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Atmospheric Measurement Techniques Discussions

Interactive comment on "AirCore-HR: A high resolution column sampling to enhance the vertical description of CH_4 and CO_2" *by* Olivier Membrive et al.

Anonymous Referee #1

Received and published: 20 October 2016

The paper describes a high-resolution version of the AirCore, a device designed to take samples throughout parts of the stratosphere and the full troposphere, and analyse them for CO2 and CH4 by retaining much of the information contained in the vertical profile structure. The paper is mostly well-written, and fits well within the scope of AMT. However, a number of issues listed below should be addressed before the paper can be recommended for publication.

General comments:

Regarding the design criteria for the AirCor-HR, a bit more details should be given. Does diffusion/dispersion during sample analysis play a role? Does the drying cartridge cause diffusion, what is the volume of the cartridge? How does this affect the

design of the AirCore, i.e. the lengths of the tubes?

Uncertainty analysis is well done in general, in that the contributions from different sources of uncertainty to the overall uncertainty of the profiles of CO2 and CH4 are assessed separately. However, the potential effects on CO2 from the chemical dryer of the AirCore-HR should be quantitatively estimated, and if possible an upper limit should be given for the loss of CO2. If there are on the order of 20 ppm CO2 missing due to a 7-hour interaction of the sample with the magnesium perchlorate contained in the dryer, the quality of the rest of the CO2 profile is rendered questionable. What is the estimated loss of CO2 during normal flow conditions? What is the volume of the dryer, what amount of magnesium perchlorate was used? Also the difference in CO2 from AirCore-HR and AirCore-GUF, which is up to 3 ppm and far beyond the uncertainty estimate for AirCore-HR, should be properly assessed in this context. If the chemical dryer has such an impact, the data should not be published.

Specific comments

Pg 1 Line 12: may be reformulate "The multi-instruments gondola also carried two other . . ."

Pg 2 Line 33: I suggest adding "for deployment on high altitude balloons as platform" after "have been developed"

Pg 4 Line 1: In Karion et al. (2010) there is no mentioning of avoiding turbulent flow as being a criteria, it just turned out to be laminar given other constraints on flow and tube diameter.

Pg 4 Line 12: A reason for not considering diffusion and dispersion during the air sampling process (i.e. the ascend of the balloon) should be given.

Pg 4 Line 15: This factor two is not included in Karion et al. (2010), it should be clearly introduced and justified

Pg 4 Line 16: Eq. 3 is a completely different equation, not just a different expression of

Eq. 2.

Pg 5 Line 17: the curve for the original AirCore shows 1 km (not 2 km) resolution at 20 km altitude

Pg 5 Line 226: I suggest rewording “to flow under” with maybe “be carried by”

Table 1: It would be useful to also include the corresponding numbers for the standard AirCore and the AirCore-GUF. Data for inner radius seem redundant, as the diameter is given. I assume with “width” the wall thickness of the tubing is meant.

Pg 6 Line 18: What is the meaning of “only” in this context? Does it point out that no humidified standard air has been used?

Pg 7 Line 19: It is not the drift due to water vapour, but the combined effect from dilution and line broadening caused by water vapour that the correction compensates for in the reported dry air mole fractions.

Pg 7 Line 29: the sentence starting “Using the ideal gas law:” is not really a sentence.

Pg 8 Line 24: may be replace “It took part to” with “It participated in”

Pg 8 Line 25: “consisted in” -> “consist of”

Pg 10 Line 25: “exchange rate . . . takes several years” this need reformulation. Also an earlier reference for deriving mean age Boering et al., 1996: Boering, K. A., Wofsy, S. C., Daube, B. C. and Schneider, H. R.: Stratospheric mean ages and transport rates from observations of carbon dioxide and nitrous oxide, Science, 1996.

Figure 8: rather than not showing the data between 70 an 90 hPa I suggest showing them in a different colour.

Pg 11 Line 22: I suggest not adding 24 ppb, as rather than “easing” the comparison it will confuse the reader. Why not doing an honest comparison? The range of the x-axis in Fig. 9 (b) (90 ppb in the inset, and 1200 ppb for the main figure) should allow for

enough room to show both profiles without alteration.

Pg 11 Line 33: there is some discussion on this in a paper that has just appeared in ACPD: Verma, S., Marshall, J., Parrington, M., Agustí-Panareda, A., Massart, S., Chipperfield, M. P., Wilson, C. and Gerbig, C.: Extending methane profiles from aircraft into the stratosphere for satellite total column validation: A comparative analysis of different data sources, Atmos. Chem. Phys. Discuss., 1–32, doi:10.5194/acp-2016-704, 2016.

Pg 11 Line 9: It should be explained why the three temperatures measured are expected to represent the uncertainty. How have they been measured exactly, and where along the tube; is it expected that the three sensors give different reasons e.g. due to an expected temperature gradient? Or is the assumption that the uncertainty will not be larger than the range, and the uncertainty is conservatively estimated?

Pg 13 Line 3: please reformulate, e.g. use “single measurement point”

P14 Line 1, Figure 12 a): As before, I also suggest here showing the CO2 data from the AirCore-GUF analysis above 200 hPa, but in a different colour.

P14 Line 7: Between 300 and 800 hPa the AirCore-GUF CO2 values are constantly above those of the AirCore-HR, mostly by more than one ppm, i.e. by significantly more than the claimed uncertainty. This cannot be explained by “only at a different resolution”. Can the authors exclude that the AirCore-HR CO2 data are more impacted by a loss of CO2 in the dryer?

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