Geophysical Research Abstracts
Vol. 16, EGU2014-1526, 2014
EGU General Assembly 2014

A novel method for the detection of acidity in ice cores

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The pH of polar ice is important for the stability and mobility of impurities in ice cores and can be strongly influenced by volcanic eruptions or anthropogenic emissions.

We present a simple optical method for continuous determination of acidity in ice cores based on the absorption spectroscopy of two common pH-indicator dyes, bromophenol blue and chlorophenol red. The method does not require calibration with CO_2 and is simpler than existing continuous flow analysis (CFA) methods for pH determination in ice cores, offering a 10-90% peak response time of 45s and a combined uncertainty of 9%.

The method has been applied to sections of Greenland firn and Antarctic ice and compared to standard techniques such as Electrical Conductivity Measurements (ECM), conducted on the solid ice, and electrolytic conductivity of melted ice samples.

The acidity as detected in the Greenland NEGIS firn core (75.38N, 35.56W), show an increasing trend up to the 1970's that can be explained by deposition of anthropogenic SO_4^{2-} and NO_X. The seasonal variability show highest acidity in winter (1900-1950 AD), but shifts towards spring for the period 1950-2000 AD.

Conductivity and pH are found to be highly correlated in the Greenland NEGIS firn core with all signals greater than 3σ variability being related to either volcanic eruptions or forest fire activity. The method is ideal for finding the volcanic spikes in the firn than conventional ECM and DEP, which require density corrections in firn. In contrast to the NEGIS site, the Antarctic Roosevelt Island ice core (79.36S, 161.71W) features an anti-correlation between conductivity and pH, most likely due to the influence of marine salts.