Automated CO_2 extraction from air for clumped isotope analysis in the atmo- and bio- sphere

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The conventional stable isotope ratios $^{13}C/^{12}C$ and $^{18}O/^{16}O$ in atmospheric CO_2 are a powerful tool for unraveling the global carbon cycle. In recent years, it has been suggested that the abundance of the very rare isotopologue $^{13}C^{18}O^{16}O$ on m/z 47 might be a promising tracer to complement conventional stable isotope analysis of atmospheric CO_2 [1, 2, 3, 4]. Here we present an automated analytical system that is designed for clumped isotope analysis of atmo- and biospheric CO_2.

The carbon dioxide gas is quantitatively extracted from about 1.5L of air (ATP). The automated stainless steel extraction and purification line consists of three main components: (i) a drying unit (a magnesium perchlorate unit and a cryogenic water trap), (ii) two CO_2 traps cooled with liquid nitrogen [5] and (iii) a GC column packed with Porapak Q that can be cooled with liquid nitrogen to -20°C during purification and heated up to 240°C in-between two extraction runs. After CO_2 extraction and purification, the CO_2 is automatically transferred to the mass spectrometer. Mass spectrometric analysis of the $^{13}C^{18}O^{16}O$ abundance is carried out in dual inlet mode on a MAT 253 mass spectrometer. Each analysis generally consists of 80 changer-over-cycles. Three additional Faraday cups were added to the mass spectrometer for simulatneous analysis of the mass-to-charge ratios 44, 45, 46, 47, 48 and 49. The reproducibility for $\delta^{13}C$, $\delta^{18}O$ and Δ_{47} for repeated CO_2 extractions from air is in the range of 0.11‰ (SD), 0.18‰ (SD) and 0.02‰ (SD), respectively.

This automated CO_2 extraction and purification system will be used to study the clumped isotopic fractionation during photosynthesis (leaf chamber experiments) and soil respiration.

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