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A setup to analyze isotopes of paleoatmospheric CH_4 and N_2O in a single ice core sample

P. Sperlich (1), C. Buizert (1), M. Guillevic (1,2), T. Jenk (1), C.J. Sapart (3), T. Röckmann (3), M. Bock (4), J. Schmitt (4), H. Fischer (4), and T. Blunier (1)

(1) Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark (sperlich@nbi.ku.dk), (2) Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette, France, (3) Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Utrecht, The Netherlands, (4) Climate and Environmental Physics and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

The isotopic composition of paleoatmospheric N_2O and CH_4 can be measured in ice core samples to study biogeochemical processes driving their atmospheric budget. We developed a new vacuum-wet-extraction method to measure CH_4 concentrations, $\delta^{15}N$ and $\delta^{18}O$ isotope ratios of N_2O, and $\delta^{13}C$ of CH_4 in a single ice core sample using one mass spectrometer. The ice sample is melted while the air is continuously cryo-pumped onto a liquid nitrogen cooled Hayesep trap. N_2 and O_2 are separated and measured with a TCD before CH_4 and N_2O and are measured by GC-IRMS. We determine the CH_4 concentrations with a precision of ± 20 ppbv by relating the IRMS peak size to the TCD peak size.

First measurements of seven pre-industrial ice core samples of 400 – 500 g agree with a standard deviation (1σ) of better than 0.05 ‰ in $\delta^{13}C - CH_4$. At this stage, the setup needs improvement for satisfactory measurements of N_2O isotopes and concentrations from ice core samples. Intercomparisons of three standard gases have been shared for N_2O and CH_4 isotopes between three laboratories. The agreement is typically within the standard deviation (1σ) for all isotope measurements.