

## LISA: a lightweight stratospheric air sampler

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We developed a new Lightweight Stratospheric Air sampler (LISA). The LISA sampler is designed to collect four bag samples in the stratosphere during a balloon flight for CO<sub>2</sub>, CH<sub>4</sub> and CO mole fraction measurements. It consists of 4 Multi Layer Foil (MLF) sampling bags, a custom-made manifold, and a lightweight pump, with a total weight of ~2.5 kg. A series of laboratory storage tests were performed to assess the stability of CO<sub>2</sub>, CH<sub>4</sub>, CO and H<sub>2</sub>O mole fractions in both MLF and Tedlar bags. The MLF bag was chosen due to its good performance for CO<sub>2</sub>, CH<sub>4</sub>, CO and H<sub>2</sub>O. Furthermore, we evaluated the performance of the lightweight pump under low-pressure environments to optimize the trade-off between the vertical resolution and the sample size.

The LISA sampler was flown on the same balloon flight with an AirCore in Sodankylä, Finland (67.368N, 26.633E, 179 m.a.s.l.) on April 26 and September 4-6, 2017. A total of 15 stratospheric air samples were obtained during these flights, where the sampler samples during the ascent of the flights. The sample size ranges between 800 mL to 180 mL for altitudes between 12 km and 25 km, with the corresponding vertical resolution ranging from 0.5 to 1.5 km. The collected air samples were analysed for CO<sub>2</sub>, CH<sub>4</sub> and CO mole fractions, and evaluated against AirCore retrieved profiles, showing mean differences of up to -0.84 ppm for CO<sub>2</sub>, -1.8 ppb for CH<sub>4</sub> and 6.3 ppb for CO, respectively.

High-accuracy stratospheric measurements of greenhouse gas mole fractions are useful to validate remote sensing measurements from ground and from space, which has been primarily performed by comparison with collocated aircraft measurements (0.15 km – 13 km), and more recently with AirCore observations (0 – 30 km). AirCore measurements of greenhouse gases are accurate in mole fractions, but are less accurate in altitude. The LISA sampler provides a viable low-cost tool for retrieving stratospheric air samples for greenhouse gas measurements that is complementary to AirCore. Furthermore, The LISA sampler is advantageous in both the vertical resolution and the sample size to perform routine stratospheric measurements of isotopic compositions of trace gases.