

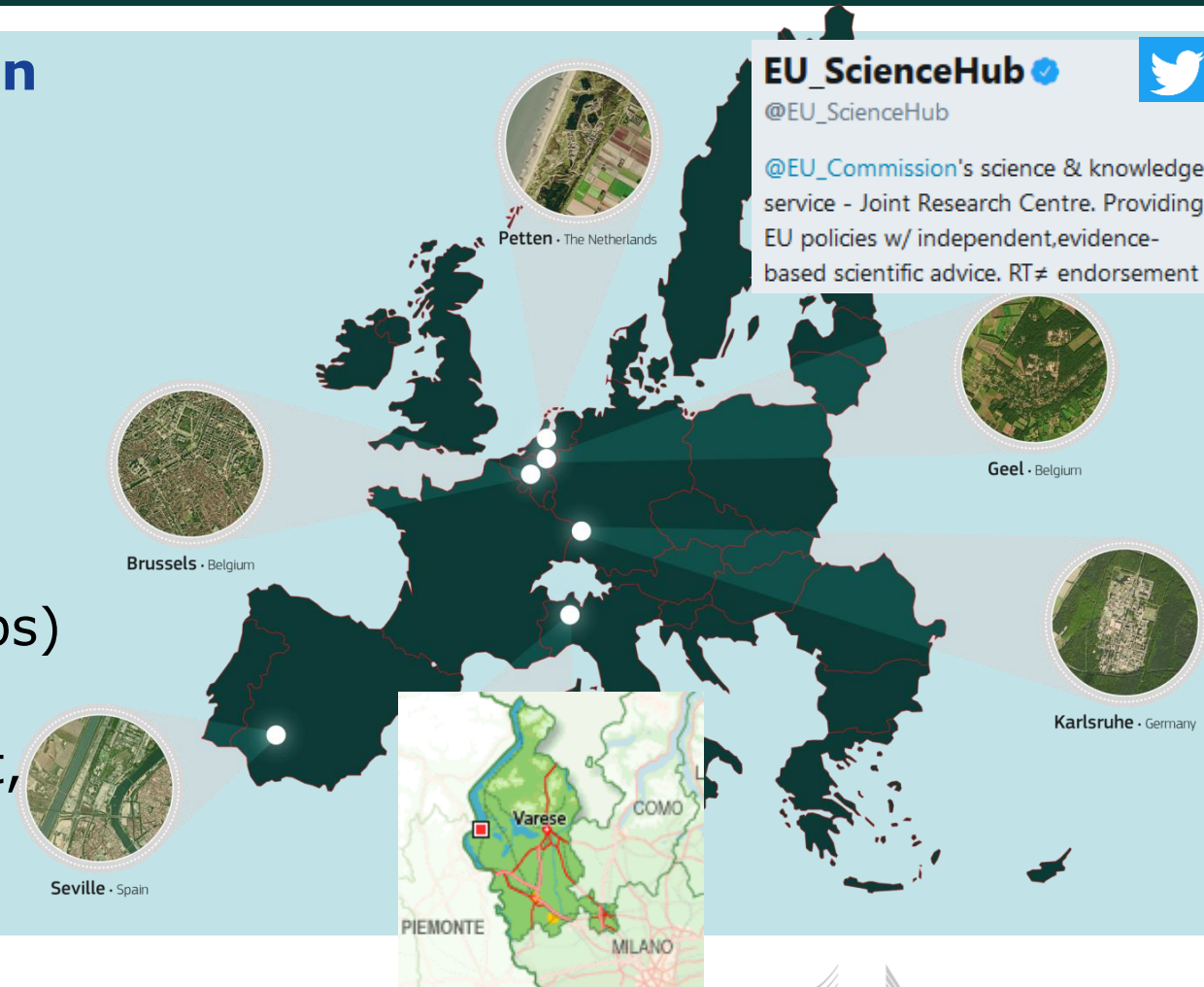
Vehicle emissions: regulatory perspective and empirical evidence

Víctor Valverde, Joint Research Center (JRC), European Commission

Storie d'aria WEBINAir Cittadini per l'aria, May 28th 2020

The Joint Research Center at a glance

- **In-house science service of the European Commission.** Independent, evidence-based scientific and technical support for many EU policies (natural resources management, cybersecurity, migration, taxes, COVID-19 response, etc.)
- **~2730 staff** ~70% researchers, >2300 publications per year
- 42 large scale research facilities including **9 vehicle emission laboratories** (VELA labs)
- **Sustainable Transport Unit** pollutant emissions, CO₂ from road transport, alternative fuels, connected and automated mobility, vehicle safety, electric mobility, electromagnetic compatibility, etc.



Motivation

Premature deaths attributable to PM_{2.5}, NO₂ and O₃ exposure in the EU-28, 2016

	Population (1 000)	PM _{2.5}		NO ₂		O ₃	
		Annual mean (a)	Premature deaths (b)	Annual mean (a)	Premature deaths (b)	SOMO35 (a)	Premature deaths (b)
Italy	60 666	16.6	58 600	22.1	14 600	6 058	3 000
EU-28	506 028	12.9	374 000	16.3	68 000	3 547	14 000

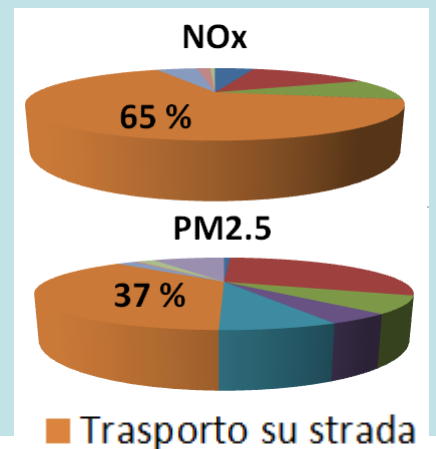
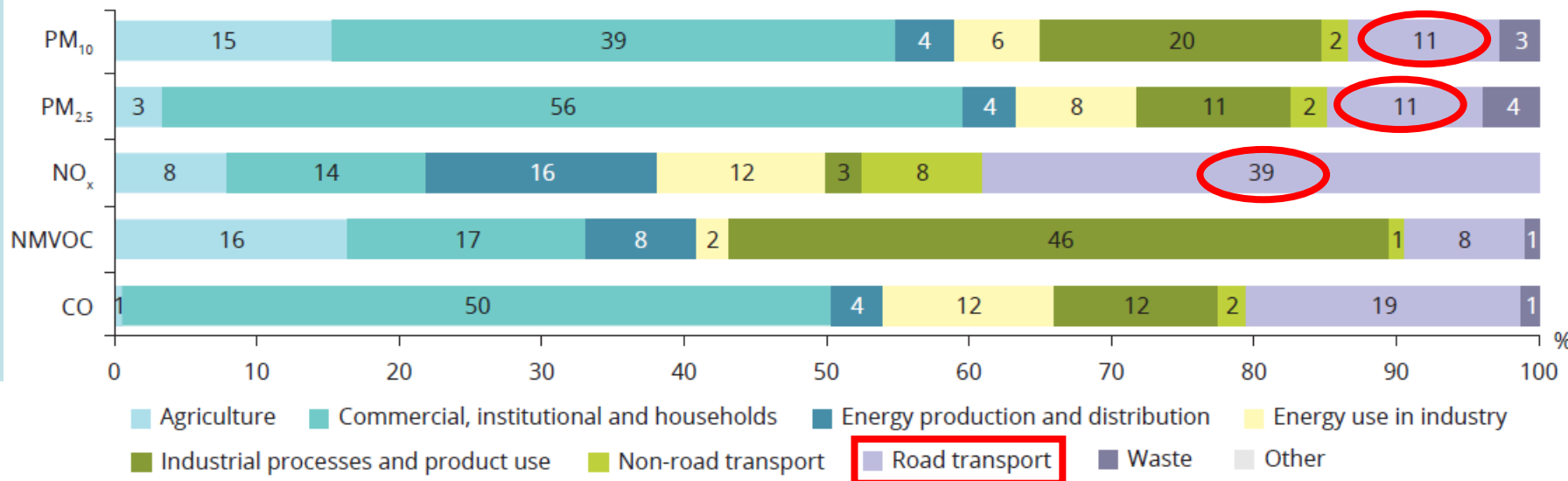
15x



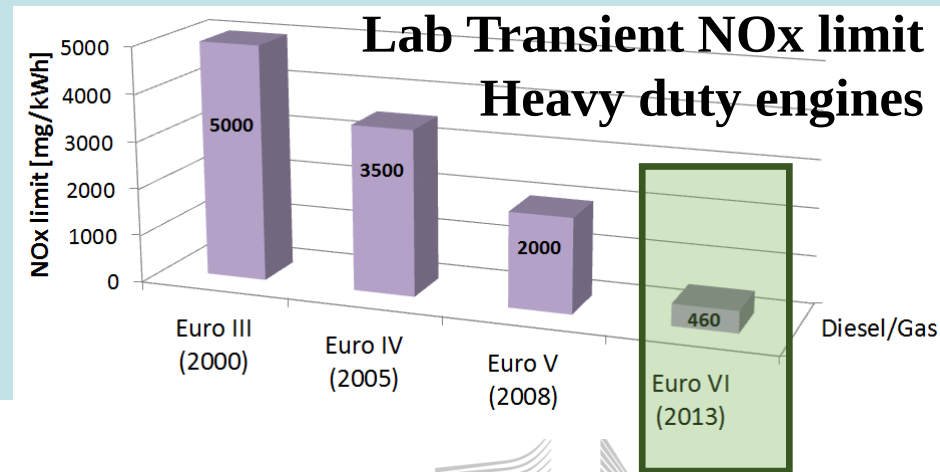
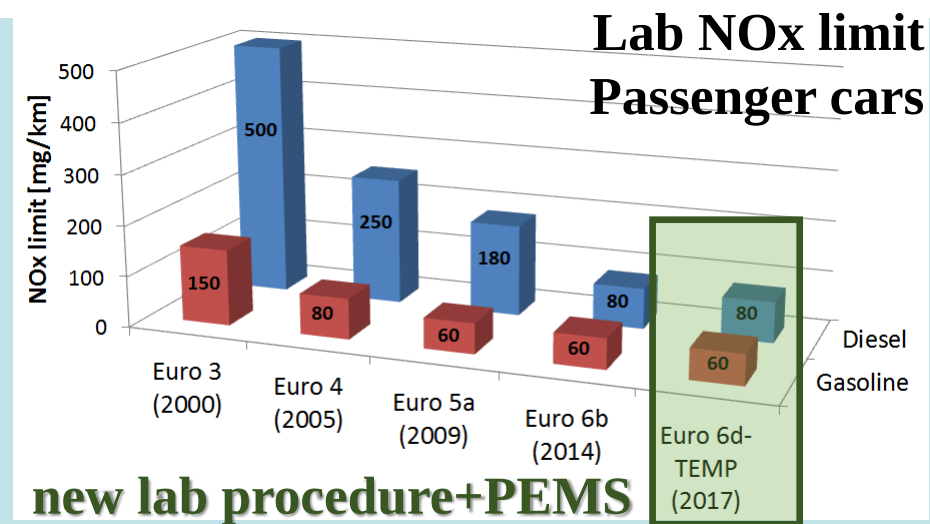
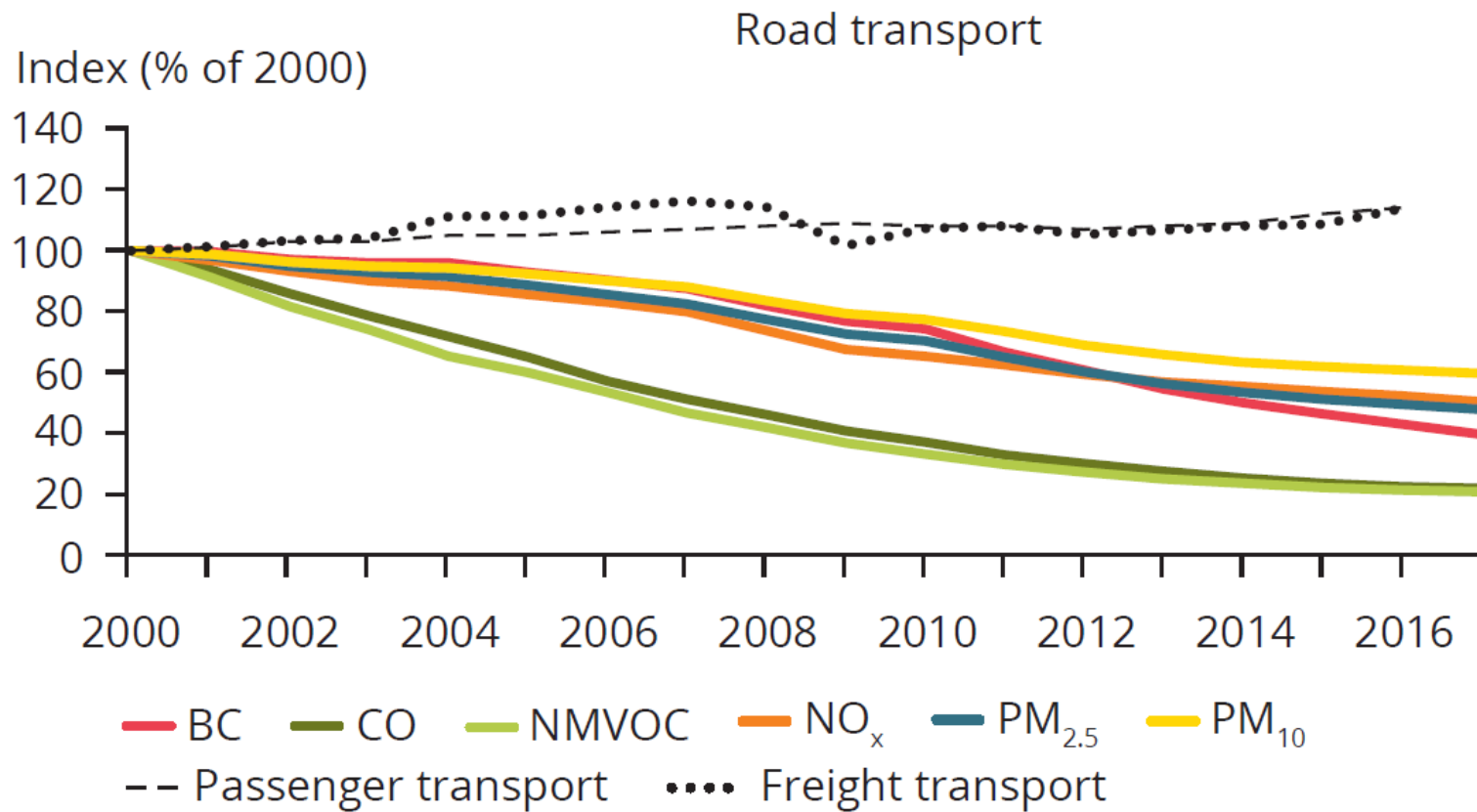
[Annual Accident Report 2018.](#)

Distribuzione percentuale delle emissioni in provincia di Milano nel 2017. [INEMAR - ARPA Lombardia](#)

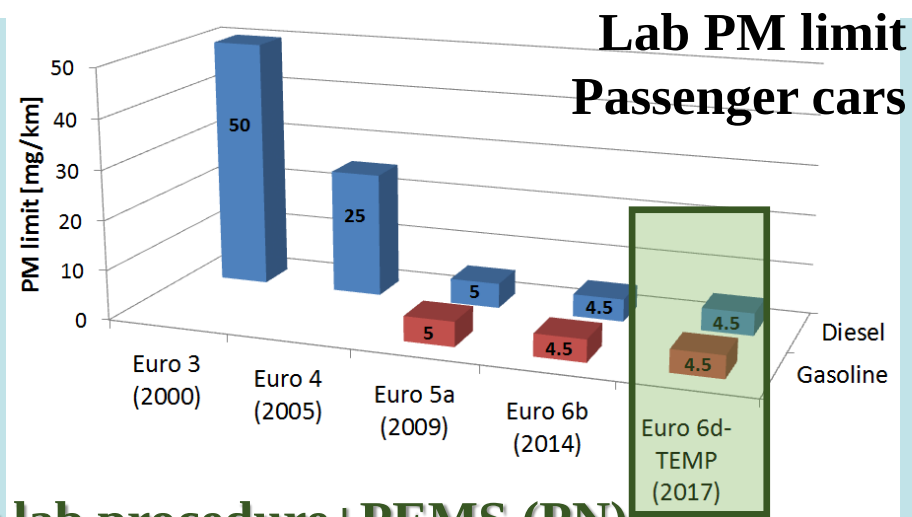
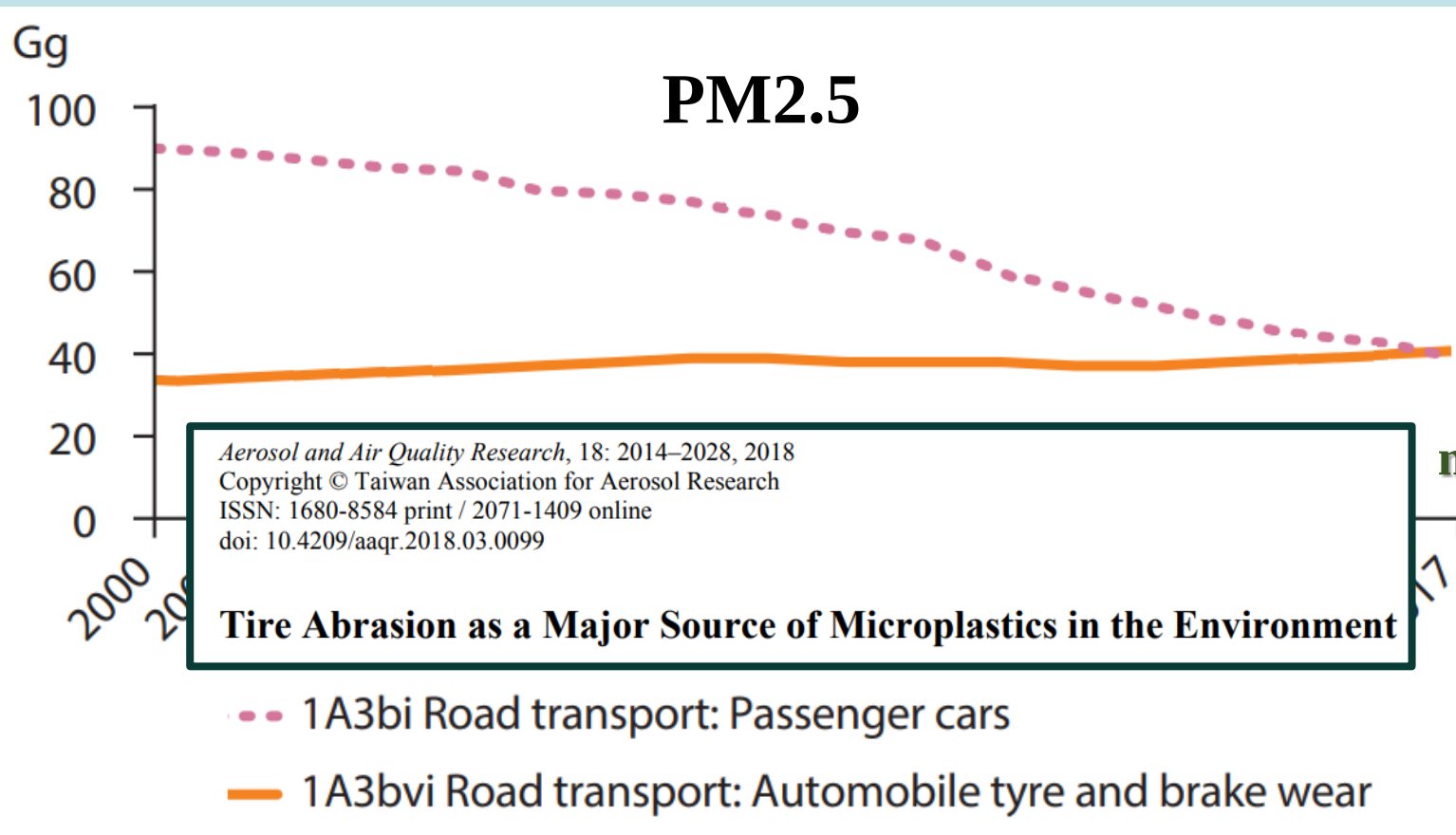
Contribution to EU-28 emissions from the main source sectors in 2017



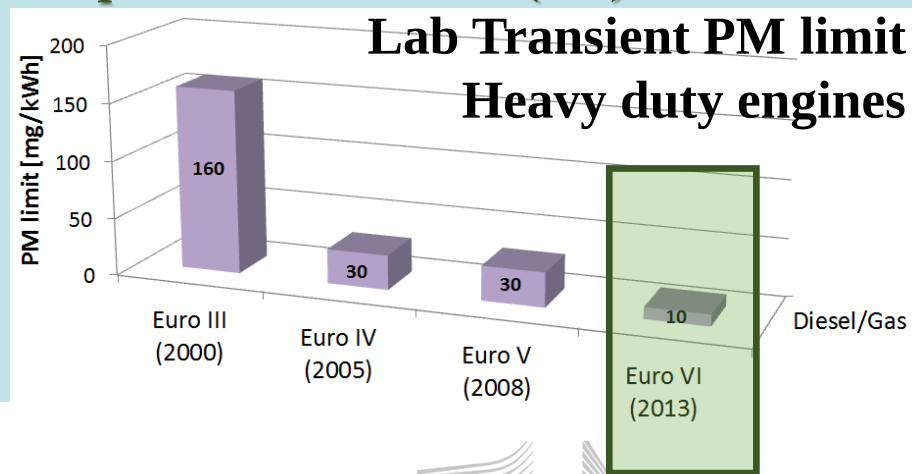
Trends in EU-28 emissions: road transport



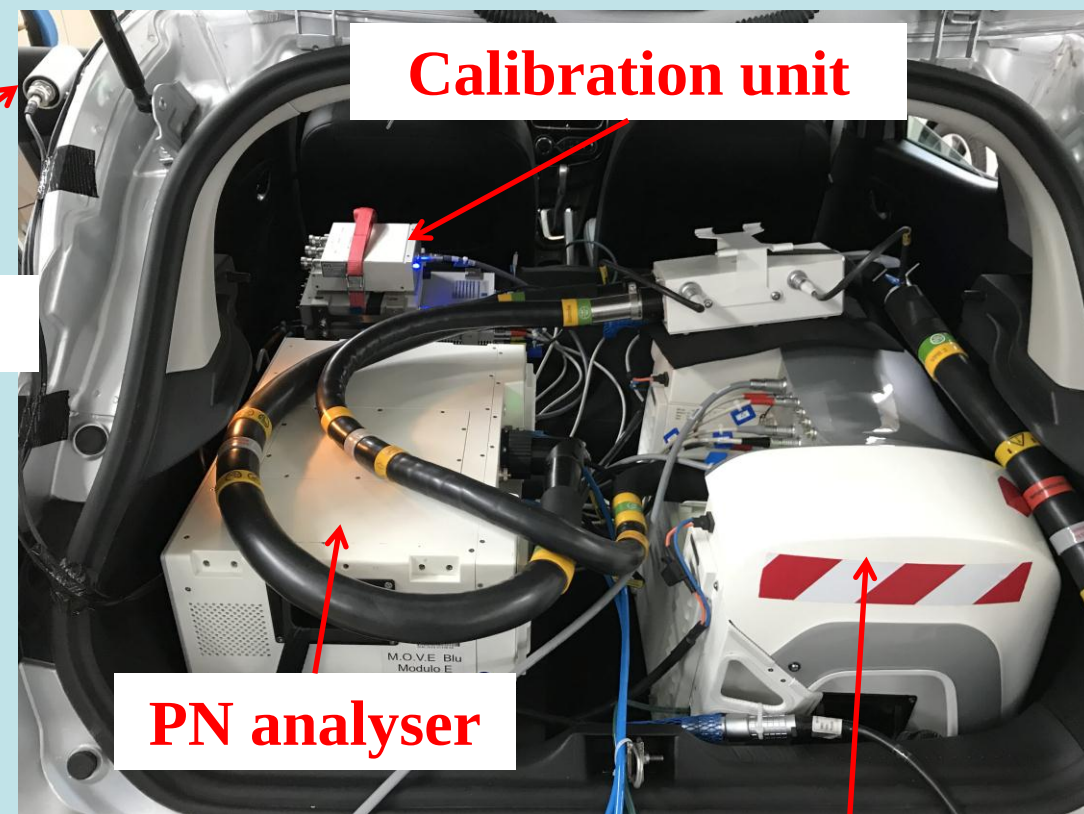
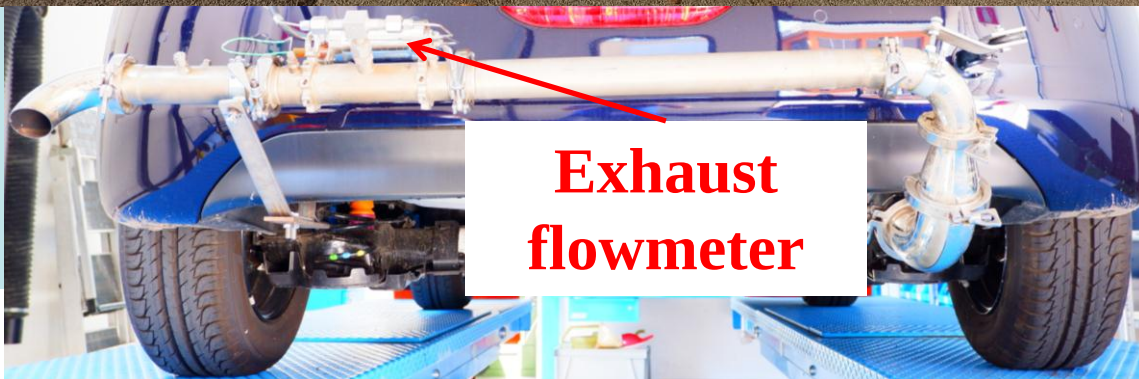
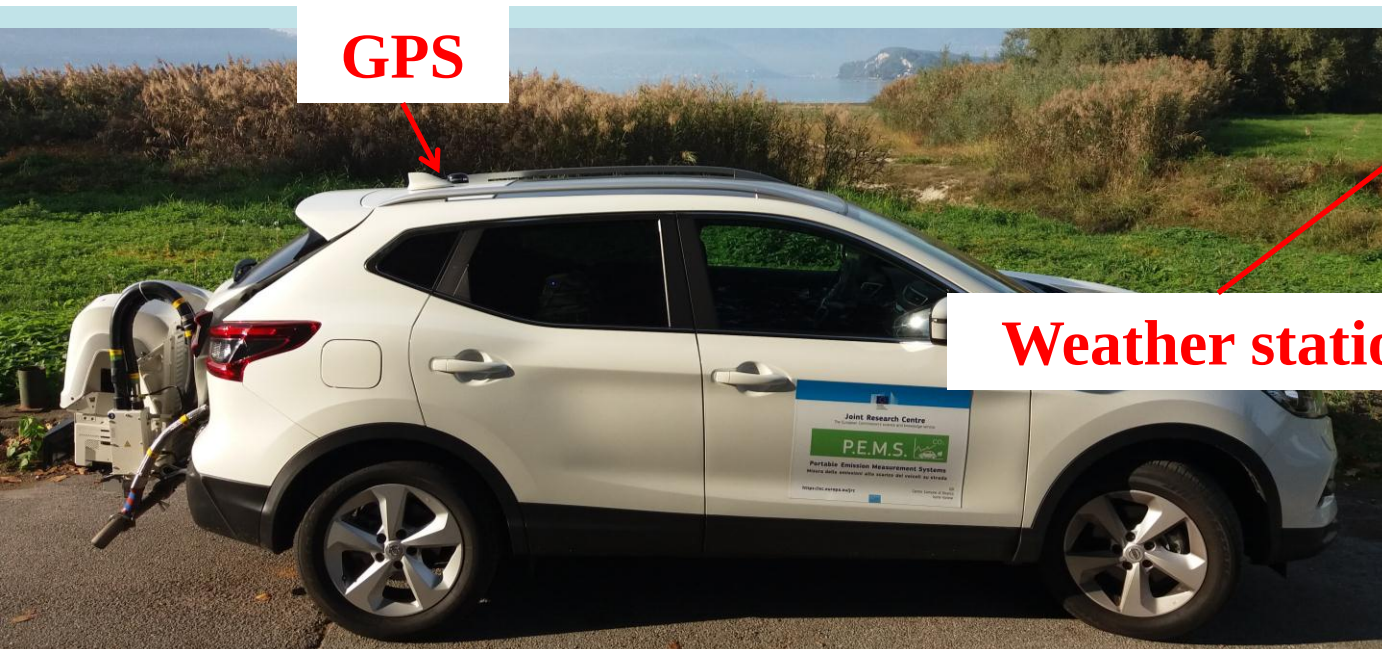
Trends in EU-28 emissions: road transport



new lab procedure+PEMS (PN)



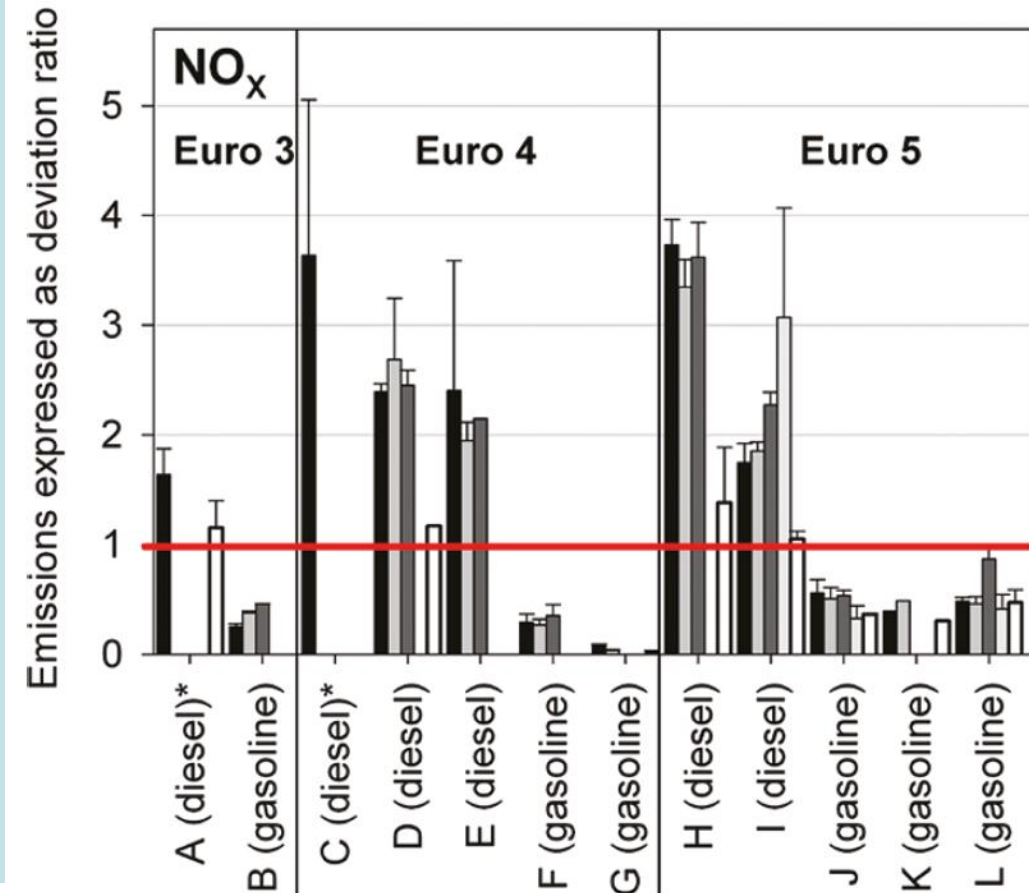
Portable Emissions Measurements Systems PEMS



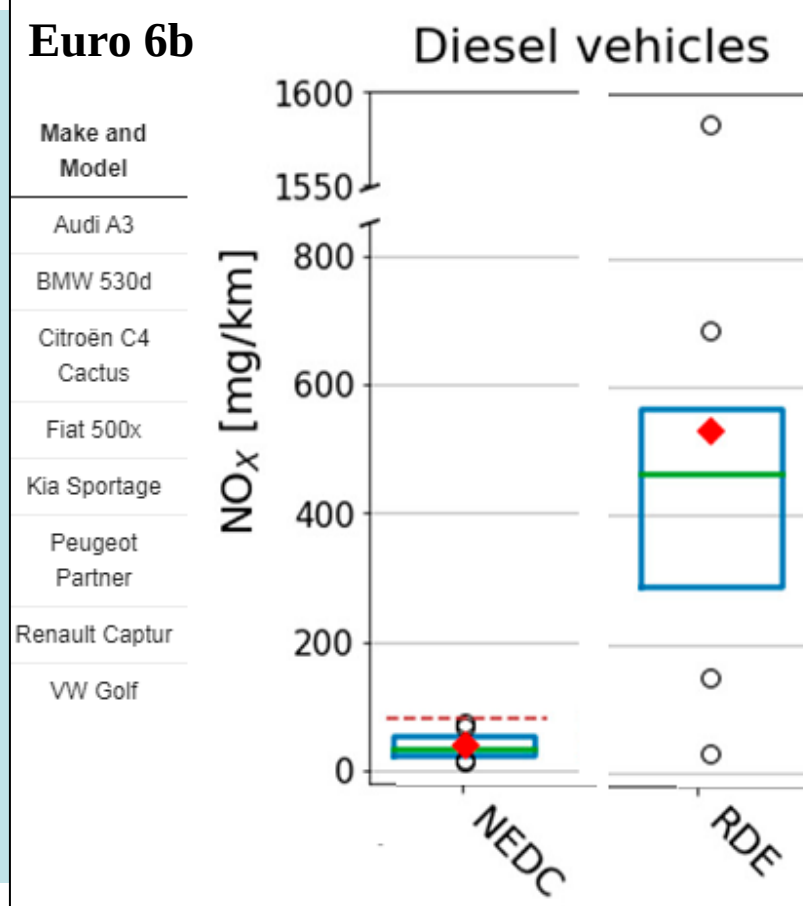
Real life NO_x emissions – PEMS

pre-RDE passenger cars tested by JRC

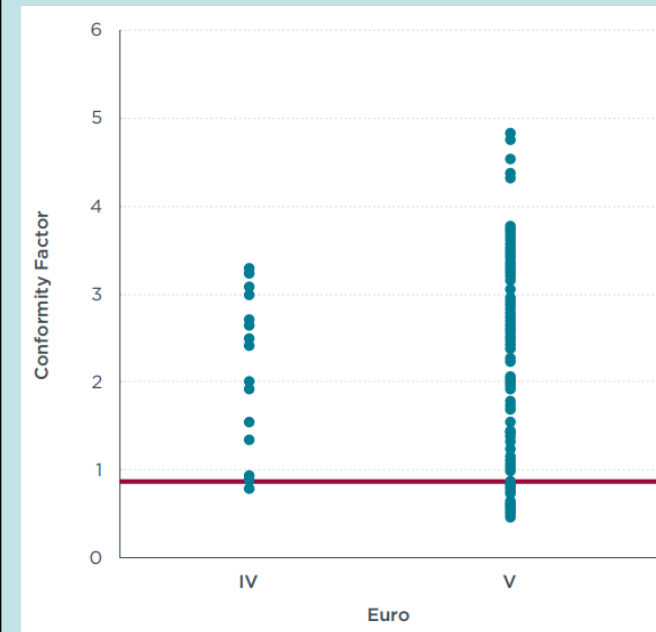
Heavy duty vehicles



[Weiss et al., 2011](#)



[Valverde et al., 2019](#)



[ICCT, 2015](#)

Real life NO_x emissions – PEMS

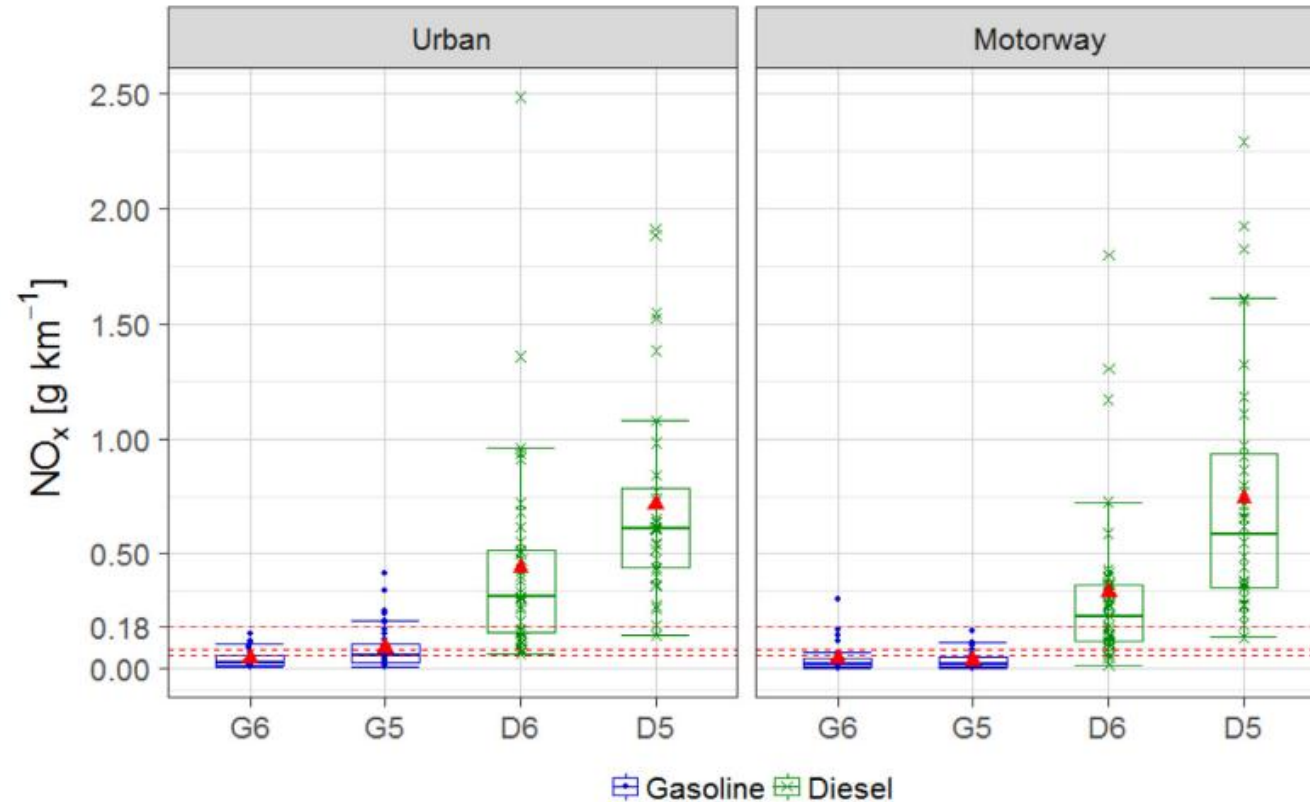


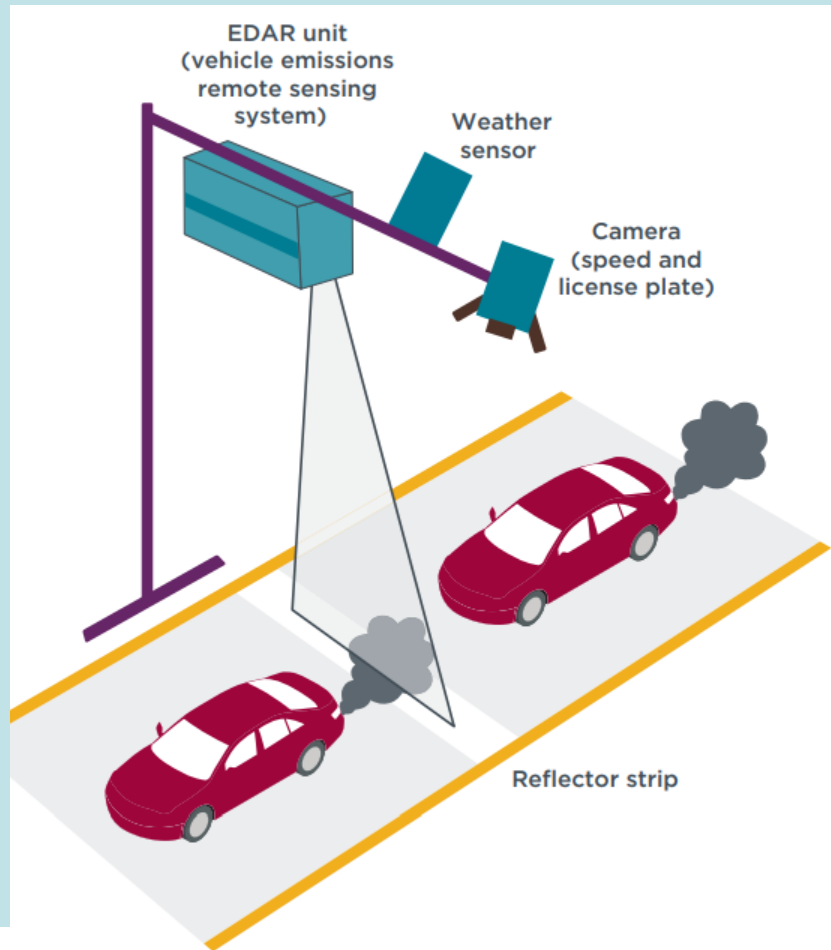
Fig. 4. Urban and motorway NO_x emissions by vehicle category (red dashed line = type approval limits, D5 limit (0.18 g km⁻¹) is labelled, below is the D6 limit (0.08 g km⁻¹) and below that gasoline limit (0.06 g km⁻¹ for G5 and G6), red triangle = mean). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**37 Gasoline Euro 5 (G5),
35 Gasoline Euro 6b (G6),
36 Diesel Euro 5 (D5),
39 Diesel Euro 6b (D6),**

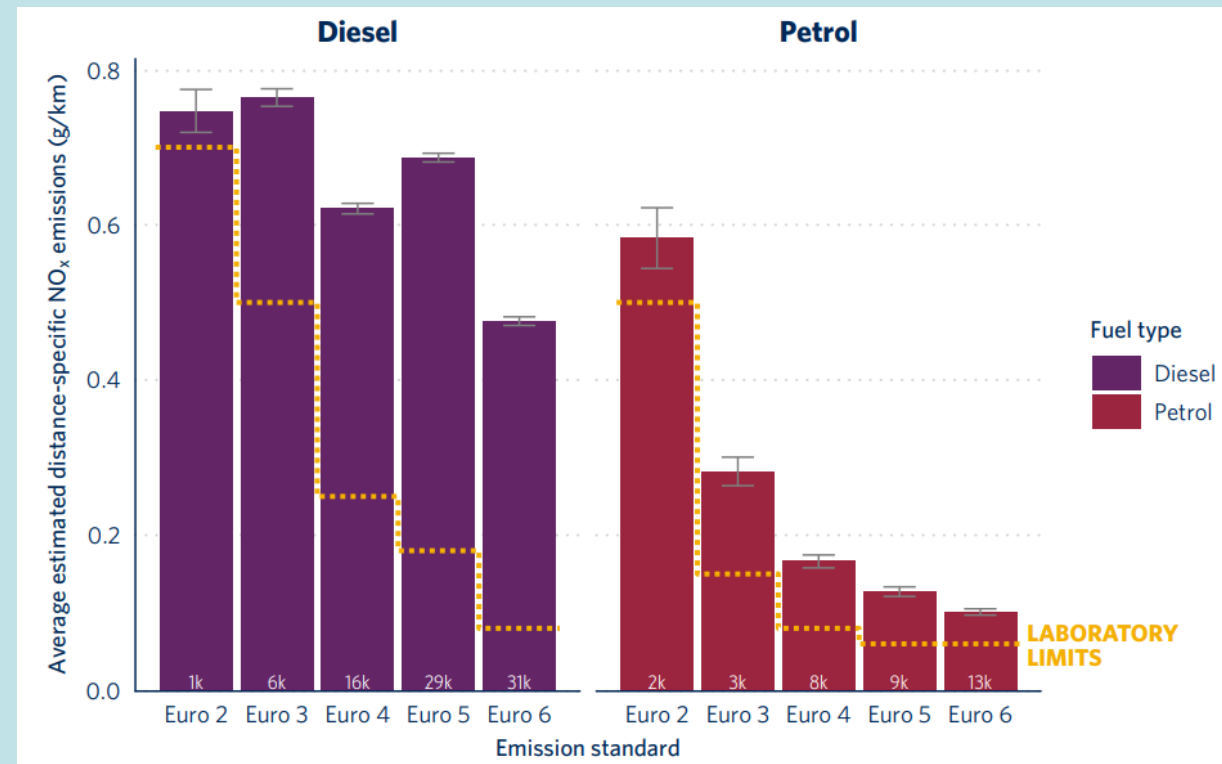
by 27 manufacturers

PEMS based

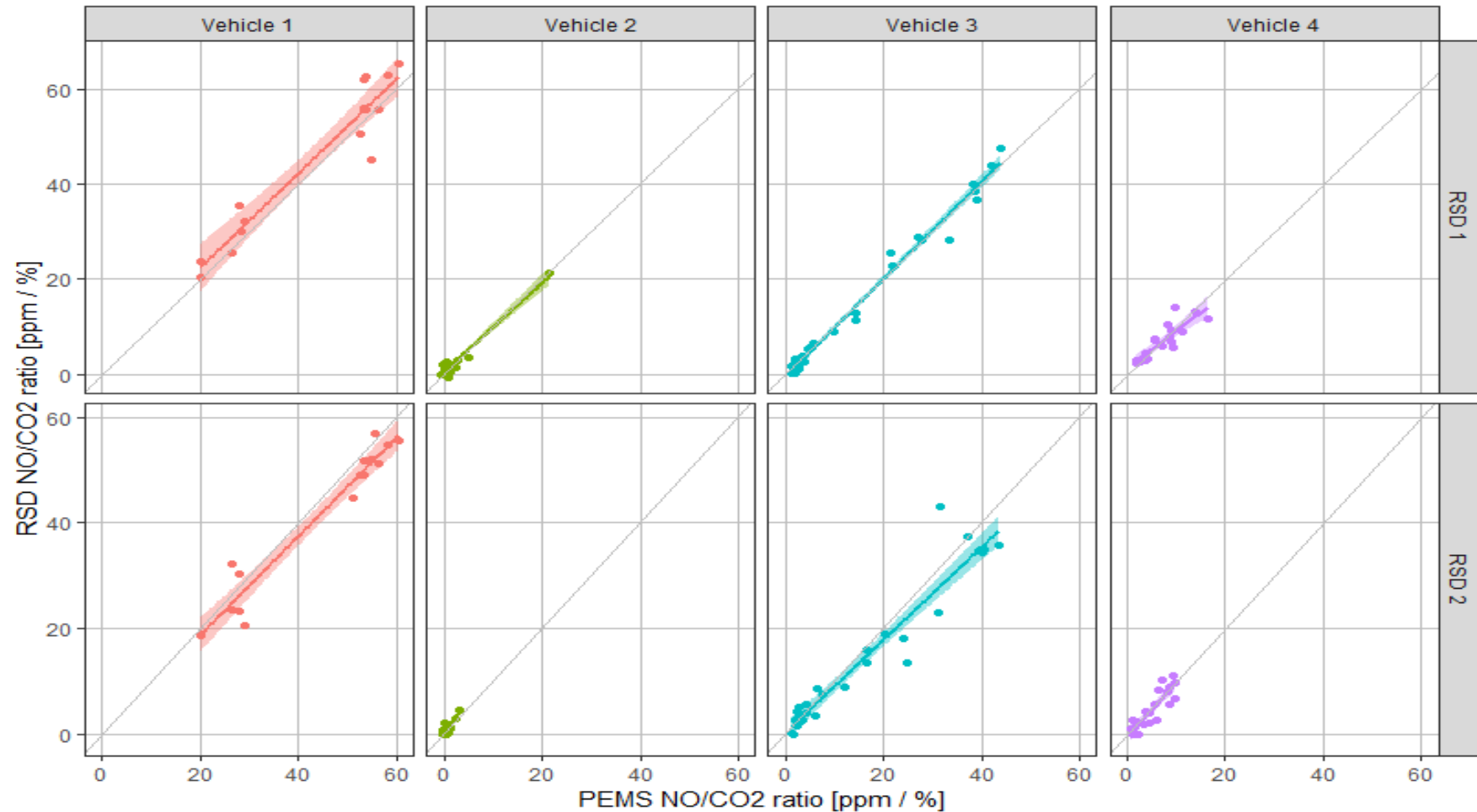
Real life NO_x emissions – Remote sensing



Data collected downtown Paris in summer 2018 – 180 000 vehicles



Remote Sensing Devices vs PEMS

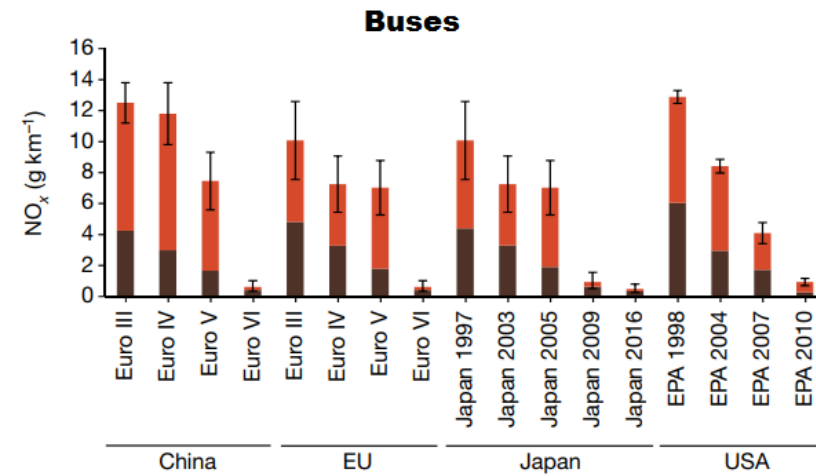
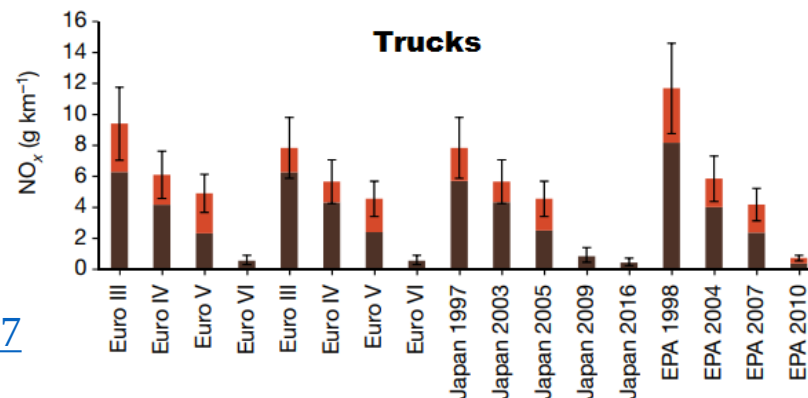
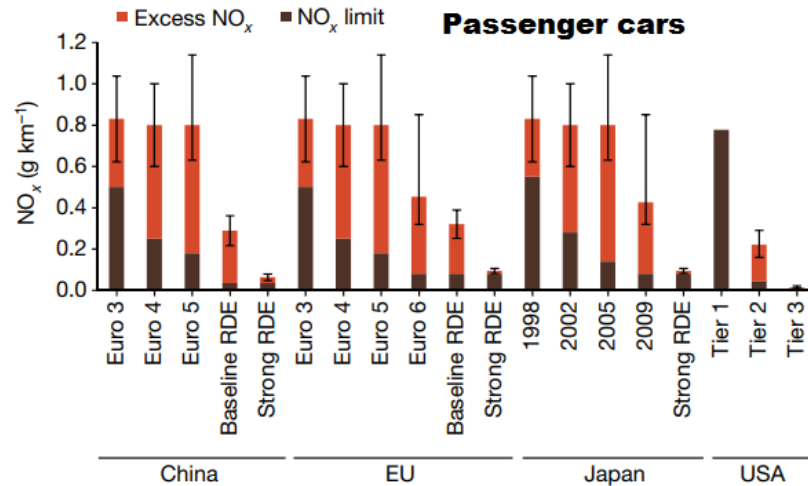


Published: 15 May 2017

Impacts and mitigation of excess diesel-related NO_x emissions in 11 major vehicle markets

Susan C. Anenberg , Joshua Miller , Ray Minjares, Li Du, Daven K. Henze, Forrest Lacey, Christopher S. Malley, Lisa Emberson, Vicente Franco, Zbigniew Klimont & Chris Heyes

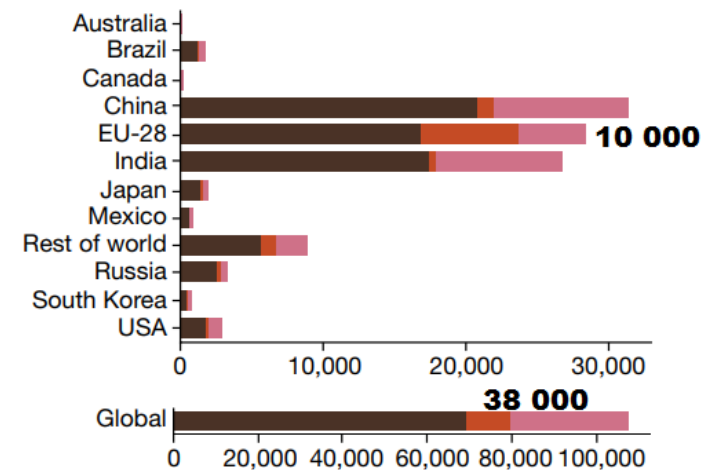
Nature **545**, 467–471(2017) | [Cite this article](#)



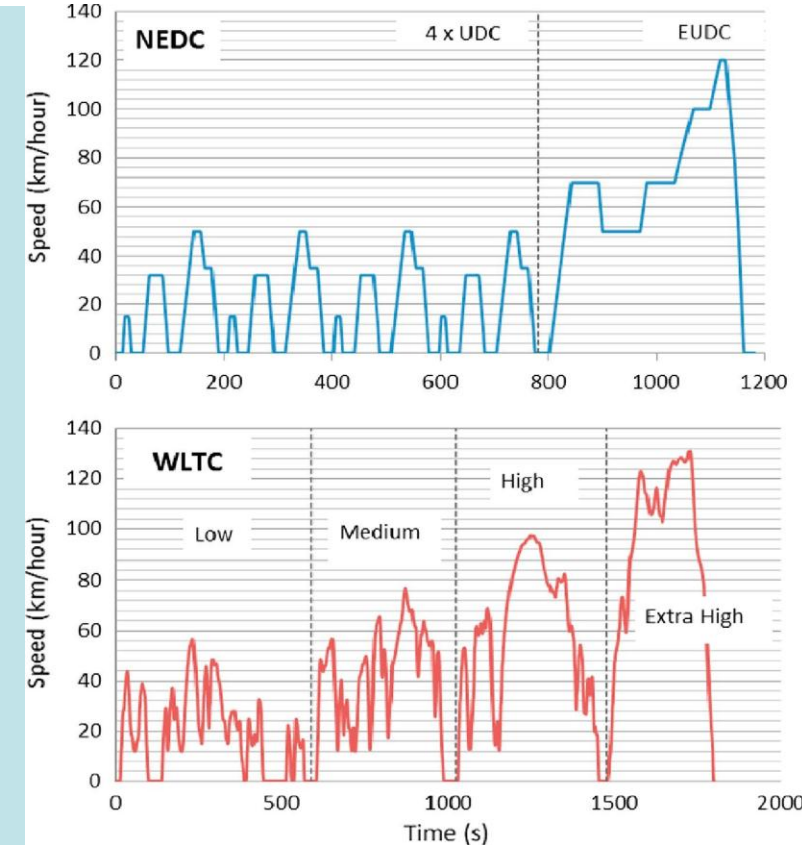
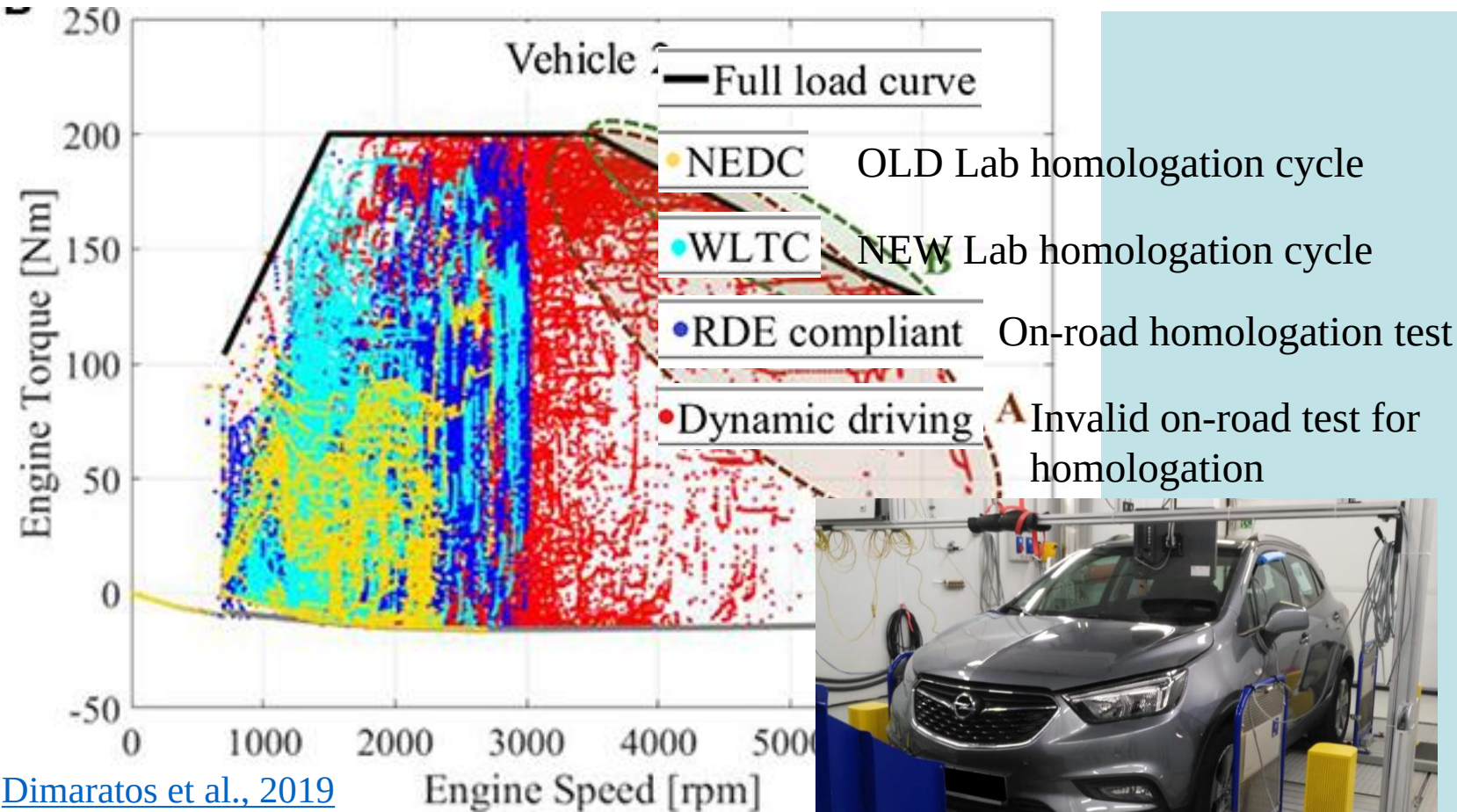
Annual PM_{2.5} and O₃ related premature deaths from on-road diesel vehicles

Source of on-road diesel NO_x

Excess HDV (pink), Excess LDV (red), Limit-2015 (black)



Engine operating points in different driving conditions



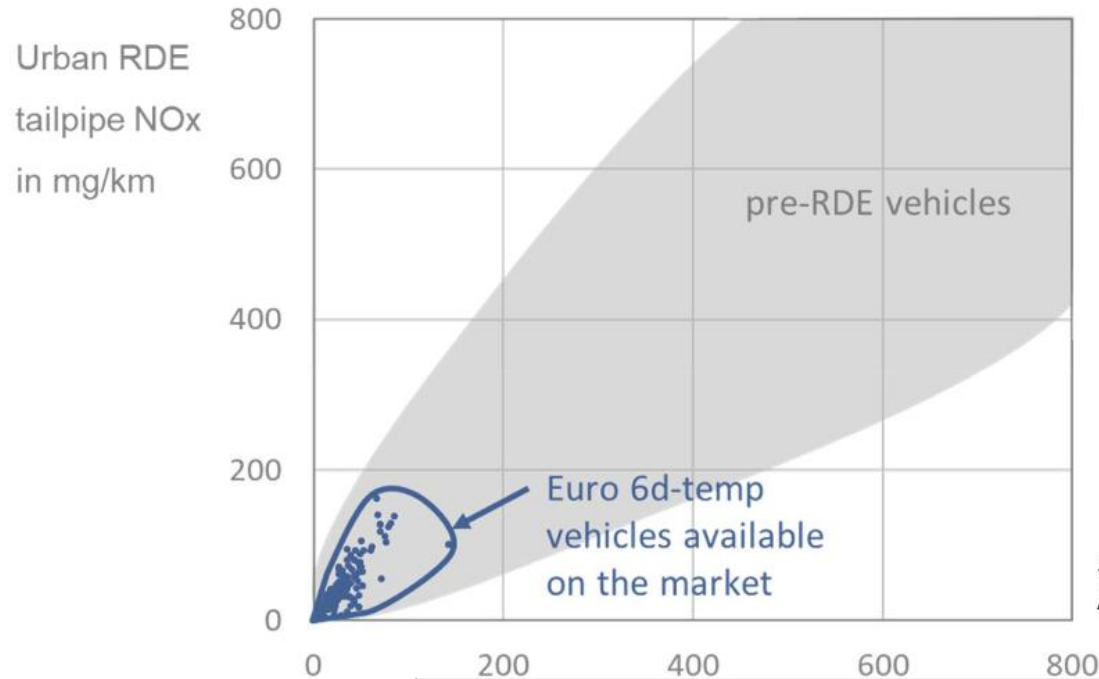
NEDC: New European Driving Cycle. [Reg. 83](#)

WLTP: Worldwide harmonized Light vehicles Test Procedure. [Reg. 2017/1151](#)

Real Driving Emissions regulation (EU-RDE)

- EU regulations 2016/427, 2016/646, 2017/1154, 2018/1832
- Phasing-in: 2017-2020 (Euro 6d-TEMP)
- Not-To-Exceed principle – NO_x & solid particle number (PN > 23 nm)
- PEMS based test (PEMS uncertainty > lab uncertainty → margin .43 NO_x, .5 PN)
- RDE boundaries: altitude < 1300 m, ambient T -7C to 35C, urban/rural/motorway, 90-120 minutes, driving dynamics, etc.
- Type-approval (homologation)
- In-service conformity (in-use up to 5 years or 100 000 km) performed by 3rd parties

Overview RDE type-approval data



Source: PEMS results from ACEA and JAMA RDE databases

acea.be/publications/article/access-to-euro-6-rde-monitoring-data

To get the real driving emissions results (according to the RDE 4th Package - [EU 2018/1832 \[4\]](#)) for the PEMS test family you are searching for enter one or more of the following parameters: make, commercial name, type, variant, version or EU Type Approval number (EUTA) and you will receive the results for the PEMS test family in which your vehicle is placed.

Enter your search parameters to get the real driving emissions results.

Instructions: Please select Make & Commercial Name, and type additional information you have on the Type, Variant, Version & WVTA. Then, click [Search]

PEMS Tests Search

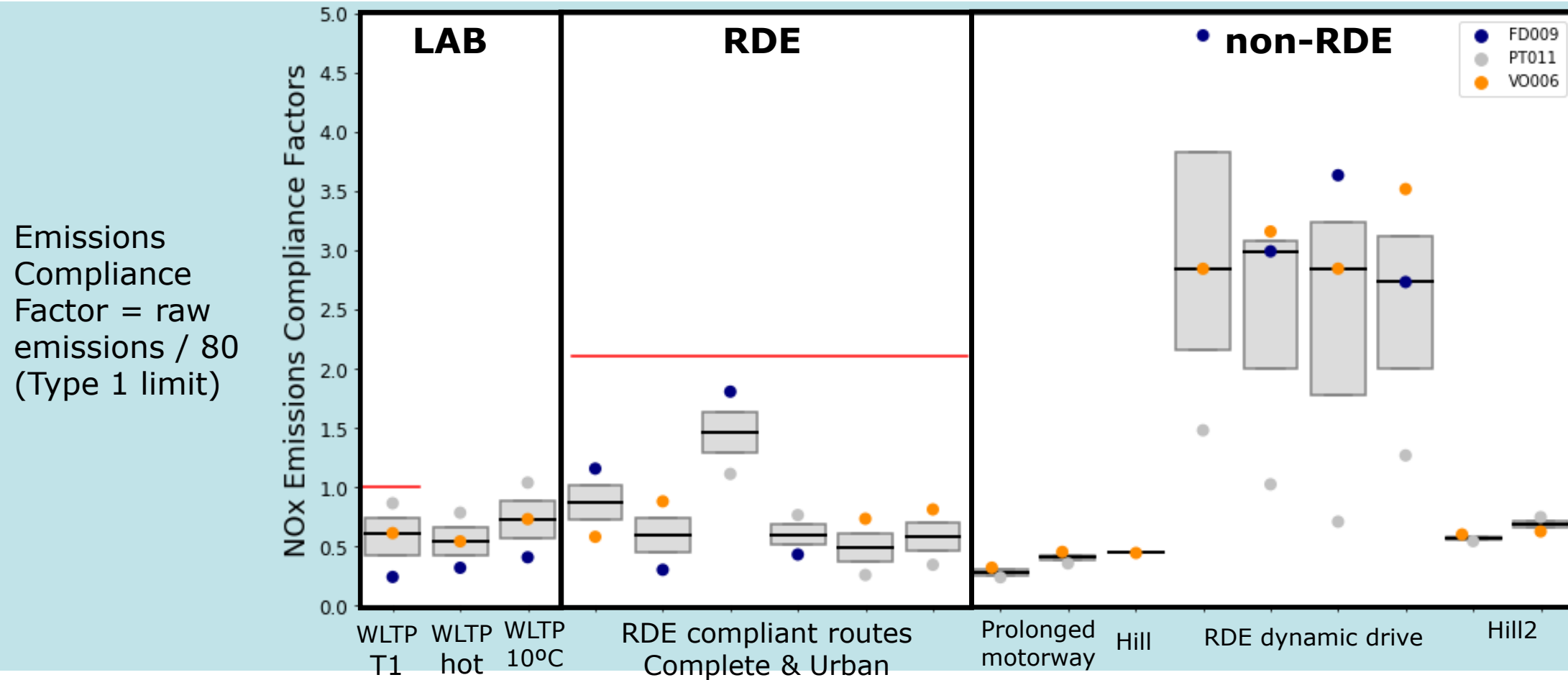
Search Clear

Make: JEEP
Commercial Name: RENEGADE
Type: Please type...
Variant: Please type...
Version: Please type...
WVTA: Please type...

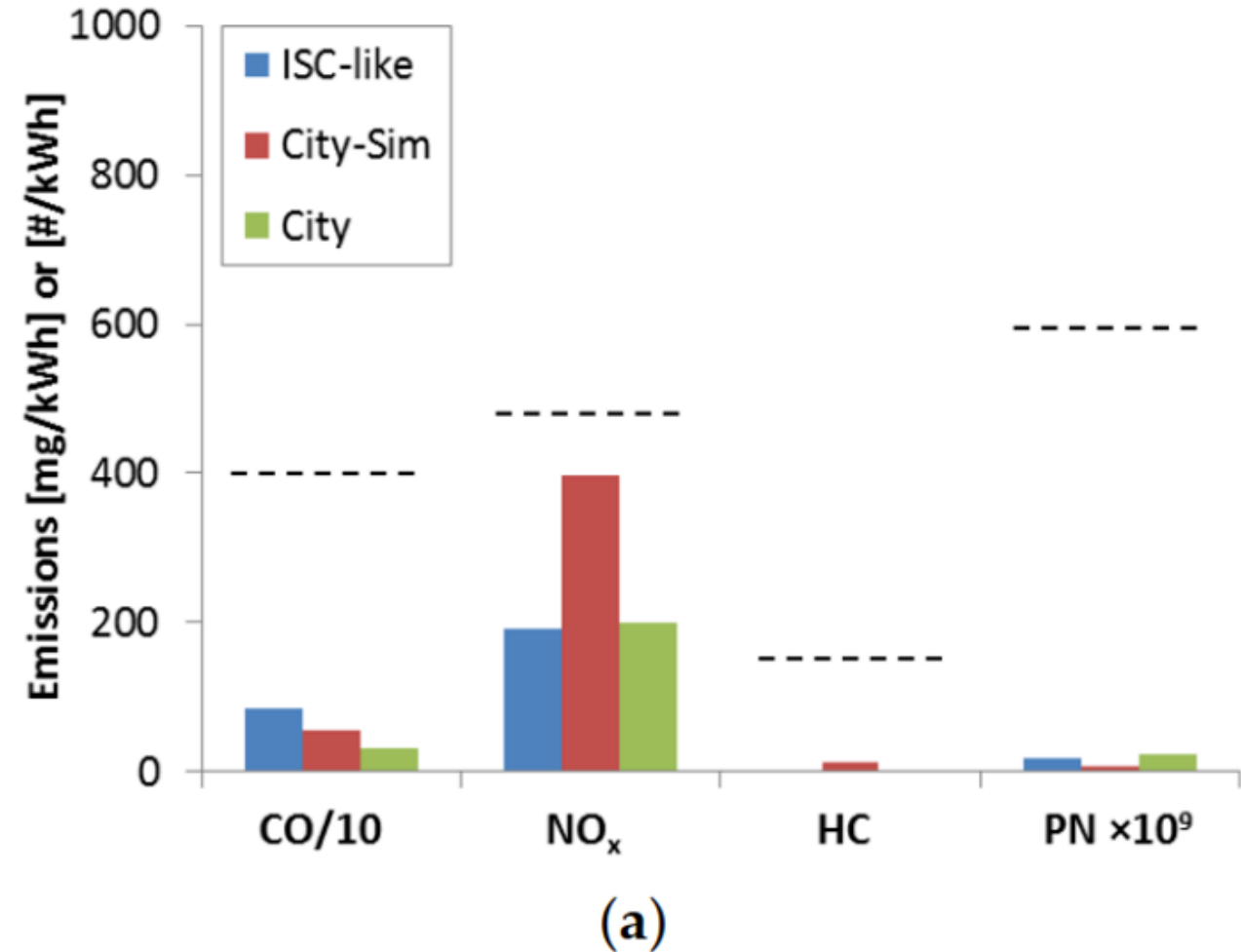
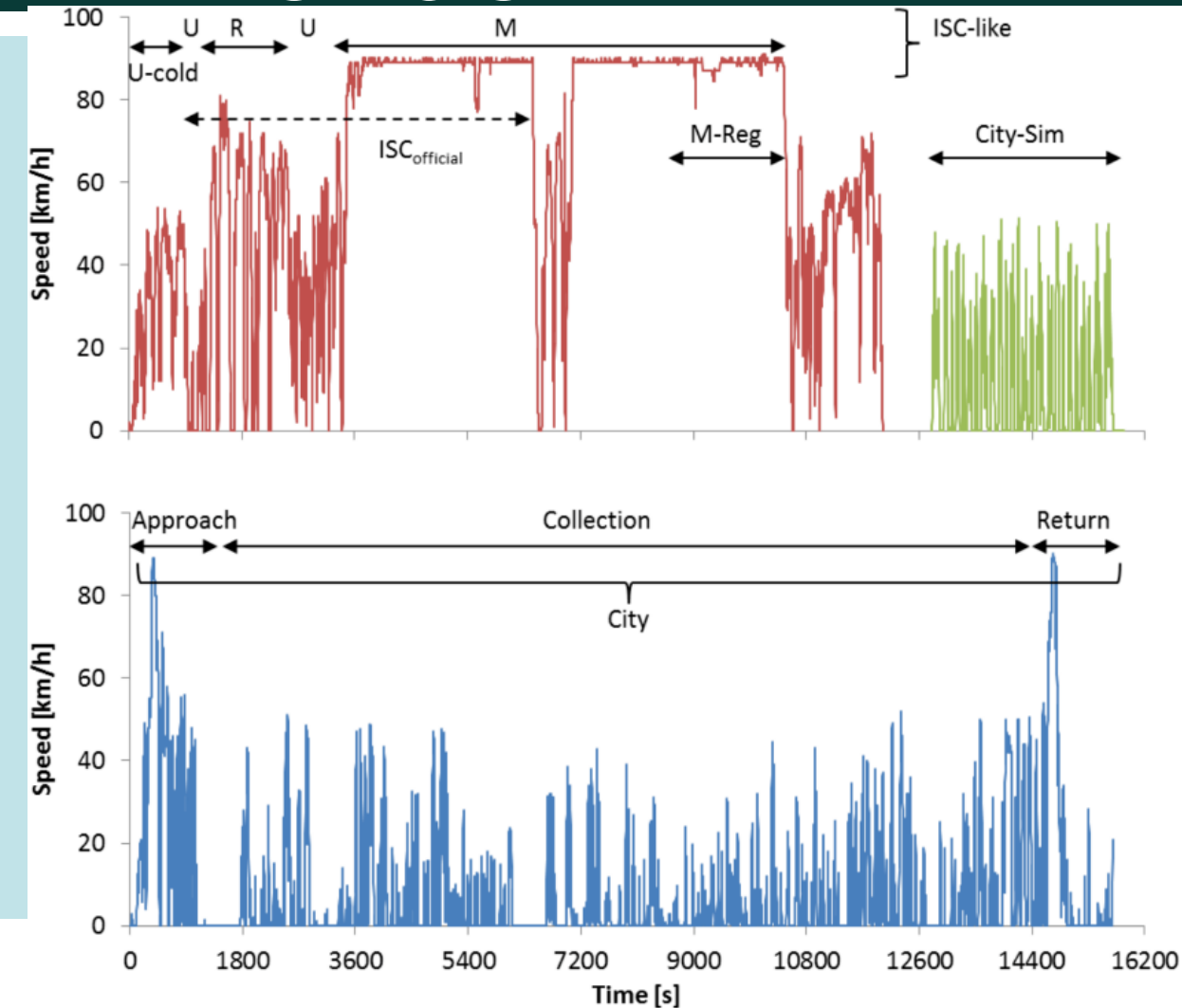
Families
E3-1C4-16-0
E3-1C4-18-0
E3-1C4-20-0
E3-1C4-21-0

Identification of PEMS TEST FAMILY (MS-OEM-X-Y)							Technical Criteria for PEMS TEST FAMILY			PEMS test results			
PEMS TEST FAMILY	emission type	Make	commercial name	type	variant	version	WVTA	propulsion type	fuel type	NO _x Total	PN Total	NO _x Urban	PN Urban
										[mg/km]	[/km]	[mg/km]	[/km]
E3-1C4-16-0	E3*715/2007*2018/1832DG*1079*00	JEEP	RENEGADE	BU	AXM11	15D	E3*2007/46*0300*24	ICE	DIESEL	11.6	2.3E+10	23.9	3.2E+10
E3-1C4-16-0	E3*715/2007*2018/1832DG*1052*00	JEEP	RENEGADE	BU	AXM1B	12D	E3*2007/46*0300*23	ICE	DIESEL	34.5	1.3E+10	59.9	2.7E+10
E3-1C4-18-0	E3*715/2007*2018/1832DG*1053*00	JEEP	RENEGADE	BU	AXR22	16D	E3*2007/46*0300*23	ICE	DIESEL	27.1	7.1E+09	45.7	9.5E+09
E3-1C4-18-0	E3*715/2007*2018/1832DG*1080*00	JEEP	RENEGADE	BU	AXR22	16E	E3*2007/46*0300*24	ICE	DIESEL	7.2	1.2E+11	21.6	1.6E+11
E3-1C4-20-0	E3*715/2007*2018/1832CG*1054*00	JEEP	RENEGADE	BU	AXN1B	13H	E3*2007/46*0300*25	ICE	PETROL	23.5	2.0E+11	19.4	3.3E+11
E3-1C4-20-0	E3*715/2007*2018/1832DG*1215*00	JEEP	RENEGADE	BU	AXN1B	13L	E3*2007/46*0300*26	ICE	PETROL	24.6	8.6E+09	36.1	6.4E+09
E3-1C4-21-0	E3*715/2007*2018/1832DG*1081*00	JEEP	RENEGADE	BU	AXP11	14C	E3*2007/46*0300*24	ICE	PETROL	20.6	4.0E+09	10.1	7.3E+09
E3-1C4-21-0	E3*715/2007*2018/1832DG*1082*00	JEEP	RENEGADE	BU	AXP22	18D	E3*2007/46*0300*24	ICE	PETROL	14.5	1.8E+11	35.9	3.0E+11

JRC testing – NO_x from diesel Euro 6d-TEMP vehicles



Euro VI Heavy-duty Diesel Refuse Collection Vehicle

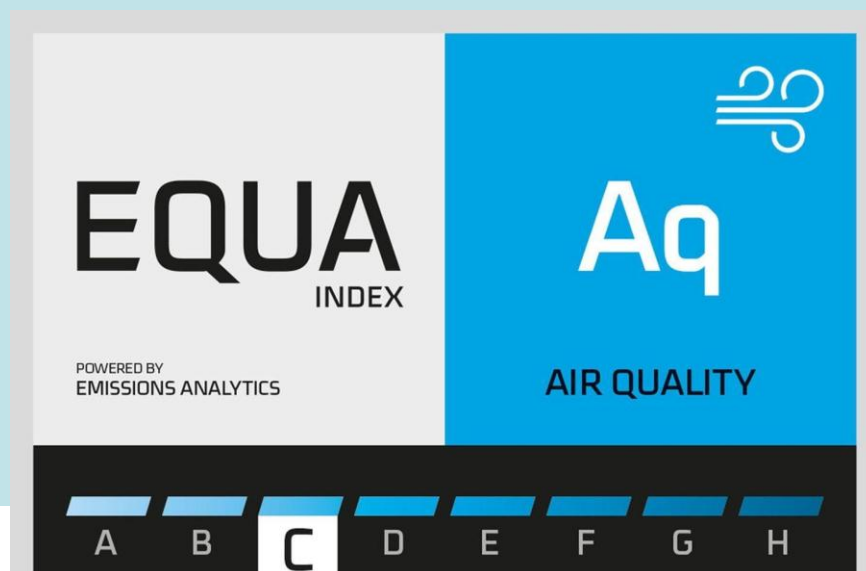


Enforcement of regulation





<https://www.greenncap.com/>



<https://equaindex.com/>



<https://www.trueinitiative.org/true-rating>



JRC publications



Conclusions

- Strong steps ahead on performant regulations to curb criteria pollutant emissions from LDV + HDV
- 1st wave of Euro 6d-TEMP vehicles (type-approved on RDE & WLTP): large reduction of real-life emissions. Pushing the adoption of best available techniques (SCR, SCRF, ASC, GPF).
- Challenges for efficient enforcement (appropriate screening methods, adequate ISC testing, robust peer-review mechanism, tampering handling, etc.)
- post-Euro 6/VI technology neutral to cover additional pollutants (NH₃, PN₁₀, N₂O, CH₄, VOCs), driving conditions (-7C),





Thanks for the attention

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