A new lightweight active stratospheric air sampler

Joram Hooghiem[1], Marcel de Vries[1], Pauli Heikkinen[2], Rigel Kivi[2], Huilin Chen[1,3]

[1]Center for Isotope Research (CIO), Energy and Sustainability Institute Groningen (ESRIG), University of Groningen, Nijenborgh 6, 9747 AG Groningen, The Netherlands. Correspondence to j.j.d.hooghiem@rug.nl

[2]Finnish Meteorological Institute (FMI), Arctic Research, Tähteläntie 62

99600 Sodankylä, Finland

[3]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, Colorado, USA

High-accuracy stratospheric measurements of greenhouse gas concentrations 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 concentrations, but are less accurate in the vertical altitudes. However, validation of AirCore measurements has been proven to be challenging, as in-situ stratospheric measurements of greenhouse gas concentrations are challenging due to either stringent requirements on the stability of on-board instruments or difficulties in collecting air samples at a low ambient pressure.

We developed a new lightweight, ~2kg, active sampler to fly with small weather balloons. The sampler consists of 4 Multi Layer Foil (MLF) sampling bags, custom-made valves and manifold, and a lightweight pump. Prior to the field test, we performed a series of laboratory storage tests to assess the accuracy of the greenhouse gas measurements using the MLF bags, and evaluated the performance of the lightweight pump under low-pressure environments.

The sampler was flown together with an AirCore in Sodankylä, Finland (67.368N, 26.633E, 179 m.a.s.l) on April 26th 2017. The sampler, sampling during ascent, successfully collected 4 stratospheric air samples. Sample sizes range from 200 mL to 500 mL, with a vertical resolution of 0.5 to 1.3 km between 12 to 22 km altitudes. We analyzed the four air samples for concentrations of CO_2, CH_4 and CO, and will show the comparison between the sample analysis results and weighted averages of the AirCore profile measurements. Furthermore, these air samples provide an excellent opportunity for analysis of isotopic composition measurements to understand and constrain atmospheric chemical and physical processes in the stratosphere.