Name of research institute or organization:

Laboratory of Radiochemistry and Environmental Chemistry, Universität Bern

Title of project:

Source apportionment of carbonaceous aerosols with ^{14}C

Project team:

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Project description:

Carbonaceous particles are a major component of the fine aerosol. They originate from anthropogenic (mainly from fossil fuel combustion and biomass burning) and biogenic emissions. For the identification and quantification of these sources, many elemental and organic molecular tracers have been employed, but their reliability often suffers from limited atmospheric lifetimes due to their chemical reactivity and highly variable emission factors. Thus, there is a large uncertainty about the importance of anthropogenic emissions for the total carbonaceous aerosol burden of the atmosphere. In contrast to these tracers, radiocarbon (^{14}C) determinations enable a direct distinction of contemporary and fossil carbon in ambient aerosols, because ^{14}C has decayed in the latter material.

TSP (total suspended particles) samples were collected at the High Alpine Research Station Jungfraujoch during August/September 2004, January-April 2005, and June-September 2005 for source investigation of the carbonaceous aerosol. Furthermore, two shallow snow cores were drilled on the Jungfraufirn ~500 m south of the Sphinx in April 2005 for comparison of ambient airborne with precipitated particulate matter. The carbonaceous aerosol (total carbon, TC) was differentiated into elemental carbon (EC) and organic carbon (OC) with a temperature-programmed combustion, followed by ^{14}C measurements at the PSI/ETHZ accelerator mass spectrometry (AMS) facility. In the following, first results of the OC fraction are presented.

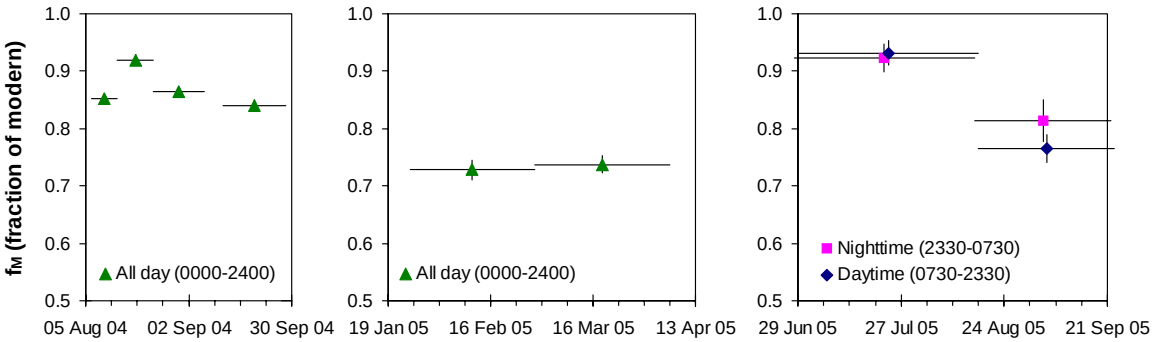

Figure 1: f_M values of airborne particulate OC at Jungfraujoch during three campaigns in 2004 and 2005. Horizontal bars mark sampling periods, vertical bars standard measurement uncertainties.

Figure 1 shows ^{14}C determinations of airborne particulate OC under summer and winter conditions. Results are given in terms of fractions of modern (f_M) representing $^{14}C/^{12}C$ ratios of a sample related to that present in the reference year 1950. Consequently, values can range from 0 for fossil substances to ~1.1 for contemporary material with the upper limit slightly exceeding the theoretical maximum of 1 as a consequence of the nuclear bomb excess. Results indicate a major influence of contemporary sources, which mainly comprise biogenic emissions of plants as well as biomass burning aerosols from forest fires and residential wood heating. Fossil sources, e.g. from traffic emissions, contributed ~35 % and ~20 % during winter and summer, respectively. Simultaneous daytime and nighttime sampling in summer 2005 revealed comparable isotopic signals suggesting similar emission patterns for both conditions. This is remarkable as the Jungfraujoch is usually situated in the undisturbed free troposphere with a well-mixed European background aerosol during summer nights, while local particulate matter transported vertically from lower elevations may interfere during daytime.

Key words:

Carbonaceous aerosol, environmental radiocarbon, source apportionment

Collaborating partners/networks:

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