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Stratospheric measurements of ozone-depleting substances and greenhouse gases using AirCores

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Retrieving air samples from the stratosphere has previously required aircraft or large balloons, both of which are expensive to operate. The novel “AirCore” technique (Karion et al., 2010) enables stratospheric sampling using weather balloons, which is much more cost effective. AirCores are long (up to 200 m) stainless steel tubes which are placed as a payload on a small balloon, can ascend to over 30 km and fill upon descent, collecting a vertical profile of the atmosphere. Retrieved volumes are much smaller though, which presents a challenge for trace gas analysis. To date, only the more abundant trace gases such as carnon dioxide (CO_2) and methane (CH_4) have been quantified in AirCores. Halogenated trace gases are also important greenhouse gases and many also deplete stratospheric ozone. Their concentrations are however much lower i.e. typically in the part per trillion (ppt) molar range.

We here present the first stratospheric measurements of halocarbons in AirCores obtained using UEA’s highly sensitive (detection limits of 0.01-0.1 ppt in 10 ml of air) gas chromatography mass spectrometry system. The analysed air originates from a Stratospheric Air Sub-sampler (Mrozek et al., 2016) which collects AirCore segments after the non-destructive CO_2 and CH_4 analysis. Successfully measured species include CFC-11, CFC-12, CFC-113, CFC-115, H-1211, H-1301, HCFC-22, HCFC-141b, HCFC-142b, HCFC-133a, and sulphur hexafluoride (SF_6). We compare the observed mixing ratios and precisions with data obtained from samples collected during various high-altitude aircraft campaigns between 2009 and 2016 as well as with southern hemisphere tropospheric long-term trends. As part of the ERC-funded EXC^{3}ITE (EXploring stratospheric Composition, Chemistry and Circulation with Innovative Techniques) project more than 40 AirCore flights are planned in the next 3 years with an expanded range of up to 30 gases in order to explore seasonal and interannual variability in the stratosphere.

References

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