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Recent enhancement of secondary organic aerosol formation indicated by a 14C-based emission-source-resolved carbonaceous aerosol record from Fiescherhorn Glacier, Swiss Alps

Content

The impact of aerosol particles on the Earth's radiative balance remains poorly constrained, in particular the radiative forcing related to the indirect effect (cloud coverage and cloud albedo due to alteration of condensation processes and cloud droplet size reduction). The level of understanding for this forcing is very low, and causes significant uncertainties in climate modeling. While recent anthropogenic emissions can be estimated from national emission inventories, assuming all emission sources are known, the level of understanding and uncertainties are largely related also to the deficient knowledge about the undocumented, pre-industrial atmospheric concentration levels. All of this is particularly the case for carbonaceous compounds, forming a major fraction of the atmospheric aerosol. Even for the most recent time-period, the effect of anthropogenic perturbation on the formation of secondary organic aerosol, not documented in inventories, is under debate. We present a first record of pre-industrial to industrial changes in concentration levels of carbonaceous aerosols, derived from an ice core from the Swiss Alps (Fiescherhorn) and representative for Central Europe. Using an analytical technique, applied also for micro-radiocarbon dating of ice, allowed: (1) To divide this record of total carbon (TC) into sub-fractions of organic carbon (OC; for which we can further distinguish between an insoluble and soluble part denoted as WIOC and WSOC, respectively) and elemental carbon (EC). (2) To attribute quantitatively, based on 14C analysis, the contribution from fossil and biogenic emission sources to each of these sub-fractions. For the industrial period, we will discuss and compare this record to model estimates based on source and industrial sector resolved European emission inventories.

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