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Super Polluter IDentifiER (SPIDER)

a tool for on-road detection of vehicles that contribute disproportionally to the vehicle fleet emissions

I. Ježek[1], T. Rutar[2], M. Ivančič[1], M. Rigler[1], A. Gregorič[1,2], G. Močnik[3,2,4]

[1] Aerosol d.o.o., Ljubljana, Slovenia

[2] University of Nova Gorica, Center for Atmospheric Research, Nova Gorica, Slovenia

[3] Jožef Stefan Institut, Ljubljana, Slovenia

[4] Haze Instruments d.o.o., Ljubljana, Slovenia

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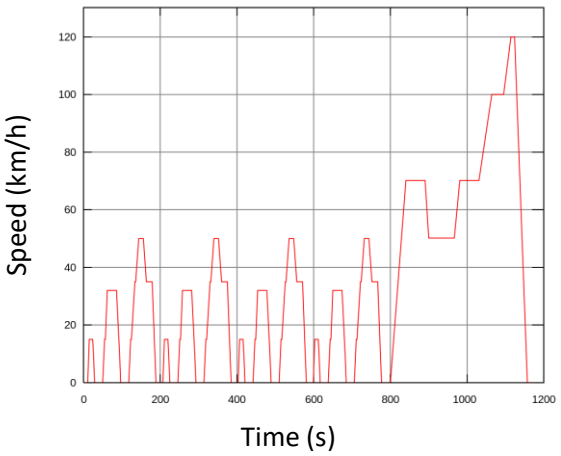
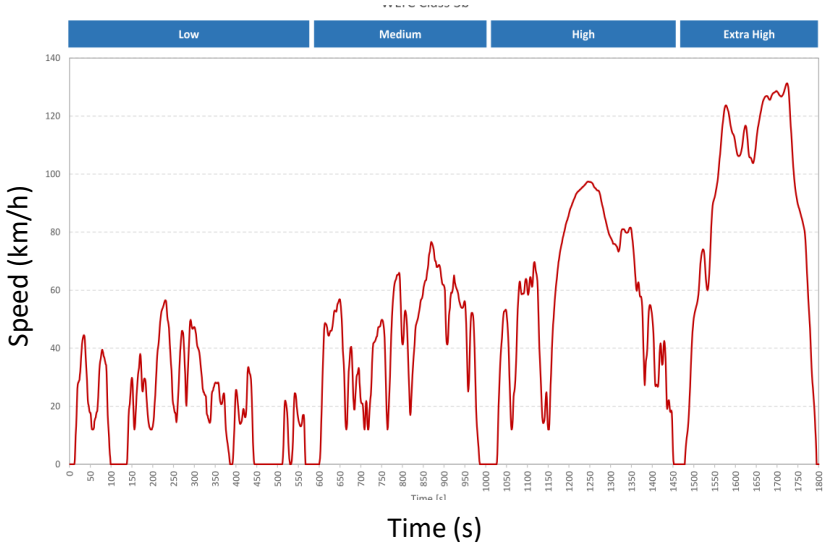
European vehicle emission standards

- In the European Union, emissions of nitrogen oxides (NO_x), total hydrocarbon (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO), particulate matter (PM) and particle number (PN) are regulated for most vehicle types.
- The standards apply to new models sold into the European market.
- Dieselgate & "Cycle beating" controversy → in 2017 introduction of new test standards with real-world conditions called Real Driving Emissions (RDE), using portable emissions measurement systems in addition to laboratory tests.

NEDC – New European Driving Cycle



WLTC Class 3b – Worldwide Harmonized Light Vehicles Test Procedure



THE ON-ROAD CHASING METHOD

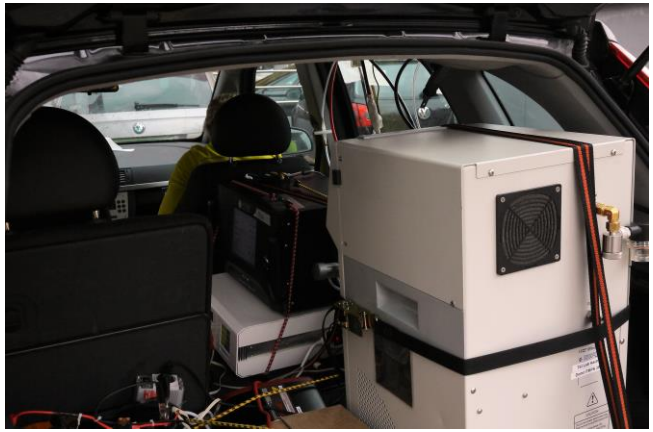
Measuring exhaust plume of a vehicle while chasing it on the road

- Subtract background
- Assume all carbon in fuel burns to CO_2
- Assume the ratio of pollutants remains the same from the tailpipe to the measurement platform

$$EF = \frac{\int_i^j (P_j - P_i)dt}{\int_i^j (CO_{2j} - CO_{2i})dt} \cdot w_c$$

Method described in Ježek et al, 2015, AMT

Pollutant	Instrument	Resolution
BC	Aethalometer AE33	1 s
PN	TSI, FMPS	1 s
NO_x (2011)	2B Technologies 410 and 401	20 s
NO_x (2017)	EcoPhysics, CLD86	1 s
CO_2	Vaisala, Carbocap GMP 343	2 s



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VEHICLE FLEET CAPTURED IN MEASUREMET CAMPAIGNS Mar 2017 and Dec 2011

Category	Vehicle type	2001/116/EC	2017 # with registry information	2017 # missing registry information	2011 # with registry information	2011 # missing registry information
Gasoline cars	Gasoline cars	M1	118 (39)		24	
	Gasoline/LPG	M1	3 (2)			
Diesel cars	Diesel cars	M1	131 (59)		51	2
	Light goods vehicles 1	N1	12 (7)		17	2
Goods vehicles	Light goods vehicles 2	N2	82 (23)	3	8	2
	Busses	M3	15 (7)	2	6	2
	Minibus	M2			1	
	Heavy goods vehicles	N3	45 (8)	24 (1)	32	15
TOTAL			406 (145)	29 (1)	139	21

2017 - in brackets is the number of vehicles to which also EF PN was determined.

2011 campaign results were published in Ježek et al., 2015, ACP

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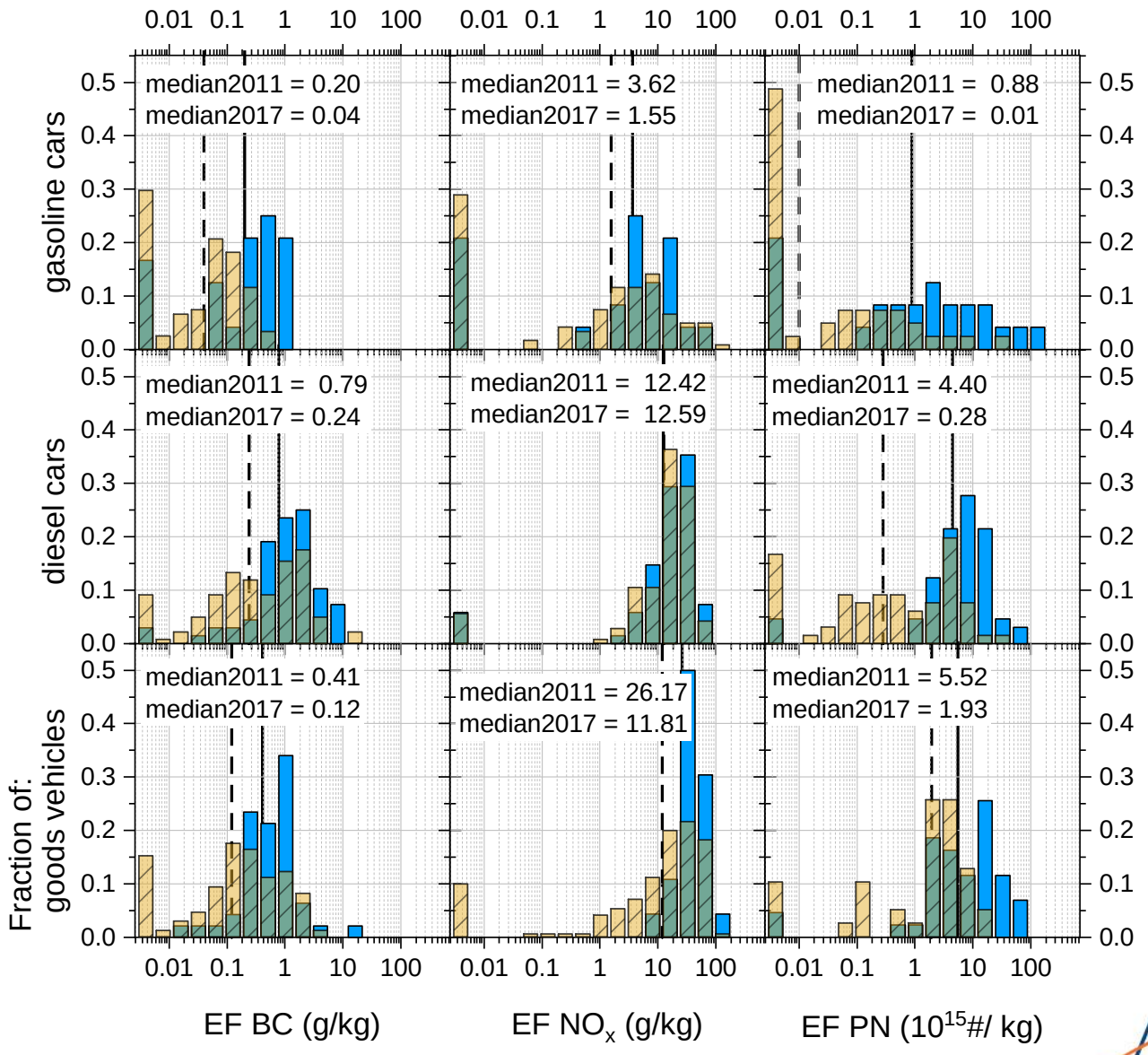
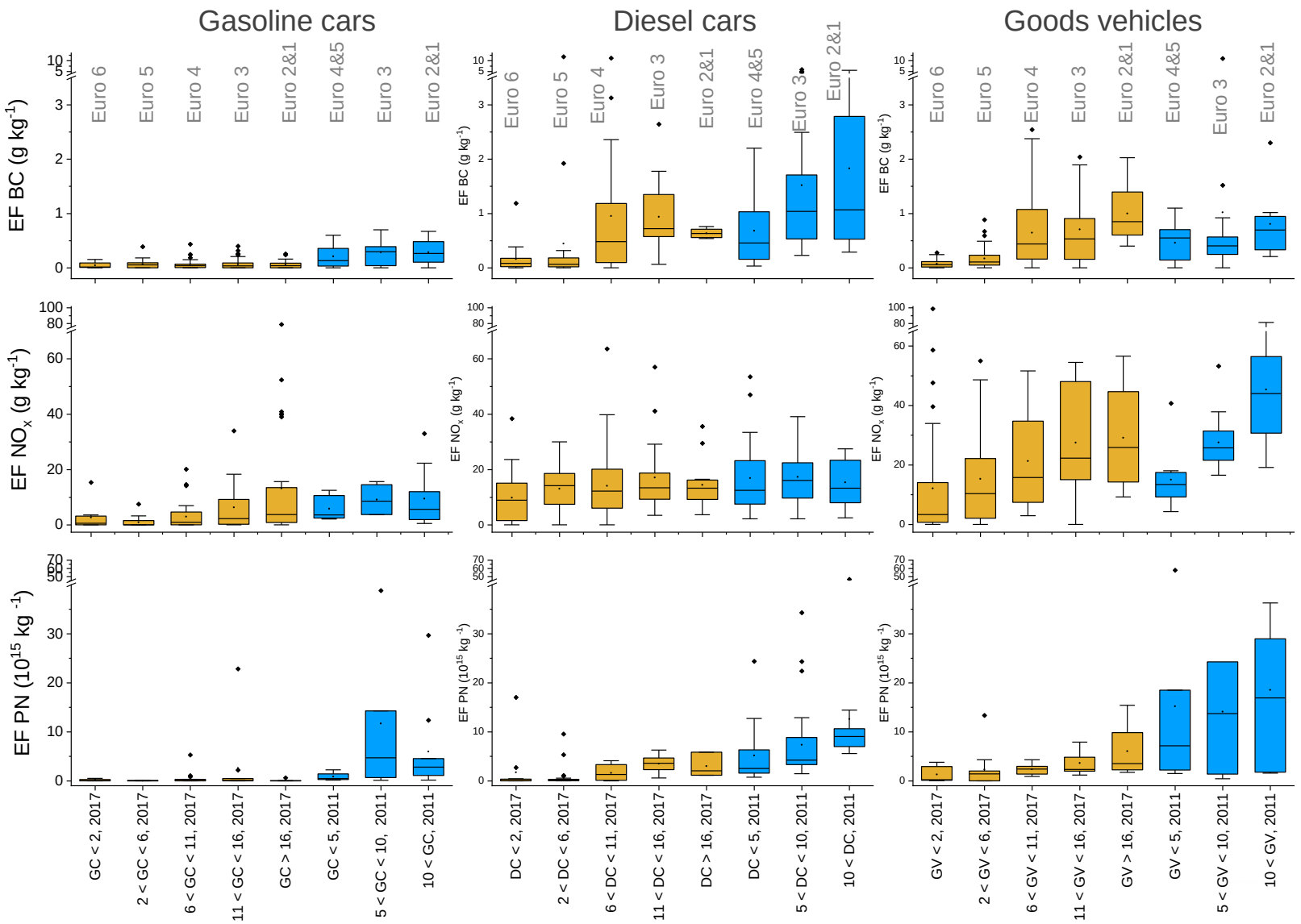
EMISSION FACTOR DISTRIBUTION 2017 (yellow) and 2011 (blue)



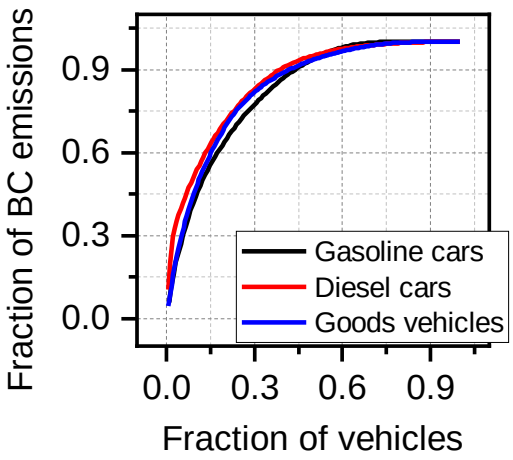
RESULTS ACCORDING TO VEHICLE AGE in 2017 (yellow) and 2011 (blue)

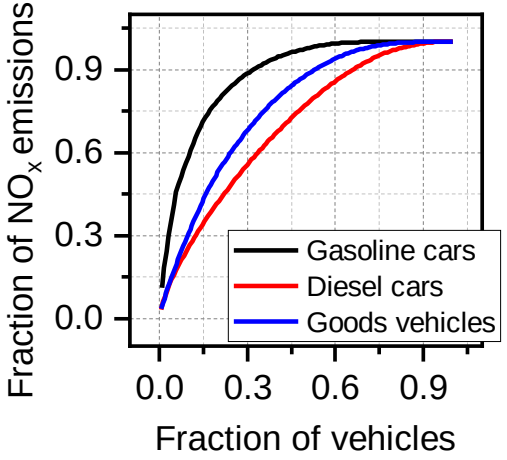


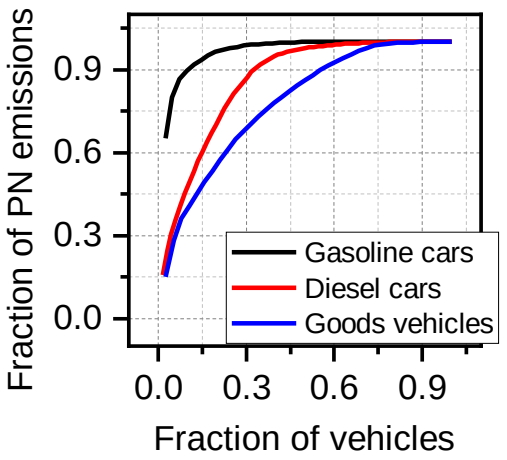
SUPER POLLUTERS

Vehicles that disproportionally contribute to total fleet emissions.

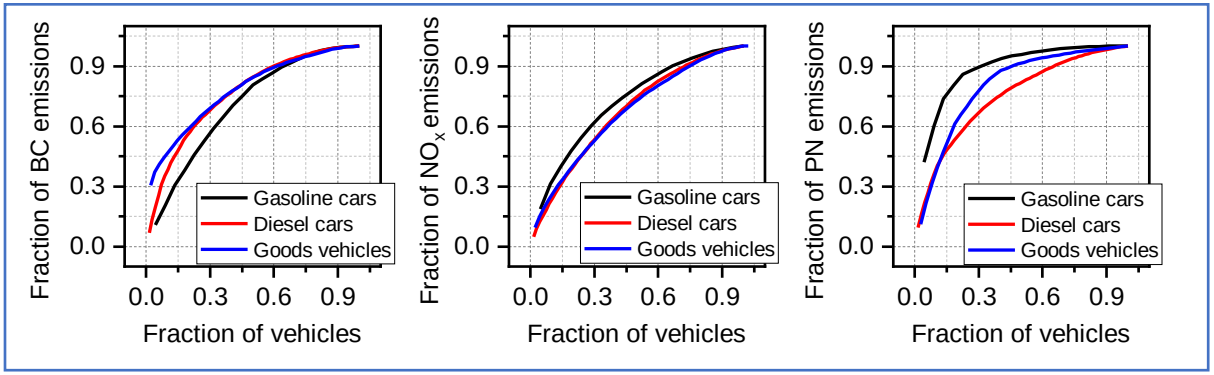
2017







2011



Excluding super polluters from the vehicle fleet would reduce the total fleet emissions more than excluding vehicles based on their age or emission standard.

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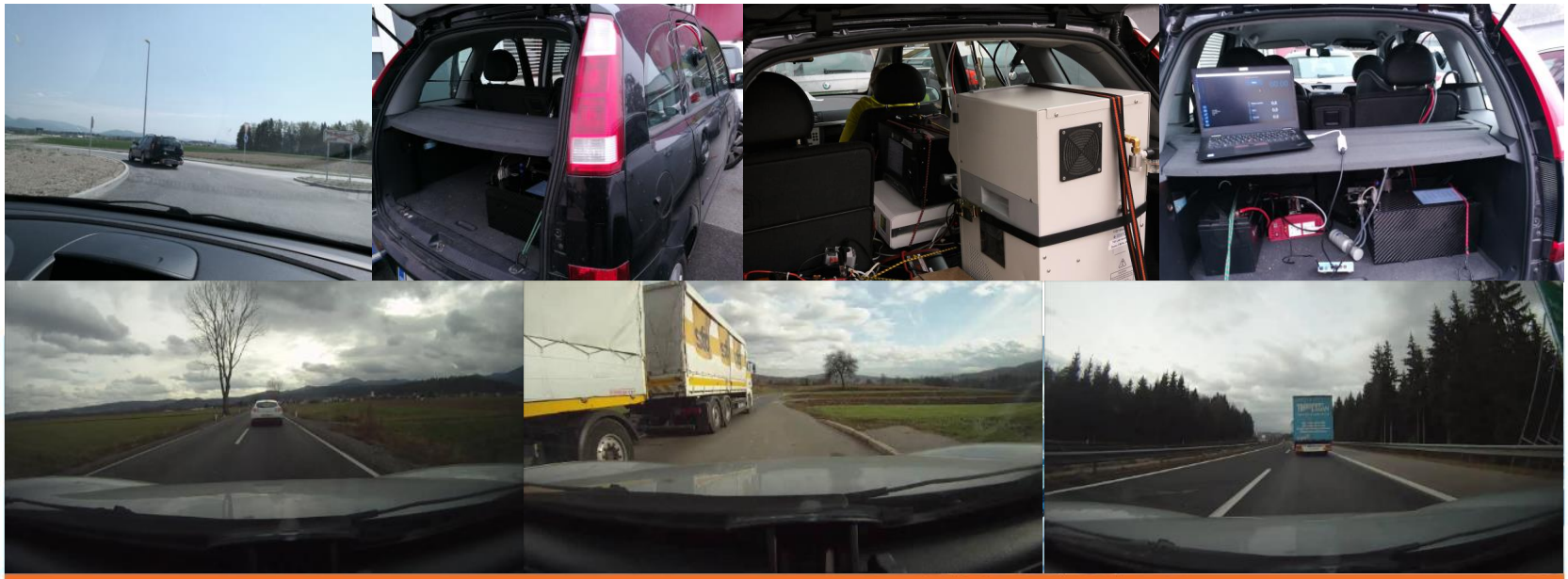
CONCLUSIONS

- **Real world measurements** are important because individual vehicle emissions depend not only on the vehicle type approval at the time it is put on the market, but also on their maintenance and the driving conditions.
- The chasing method is **a simple method** that can be used to determine individual vehicles EF.
- **Independent method** to monitor fleet emissions and effectives of new emission standards.
- Determination of **super polluters**. Excluding Super Polluters can significantly reduce total vehicle fleet emissions.

Further testing of the chasing method with PEMS.



Contact: irena.jezek@aerosol.eu

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