Reply to RC3

Manuscript information:

- Title: Testing the altitude attribution and vertical resolution of AirCore measurements with a new spiking method
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We would like to thank Anna Karion for the constructive comments. In the following document, the reviewers' comments are marked in *italic font* and indented, our answers are in regular font. Changes in the manuscript are marked-up in red and listed as framed screenshots below the respective comment. The line numbers in our listed changes refer to the marked-up version of the revised manuscript, that is provided separately.

Point-by-Point reply

1. *L188, perhaps I missed this earlier but what is ml_n ? (and again elsehwere including L326, after 1.4 liters (ln?))?*

Thanks for pointing that out. We added an explanation and changed volumetric units to SI units in the updated version of the manuscript:

> (Fig. 1b), so that the sample is pushed through the analyzer. Since June 17, 2019, our Picarro analyzer operated in the inlet valve control mode at a constant rate at ~30 cm^3_n min^{-1} (n indicates normal conditions: 1013 hPa, 0 °C)~~seem~~ for AirCore measurements. This is similar to previously published operating methods (e.g. Andersen et al., 2018; Membrive et al., 2017).

> for sampled air, while inducing only a minimal dead volume to the sampling system. We used the micro valve SMLD 300G by Gyger, which is light-weight and suited to dose signal gas volumes of around ¼ cm^3~~l~~$_n$ on the time scale of 20–100 milliseconds, thereby influencing the sampling process during descent as little as possible. Figure 3 illustrates the ~~fastening type~~mounting hardware for the micro valve.
> We utilized a modified nylon compression ring and an additional O-ring (Figure 3, (3)) to achieve leak-tightness at low-temperature. In addition, the micro valve is heated during flight in order to remain leak-tight and maintain its functionality. The signal gas reservoir consists of a 2 m tubing (total volume approximately 50 ~~ml~~cm^3) and a particle filter. The particle filter

> measurement flight and to directly compare it to the theoretical altitude resolution. The volume of signal gas is of the order of ¼ ~~ml~~cm^3_n per spike and thus considered very small compared to the total sample volume of 1~~.~~400 ~~l~~cm^3_n, respectively the stratospheric sample of 100 ~~ml~~cm^3_n above 18 km, with respect to the GUF AirCore. The time that the spiking valve is opened

2. *L197, rather than "bar" perhaps SI units would be used here (editors can comment on journal policy) (same comment, line 332 using "atm".)*

Changed that from 4 bar to 0.4 MPa and from 1 atm to 1013 hPa.

> packed together with the AirCore in the Styrofoam box and directly connected to the micro valve. It can be pressurized via a valve at the other end of the tube and flushed by activating the micro valve. For flight preparation, the signal gas reservoir is pressurized from a signal gas canister with approximately 0.4 MPa~~bar~~, flushed by activating the micro valve and then pressurized again. The signal gas has a very high mixing ratio of CO (in our case approx. 90 ppm) compared to typical

gas spike standard deviation serves as a measure for the altitude resolution for the measurement flights. We used the same approach as Membrive et al. (2017) and Engel et al. (2017) to calculate the theoretical vertical resolution of the CO profile, taking into account a 2 h time lag between landing and analysis, the molecular diffusivity of CO in air at 0 °C and 1013 hPa ~~atm~~

3. *L213, approximately should be spelled out here and elsewhere I believe (editors can comment on that)*

Done.

4. *L 229 Typo, June 18 is used twice, should be June 17*

Done.

5. *L243 should be the analyzer's (apostrophe added)*

Done.

6. *Fig 4 and Fig 5, one is labeled GPS Altitude and one geometric - are these the same thing? (i.e. both based on the GPS reading?). (and same question for other figures - perhaps they should all be made with consistent labeling).*

This is an interesting point, that has also been risen by the editor of this manuscript, Fred Stroh (editor review prior to interactive discussion). There is a small difference: In Fig 4 the GPS altitude information is directly linked to the descent velocity (which is calculated from the GPS altitude time series). In Fig 5 (and the following) the GPS altitude data has been attributed to the trace gas mixing ratios that were measured after the flight. In context of this paper it seems appropriate to be specific especially in the latter case (thanks again to Fred Stroh for pointing this out).

We updated the Fig 4 caption and the yaxis label of Fig 8 in order to make this clearer and consistent:

Figure 4: Descent velocities for the CO-spiking flights calculated from the GPS altitude time series on June 17 (dark, dashed) and June 18 (light, dash dotted), Traînou 2019. The data is smoothed with a Savitzky-Golay filter.

Both descent velocity profiles have a similar shape. At the top of the profile (when the balloon just burst) the payload accelerates within a few hundred meters to reach its maximum speed of approximately 50 m s^{-1} (70 m s^{-1}) on June 17

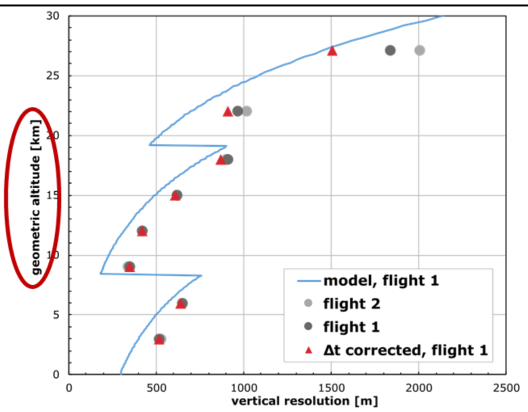

Figure 8: Modelled (blue line), uncorrected (flight 1: dark grey circles, flight 2: light grey circles) and corrected (only flight 1: red triangles) vertical resolution of GUF003.

7. *L286: "between the both" should be "between the two"*

Done.

8. *L335 and on: It would help the reader if discussion of Figure 8 could mention the sharp changes in the modeled resolution occur at the junctions between different diameter parts of the Aircore.*

Thanks for pointing that out. William Sturges also raised this point. We added one sentence for clarification:

> **Figure 8:** Modelled (blue line), uncorrected (flight 1: dark grey circles, flight 2: light grey circles) and corrected (only flight 1: red triangles) vertical resolution of GUF003.
>
> Taking into account the three different inner diameters and lengths of GUF AirCore tubing, the modelled vertical resolution exhibits two steps corresponding to the junctions between two adjacent parts of tubing. Figure 8 shows the modelled vertical resolution profile as a function of altitude, the Gaussian standard deviation of the respective peak and the Gaussian standard deviation derived from the Δt-corrected profile from June 17. Regarding the second flight on June 18, only data from the