In 2.4 general requirements and table 1, the different parameters mandatory and recommended for the different classes of station are given but not much information about why they were deemed mandatory or recommended. Two parameters in table 1, the mandatory atmospheric pressure observation at ground level and the recommended eddy covariance flux for CO2 are not mentioned in the text at all.

In 2.2 greenhouse gas calibration requirement: Add an example or range for the automatically filtered data.

2.3.3 Intake line and water vapour correction tests: The text is a bit unclear, it mentions a shelter test every 6 months and testing the outside lines every year, then later in the text it mentions testing of the whole line is recommended at sites where lines are older than 10 years. Is the yearly testing of the outside line just to tests from the base of the tower to the shelter or is the yearly testing of the whole outside line only recommended

for lines older than 10 years? I assume that since ICOS focusses on tall tower sites, yearly full line tests would be very expensive (hiring climbers to climb the tower twice for each test to connect and disconnect the lines).

2.4.4 Calibration drift and optimization: In this section and in figure 6 the word calibration drift is used for the instrument drift that is then corrected and optimized with the calibration, this is very confusing as there is also such a thing as a drift in the concentration of calibration gases.

2.4.7 Diagnostic parameters, Page 10, line 7: A low flow rate within the line could also be indicative of an obstruction in the line (damage to sampling line or blockage).

3. Presentation of the 23 labelled stations Page 11 line33: The paper generally describes all the site setups in great detail, but there is no description of the 4 sites with buffer volumes. I appreciate that everyone in the community has strong opinions about the usage of buffer volumes, but regardless of their merits or lack thereof, a more detailed description of the buffer volume setups (integration volume, flow rate and in integration time) would be helpful.

4.1 Calibrations: Is the drift described this chapter and in table 5 the same instrument response drift described in 2.4.4 and figure 6? The naming is ambiguous as it implies it is the calibration that is drifting not the instrument response. There is also no description of how the drift was calculated.

4.3 Uncertainties: Figures 16-18 contain a lot of information, while some of it is explained here in detail, other artefacts are left unmentioned or are mentioned later in the text and then not referenced. For example in Figure 16: For JFJ, The continuous instrument repeatability (CMR) is good but the long-term repeatability (LTR) is high, later in paragraph

4.6 it is explained that this is was due to a polytube Nafion, but the text does not reference figure 16. Then there is OPE that seems to have had a bias in the target

value for both CH4 and CO2 for a while. On page13, line 21 it is mentioned that two sites show values outside of the WMO targets for CO, but it is not specified which of the subplots this refers to. 3 additional sites show larger biases after the initial test period (IPR, SMR and NOR) but they are not mentioned in this section. Later in the troubleshooting section, there is a mention of the issue with CO that was related with the use of heated inlet cups but figure 18 is not mentioned in that section and the sites are referred to with their full name.

Figure 11: This figure is not easy to read and within the text, it is just casually referred too, does it add any value? How does it help evaluate the influence of different sources (is it because it shows the different inlet heights?) whatever information it is supposed to convey is lost in the sheer amount of data (1 year 4 heights 3 compounds, plus quality assurance subplots). I could see the value of a plot like this online where you can zoom in to it. The short-term long-term target stability on the right-hand side is interesting but is not even mentioned in the text or legend of the figure and the short and long-term targets are also shown in figure 1.

Technical comments: Page 3, line 11: First mention of WMO compatibility goals but no information what they are for the gases discussed in the paper.

Page 5, line 1: No reference for the ICOS specification document.

Page 5, line 25 mentions that Table 2. Contains the raw minute and cycle but then Table 2 contains the minute, injection, and cycle data. Is an injection not the same as a cycle? The words are interchangeably used throughout the paper for example in figure 7.

Page 7 line 22: What is meant with the intrinsic bias of the instrument?

Page 7, line 31: Rephrase to clarify that the onsite water test needs to be performed if the last instrument test at MLab was longer than a year ago.

Page 10, line 20-21: Clarify that the instrument flow rate can be used to estimate the

lifetime of cylinders.

Page 11, line 1: LTR, is defined as the Long-Term Repeatability which is I understand to be the 3 day average of the standard deviation of the short-term target measurement. The text does not specify that it is based on the short-term target although it must be as the long-term target would not be measured often enough for this. The naming is confusing as the short-term target makes up the long-term repeatability but then there is also a long-term target.

Page 13, line 15: Figure 12, not 13 describes the bias calculation, the text would be easier to follow it the calculation was described within the text of the chapter and or the relevant figure description.

Page 13, line 18 change to: The red dot.

Page 13, line 29-Page 14, line 4: Restructure this part to make it easier to read. The text references that the description of figure 19 contains how the bias was calculated but figure 19 contains no calculations. Later in the paragraph in page 14, line 4 it is clarified that the bias is (measured-reference) I assume what is described as the bias is just the difference between the concentration measured in the line vs. directly in the tank but the roundabout description makes it harder to understand than necessary. Maybe just rephrase the second sentence to make it clear it is measured - reference as currently, it is the other way around.

Page 14, line 13: Reference water droplet test protocol used.

Page 14, line 30: If available add part numbers and manufacturer for both the recommended Nafion membrane and cryogenic water trap.

Table 1: is missing a reference to the ICOS specification document.

Table 4: 5069% in KRE?.

Figure 2: No labelling and description of parts and existing text font size too small.

Figure 11: The colour choice is not ideal (yellow on white background, and red and green lines and circles for both the target values). The numbers above the target plots are not explained anywhere, one I assume is the targets assigned concentration but Ptp is not explained anywhere. For the H2O % the target numbers are also present but empty (0.00 for all) please remove.

Figure 15-19: It is hard to visually align the legend at the bottom with the two figures above, especially in figure 16-18 where there are 2 box and whisker plots for each instrument. Adding the legend to the other 2 plots or some kind of shading or line might help.

Figure 16: Has some random signs at below the figure legend # # \.

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