Transformation of logwood combustion aerosols: implications for day and nighttime aging

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Emissions from small-scale wood combustion have a significant worldwide contribution to the atmospheric PM, producing large amounts of submicron black carbon (BC), primary organic aerosols (POA) and secondary organic aerosols (SOA). SOA is formed via the oxidation of combustion emitted volatile compounds and atmospheric aging processes affect the crucial properties of combustion emissions including POA (Hennigan et al., 2011).

Atmospheric aging processes of logwood combustion aerosols were studied both in an environmental chamber equipped with adjustable UV lights (Fig. 1; Leskinen et al., 2015), simulating conditions in the atmosphere and in a flow tube reactor that have been developed to achieve a wider degree of oxidant exposure times and a continuous aging process. Aged combustion aerosols were measured by the soot particle aerosol mass spectrometer (SP-HR-ToF-AMS, Aerodyne Research, Inc.) to determine changes in mass concentrations and chemical compositions of submicron species. OA spectra were analyzed by positive matrix factorization (PMF) and categorized into subgroups according to their formation mechanisms.

Substantial SOA formation was observed during 7h aging in environmental chamber (dark aging + photo-oxidation) of logwood (spruce) combustion emissions with ambient OH concentration levels resulting in a roughly doubling of the initial OA mass highlighting importance of dark aging. Long aging time (flow tube, chemical age > 2 week) did not increase SOA mass but increased oxidation state from 0.1–0.5 (chamber) to around 1.5 (flow tube).

A five factor PMF solution consisted of two primary OA (POA1 and POA2) factors and three secondary OA factors (SOA1, SOA2 and SOA3) representing the three major oxidizers: ozone, OH radical, and nitrate radical. SOA1 and SOA2 occurred after ozone injection (i.e., dark aging) and the third SOA factor (SOA3) occurred after UV lights were switched on.

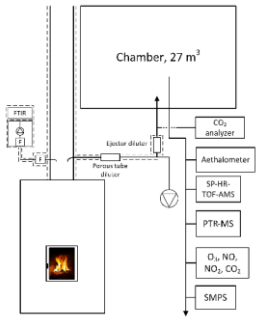

Figure 1. Experimental set-up of environmental chamber experiments in ILMARI combustion research facility at the University of Eastern Finland.

The results prove that logwood burning emissions are subject of intensive chemical processing in the atmosphere, and the time scale for these transformations is short. Results indicate also that the observed nitrate for logwood combustion is most likely present as organonitrates.

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Hennigan, C. J. et al. Chemical and physical transformations of organic aerosol from the photo-oxidation of open biomass burning emissions in an environmental chamber, *Atmos. Chem. Phys*., 11, 7669-7686, 2011.

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