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Sources of carbonaceous aerosols during extreme haze events in Beijing and Xi'an, China

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During December 2016 and January 2017 extreme haze events occurred in Xi'an and Beijing, two of the most heavily polluted cities in China. Using radiocarbon source apportionment, we investigated the source contribution to carbonaceous aerosol in both cities during several haze periods with daily PM2.5 concentrations as high as 500 μg/m3. We compared the haze periods to subsequent clean periods, with PM2.5 concentrations below 100 μg/m3.

24-hour filter samples were collected in Beijing and 12-hour samples were collected in Xi'an, separately for day and night time, starting at 8:15 and 20:15. The filters were analyzed for organic and elemental carbon (OC and EC) concentrations using a Desert Research Institute (DRI) Model 2001 Thermal/Optical Carbon Analyzer following the IMPROVE_A thermal/optical reflectance (TOR) protocol. Radiocarbon (14C) was measured OC and EC and used to distinguish fossil (mainly coal burning and traffic emissions) and biomass burning sources of the carbonaceous aerosol.

Our data show that the sources of carbonaceous aerosol differ strongly for Xi'an and Beijing: In Xi'an around 25-30% of EC and 55% of OC come from biomass burning, and the rest from fossil fuels with a considerable fraction from car emissions. In Beijing, only $\sim$ 20% of EC and 30% of OC originate from biomass burning. The similar fossil contribution to OC and EC in Beijing suggests that coal burning is the dominant fossil source. Since primary OC/EC ratios of coal combustion are higher than those of traffic emissions, we expect higher fossil contributions to OC and a smaller difference in the fossil fraction of OC and EC in cites with significant contributions from coal-burning emissions. This will be further explored in a dedicated sensitivity study.

Both in Beijing and Xi'an the fossil contributions to OC and EC did not change drastically during the haze events. However, some interesting, subtle differences between haze and clean periods are apparent. In Beijing the difference in the fossil fraction of OC and EC is larger in the clean than in the haze periods, which might indicate a higher relative contribution from traffic sources during clean periods. In Xi'an the clean period shows a slight day-night difference with increased fossil contribution to OC and EC during the day. During strong haze, this day-night difference disappears, which suggests a long residence time of the pollution particles in the urban atmosphere during haze events.