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Atmospheric Measurement Techniques Discussions

Interactive comment on "Development of a balloon-borne instrument for CO_2 vertical profile observations in the troposphere" *by* M. Ouchi et al.

Anonymous Referee #3

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General comments: The paper thoroughly describes a useful approach for measuring CO2 profiles up to an altitude of CO2 with moderate precision using balloons. The paper is well-organized and clear but has many minor grammatical errors that should be addressed before publication.

Magnesium perchlorate is a hazardous material (oxidizer). Are there regulations that describe the maximum quantity that is allowable for this application? Perhaps a nafion membrane could be used instead if not too expensive. If calibration gases and atmospheric samples were both routed through a nafion tube then artifacts would be minimal. Several studies have shown that configurations are possible where humid ambient samples and dry standard gases emerge from a sufficiently long nafion tube with nearly identical humidity so that water-related errors become negligible.

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The fact that the payload is not recovered and instead "thrown away in the ocean" is unfortunate due to toxic/hazardous batteries and magnesium perchlorate, and styrofoam packaging and other components that are not biodegradable.

What is the approximate cost per flight (including time to manufacture and test the sensor package)? How does the cost compare to a typical charter aircraft flight such as the NIES/JAXA flights described here?

More than 20 flights have been performed. Are these data publicly available?

Figure 3: It would be nice to include a measure of the uncertainty of the time interpolation (i.e. uncertainty bands on each of the spline curves for the high and low standard.)

page 15, line 359 & Figure 5: The vertical error bars are said to represent "the square-root of the sum of squares for the standard deviations of the sample and standard gas at each step". Is the the standard deviations of the 30s intervals that are retained for each measurement? Is the ambient air / calibration gas sequence the same as shown for the flight in Figure 3? Is there interpolation of the standards over time? It is not clear whether there is drift in the sensor response over the course of the experiment that should also be taken into account. It would be useful to try to separately estimate random uncertainty and bias. The black dashed line in Figure 5 seems to be quite close to the stated value of the sample gas (377.3 ppm). Was the cylinder measured separately? Or was the value inferred based on this experiment? That is, does this experiment provide information about bias? The errors given on line 361 evidently correspond to the 30-sec measurement periods, and Fig 5 seems to show that some of this variability is random.It would be interesting to see how averaging groups of points (e.g. n=3, n=5) reduces the scatter (information similar to what can be learned form an Allan variance plot).

Fig 7 & 8. It would be useful to show the corresponding CO2 profiles from a CO2 data assimilation system or inverse model (e.g NOAA's CarbonTracker or the ECMWF/CAMS system for which simulated mole fractions are readily available or other

similar product). Since the profiles are not co-located, some differences are to be expected, and it would be interesting to see how the modeled gradients compare to the observations. This is especially true for the case in Feb 2011, where the Contrail flight is on the previous day. Although these models are imperfect, they do a reasonable job of capturing gradients associated with weather systems.

Figure 9 & 10, it would be nice to also show the H2O mole fraction in panel c.

If length is a concern, then the information provided in the Tables could be moved to a supplement.

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