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# MECEDES MEstno in CEstno Določanje Superemitorjev

## CITROEM

## CITy and on-ROad Emission Measurements

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European Regional Development Fund

# Hoaxwagen.

The Largest Automobile Scandal  
in the history !



## Superemitter

- Vehicles that disproportionately contribute to total fleet emissions.
- Not only old vehicles but also new vehicles that are not properly maintained
- ... or were released on the market with fraudulent emission compliance tests (Dieselgate)



# REAL WORLD EMISSION FACTOR MEASUREMENTS

- tunnel
  - remote sensing
  - on-road (chasing)
  - on-board measurements (PEMS)
- Less precise and repeatable (absence of a standard test cycle, additional sources of variability: environmental or traffic conditions, driver behaviour or highly transient operation)
- + validation of EFs gained from laboratory testing
- + identification of gaps in emission models and establish model development priorities.



# On-road chasing method

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

- Subtract background
- Assume all carbon in fuel burns to  $\text{CO}_2$
- Assume the ratio of pollutants remains the same from the tailpipe to the measurement platform



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

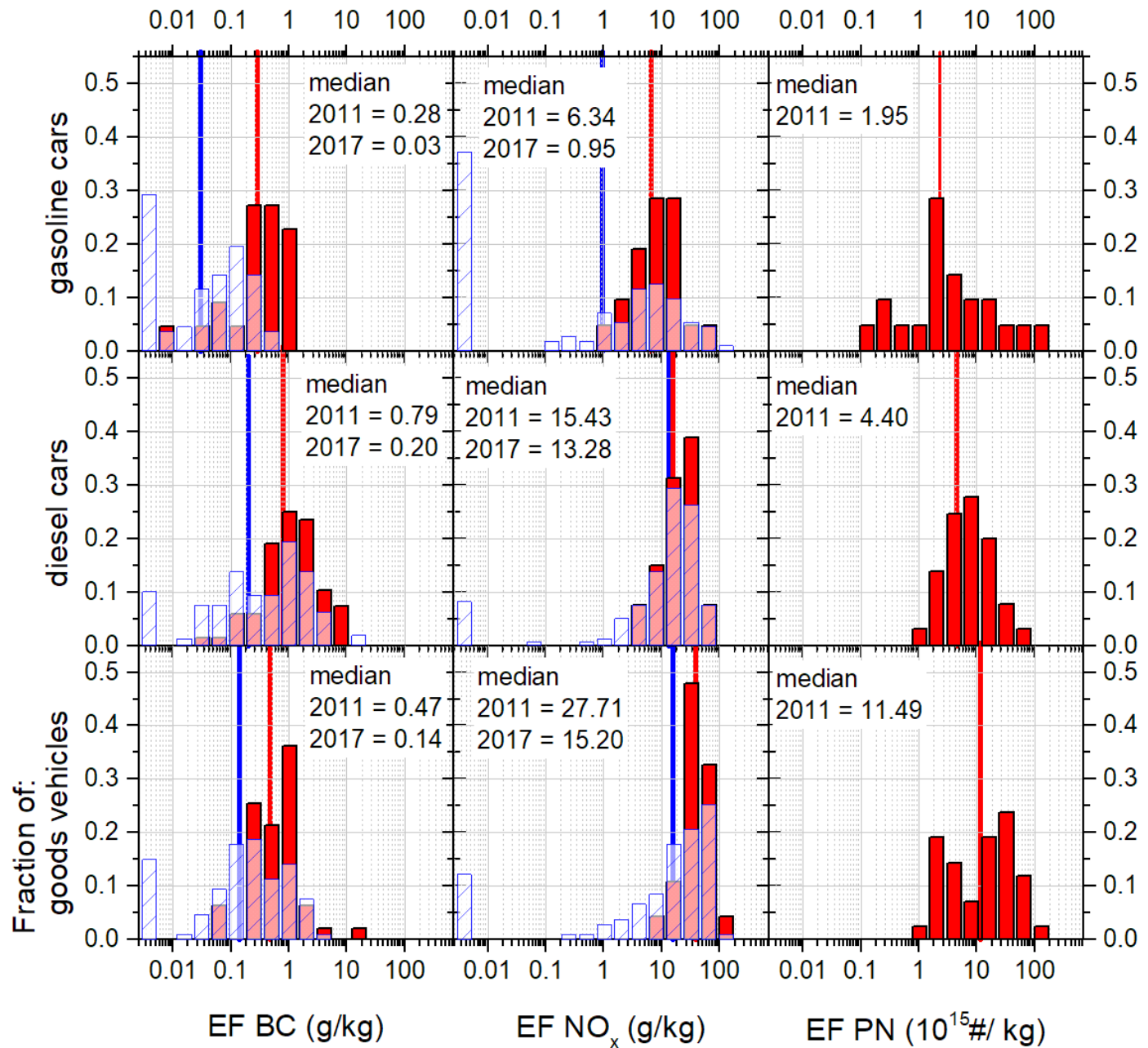
# On road EF measurement campaigns

- 1<sup>st</sup> in December 2011 (results published in ACP, Ježek et al., 2015)
- 2<sup>nd</sup> in March 2017 (preliminary results)

Category	Vehicle type	# in 2011	# in 2017
<b>Gasoline cars</b>	Gasoline cars (M1)	24	113
	Diesel cars (M1)	51	119
<b>Diesel cars</b>	Light goods vehicles (N1)	17	41
	Light goods vehicles (N2)	8	12
<b>Heavy Goods Vehicles (HGV)</b>	Mini bus (M2)	1	0
	Buses (M3)	6	14
	Heavy goods vehicles (N3)	32	81
	<b>Total</b>	<b>139</b>	<b>380</b>

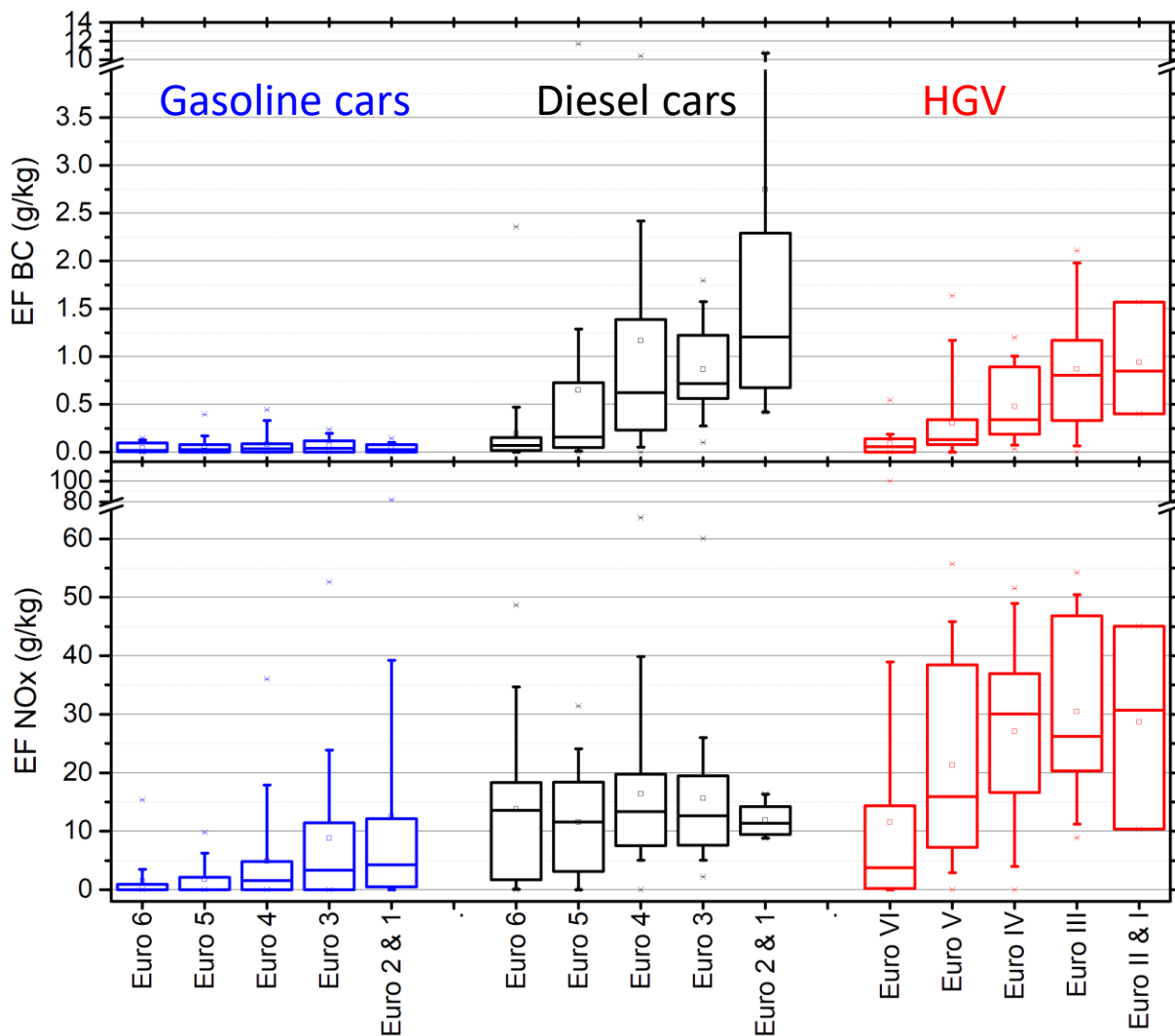
# Results

2011  
and  
2017



# Effect of vehicle age

## Results from 2017 campaign



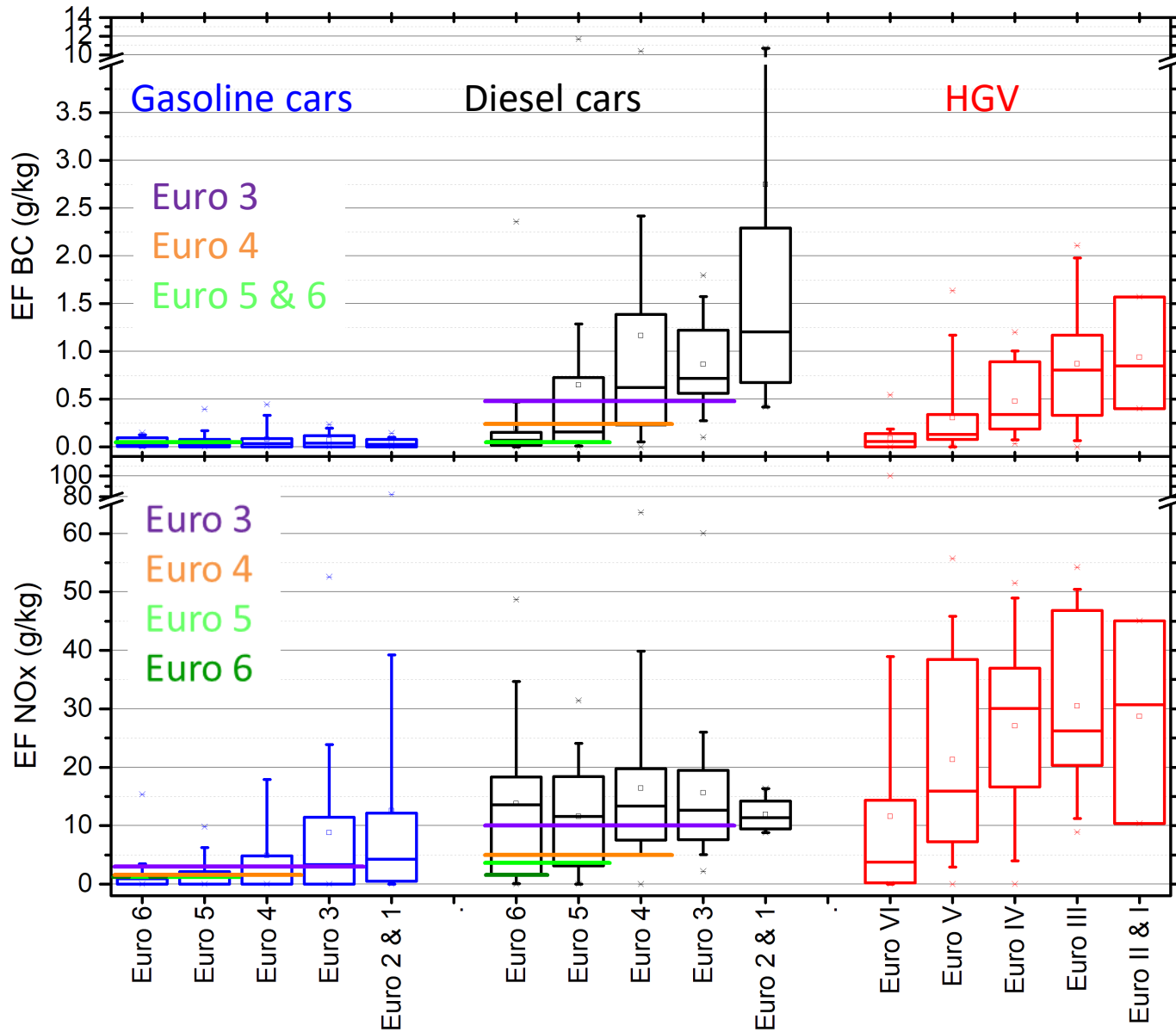
The median BC EF of Euro 6 diesel cars was **reduced by 88%** compared to Euro 4.

Median BC EF of Euro VI HGV was **reduced by 83%** compared to Euro IV

**No decrease** in median NO<sub>x</sub> EF of diesel cars, decrease in range

Median NO<sub>x</sub> EF of Euro VI HGV was **reduced by 87%** compared to Euro IV

# ...compared to Euro emission standards



Vehicle emission standards were converted from g/km to g/kg using

- 6l per 100km fuel consumption
- Fuel density 0.832 kg/l
- BC in PM 47.6%

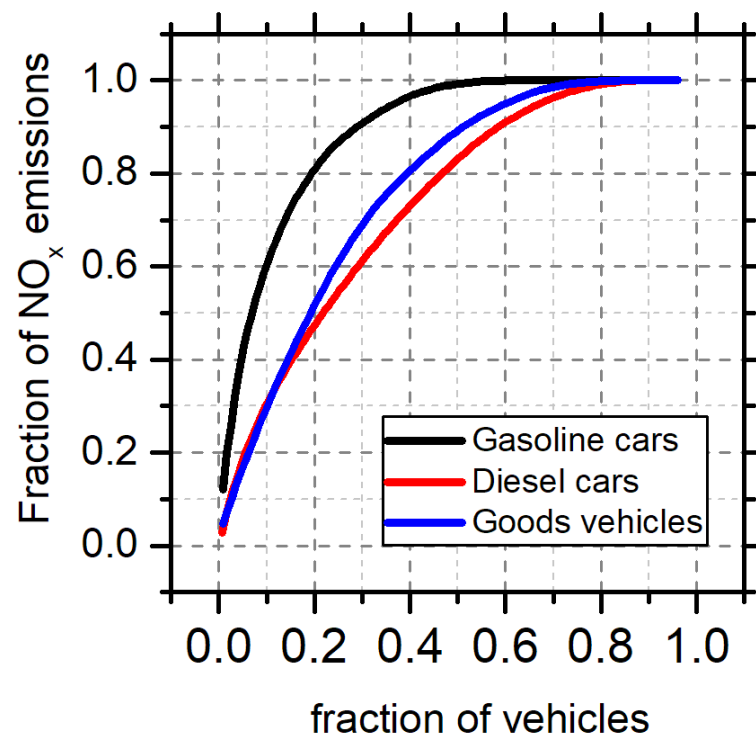
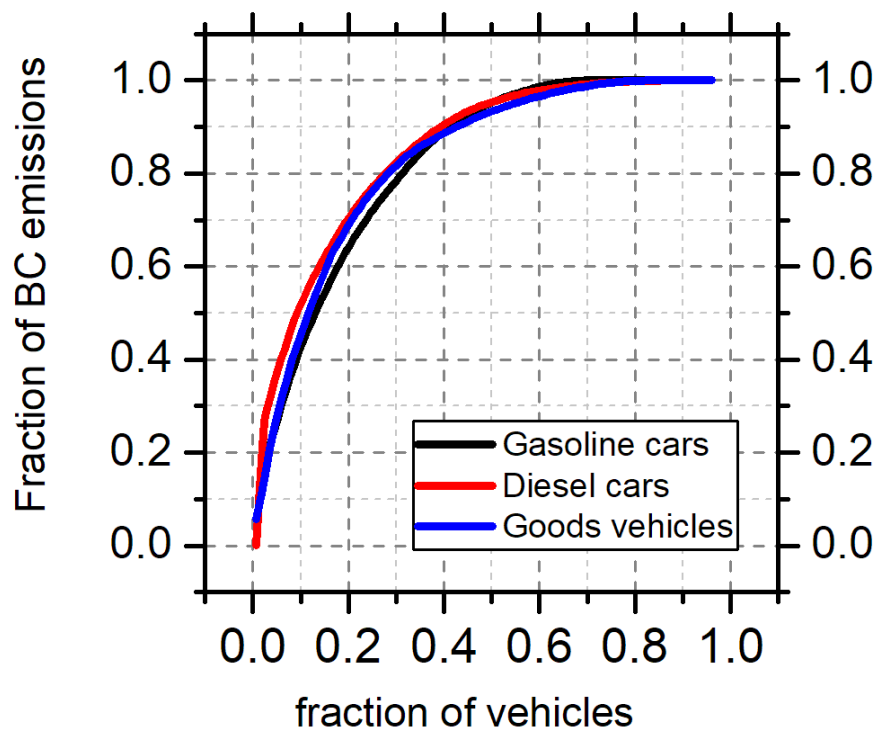
Reduction in emissions for diesel cars from Euro 4 to Euro 6

- ✓ BC by 80%
- ✗ NOx by 68%



# Superemitters contributions 2017

- Contribution of super emitters: 25% of vehicles contribute from 53% to 85% to the total fleet emissions
- 25% of highest emitting diesel cars contributed 76% of BC and 53% of  $\text{NO}_x$  emissions.



# Conclusion s

- Results from a follow-up study in 2017 with a larger fleet sample
- Clear reduction in BC EF of diesel cars and HGV with introduction of new technologies.
- No decrease in median NO<sub>x</sub> EF of diesel cars. There was a reduction in median NO<sub>x</sub> EF for gasoline cars and HGV.
- Simple and efficient methodology for monitoring emissions of the in-use vehicle fleet
- Eliminating super emitters would significantly reduce total vehicle fleet emissions



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Thank you for your attention!  
**Hvala za pozornost!**

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