Atmos. Meas. Tech. Discuss., 7, C2960–C2964, 2014
www.atmos-meas-tech-discuss.net/7/C2960/2014/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Development and field testing of a rapid and ultra-stable atmospheric carbon dioxide spectrometer" *by* B. Xiang et al.

Anonymous Referee #2

Received and published: 1 October 2014

General Comments

This paper is a follow-up to a previous paper by the same author about essentially the same instrument, which measures CO2 with very little drift over time. This manuscript describes technical improvements that have been made and it describes the instrument stability over a long-term deployment in the field. Although the results seem only an incremental step in novelty over what was already described in the previous paper, they still should be published, because they show the performance of the analyzer in the field, which is what most will interest future users. The main finding is that the analyzer is remarkably stable over a long period of time. I recommend publication, although I did have a few more questions about analyzer performance that were not answered in the manuscript as it is currently written.

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

There were two questions I was left with after reading the manuscript.

1) Is the sample dried prior to measurement, or is the measurement corrected for the influence of water vapor? If it is dried, how is that accomplished in this experiment? Page 8111 Line 6 mentions that it could correct for water vapor, but drying is not mentioned anywhere.

2) I would have liked to see some mention of how the analyzer responds to motion/vibration, i.e. if on a vehicle or aircraft. The lack of calibration need would be ideal for such applications where calibration gases are even more problematic than at a stationary site with plenty of space. Perhaps if this has not been examined, it could be part of future efforts to field test the instrument and could be mentioned as such.

Other questions: 3) What inlet pressure range can be used? No plumbing diagram is given, but it seems clear that the analyzer has its own pump to pull ambient-pressure air through. Does the flow rate vary based on inlet pressure – or can it be varied by the user for different applications?

4) What are the size/weight and power requirements?

5) What is the response time of the analyzer to a quick change in mole fraction? (i.e. What kind of response does the instrument have when switching over to a tank measurement – this comes up in the figures for the tank measurements – how much data needs to be cut out at the beginning?)

Clearly the stability that the field deployment shows is impressive and the authors seem to recommend that it can be deployed with no calibration in the field beyond occasional replacement of the quartz reference cell. But although the authors compare with the manufacturer specs of the Picarro CRDS unit, they do not compare with literature about the stability of those analyzers (Scott J. Richardson, Natasha L. Miles, Kenneth J. Davis, Eric R. Crosson, Chris W. Rella, and Arlyn E. Andrews, 2012: Field Testing of Cavity Ring-Down Spectroscopy Analyzers Measuring Carbon Dioxide and Water Va-

AMTD

7, C2960–C2964, 2014

por. J. Atmos. Oceanic Technol., 29, 397–406. doi: http://dx.doi.org/10.1175/JTECH-D-11-00063.1 or Karion, A., Sweeney, C., Wolter, S., Newberger, T., Chen, H., Andrews, A., Kofler, J., Neff, D., and Tans, P.: Long-term greenhouse gas measurements from aircraft, Atmos. Meas. Tech., 6, 511-526, doi:10.5194/amt-6-511-2013, 2013.).

Do the authors have any idea how the stability of different individual units will vary, i.e. is this good performance the norm for this type of analyzer?

Specific Comments P8107 L7: It was not clear how a flow controller was used to control cell pressure more accurately than the pressure sensors that were tested. What was the flow rate?

P8109 L15: What are the repercussions after such a power or pump failure? What maintenance or recovery procedure is required after such a disruption? (This is an important piece of information for instruments running at remote locations).

P8110, L4: Is this typical over any given week? (the authors should mention this, to make clear that this particular week was not chosen because of the good stability - perhaps it was chosen as typical or because it showed a large temperature range?).

P8110, L12: Some Picarro analyzers have demonstrated much better stability than this spec, which is quite conservative. Would all ABC analyzers be able to achieve this high stability as the one shown here?

P8111 L4: Is this the manufacturer (Picarro) spec or the precision of the actual analyzer at the site? Picarro's web site claims 1-sigma precision of < 70 ppb at 5 seconds (half what is stated here) – again, some literature claims better precision than this, but presumably the manufacturer spec is conservative.

P8111 L5: Is this typical, or were the measurements only existing for this one week?

P8111 L6: If it is not applied for this test, how are the measurements accounting for water vapor? Is the sample dried?

AMTD

7, C2960–C2964, 2014

Table 1: Looking at the last column with the tank measurements: these are very small differences, but the slope of the linear fit is changing with time. Some tanks are going up, some down. Seems like a user would not get to the 0.1 ppm level reproducibility without working tanks (or with?).

Figure 4 a. This is a very nice figure showing really terrific stability. However... The aluminum tank values (or differences) don't seem to correspond with the table 1 values. Looking at Tank 4, there should be a 0.35 ppm difference between the first and last measurements according to the table but in the figure it is less than 0.2 ppm? Or perhaps I am misunderstanding the table or figure – if so, they should be clarified.

Figure 4b caption: Is this an average of the last 30 seconds of a 2-minute measurement? (at 1 Hz)?

Figure 6: Including the residuals for the steel tanks, which were shown to have issues unrelated to the analyzer, magnifies the axis on the lower plot so that it is not easy to determine the residuals for the aluminum tanks. I would recommend only showing the aluminum tanks here.

Technical Corrections

P8107 L25. "was developed" – should this be "became commercially available"? (otherwise it implies that it was developed by the authors for this specific project?).

P8110 L 25: Should perhaps read: "using the same Picarro CO2 instrument". (the mentioning of the Licor is confusing here).

P8111 L13: "Majorly" should be reworded.

P8111 L25: 3%, not per mil.

P8112 L8: "tank" should be "tanks"

P8112 L13: Kept going up after the temperature stabilized? Unclear wording.

AMTD

7, C2960–C2964, 2014

P8112 L26: Not clear what “tank science” means, or why it is in quotes?

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 8101, 2014.

AMTD

7, C2960–C2964, 2014