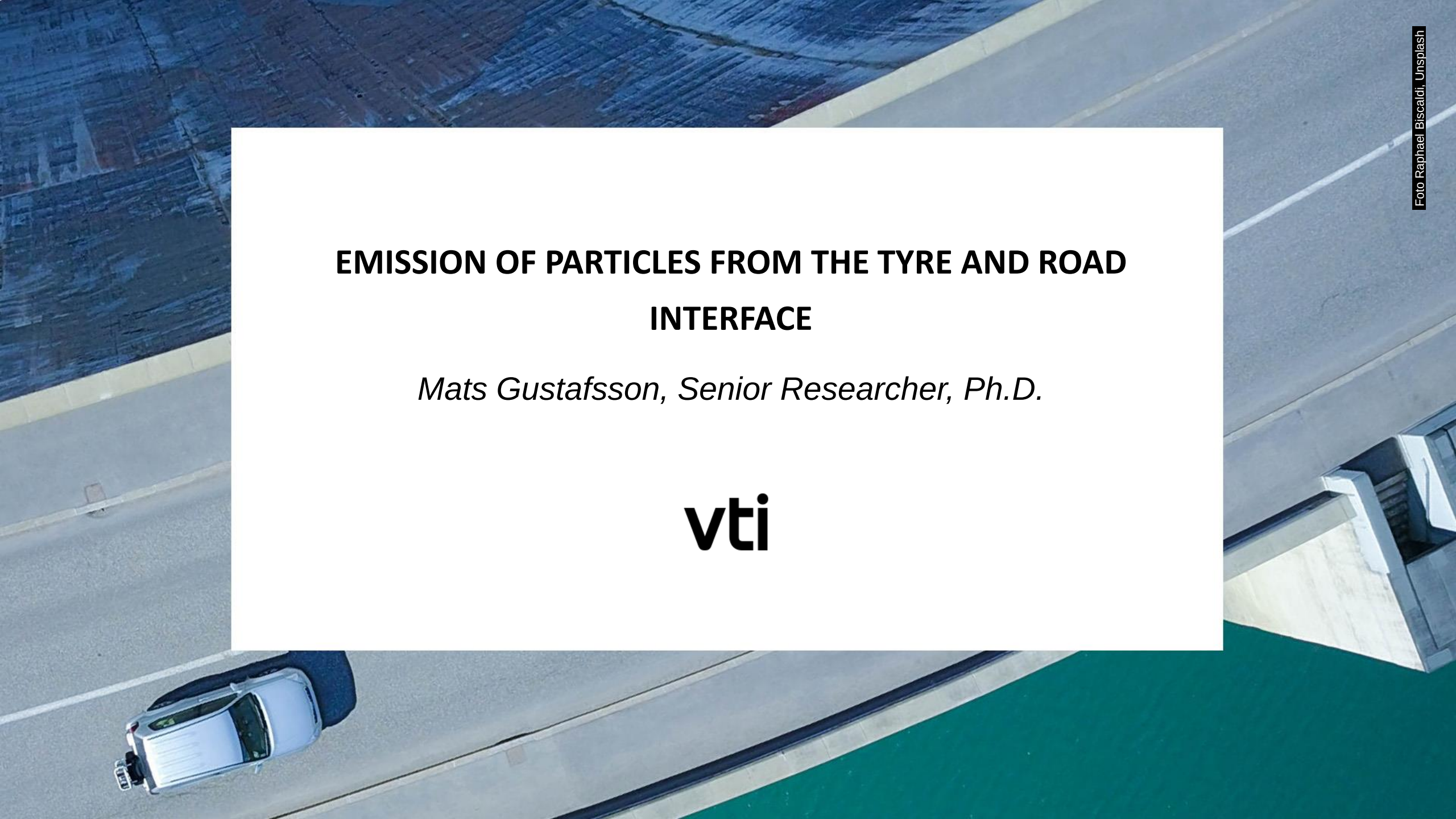

EMISSION OF PARTICLES FROM THE TYRE AND ROAD INTERFACE

Mats Gustafsson, Senior Researcher, Ph.D.

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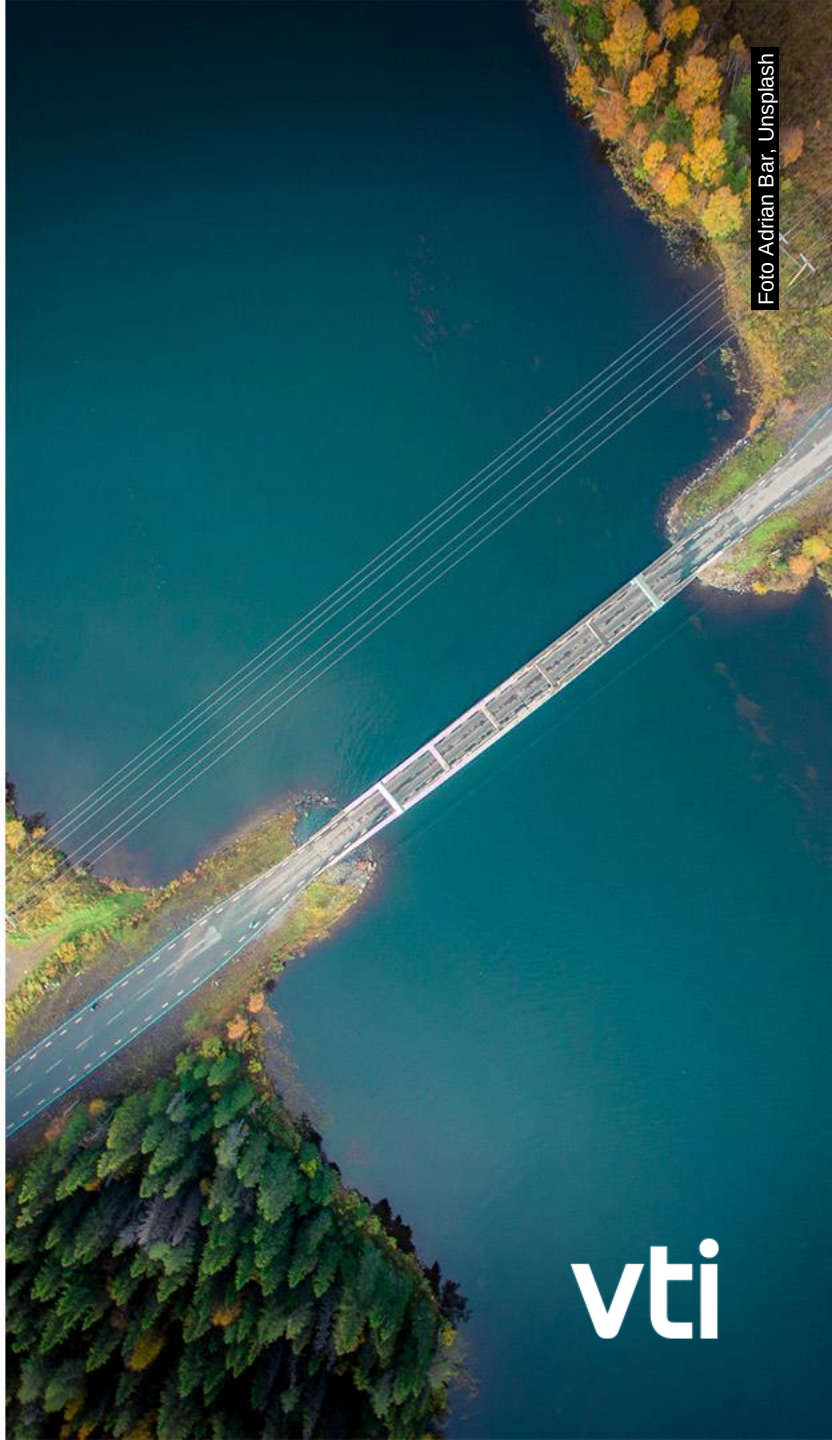
Foto Raphael Biscaldi, Unsplash

OUTLINE

- Tire and road interaction
- Emissions and some influencing factors
  - Tyres
  - Road
  - Road dust resuspension
- Conclusions



TIRE AND ROAD INTERACTION

In focus as a problem contributing to both:

- *air quality* as an increasing and unregulated source for PM
- *microplastic pollution* as tyre wear is regarded a main source. Also, wear of road markings and polymer modified bitumen in asphalts are regarded as microplastic sources.

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Photo: User_50435/Mostphotos.com

TIRE AND ROAD INTERACTION

Both

- *Source* for primary emissions of tire and road wear particles
- Main *emitting process*, for primary emission and (re-)suspension, depending on:
  - Tire type and dimensions
  - Vehicle type and weight
  - Speed
  - Lateral position on road
  - Road surface conditions

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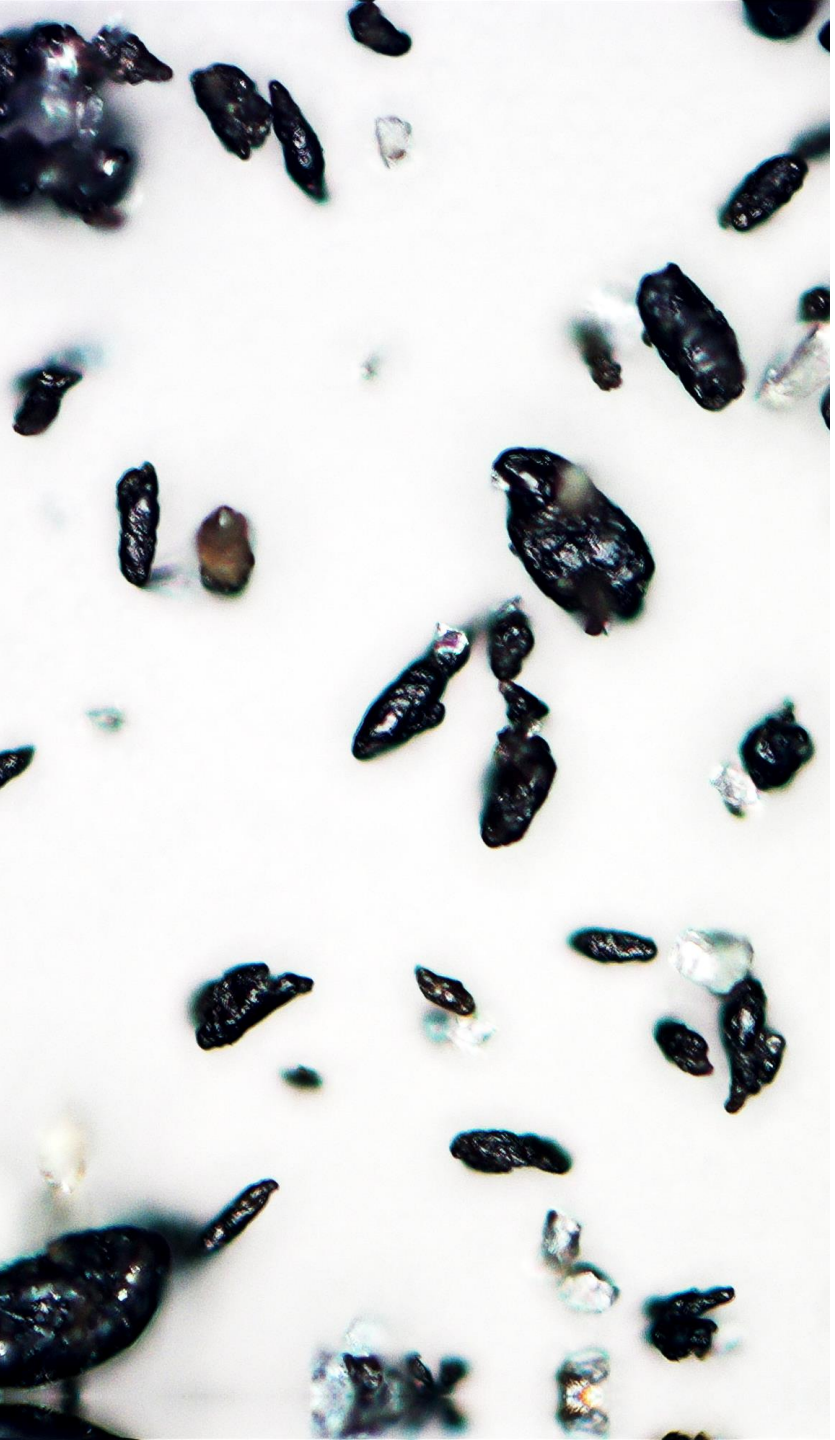

TIRE AND ROAD INTERACTION

Properties differ from exhaust particles

- Coarser (mainly > 1 µm)
- Composition
  - tire rubber mix
  - minerals and binder
  - any material accumulated on the surface
  - TRWP aggregates of tire and mineral particles
- Shape
  - elongated TWP common
  - minerals (shards, grains etc.)

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PARAMETER INFLUENCE ON TIRE WEAR EMISSIONS

Order	Parameter	Influencing part of system
1	Side slip angle	vehicle/driver, maintenance
2	Speed	vehicle/driver behaviour
3	Sprung mass	vehicle/driver, choice (load)
4	Ambient temperature	Meteorology
5	Tire pressure	tire/driver, maintenance
7	Unsprung mass	vehicle
8	Suspension damping	vehicle
9	Road roughness	road
10	Suspension stiffness	vehicle
11	Tread damping	tire
12	Tread stiffness	tire
13	Sidewall stiffness	tire
14	Sidewall damping	tire

After Li et al., 2011

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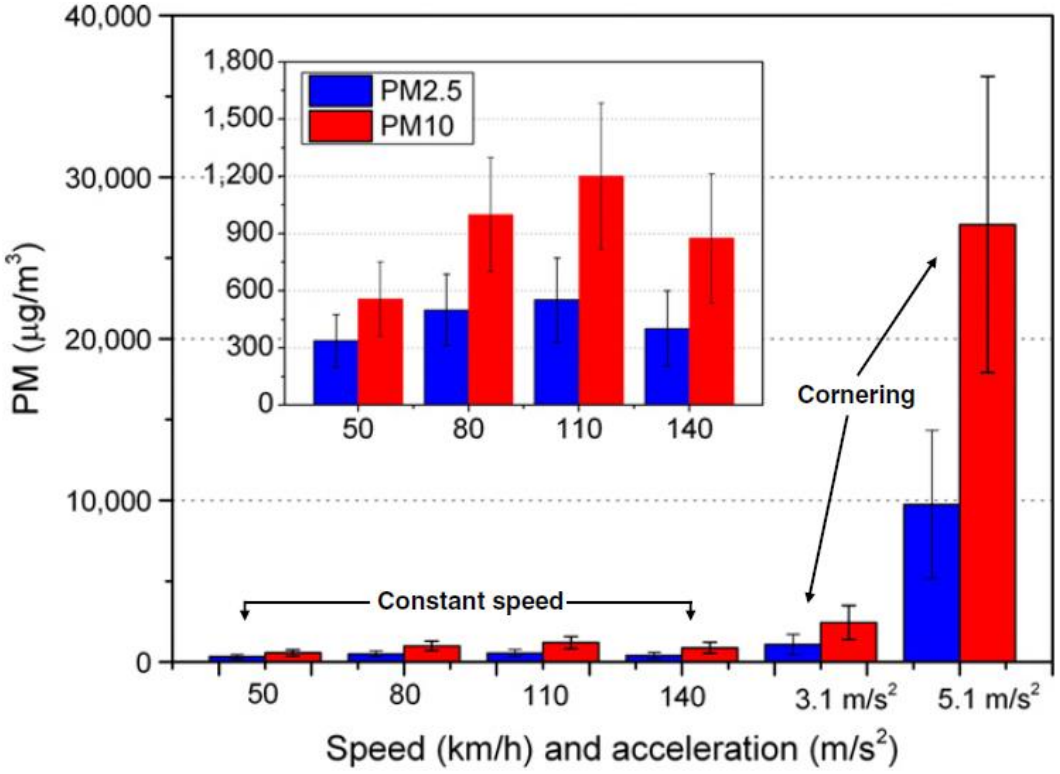
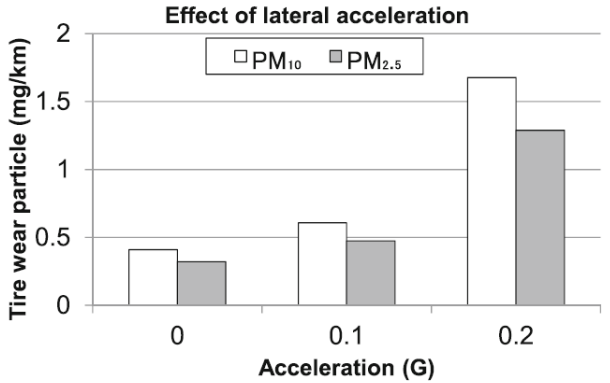
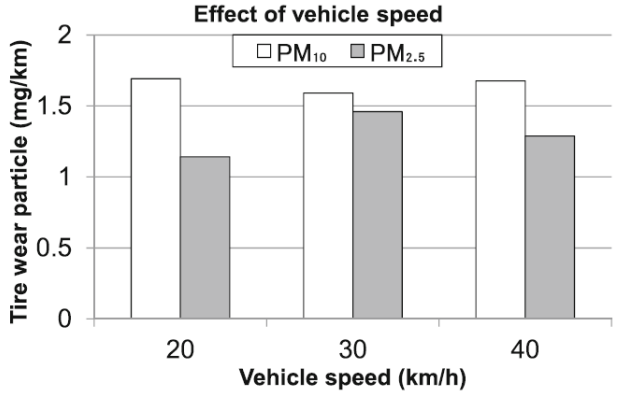
INFLUENCE OF DRIVING PARAMETERS ON PM EMISSION AND TIRE WEAR – REAL WORLD TESTS



Kwak et al., 2013

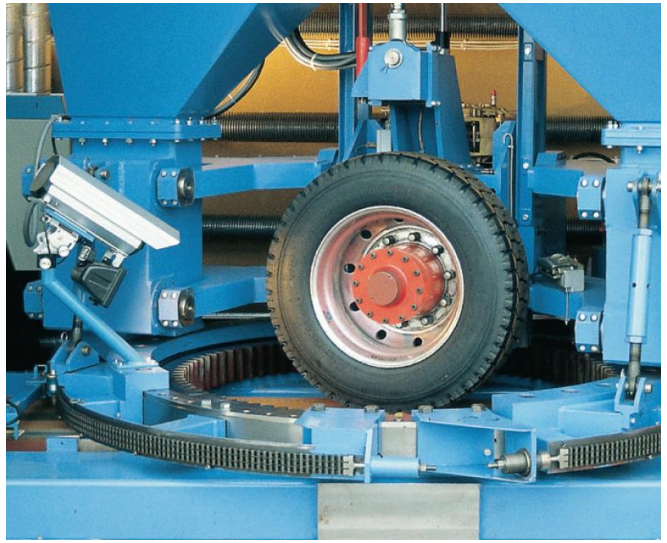




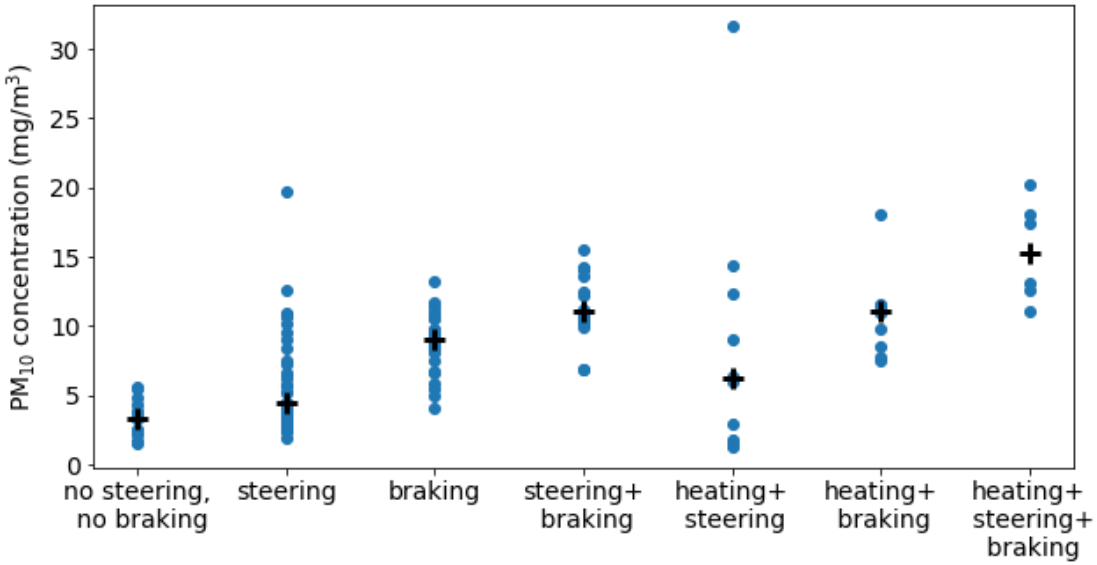
Tonegawa & Sasaki , 2021

ONGOING ACTIVITIES IN H2020 PROJECT

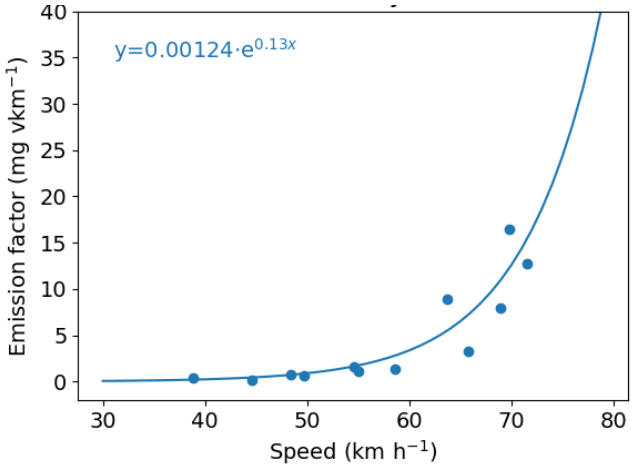
uCARe
You Can Always Reduce Emissions
because you care



PM10 behind tyre at different manouvers



Speed dependance of PM10 emission factor in road simulator



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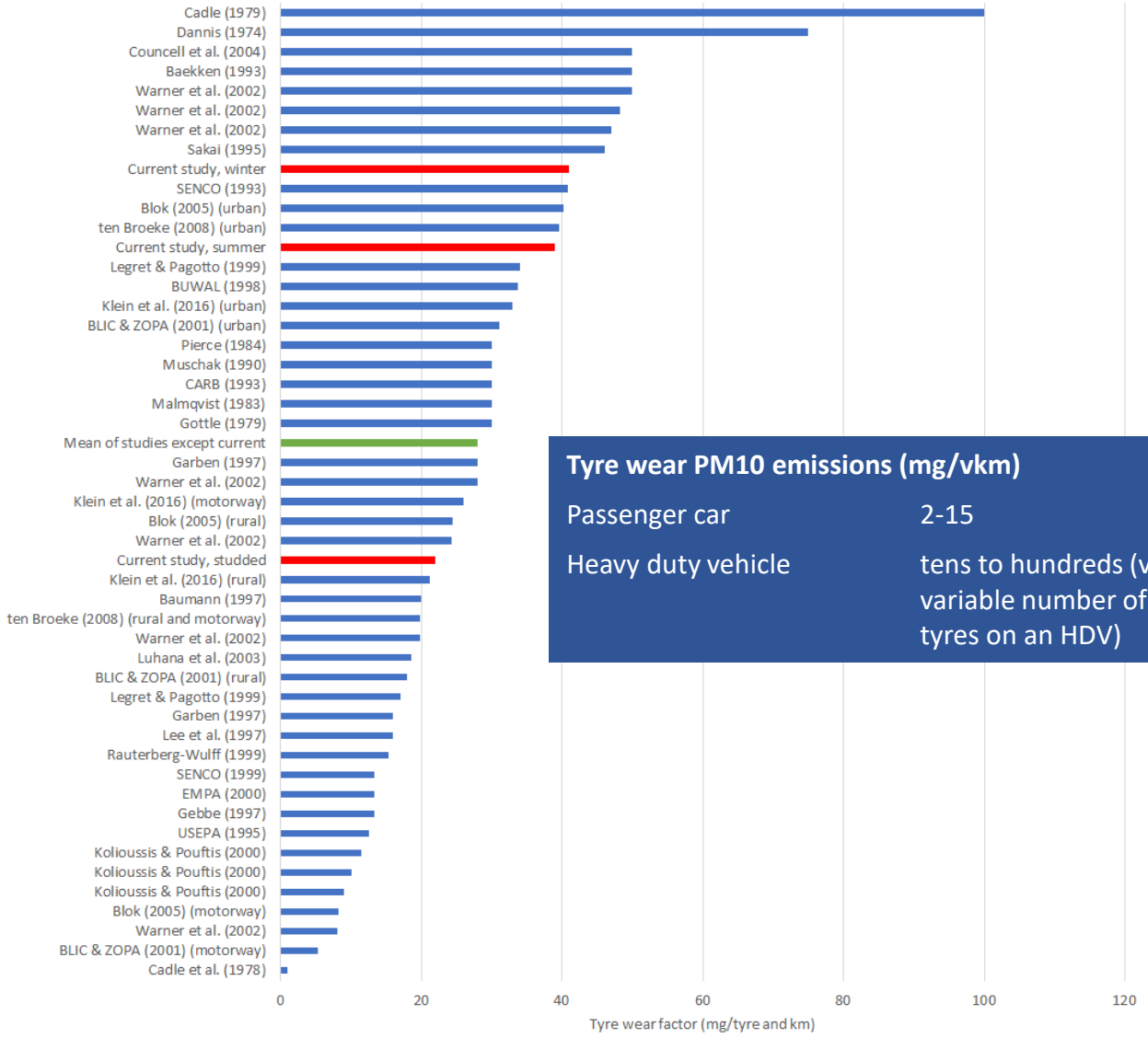
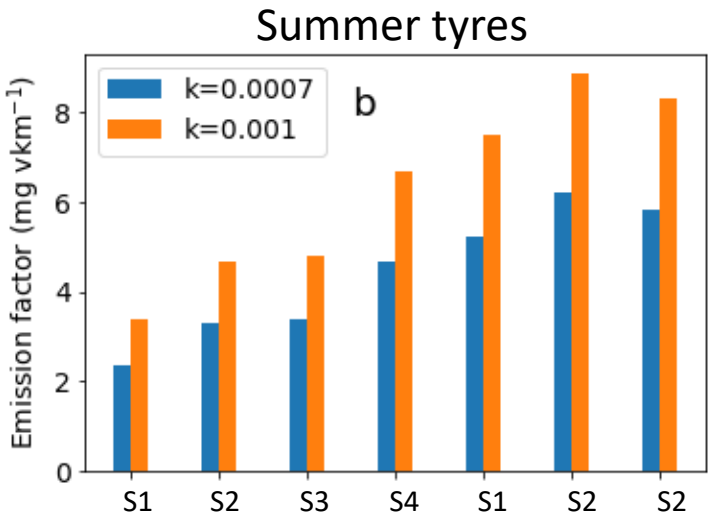
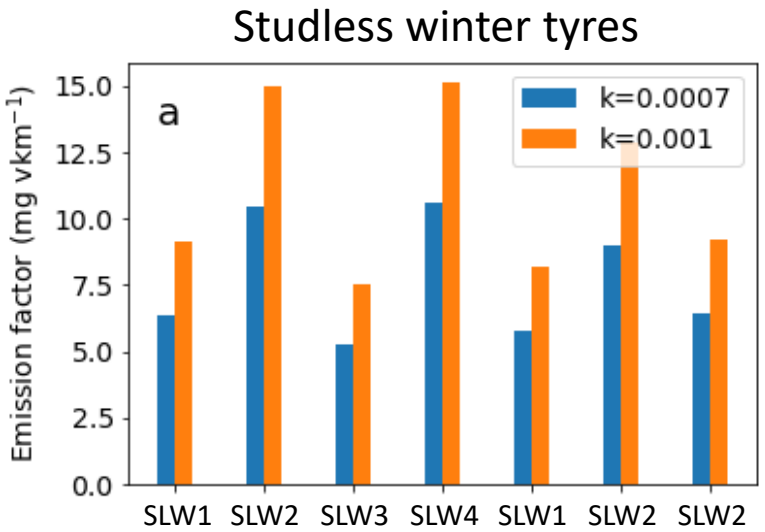
TYRE WEAR AND PM EMISSIONS…



Tyre wear PM10 emissions (mg/vkm)	
Passenger car	2-15
Heavy duty vehicle	tens to hundreds (very variable number of tyres on an HDV)





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ROAD WEAR EMISSIONS

depend on:

- Wear resistance of paving
  - Road material and construction
  - State of road surface
- Tire type (especially use of studded tires)
- Traffic properties (amount, speed, weight composition etc.)
- Interaction with material on road surface
  - ”Sand-paper effect” - traction sand and road dust wearing the pavement surface under tyres

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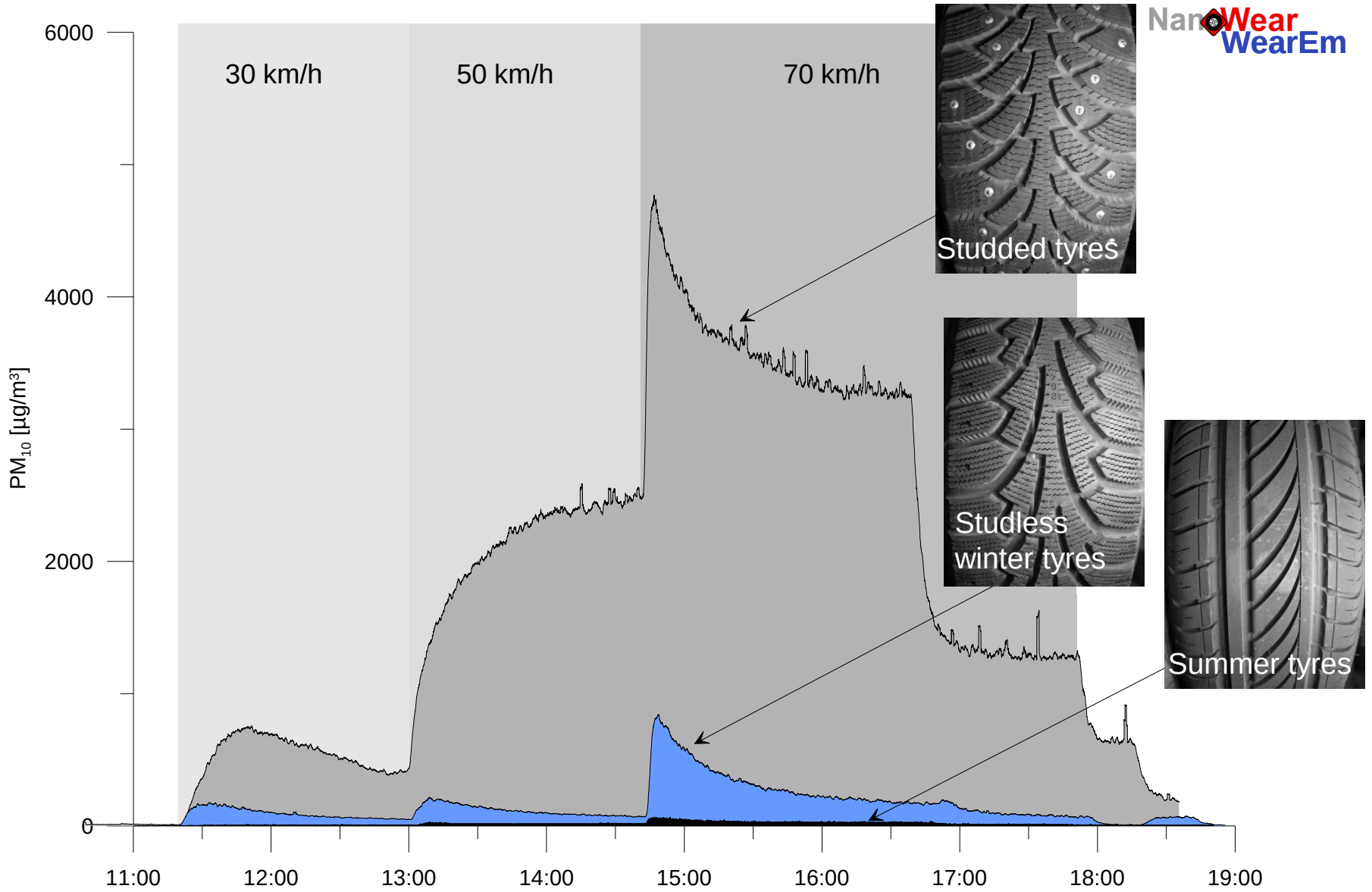
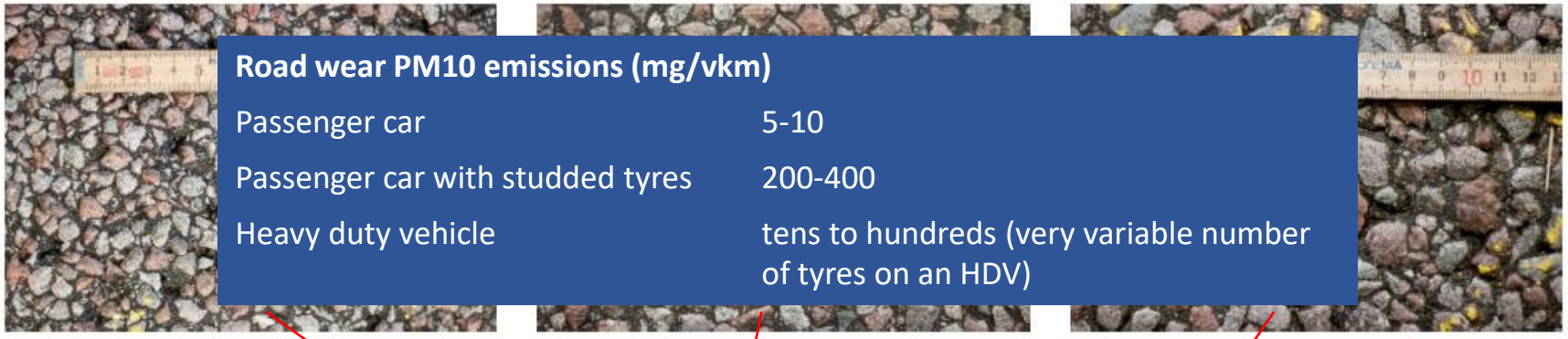
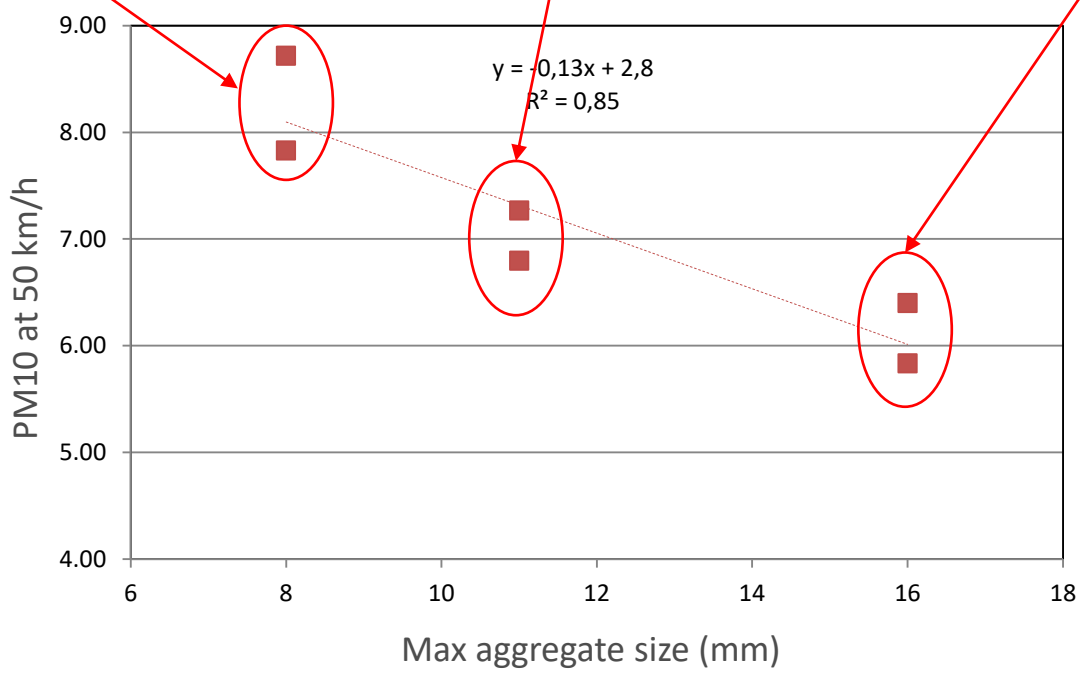
TIRE TYPES INFLUENCE ROAD WEAR PM_{10} EMISSION



MAXIMUM AGGREGATE SIZE REDUCE ROAD WEAR PM10 EMISSON



Road wear PM10 emissions (mg/vkm)	
Passenger car	5-10
Passenger car with studded tyres	200-400
Heavy duty vehicle	tens to hundreds (very variable number of tyres on an HDV)



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ROAD DUST RESUSPENSION

depends on:

- Source strengths (wear, road operation, deposition)
- Loss and redistribution processes
- Crushing and aggregation
- Surface texture
- Traffic properties
- Surface conditions (humidity)

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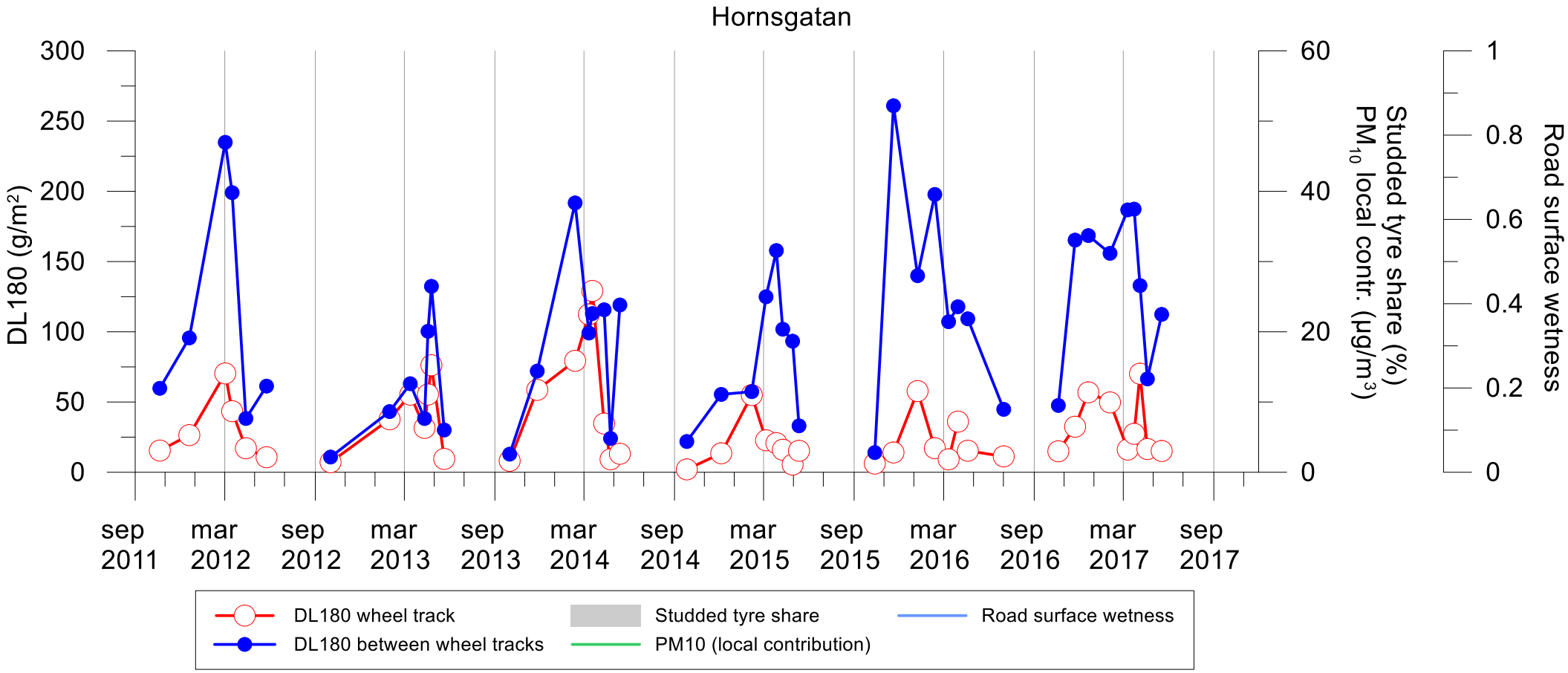
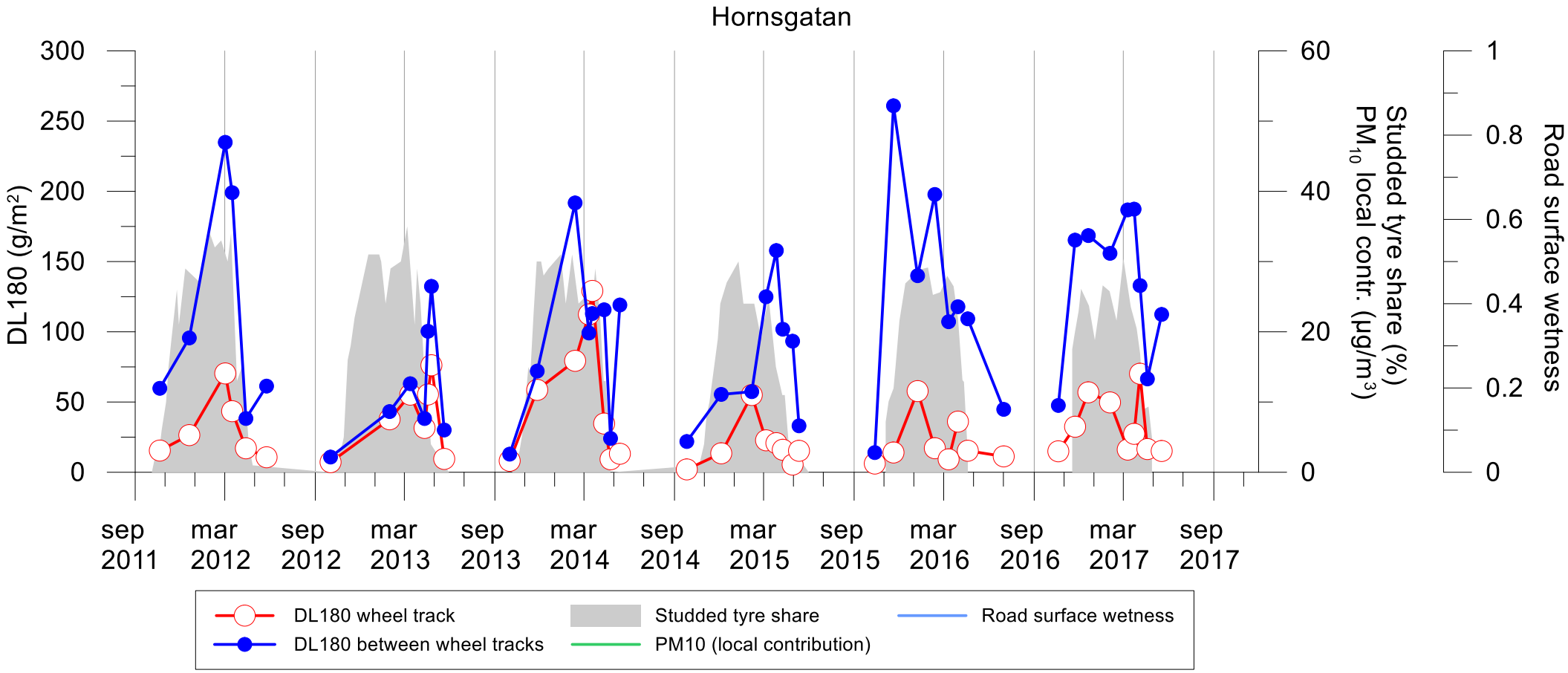
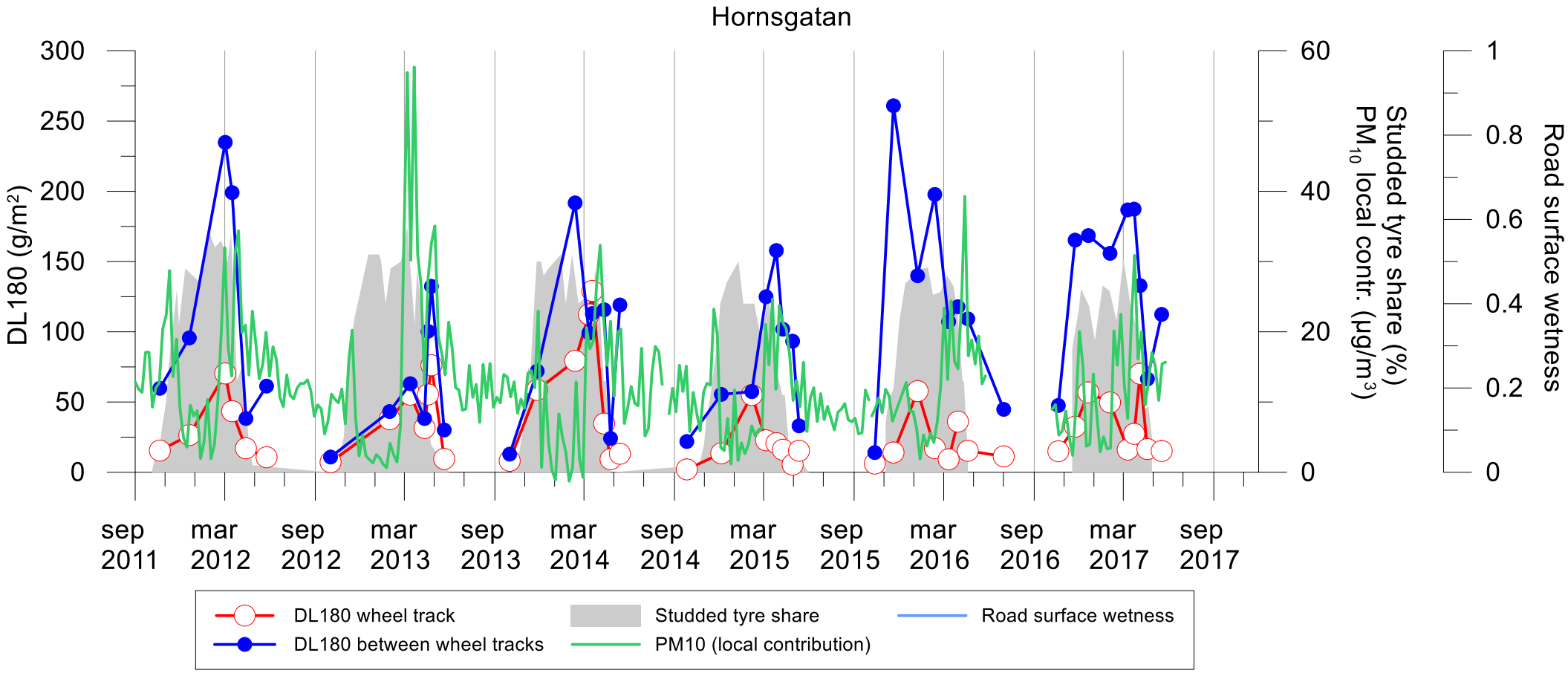
ROAD DUST LOAD, HUMIDITY AND PM10



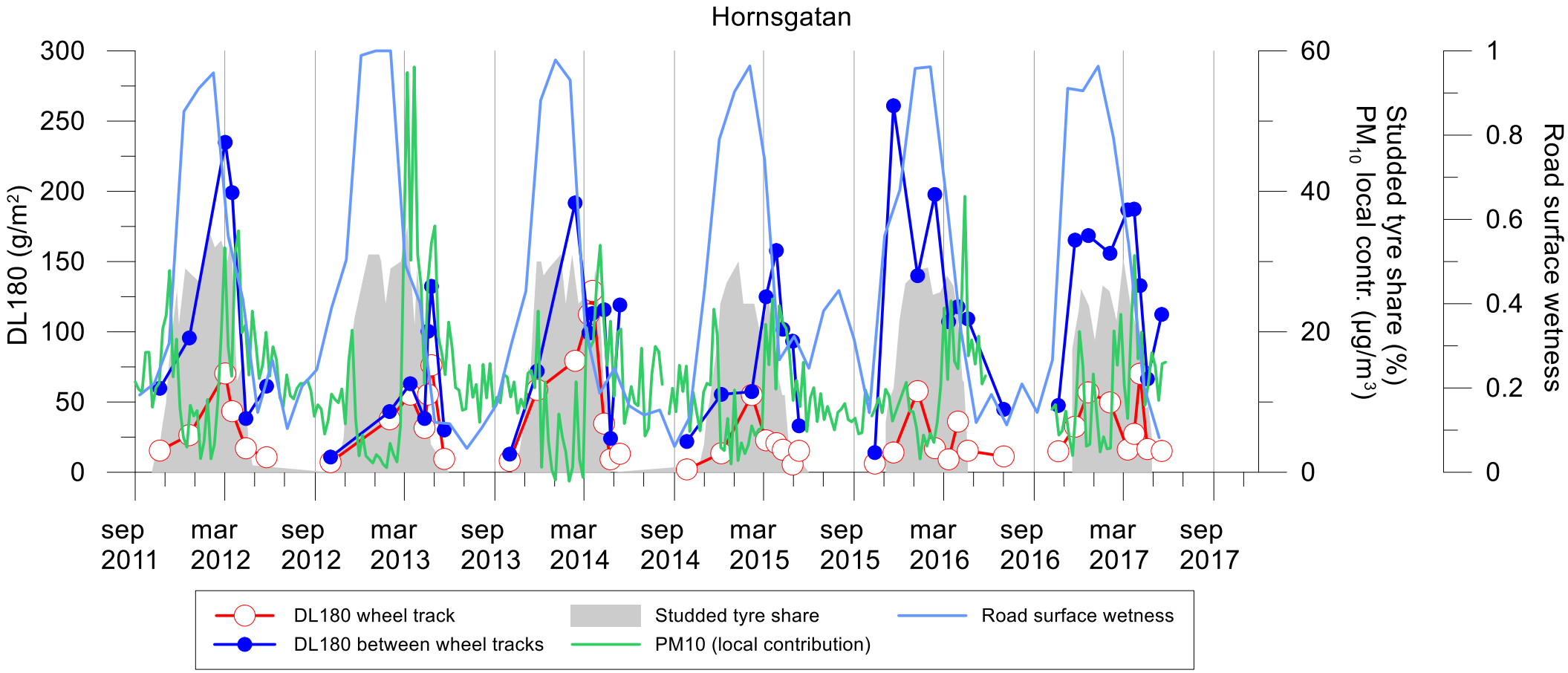
ROAD DUST LOAD, HUMIDITY AND PM10



ROAD DUST LOAD, HUMIDITY AND PM10



ROAD DUST LOAD, HUMIDITY AND PM10



Resuspension PM10 emissions (mg/vkm)

tens to thousands (HDV:s much higher, but depends on road dust load)

CONCLUSIONS

- Non-exhaust from the tyre and road interface is a large, increasing and unregulated source for air pollution
- Non-exhaust PM emissions from similar to MUCH(!) higher per vkm than from exhaust
- Emissions, and consequently also mitigation possibilities, depend on a vast range of factors
- Many ongoing initiatives, but a lot to learn.

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Thanks!

Contact:
mats.gustafsson@vti.se
www.vti.se/en search for ”air quality” and/or ”microplastics”