Introducing the EXC³ITE Project: EXploring Stratospheric Composition, Chemistry and Circulation with Innovative TEchniques

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In recent years debate has arisen over the potential impact of global climate change on stratospheric mean meridional circulation (the Brewer-Dobson circulation, BDC). Models predict an increase in the strength of the BDC, although substantial uncertainties still surround our understanding of past and future changes in this region. Previous studies have been limited by the cost of sampling, resulting in patchy temporal and seasonal coverage, and the limitations of satellites with respect to their precision and vertical resolution, as well as the number of relevant species they can quantify.

Recent work at University of East Anglia (UEA) has found initial evidence for substantial past stratospheric changes which implies a large and persisting change in the BDC. Acceleration of the BDC would have an impact on chemical and physical processes in the stratosphere; notably altering the removal of ozone-depleting substances (ODSs), which are exclusively broken down in the stratosphere.

The EXC³ITE project will run from 2016 to 2021 and aims to increase our understanding of changing stratospheric dynamics by combining a novel, cost effective measurement technique, “AirCore” (a long narrow-bore sampling tube launched as a payload on a small balloon), with state of the art analysis via UEA’s highly sensitive (detection limits of 0.01-0.1 pmol mol^{-1} in 10 ml of air) gas chromatography mass spectrometry system which has the capability of measuring >30 atmospherically important species. EXC³ITE will combine at least 45 stratospheric balloon flights with an unprecedented investigation of stratospheric air archives spanning 40 years and >50 trace gases. First results will be presented (Fig. 1). As well as improving our understanding of stratospheric circulation changes, EXC³ITE will also provide: (1) observations of ODSs not currently controlled by the Montreal Protocol but currently increasing in the atmosphere, e.g. short-lived chlorocarbons; (2) observations of hydrofluorocarbons and perfluorocarbons – strong greenhouse gases; (3) crucial calibrations and validations of satellite instruments; (4) new diagnostic tools (e.g. improved mean ages of air from multiple tracers); and (5) a detailed comparison with state-of-the-art models to identify the implications for future climate.

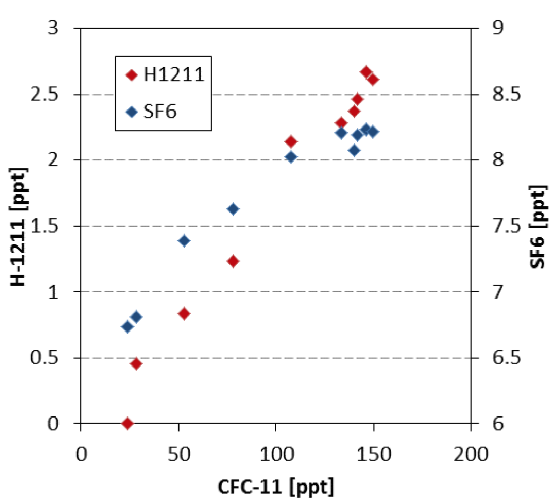

Figure 1. ODS mole fraction ratio correlations from initial Aircore samples collected above Finland in early 2016. Average precisions were 0.2%, 0.6% and 1.5% for CFC-11, sulfur hexafluouride, and H-1211 respectively.