Identification of biogenic and anthropogenic components of secondary organic aerosol (SOA) by nuclear magnetic resonance spectroscopy

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The chemical composition of the major fraction of the atmospheric aerosol organic mass is poorly characterized and not resolved at the molecular level, and consequently the apportionment of the atmospheric particulate compounds into their different anthropogenic and biogenic components is still challenging.

Analogously to aerosol mass spectrometers (AMS) which provide quantitative apportionment of the organic aerosol composition into a few groups (e.g. OOA and HOA), proton-nuclear magnetic resonance (^{1}H-NMR) spectroscopy provides information on the integral chemical properties of the organic mixture and, through them, it allows to fingerprint the possible sources of oxidized organic matter in the aerosol samples.

Here we present results of chemical characterization of SOA produced during photooxidation and ozonolysis experiments from biogenic and anthropogenic VOCs in the PSI and SAPHIR simulation chambers. These laboratory experiments provided useful ^{1}H-NMR fingerprints for the identification of SOA from different precursors and were eventually used for the interpretation of field data. In particular, series of NMR spectra recorded during field experiments in pristine forested environments and in polluted rural stations were subjected to statistical multivariate analysis and the resulting factors were compared to the ^{1}H-NMR spectra characteristic of SOA obtained in the laboratory.

These findings show that spectroscopic techniques such as NMR spectroscopy can profitably complement AMS in organic aerosol source apportionment studies.

Surface exposure dating in the Holocene – Precise ^{10}Be technique for very young surfaces

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Recent advances in sample preparation and in instrumental techniques have improved AMS sensitivity to the point that ^{10}Be concentrations can be determined with good accuracy in Holocene samples, even those young enough to be dated on the basis of historical records. We present the requisite geochemical and analytical techniques for dating samples with concentrations as low as one thousand ^{10}Be atoms/g quartz. Our new ^{10}Be data sets include the youngest samples ever dated by cosmogenic nuclide techniques and achieved a high reproducibility of ages, with very few outliers. These results indicate that disturbance caused by geomorphic processes such as inheritance, erosion and snow cover are much less important than previously thought in certain settings, and, in turn, that in some applications ^{10}Be surface exposure dating can rival radiocarbon dating in accuracy. We elaborate the scientific impacts of this geochronological progress with examples from well-preserved moraine sequences from both the Southern and the Northern Hemispheres focusing on the key climate question of the extent to which Holocene glacial advances were inter-hemispheric events.