

1 **A new setup for simultaneous high precision**
2 **measurements of CO₂, δ¹³C-CO₂ and δ¹⁸O-CO₂ on small ice**
3 **core samples**

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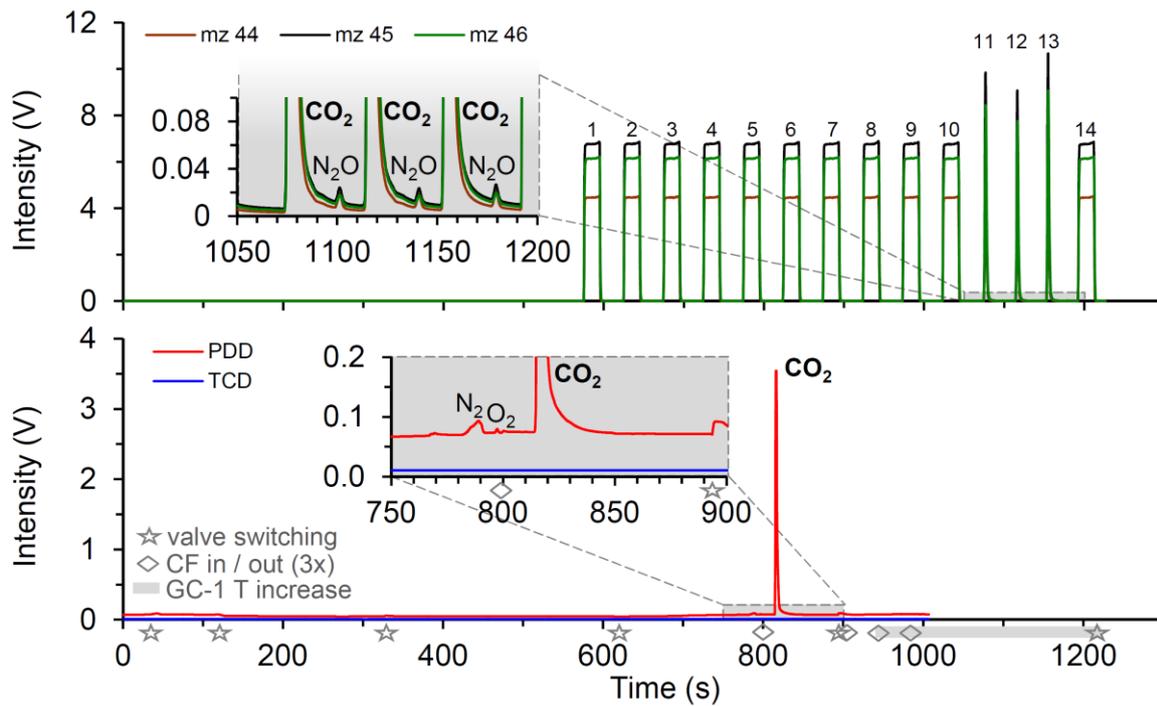
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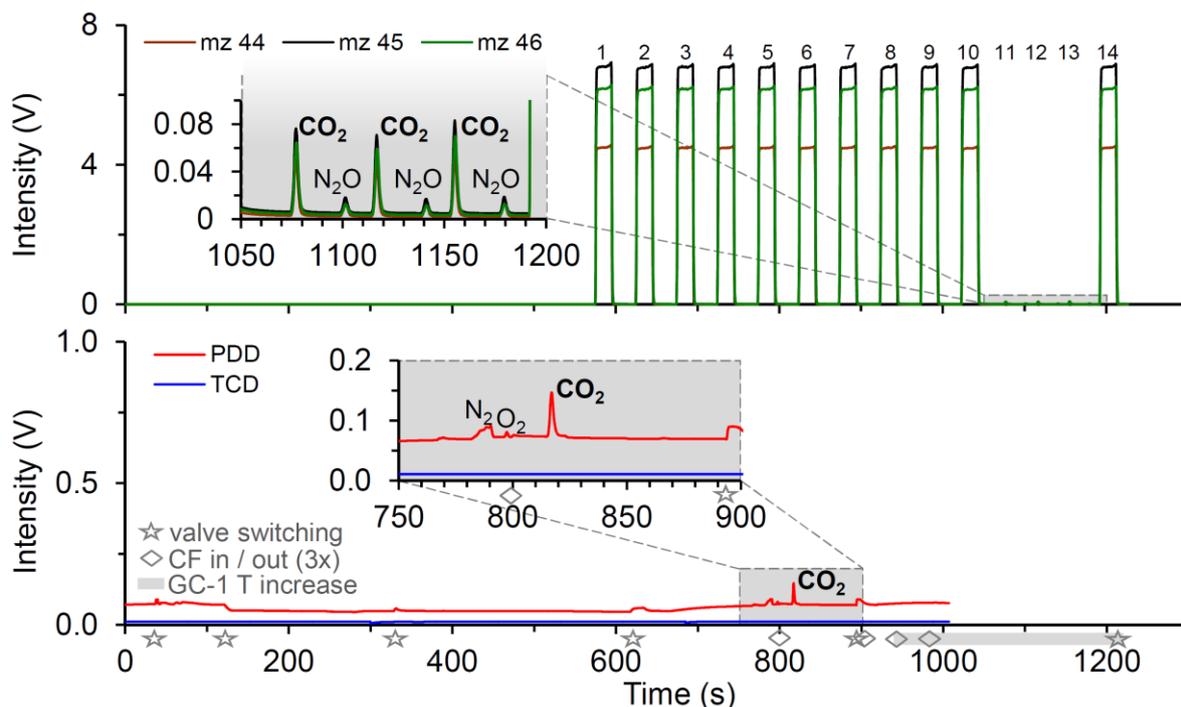
1 **Supplement**



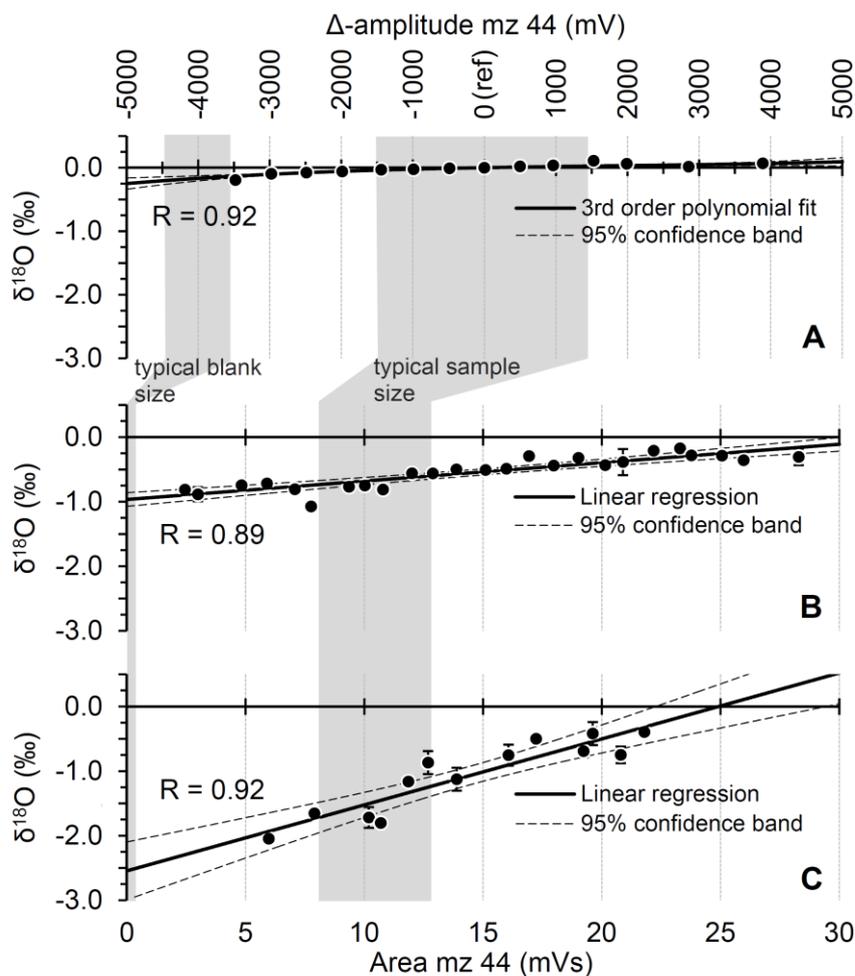
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3 Figure S1: Chromatograms for the measurement of pure CO₂-WS injected into section B of
 4 the setup (Fig. 2) and subsequently passing the PreCon-GC system. Upper panel: IRMS
 5 signal intensity for mass 44, 45, and 46. The flat-topped peaks are on/off peaks of the WS
 6 injected via the open split. Peaks 1-9 are used to reach stable source conditions while peaks
 7 10 and 14 before and after the samples (i.e. the WS passing the PreCon-GC system) are used
 8 for referencing. The inset shows baseline details and N₂O separation in detail. Lower panel:
 9 PDD and TCD intensity signal for CO₂ and air (not detected for the pure CO₂ sample injected
 10 here), respectively. Stars indicate valve switching, resulting in small variations in the PDD
 11 signal due to changes in pressure and flow (see inset, not detected by the less sensitive TCD).
 12 Diamonds indicate immersion of the three capillary traps into liquid nitrogen for CO₂
 13 cryofocusing and their subsequent one by one release resulting in the three peaks of the split
 14 sample shown in the upper panel (peaks 11–13). Over the time period indicated by the grey
 15 bar the GC-1 temperature is increased to 150 °C in order to pre-condition the column for the
 16 next sample. The enlargement shows baseline details and the N₂ and O₂ signal of the system
 17 blank contribution.

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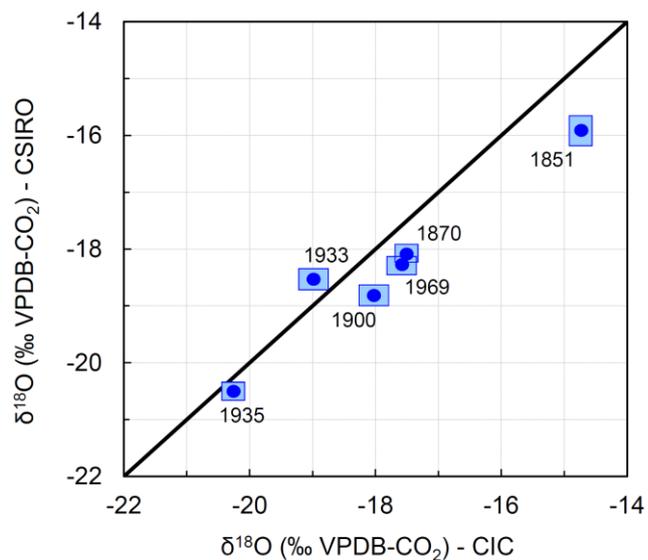
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2 Figure S2: Chromatograms for the measurement of a system blank including both sections A
3 and B (Fig. 2) and below compression (i.e. needle movement but no ice). Upper panel:
4 IRMS signal intensity for mass 44, 45, and 46. The flat-topped peaks are on/off peaks of the
5 CO₂-WS injected via the open split. Peaks 1–9 are used to reach stable source conditions
6 while peaks 10 and 14 before and after the samples (i.e. the system blank) are used for
7 referencing. The inset shows baseline details and the system blank signal of CO₂ and N₂O in
8 detail. Lower panel: PDD and TCD intensity signal for CO₂ and air (not detected),
9 respectively. Stars indicate valve switching, resulting in small variations in the PDD signal
10 due to changes in pressure and flow (see inset, not detected by the less sensitive TCD).
11 Diamonds indicate immersion of the three capillary traps into liquid nitrogen for CO₂
12 cryofocusing and their subsequent one by one release resulting in the three peaks of the split
13 sample shown in the upper panel (peaks 11–13). Over the time period indicated by the grey
14 bar the GC–1 temperature is increased to 150 °C in order to pre-condition the column for the
15 next sample. The enlargement shows baseline details and the system blank contribution of
16 N₂, O₂ and CO₂.
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2 Figure S3: Fractionation effects for $\delta^{18}\text{O}$: A) IRMS nonlinearity effect; $\delta^{18}\text{O}$ dependence on
 3 peak amplitude (top x-axis), Δ -amplitude is the deviation in intensity (mass 44) from the
 4 reference peak (ref, $\delta^{18}\text{O}$ and Δ -amplitude = 0). The data is obtained from a total of 177
 5 measurements and shown are mean values with the 1σ standard deviation. B) PreCon-GC
 6 linearity (bottom x-axis); CO_2 sample size dependence for pure CO_2 working standard
 7 directly injected to section B. The data is obtained from a total of 318 measurements
 8 corrected for IRMS nonlinearity and blank; shown are mean values with the 1σ standard
 9 deviation. C) Air amount dependence (bottom x-axis); air sample size dependence for air
 10 standards/samples injected to section A. The data is obtained from a total of 46 measurements
 11 corrected for IRMS nonlinearity, PreCon-GC linearity and system blank, shown are mean
 12 values with the 1σ standard deviation. The grey bars indicate the typical procedural blank and
 13 sample size range of air extracted from ice samples, respectively.

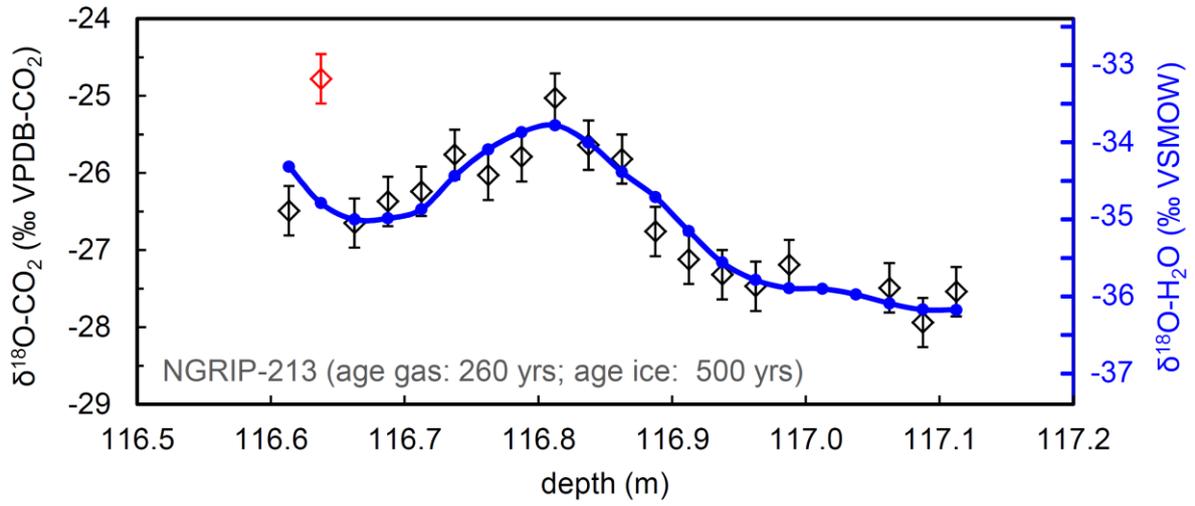
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2 Figure S4: Laboratory comparison measurements of Law Dome ice samples covering the
 3 recent past (1851–1969 AD). Shown are the $\delta^{18}\text{O}$ - CO_2 values measured at CIC (x-axis) and
 4 CSIRO (y-axis; Rubino M., pers. communication). Blue boxes indicate 1σ uncertainties
 5 defined for each laboratory by the respective side length.

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2 Figure S5: High resolution records of $\delta^{18}\text{O-CO}_2$ with error bars (1σ , left axis) and $\delta^{18}\text{O-H}_2\text{O}$
 3 (right axis) for an ice section from NGRIP. The sample in red has been defined as an outlier
 4 (for details see Sect. 4.3 in the main manuscript).