Geophysical Research Abstracts
Vol. 12, EGU2010-9669, 2010
EGU General Assembly 2010

Continuous analysis of phosphate in a Greenland shallow ice core

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Phosphate is an important and sometimes limiting nutrient for primary production in the oceans. Because of deforestation and the use of phosphate as a fertilizer changes in the phosphate cycle have occurred over the last centuries. On longer time scales, sea level changes are thought to have also caused changes in the phosphate cycle. Analyzing phosphate concentrations in ice cores may help to gain important knowledge about those processes.
In the present study, we attach a phosphate detection line to an existing continuous flow analysis (CFA) setup for ice core analysis at the University of Copenhagen. The CFA system is optimized for high-resolution measurements of insoluble dust particles, electrolytic melt water conductivity, and the concentrations of ammonium and sodium. For the phosphate analysis we apply a continuous and highly sensitive absorption method that has been successfully applied to determine phosphate concentrations of sea water (Zhang and Chi, 2002). A line of melt water from the CFA melt head (1.01 ml per minute) is combined with a molybdate blue reagent and an ascorbic acid buffer. An uncompleted reaction takes place in five meters of heated mixing coils before the absorption measurement at a wavelength of 710 nanometer takes place in a 2 m long liquid waveguide cell (LWCC) with an inner volume of 0.5 ml. The method has a detection limit of around 0.1 ppb and we are currently investigating a possible interference from molybdate reacting with silicates that are present in low amounts in the ice. Preliminary analysis of early Holocene samples from the NGRIP ice core show phosphate concentration values of a few ppb.
In this study, we will attempt to determine past levels of phosphate in a shallow Northern Greenland firn core with an annual layer thickness of about 20 cm ice equivalent. With a melt speed of 2.5 cm ice per minute our method should allow the resolution of any seasonal variability in phosphate concentrations.