Multiple tracer gases from aircraft and AirCores and their potential as diagnostic tools for stratospheric changes

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Chemical tracers are often used as proxies for quantifying stratospheric transport, specifically the Brewer-Dobson circulation (BDC). Ideal tracers should be inert and have shown a linear tropospheric trend for at least a decade. SF_6 and CO_2 are commonly used tracers, but both are not without problems. Complementing them with the use of additional tracers is likely to benefit our understanding of current and future changes to the stratosphere. The use of chemical tracers is also limited by the temporally and spatially patchy nature of stratospheric trace gas profiles. Observing current and predicting future changes to stratospheric dynamics and processing (e.g. BDC, changes, stratosphere-troposphere exchange processes, ozone chemistry) in response to climate change would benefit from an increased number of profiles. Recent work at UEA has focused on addressing both of these issues:

Firstly, a suite of alternative stratospheric transport tracers – the PFCs CF_4, C_2F_6 and C_3F_8 and the HFCs HFC-23 and HFC-125 – have been evaluated and found to have suitable tropospheric growth rates and measurement precisions for use as age tracers. A comprehensive uncertainty analysis was performed and resulted in uncertainties on mean ages derived from these 'new' age tracers that are comparable to SF_6.

Secondly, the use of AirCores – long coils (up to 200 m) of lightweight stainless steel tubing carried below a large meteorological balloon – to provide regular, cheap stratospheric profiles has been extended at UEA to include measurements of ppt range trace gases. 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 (GHGs) and ozone depleting substances (ODSs) from AirCores.

Here we combine these approaches by presenting both our collection of stratospheric AirCore profiles (>10 currently flights covering all seasons and 10-30 trace gases with analytical uncertainties comparable to those from larger volume aircraft samples) and mean ages derived from these profiles for selected new age tracers.

Key words: halocarbons, AirCore, age-of-air, trace gases, chemical tracers