Introducing EXC³ITE: Exploring stratospheric composition, chemistry and circulation with innovative techniques


**WP1: BETTER STRATOSPHERIC OBSERVATIONS THROUGH NEW AIRCORE TECHNOLOGY**

Flights: At least 45 flights over 9 campaigns:
- Test campaign,
- 8 campaigns over 2 years, sampling each season twice.

Sampling will hopefully include joint campaigns with partners measuring key greenhouse gases such as N₂O, CO₂ and CH₄.

Aircores: Long (up to 100 m), thin stainless steel tubes, closed at one end. The tube evacuates during ascent as it equilibrates to low ambient pressure and fills on descent—collecting a vertical profile of the atmosphere.

Launched via small balloon (payload < 3 kg). Aircores can ascend to >30 km.

**PRELIMINARY RESULTS**

Several Aircore deployments have already been made and the samples analysed at UEA. Fig. 1 shows a subset of results for deployments in March and April 2016 compared to measurements from Laube et al.

Precisions (calculated from replicate analyses of a standard across a day, error bars on Fig. 1) as low as 0.56% (SF₆, March) were achieved, and will hopefully be improved upon with the development of an automated sample pre-concentration system in the coming months.

**EXTRA BENEFITS**

1. Observations of ODSs not controlled by the Montreal Protocol but currently increasing in the atmosphere, e.g. short-lived chlorocarbons.
2. Observations of HFCs and PFCs — strong greenhouse gases with high global warming potentials for which we have a poor understanding of their stratospheric distributions.
3. Crucial calibrations and validations of satellite instruments.

**WP2: USING IMPROVED AGE OF AIR SPECTRA TO DIAGNOSE CIRCULATION CHANGES**

The age of any stratospheric air sample can be described by a probability distribution function (Fig. 1) with the mean age of air representing the average transport time in the stratosphere.

Altering stratospheric dynamics may alter transport times and therefore observed mean ages are also likely to change.

We will conduct high precision analysis of > 300 samples historical (1975-2012) stratospheric samples for > 50 compounds. We will use up to 18 long-lived halocarbon tracers to refine our understanding of age spectra and to help diagnose stratospheric circulation changes.

**REFERENCES**

2. Karion et al. (2010) doi:10.1175/TECHA1448.1;

**WP3: USING FRACTIONAL RELEASE FACTORS (FRFs) TO DIAGNOSE STRATOSPHERIC CHEMISTRY CHANGES**

FRFs tell us the degree of decomposition of a halocarbon at a particular point and time. The relationship between mean age and FRF should be constant… unless transport pathways or stratospheric chemistry processes change.

Preliminary work at UEA is already showing changes in the relationship between FRFs and mean air over time - by over 40% between 1997 and 2009 alone - evidence for substantial past stratospheric changes (Fig. 3).

**WP4: MODEL COMPARISONS AND ASSESSMENT OF FUTURE IMPACTS**

1. Combining age spectra and FRFs from WP2&3 to update ozone depletion potentials for key gases.
2. Comparing these values with those derived from recent chemistry-climate model runs.

Quantification of the differences between (1) and (2) to help improve future model analyses.