

## ***Interactive comment on “Long-term greenhouse gas measurements from aircraft” by A. Karion et al.***

**A. Karion et al.**

anna.karion@noaa.gov

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We thank both reviewers for their helpful comments and positive suggestions on improving the manuscript.

Responses to Reviewer 2 Comments

General Comments

R2: It is helpful to describe the overall precisions (in your typical averaging time) for CO<sub>2</sub>, CH<sub>4</sub> and CO, which are influenced by short-term variation, calibration, water vapor correction and others.

C3599

A: The estimated uncertainty of our CRDS measurements is now included in the abstract and conclusion for the native instrument measurement reporting time (~2 seconds).

R2: It is also helpful to mention the response time in CRDS measurement which may mainly depend on the inner volume of plumbing and the flow rate.

A: The section discussing the response time of the analyzer when switching from a wet to a dry gas is now expanded and given its own section heading; we also include a paragraph discussing the response time between two dry gases, although we note that further experiments and analysis are required to determine the variables that affect the response time.

Specific Comments

R2: Page 7346, line 24, “2-3 psig”, line 26, “1000 millibar (mb)”: Authors should use SI unit.

A: We have replaced all pressure and diameter units with SI units (hPa), with English units in parentheses where we describe a part that is specified in English units.

R2: Page 7347, line 17, What is the difference between a “Normal” critical orifice and that designed for flight?

A: The text has more detail now on the difference between flight and ground analyzers (2.1 and 2.1.1), explaining the method each uses to control pressure in the cell. Only flight analyzers have critical orifices in order to keep the mass flow rate constant at different altitudes.

R2: Page 7348, line 6, “corresponding to three flush volumes of the line”: This value is variable depending on the altitude (outside pressure).

A: We have clarified that we mean three flush volumes at sea level pressure, which would be more volume at altitude.

C3600

R2: Page 7348, line 14-28, Slower CO<sub>2</sub> and CH<sub>4</sub> response during the transition from wet to dry or dry to wet gases is very interesting for CRDS users. Can you describe the reason? For example, is it due to the adsorption of water vapor on the inner surface of tubing or cavity?

A: This section has expanded now after consulting with Chris Rella at Picarro for the reason for the slow transition. It is not caused by anything physical, rather an averaging scheme in the software.

R2: Page 7350, line 2-3, "dramatically improved": How amount the short-term precision improved?

A: These values were previously in Table 1, now they are also in the text. In general the short-term precision was improved to be similar to the value when there is no motion.

R2: Page 7351, line 21-25, I cannot understand the essential difference between the correction using "other methods" and "first method".

A: We have clarified this in the text. There are many ways to correct the sample measurements using standards measurements, and we compare a few to ensure that our method is not very different from others, and to make sure it is appropriate.

R2: Page 7352, line 1-26, As authors mentioned, a long-term drift is analyzer specific. I think it is worthwhile to calculate the sample concentrations by standard values and standard measurements in each flight. Why authors use standard measurements only for the mean temporal drift correction?

A: We do calculate the final sample mole fractions using the standards measurements in each flight. We only show the long-term drift of the tanks because it may be of interest to the community, to show how stable the measurements would be in the absence of calibrations, and to give an idea of how often they need to be run.

R2: Page 7353, line 5, Nara et al., AMT, 5, 2689-2701, 2012 also examined water vapor influence for CRDS.

C3601

A: This reference has been added.

R2: Page 7358, line 17-20, Could you describe some words for the reason of recent high CO<sub>2</sub> flask?

A: We have added a sentence to the text that we do not know the reasons, simply that we see the same effect at other sites, where we also observe the flasks of biasing the CO<sub>2</sub> high. Laboratory testing is currently under way to examine this problem.

R2: Page 7359, line 7-8, Inadequate flushing in standard gas makes higher standard measurements and leads to lower sample concentrations. It is not consistent with positive offsets in Fig. 9a.

A: We clarify this effect in the text now. We have found in all our work that when a tank regulator is not flushed properly, measurements of that tank are lower than they should be, not higher. This leads to a sample measurement that is too high, consistent with our finding of a positive offset.

R2: Page 7361, line 1-28, What are the advantages to measure water vapor by CRDS compared to Vaisala humidity sensor?

A: We don't suppose there are any in our application, but we still find the evaluation of the CRDS H<sub>2</sub>O measurement useful.

R2: Page 7362, line 12-13, "three large standard tanks": What is the size of these tanks?

A: We have added Table 2 to the manuscript, as both reviewers had questions regarding the sizes and/or values of the tanks.

R2: Figure 6, What are indicated by error bars?

A: The legend now explains that they are the 1-sigma standard deviation of the measurement of the standards at their 0.5-Hz resolution (i.e. short-term precision).

C3602

Technical corrections

R2: Page 7358, line 4, "Fig. 9, right panel" → "Fig. 9c". Figure 5. Legend of the left panel, "Wet to Dry-original" should be "Wet to Dry-updated" and "Wet to Dry-updated" should be "Wet to Dry-original".

A: These corrections have been made as suggested.

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Interactive comment on Atmos. Meas. Tech. Discuss., 5, 7341, 2012.

C3603