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Radiocarbon analysis in an Alpine ice core: record of anthropogenic and biogenic contributions to carbonaceous aerosols in the past (1650–1940)

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Abstract. Long-term concentration records of carbonaceous particles (CP) are of increasing interest in climate research due to their not yet completely understood effects on climate. Nevertheless, only poor data on their concentrations and sources before the 20th century are available. We present a first long-term record of organic carbon (OC) and elemental carbon (EC) concentrations – the two main fractions of CP – along with the corresponding fraction of modern carbon (f_M) derived from radiocarbon (^{14}C) analysis in ice. This allows a distinction and quantification of natural (biogenic) and anthropogenic (fossil) sources in the past. CP were extracted from an ice archive, with resulting carbon quantities in the microgram range. Analysis of ^{14}C by accelerator mass spectrometry (AMS) was therefore highly demanding. We analysed 33 samples of 0.4 to 1 kg ice from a 150.5 m long ice core retrieved at Fiescherhorn glacier in December 2002 (46°33'3.2" N, 08°04'0.4" E; 3900 m a.s.l.). Samples were taken from bedrock up to the firn/ice transition, covering the time period 1650–1940 and thus the transition from the pre-industrial to the industrial era. Before ~1850, OC was approaching a purely biogenic origin with a mean concentration of 24 μg kg^{-1} and a standard deviation of 7 μg kg^{-1}. In 1940, OC concentration was about a factor of 3 higher than this biogenic background, almost half of it originating from anthropogenic sources, i.e. from combustion of fossil fuels. The biogenic EC concentration was nearly constant over the examined time period with 6 μg kg^{-1} and a standard deviation of 1 μg kg^{-1}. In 1940, the additional anthropogenic input of atmospheric EC was about 50 μg kg^{-1}.

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