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Time-resolved characterization of primary particle emissions and secondary particle formation from a modern gasoline passenger car

Panu Karjalainen et al.

Correspondence to: Topi Rönkkö (topi.ronkko@tut.fi)

Supplementary information

Primary particle losses in a PAM chamber (Fig. S1) measured with similar PAM chamber that was used in the vehicle experiments.

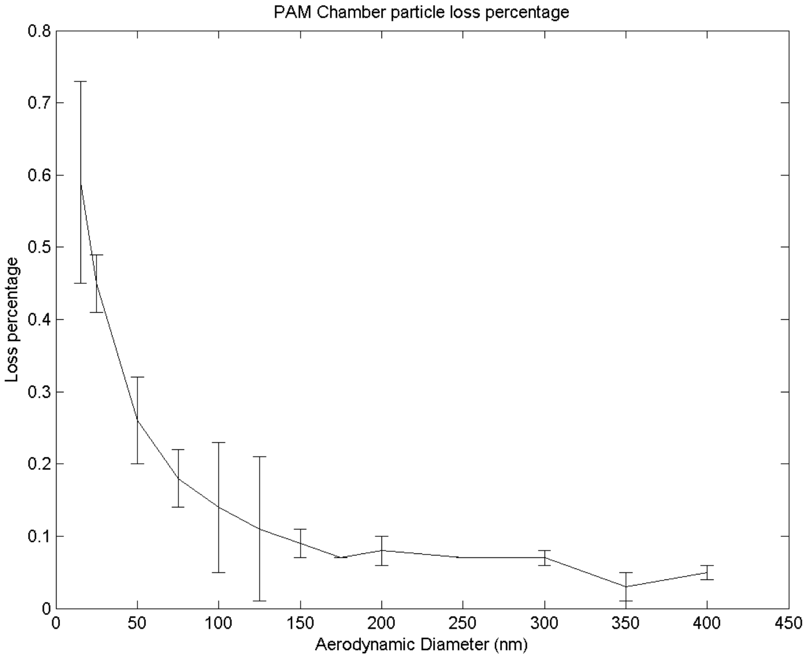

Figure S1. Primary particle losses in a similar PAM chamber that was used in the study.

The mean mass spectra over the NEDC cycle for primary and all particles is presented in Figure S2.

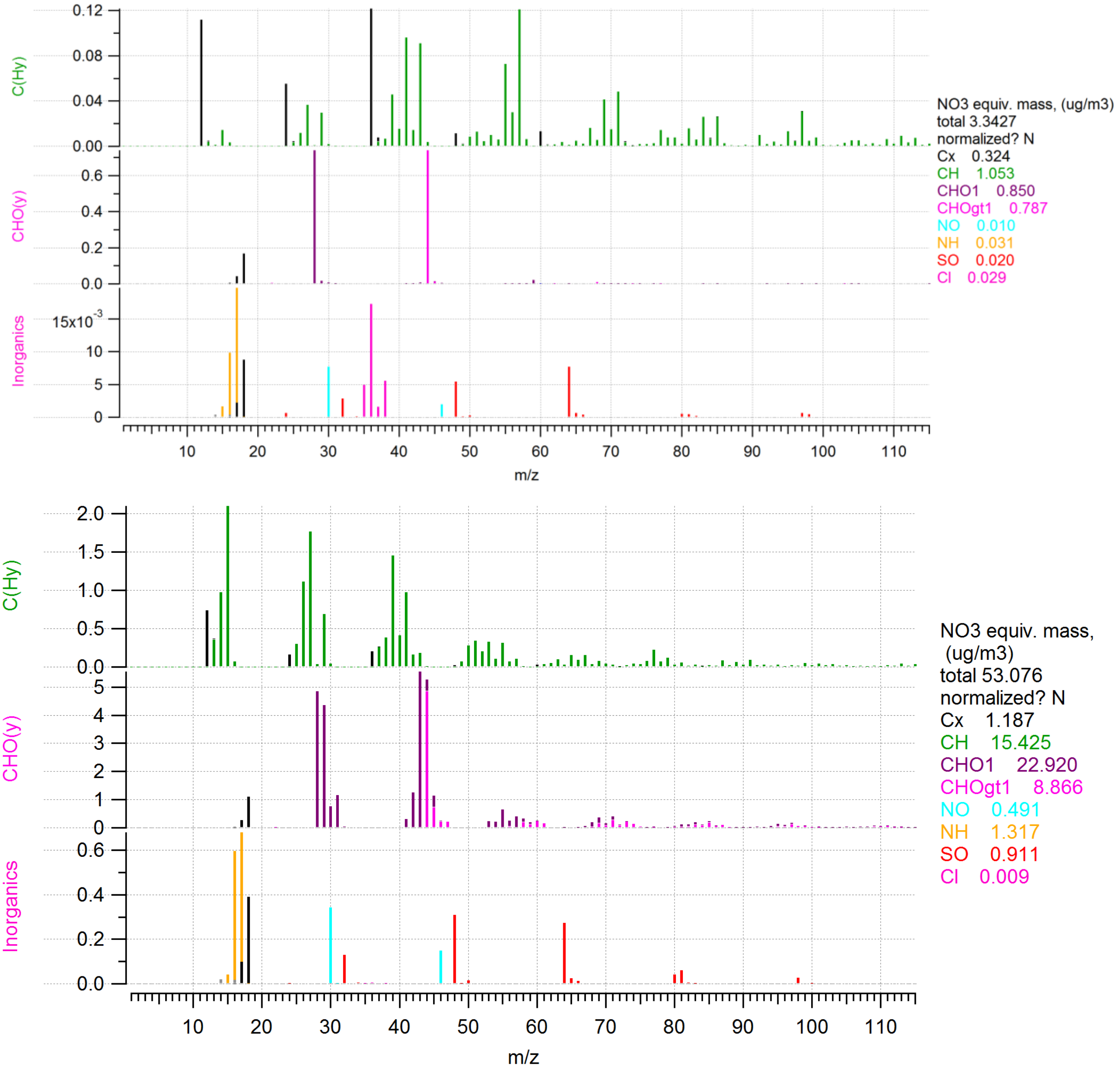

Figure S2. Mass spectra divided to different components (carbon (Cx), hydrocarbons (Ch), oxidized hydrocarbons (CHOx), inorganics) over the NEDC cycle for primary (upper panel) and all (lower panel) particles.

High oxidant levels were necessary to ensure the availability of oxidants in chamber during the NEDC cycle. AMS O:C, and H:C –ratios (Figure S3) and f43, f44 ratios were used to follow the oxidation. After the cold start, high concentrations of gaseous and particulate emissions were observed. Elemental ratios show that right after cold start the O:C ratio dips and H:C ratio increases, and it is possible that temporarily the amount of oxidants is not sufficient to oxidize all compounds to the maximum rate. It is possible that during the cold start and following few minutes the forming secondary aerosol mass is underestimated.

However, during five minutes the situation stabilizes and for rest of the cycle the oxidation levels seem to remain stable.

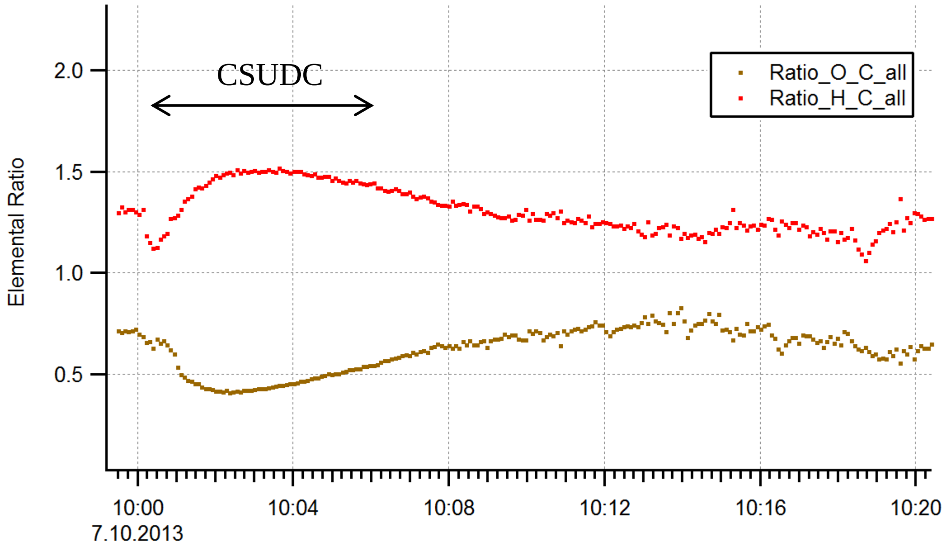

Figure S3. O:C and H:C ratios during the NEDC cycle.

The emission factors (mg/km) obtained from the SP-AMS data are presented for different parts of the test cycle in Figure S4 and Table S1.

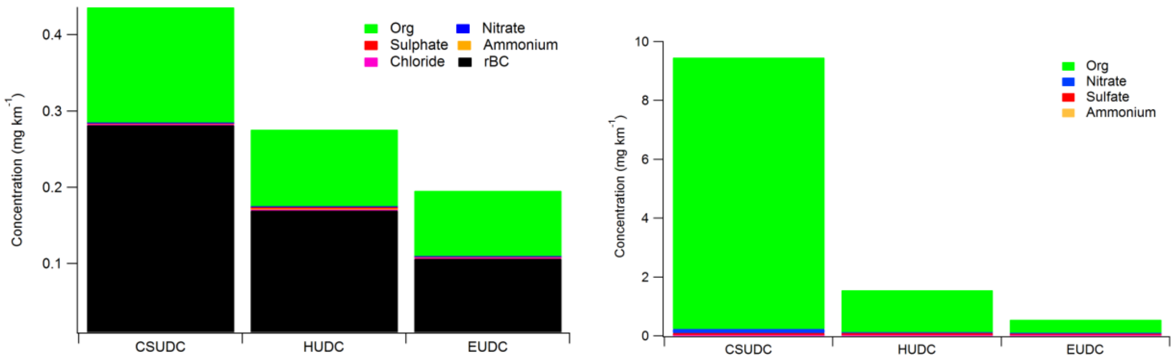
(a) (b)

Figure S4. Emission factors (mg/km) of primary (a) and secondary (b) particulate material for different parts of the NEDC cycle.

Table S1. Emission factors for secondary components for different parts of the NEDC cycle.

	ORG	NO_3	SO_4	NH_4	Cl	rBC
Part	mg/km	mg/km	mg/km	mg/km	mg/km	mg/km
CSUDC	9.38	0.139	0.0698	0.0253	0.000891	0.646
HUDC	1.54	0.0127	0.0893	0.0154	0.000553	0.133
EUDC	0.52	0.0417	0.0542	0.0187	0.000533	0.142
Total	3.81	0.0645	0.0711	0.0198	0.000659	0.307

For VOC analysis bag samples were collected during different cycle parts. The bag samples were analyzed with gas chromatography. Concentrations in the PAM were calculated from raw exhaust concentrations. OH reactivities for analyzed VOCs and CO during the CSUDC, HUDC and EUDC are presented in Table S2.

Table S2. Rate constants, concentrations in the PAM, and OH reactivities for analyzed VOCs and CO during the CSUDC, HUDC and EUDC.

	Rate constant	Conc. CSUDC	Conc. HUDC	Conc. EUDC	OHR CSUDC	OHR HUDC	OHR EUDC
	cm^3 molec.$^{-1}$ s^{-1}	molec./cm^3	molec./cm^3	molec./cm^3	s^{-1}	s^{-1}	s^{-1}
Methane	6.40E-15	4.58E+13	1.02E+13	1.42E+13	2.93E-01	6.53E-02	9.11E-02
Ethane	2.48E-13	5.74E+12	0.00E+00	0.00E+00	1.42E+00	0.00E+00	0.00E+00
Ethene	8.52E-12	1.91E+13	0.00E+00	0.00E+00	1.63E+02	0.00E+00	0.00E+00
Propane	1.09E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Propene	2.63E-11	4.63E+12	0.00E+00	0.00E+00	1.22E+02	0.00E+00	0.00E+00
Acetylene	8.80E-13	7.52E+12	0.00E+00	0.00E+00	6.62E+00	0.00E+00	0.00E+00
Iso-butene	5.14E-11	2.02E+12	0.00E+00	0.00E+00	1.04E+02	0.00E+00	0.00E+00
1,3-Butadiene	6.66E-11	6.20E+11	0.00E+00	0.00E+00	4.13E+01	0.00E+00	0.00E+00
Benzene	1.22E-12	4.50E+12	0.00E+00	3.30E+11	5.49E+00	0.00E+00	4.03E-01
Toluene	5.63E-12	7.17E+12	1.05E+11	3.46E+11	4.04E+01	5.90E-01	1.95E+00
Ethylbenzene	7.00E-12	1.98E+12	0.00E+00	0.00E+00	1.39E+01	0.00E+00	0.00E+00
m/p-xylene	1.87E-11	4.42E+12	0.00E+00	0.00E+00	8.26E+01	0.00E+00	0.00E+00
o-xylene	1.36E-11	2.02E+12	0.00E+00	0.00E+00	2.75E+01	0.00E+00	0.00E+00
Formaldehyde	9.37E-12	2.60E+12	6.12E+11	3.40E+11	2.44E+01	5.73E+00	3.19E+00
Acetaldehyde	1.50E-11	1.10E+12	1.78E+11	1.16E+11	1.65E+01	2.66E+00	1.74E+00
CO	1.50E-13	2.50E+15	5.69E+13	3.38E+14	3.75E+02	8.54E+00	5.07E+01
				SUM	1007.2	14.9	56.4