Name of research institute or organization:

Labor für Radio- und Umweltchemie der Universität Bern und des Paul Scherrer Instituts

Title of project:

VITA Varves, Ice cores, and Tree rings – Archives with annual resolution

Project leader and team:

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Project description:

VITA (Varves, Ice cores and Tree rings – Archives with annual resolution), the subprogram of the National Center of Competence in Research on Climate (NCCR Climate) aims to compare proxy climate records obtained from trees, lakes, peat bogs and glaciers (http://www.nccr-climate.unibe.ch/). The site selected for ice coring was the Fiescherhorn glacier in the Berner Oberland (FH, Swiss Alps, 46°33'3.2''N, 08°04'0.4''E; 3900 m asl.), close to the Jungfraujoch. Samples from this ice core were analysed to obtain a first long-term record of the two main fractions, organic carbon (OC) and elemental carbon (EC) of carbonaceous particle concentrations in ice along with the fraction of modern carbon derived from ^{14}C analysis. Long-term concentration records of carbonaceous particles are of increasing interest in climate research due to their not yet completely understood effects on climate. We analysed 33 samples of 0.4 to 1 kg ice, covering the time period ~1670-1940. Details of sample preparation and analysis can be found elsewhere (Jenk et al., submitted).

Since analysis of standard parameters like stable isotopes ($\delta^{18}O$, δD) and chemical species, e.g. ammonium, used for dating of ice cores by annual layer counting (ALC), is not completed yet for the Fiescherhorn glacier core, dating of the presented samples was performed by ALC back to 1880 (uncertainty: ± 2 years) and by a Nye ice flow model for the time before (± 10, rising to the end). Ice samples were obtained by cutting slices along the recovered core sections of about 70 cm length and were prepared as described in (Jenk et al., submitted).

Concentrations of OC, EC and total carbon (TC) in µg/kg ice are presented in Fig. 1, representing the water insoluble amount. OC, as a tracer of biogenic emissions, shows a high variability in concentrations. An influence from anthropogenic emissions is not obvious for the examined time period, since high concentrations were already observed around 1700. The relatively low levels during the early 19th century are unexpected. A possible explanation might be a change in bioactivity due to colder conditions around 1800. EC concentrations, as a tracer of anthropogenic emissions show less variability. In contrast to OC, the anthropogenic influence due to industrialisation and the use of fossil fuels (hard coal, later oil and gasoline) is clearly reflected in EC concentrations, which began to increase around 1880.

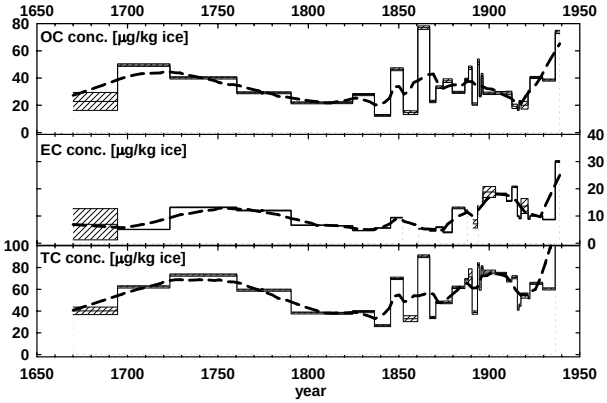

Fig. 1: OC, EC and TC concentrations as µg/kg ice from 1670 to 1940 (solid lines) with measurement uncertainties (1 σ, shaded areas). The dashed line was obtained by smoothing of the data.

^{14}C analysis has shown to be a powerful tool for source apportionment of carbonaceous particles (Szidat et al., 2006). In Fig. 2, results of ^{14}C analysis are presented for OC and EC as fraction of modern carbon (f_M) corrected for the decay by accounting for the age of the sample. The f_M thus indicates the level of biogenic/anthropogenic contribution to the sample. Accordingly, a sample with a f_M = 1 originated to 100% from biogenic sources. The record for the f_M of OC shows - similar to the EC record in Fig.1 - a rising of anthropogenic emissions after 1880. The level for 1940 is already comparable to recent aerosol samples with an anthropogenic contribution of around 40% [3]. A very strong peak of anthropogenic emissions between 1880 and 1900 is interesting for further investigation. Before 1850, OC was almost purely of biogenic origin. This is an important finding as we intend to use OC for radiocarbon dating of the oldest sections of ice cores. The f_M of EC reflects a more and more dominating contribution of anthropogenic sources after 1900 until reaching about 80% of the total EC emissions in 1940, comparable to what is observed in recent aerosol samples (Szidat et al., 2006). Interesting but without explanation yet is the f_M for the sample from around 1850. EC seems to be influenced by ^{14}C extinct sources even around 1850.

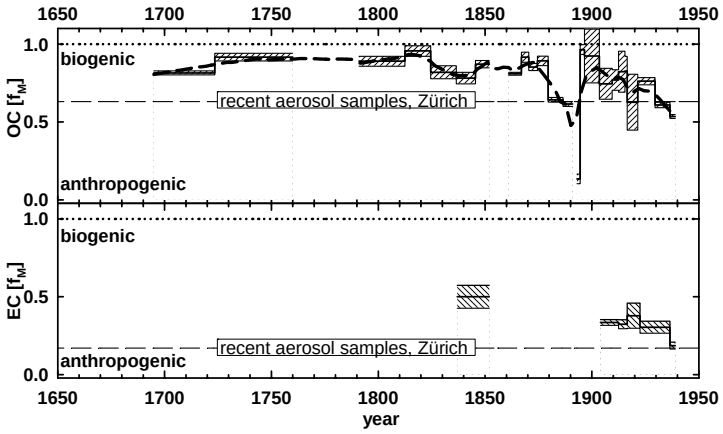

Fig. 2: f_M of the OC and EC fractions derived from ^{14}C AMS analysis (solid lines) with measurement uncertainties (1 σ, shaded areas). The dashed line was obtained by smoothing of the data. The dotted line represents 100% biogenic origin.

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References:

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Key words:

carbonaceous particles, radiocarbon, aerosol effect

Internet data bases:

http://lch.web.psi.ch/
http://www.nccr-climate.unibe.ch/

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Scientific publications and public outreach 2005:

Refereed journal articles

Sodemann, H., A.S. Palmer, C. Schwierz, M. Schwikowski, H. Wernli, The transport history of two Saharan dust events archived in an Alpine ice core, Atmos. Chem. Phys. Discuss. 5, 7497-7545 (2005).

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