Contribution of fossil and modern carbon to PM2.5 and CO_2 in the atmosphere of Debrecen, Hungary

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Atmospheric fossil CO_2 observations have been running in Debrecen, Hungary since the autumn of 2008 (Molnár et al., 2010). From the winter of 2010 synchronized aerosol sampling and C-14 analyses started to compare the aerosol fossil carbon content to the fossil carbon-dioxide results in the same time period and the same location.

Integrated bulk aerosol PM2.5 samples were collected on prebaked quartz filers with 10 L/min flow rate over the months at an urban background site in Debrecen, Hungary. One or two weeks long integrated samples were collected on a filter and those periods were synchronized with the parallel monthly atmospheric CO_2 observations. The collected total aerosol mass was determined by gravimetry, and its carbon content was measured through the amount of CO_2 produced after its combustion in the AMS C-14 sample preparation line.

Atmospheric fossil CO_2 measurements were done using the ATOMKI gas proportional counting based C-14 dating facility. C-14 measurement of the aerosol samples was carried out at the new EnvironMICADAS AMS facility of ATOMKI. The applied sample pretreatment steps were tested by multiple pretreatment of different sections of several real samples. Test results showed very good reproducibility for the applied aerosol sample preparation method and AMS C-14 analyses.

During the year from November 2010 to November 2011 in Hungary there were very high PM concentrations in the city air several times, particularly during the heating season.

The atmospheric CO_2 and $PM_{2.5}$ concentrations showed high similarity for Debrecen. During the winter heating period significantly higher total $PM_{2.5}$ concentrations could be observed which was also reflected in the quantity of the total carbon. The fossil CO_2 excess was very similar to the fossil carbon content of the $PM_{2.5}$. In the case of CO_2 the role of fossil excess from natural gas, oil and carbon combustion was the dominant for the heating period. For PM2.5 the contribution of modern carbon from biomass burning seems to be the determinant, since not the fossil but the biogenic carbon caused the elevated PM concentrations in the city of Debrecen. In absolute terms, the fossil part of the $PM_{2.5}$ increased, as well, in the heating period, however, even this value was exceeded by the increment of the modern carbon showing that the dominant process of aerosol emission is biomass burning due to municipal wood combustion.

These results clearly show the very different fossil/biogenic contribution in the atmospheric aerosol compared to the carbon-dioxide fraction.

Our results are in good agreement with other published city fossil aerosol results (e.g.. from Zürich) (Szidat et al., 2004). To help the source apportionment of the collected urban aerosol samples also $\delta^{13}C$ stable isotope ratio of the combusted carbon fraction was measured using a Finningan Delta XP plus stable isotope mass spectrometer.

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