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Continuous field deployable methane concentration measurements from ice cores with near-infrared cavity ring-down spectroscopy

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The analysis of gases and chemical impurities trapped in ice provides knowledge of earth's past climate. Deep ice cores from Greenland act as climate archives with high temporal resolution for more than the last 100,000 years covering Holocene, last glacial period and part of the previous interglacial called Eemian.
Traditionally methane concentrations from ice cores are measured by gas chromatography. This technique is time consuming, labor intensive and generally not field deployable.
Here we present results from the first laboratory and field tests of a new method for measuring methane concentrations from deep ice cores with high temporal resolution using a commercially available but slightly modified near-infrared cavity ring-down spectrometer (NIR-CRDS; http://www.picarro.com/).
The NIR-CRDS is connected to a Continuous Flow Analysis (CFA) system, where air bubbles are continuously extracted from the melted ice water stream with the help of a hydrophobic membrane. The extracted gases are forwarded into the NIR-CRDS where the methane concentration is measured every 4 to 5 seconds. As the sample is diluted with helium during the extraction process an oxygen sensor is built into the NIR-CRDS.
The continuous extraction of air and the high measurement frequency yield an extremely high temporal resolution, thus better exploiting the temporal resolution available from ice cores. At a typical CFA melt rate of 35 mm/min we obtain concentration measurements approximately every 3 mm of ice.
The system is robust, compact and therefore suited for field measurements in combination with a continuous melting device. It was tested on the Greenland ice sheet during the 2009 field season of the North Greenland Eemian Ice Drilling (NEEM) project coupled to the University of Bern CFA system and under laboratory conditions with NGRIP ice coupled to the Copenhagen CFA system. The precision of the measurements of the first field season is encouraging but does not match the precision of gas chromatography measurements. The system is being improved and we expect to out compete or at least match gas chromatography for precision. Measurements of ice from the Eemian period are scheduled for the 2010 field season of the NEEM project.