Secondary organic aerosol production potential from diesel and gasoline vehicle exhaust under different ambient conditions

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Organic aerosol (OA) is a major fraction of the submicron aerosol known to influence climate and to adversely affect health. OA consists of directly emitted primary OA (POA), and "secondary" OA (SOA), formed in-situ in the atmosphere via the reaction of volatile precursors. Vehicle exhaust is already a known source of POA and likely contributes to SOA in urban areas (Robinson *et al.*, 2007; Weikamp *et al.* 2007). However, the magnitude of this contribution is unknown.

The secondary organic aerosol production potential (SAPP) of vehicle exhaust has recently been estimated by (i) analyzing ambient data from urban areas combined with fuel consumption data (Bahreini *et al.*, 2012), or (ii) by examining the chemical composition of raw fuels (Gentner *et al.*, 2012). Contradictory and thus somewhat controversial results in the relative SAPP of diesel vs. gasoline vehicle exhaust were observed.

Experimental data from smog chamber studies can provide quantitative measurements of the relative SAPP of different fuels and vehicle types, and elucidate the impact of variable ambient conditions. This information is crucial for our understanding of vehicular pollution and formulation of emission control strategies.

Therefore, we studied the SAPP of passenger cars and trucks as a function of fuel type (gasoline, diesel) at different temperatures (T 22 vs. -7°C) and relative humidity (RH ~40 vs. ~90%). Vehicle exhaust was sampled at the tailpipe during regulatory driving cycles on chassis dynamometers (European Joint Research Centre Ispra, Italy), diluted (200 – 400x) and introduced into the PSI mobile smog chamber (Platt *et al.* 2012) via a heated tube (150 °C). OA was quantified with a high-resolution time-of-flight aerosol mass spectrometer. Black carbon was measured using aethalometers. Volatile organic compounds (VOCs) were analysed with a high resolution proton-transfer time-of-flight mass spectrometer. Gas-phase monitors were used to quantify CO, CO_2, CH_4, total hydrocarbons, NH_3 and other gases in the chamber. Emission factors (EFs, e.g. g per kg fuel) were calculated from a carbon mass balance.

We found that the vehicle emissions and SAPP are significantly affected by temperature and RH: doubling the RH in the chamber resulted in a 3-fold higher SOA EF (*Figure 1*). Primary and secondary aerosol emissions from diesel and gasoline vehicles will be compared at different temperature and RH.

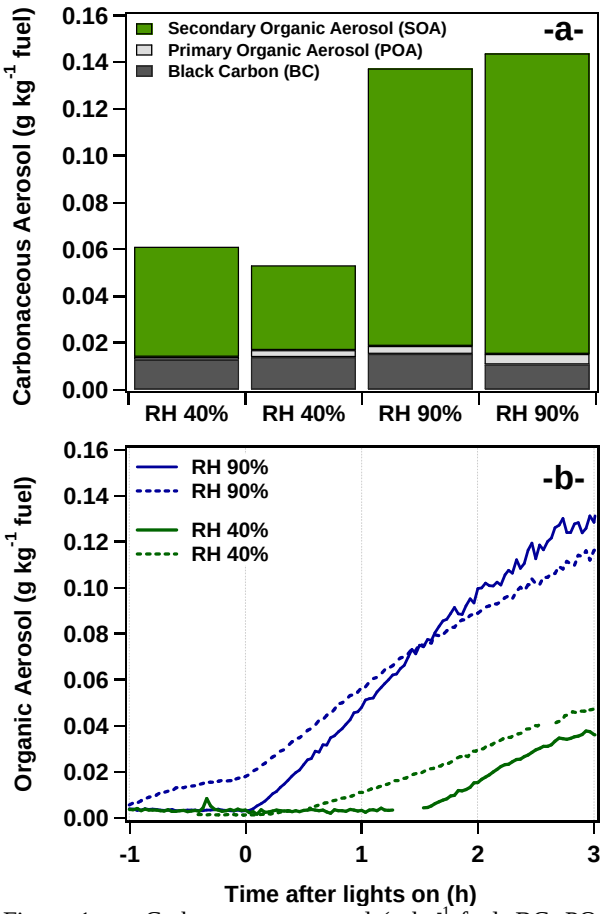

Figure 1. -a- Carbonaceous aerosol (g kg^{-1} fuel, BC, POA and SOA) from a Euro 5 gasoline car. -b- Temporal evolution of the OA formation in the smog chamber at similar OH exposure but different relative humidity (RH).

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