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# Multiple tracer gases from AirCores: a new way of investigating the changing Brewer-Dobson Circulation

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Stratospheric trace gas measurements are temporally and spatially patchy compared to many of their tropospheric counterparts. Research aircraft flights are limited to a maximum altitude of ∼20 km and by operational expense. Satellites are increasing in both number and the range of species they can observe, but they still do not cover the full range of gases that can be measured in whole air samples (at UEA we routinely measure 30-50 trace gas species) and require validation. Yet the need for stratospheric trace gas profiles is increasing. The response of the stratospheric mean meridional circulation, the Brewer-Dobson Circulation (BDC) to current and future climate change is still unclear: models predict an increase in the strength of the BDC whilst measurements show no change within uncertainties. The potential impact on interactions between the BDC and the processing of ozone-depleting substances (ODSs), and therefore ozone hole recovery, is also poorly understood.

The use of AirCores to collect stratospheric profiles of $CO_2$ and $CH_4$ up to 30 km has been increasing in recent years. AirCores are technically simple and inexpensive to build and deploy. They consist of long coils (up to 200 m) of lightweight stainless steel tubing carried below a large meteorological balloon. The tubing evacuates during ascent as the ambient pressure falls, and fills during the subsequent descent. Due to the payload restrictions sampled air volumes are small, around 200-300 ml of stratospheric air. This makes analysis of less abundant (ppt range) trace gases difficult. Analysis on UEA's highly sensitive (detection limits of 0.01-0.1 ppt in 10 ml of air) gas chromatography mass spectrometry system has provided the first measurements of non-$CO_2$/$CH_4$ greenhouse gases and ODSs from AirCores.

The ERC-funded EXC$^3$ITE project (EXploring stratospheric Composition, Chemistry and Circulation with Innovative Techniques) has been analysing AirCore samples for a range of trace gases since early 2016. This new collection of stratospheric vertical profiles currently consists of more than 10 flights up to a maximum altitude of 30 km, covering 3 seasons and 10-30 trace gases. As analytical uncertainties for several compounds are comparable to those from previous, larger volume aircraft samples, our dataset already has potential for improving our understanding of the BDC. For example, $SF_6$ uncertainties from AirCore samples ∼0.8% compared to 0.5-1.2% for aircraft-derived mole fractions. This allows us to begin using AirCore data to calculate derived quantities used as proxies for stratospheric circulation. We will present early calculations of Fractional Release Factors and mean ages derived from our AirCore profiles, and explore the variability of these quantities within our dataset and when compared to aircraft-derived data.