



Gas phase emissions from cooking processes and their secondary aerosol production potential

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Long before the industrial evolution and the era of fossil fuels, high concentrations of aerosol particles were alluded to in heavily populated areas, including ancient Rome and medieval London. Recent radiocarbon measurements (¹⁴C) conducted in modern megacities came as a surprise: carbonaceous aerosol (mainly organic aerosol, OA), a predominant fraction of particulate matter (PM), remains overwhelmingly non-fossil despite extensive fossil fuel combustion. Such particles are directly emitted (primary OA, POA) or formed in-situ in the atmosphere (secondary OA, SOA) via photochemical reactions of volatile organic compounds (VOCs). Urban levels of non-fossil OA greatly exceed the levels measured in pristine environments strongly impacted by biogenic emissions, suggesting a contribution from unidentified anthropogenic non-fossil sources to urban OA.

Positive matrix factorization (PMF) techniques applied to ambient aerosol mass spectrometer (AMS, Aerodyne) data identify primary cooking emissions (COA) as one of the main sources of primary non-fossil OA in major cities like London (Allan et al., 2010), New York (Sun et al., 2011) and Beijing (Huang et al., 2010). Cooking processes can also emit VOCs that can act as SOA precursors, potentially explaining in part the high levels of oxygenated OA (OOA) identified by the AMS in urban areas. However, at present, the chemical nature of these VOCs and their secondary aerosol production potential (SAPP) remain virtually unknown.

The approach adopted here involves laboratory quantification of PM and VOC emission factors from the main primary COA emitting processes and their SAPP. Primary emissions from deep-fat frying, vegetable boiling, vegetable frying and meat cooking for different oils, meats and vegetables were analysed under controlled conditions after ~100 times dilution. A high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) and a high resolution proton transfer time-of-flight mass spectrometer (PTR-ToF-MS) were used to quantify OA and VOC emissions, respectively. SOA production potential of the different emissions was quantified by introducing them into the PSI mobile smog chamber and a potential aerosol chamber (PAM) where they were photochemically aged.

The measurements of primary emissions suggest that the COA factor identified in ambient atmospheric aerosols is mostly related to fat release from frying with vegetable oils or grilling fatty-meats. In contrast, vegetable cooking (boiling and frying) was associated with significant VOC emissions. The VOC emissions from frying consist mainly of aldehydes which are formed through breaking of fatty acids. Gas phase composition, emission factors and SAPP from all these processes will be presented.

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