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Mean Age from in situ observations with AirCore: Accuracy of altitude attribution investigated with the CO-spiking experiment

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In order to monitor possible changes of the mean age of air in the stratosphere, in situ high altitude observations of suitable tracers are required. The AirCore is a simple sampling technique, which can be deployed to weather balloons in order to capture a continuous vertical profile of atmospheric trace gases up to 30 km. During ascent it empties due to the decreasing ambient pressure with height. During descent the AirCore fills with ambient air due to the positive change in ambient pressure. The analysis results from a continuous gas analyzer are merged with the recorded in-flight information to obtain the vertical distribution of the target trace gases mole fractions.

In context of the Goethe-University data processing procedure, an instantaneous pressure equilibrium is assumed across the whole AirCore. Since the amount of collected air sample is especially low at high altitudes, the assumptions made for data processing affect the accuracy of the altitude attribution primarily in the stratosphere. In order to evaluate the sample-to-altitude attribution procedure, the setup for an altitude dependent CO-spiking experiment was developed, tested and deployed to an AirCore that was flown and analyzed in Traînou, France, in June 2019. This setup allows for releasing small spikes of high CO signal gas in the inlet of the AirCore during descent at predefined GPS altitudes. By assigning the associated mole fraction measurements to the sampling altitude, the spiking signals are assigned to a modelled altitude as well. The quality of the altitude retrieval can be evaluated by comparing the assigned signal altitudes to the GPS release altitudes. In principle, every laboratory can deploy this experiment to its respective AirCores in order to evaluate its altitude attribution quality. Here we present the experimental details and the results of the evaluation to show the accuracy of the altitude registration of Goethe-University AirCore profiles. In addition, the long-term time series of mid-latitude stratospheric mean age observations from Engel et al 2017 is extended with mean age calculated from CO₂-profiles obtained from recent AirCore observations.