

Interactive comment on “Development of a balloon-borne instrument for CO₂ vertical profile observations in the troposphere” by M. Ouchi et al.

Anonymous Referee #1

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General comments:

Ouchi et al. developed a balloon-borne in situ CO₂ system for vertical profile observations in the troposphere. The system has been designed to be lightweight (~2kg) and relatively cheap so that it can be flown on a regular basis. The weight limit was met mainly due to the use of lightweight calibration gas bags. As the calibration gas bags may be over pressurized or be exhausted at around 10 km, which determines the upper altitude limit of the measurements by the system. To this end, it is a nice system that has been developed for CO₂ vertical profile measurements.

The critical part is the (in)accuracy of the system. The observed average differences between the CO₂ sonde and other aircraft measurements were on the order of 1 ppm up to 7 km, although the differences at individual altitudes could be significantly larger

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than that. It should be made clear that the differences between the measurements above 7 km were much larger than 1 ppm. That being said, the reviewer is skeptical about the usefulness of the system in the real world where the potential biases in the free troposphere simulated by carbon cycle models are often smaller than 1 ppm. The system may be limited to observe the difference of large signals in the boundary layer. There is certainly a need to further improve the accuracy of such a system before it can be useful for the carbon cycle research. However, given the significant development and the detailed documentation, it is worth considering publication after making the message clear. Perhaps it will be more suitable for a technical note.

Detailed comments:

L28: It is certainly not "accurately". L34-35: In my opinion, the usefulness of the instrument is not justified. L141: What's the source of 2 kg based on the legal restriction by the US FAA? The weight limit may be higher.

L139: Design of the CO₂ sonde: Why was the dehumidifier not placed in front of the pump to avoid a wet pump that may be a contamination source of CO₂? Does the pump create significant pressure variations in the cell of the CO₂ sensor? It may be useful to monitor the cell pressure.

L288 Data processing procedures: the use of cubic spline fitting curves for the observation points needs to be justified, e.g. by comparing with a linear interpolation approach to see whether the measurements will be more stable in the laboratory or will compare better with aircraft measurements in the field.

L388 Comparison with aircraft data: the large difference between CONTRAIL and the CO₂ sonde measurements at certain altitudes, especially above 7000 m in Figure 7&8 could be partially explained by the observed large variations at low pressures seen in Figure 5, but the large part of the difference will remain unexplained.