PEMS 10th Annual International Conference

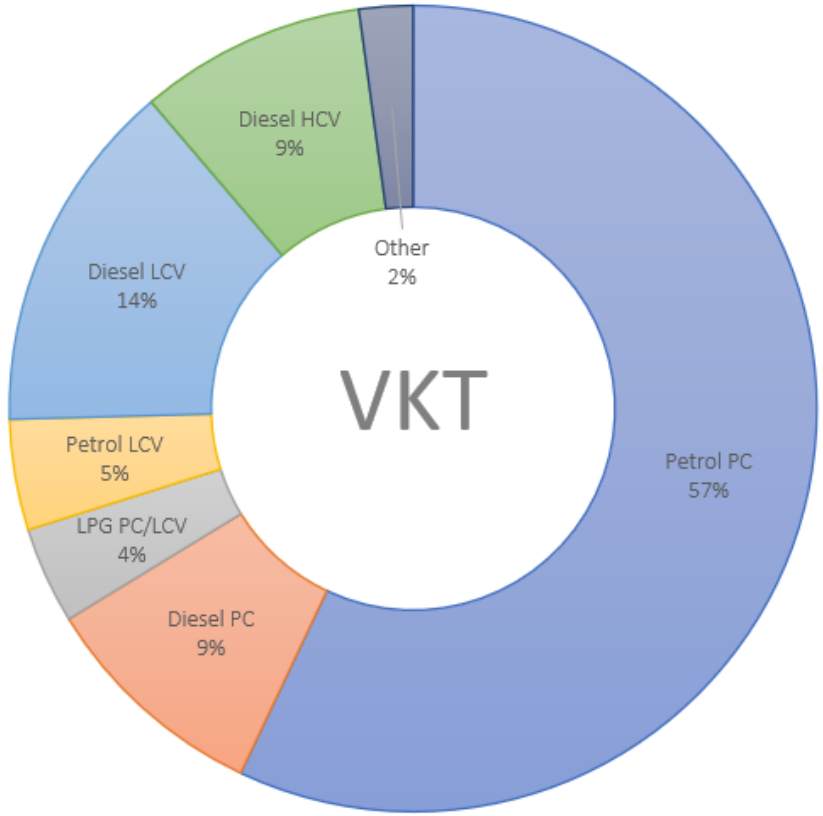
# An overview of measuring and modelling real-world vehicle emissions in Australia

PEMS 2021 Conference USA

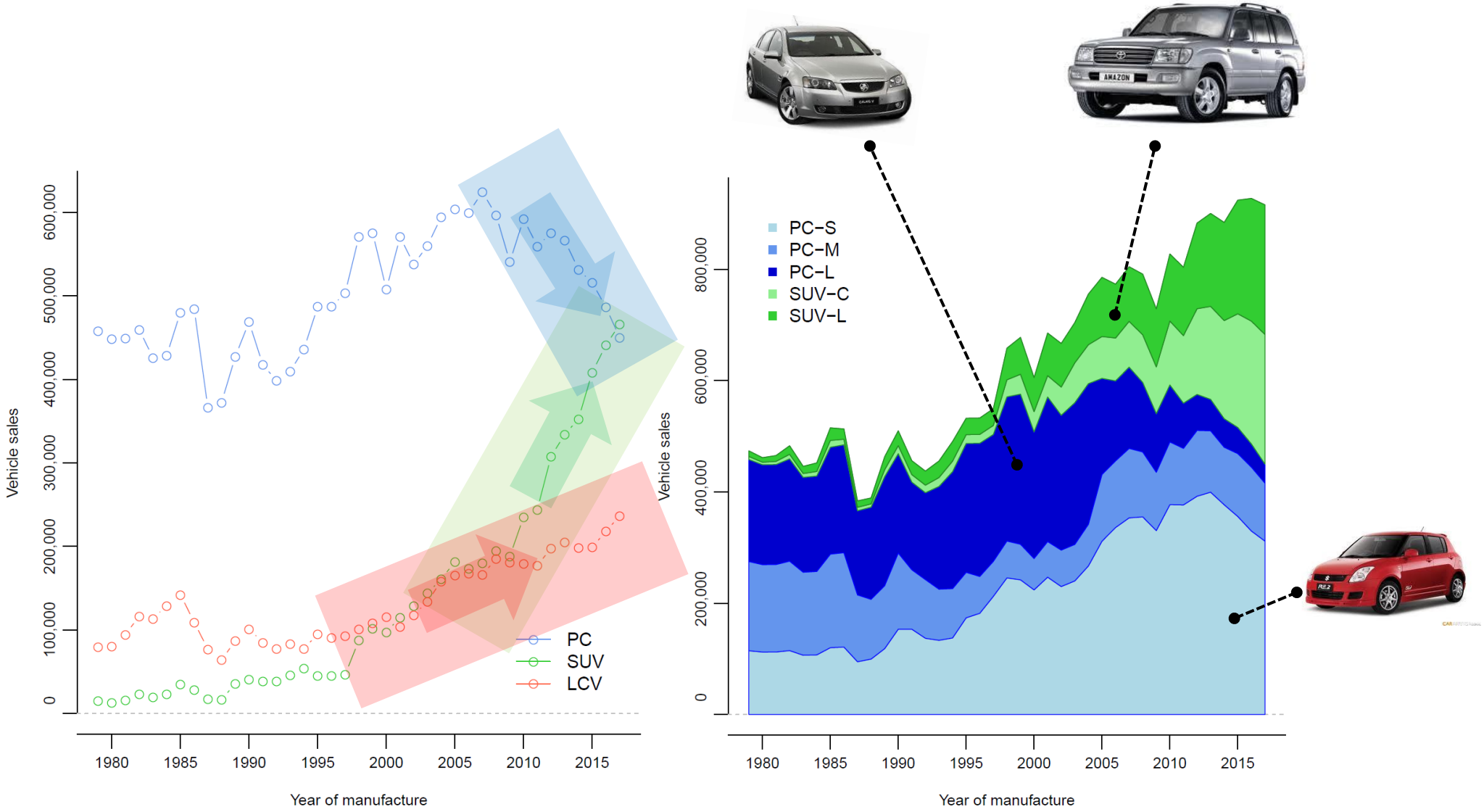
A/A Prof Dr Robin Smit, 11 March 2021

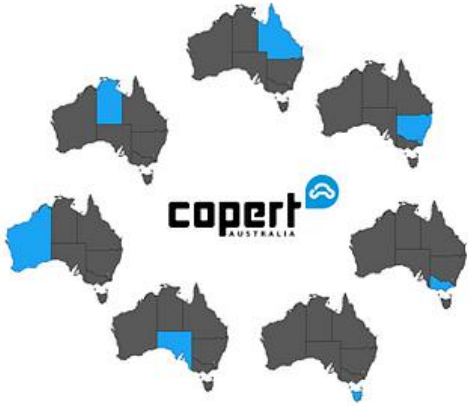
# Australian on-road fleet – some statistics

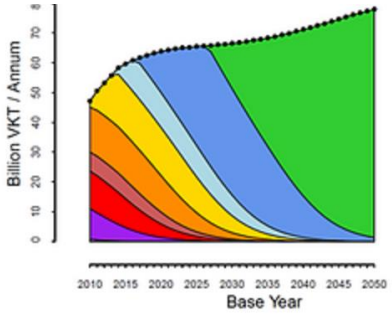
- About 19 million vehicles (2018)
- PV petrol ~ 60% total VKT (about 25% SUV)
- PV Diesel ~ 10% total VKT (about 75% SUV)
- LCV ~ 20% total VKT (about 75% diesel)
- LPG LDV ~ 5%
- Diesel trucks and buses (~10%)

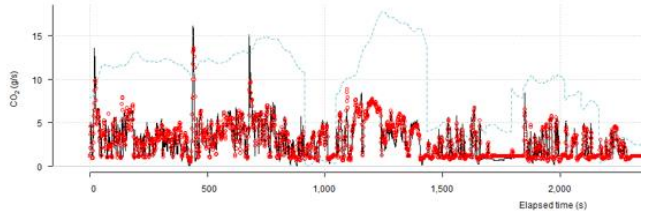


# Fleet model = essential





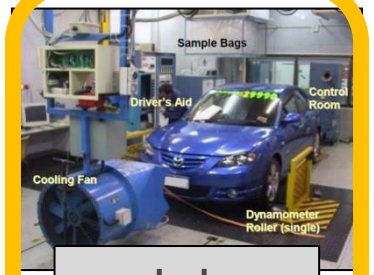

copert AUSTRALIA

AFM

POP
vehicle emission simulator

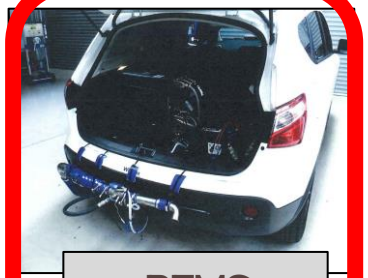
## Emission Modelling

## Emission Measurement




Lab

Tunnel



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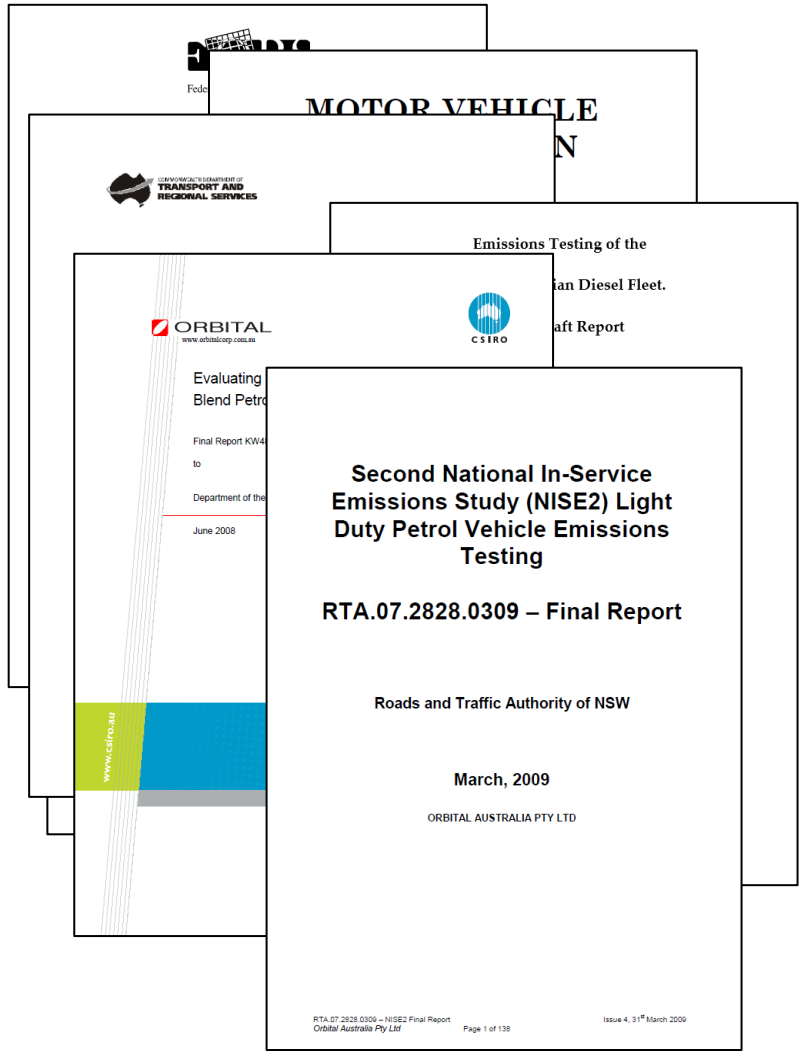
On-road

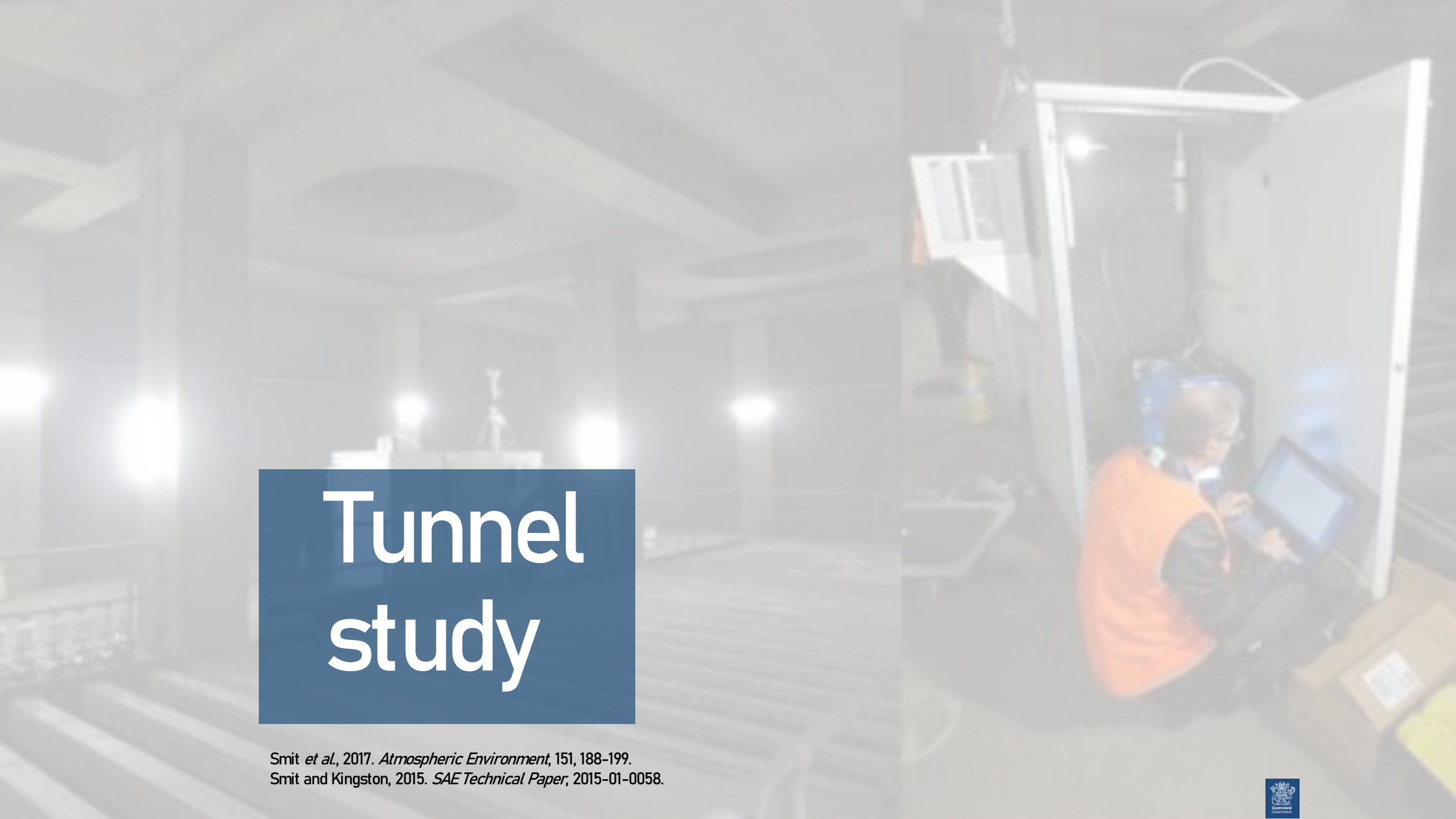
# Measuring vehicle emissions – Australia

- Several in-service vehicle emission test programs have been conducted in Australia (laboratory, chassis dyno):
  - 1996, NISE1, 634 vehicles (petrol)
  - 1997, NISE-LPG, 37 vehicles (LPG)
  - 2000, DNEPM, 75 vehicles (diesel)
  - 2001, CVES, 46 vehicles (petrol, LPG)
  - 2008, SATR, 393 vehicles (diesel)
  - 2008, EthS, 21 vehicles (petrol, E5/10)
  - 2009, NISE2, 410 vehicles (petrol)
- This large combined database has enabled the development of Australian vehicle emission software.



# Vehicle emission measurements in Australia

- Australia lacks a nationally coordinated vehicle emission and model development program, in contrast to e.g. EU, Asia, USA.
- This poses challenges with regard to:
  - consistent
  - up-to-date
  - reliable assessment of motor vehicle emissions.
- 2015 to date – targeted measurement programs to validate and update models.
- Real-world vehicle emission measurements are essential for:
  - accurate emission estimation
  - identification of emerging new issues.

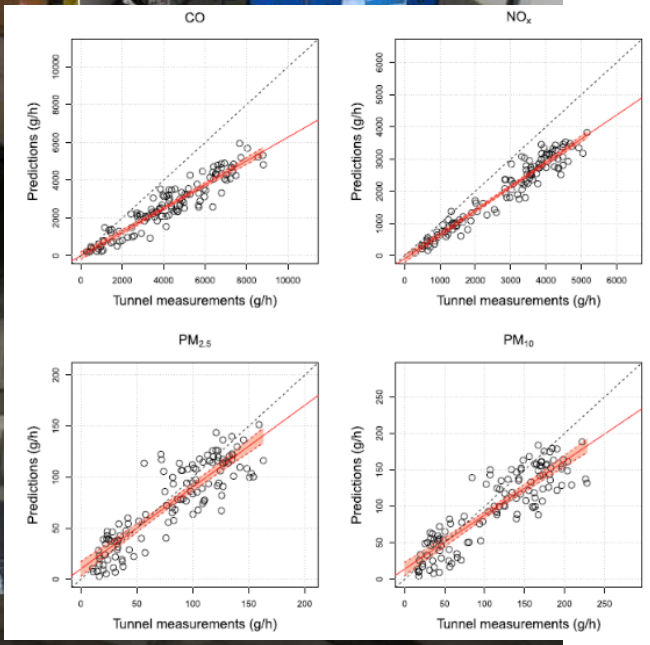


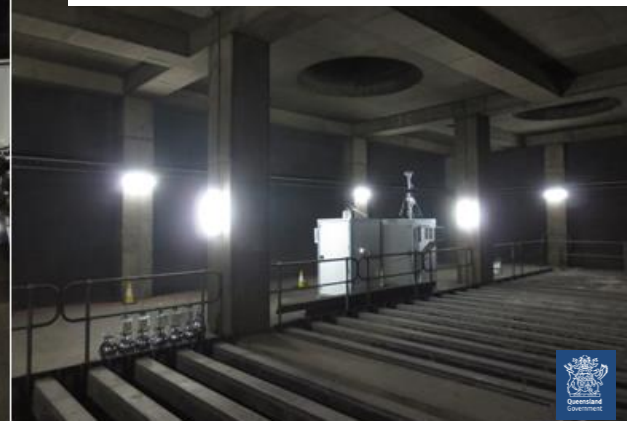
# Tunnel study

Smit *et al.*, 2017. *Atmospheric Environment*, 151, 188-199.
Smit and Kingston, 2015. *SAE Technical Paper*, 2015-01-0058.

# Tunnel study

- CLEM7 tunnel BNE 2014
- Validation COPERT Australia + PΔP software.
- Prediction errors:
  - PM within 20%
  - NOx and CO within 40%
- Speciated hydrocarbons large uncertainty.



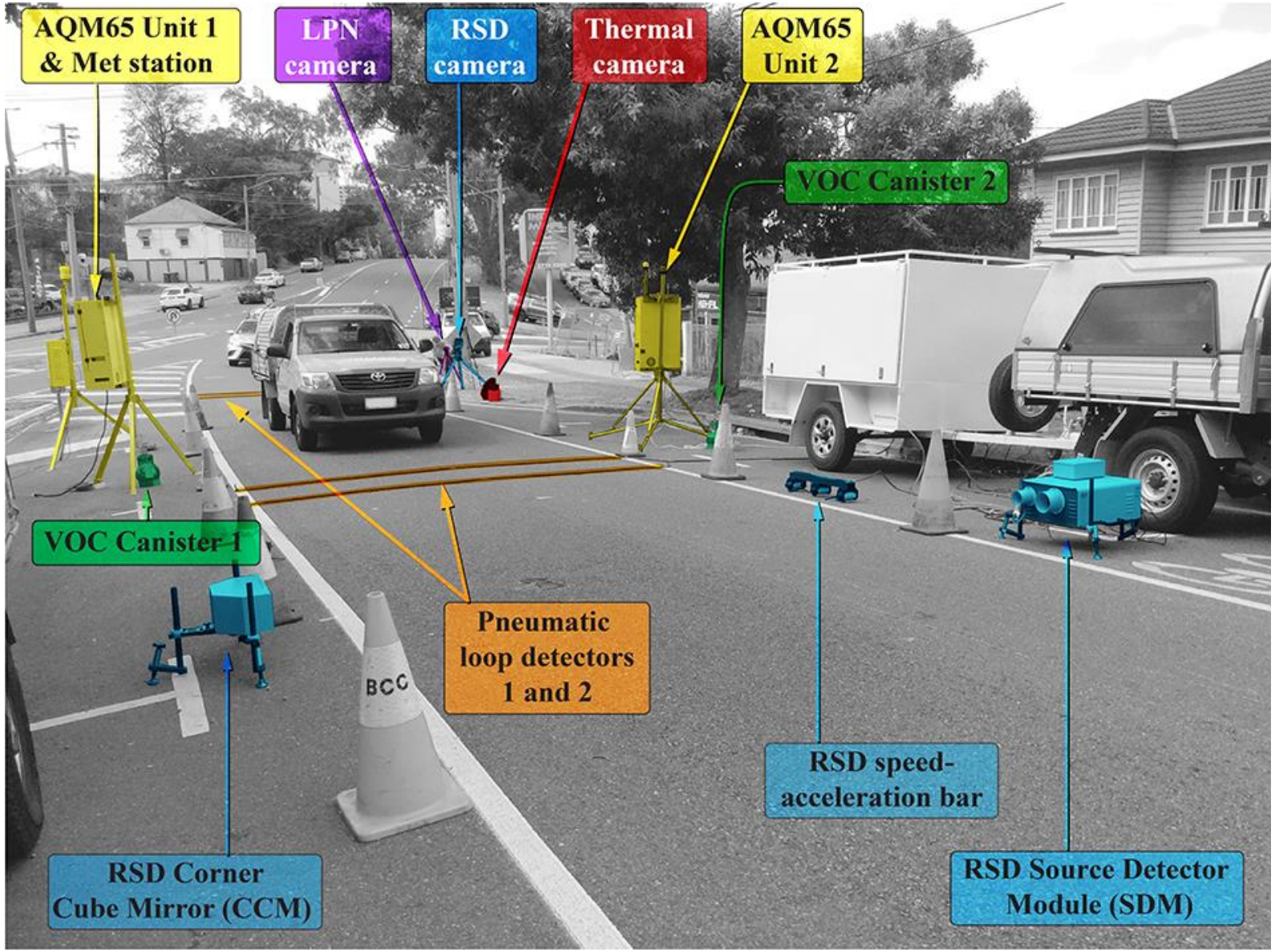




# Remote sensing

Smit *et al.* 2021. *Atmospheric Environment*, accepted for publication.
Smit and Kennedy, 2020. *Atmosphere*, 11 (294), 1-17.
Smit *et al.* 2019. *Atmospheric Environment*, 218, 1-13.
Smit and Kingston, 2019. *Atmosphere*, 10 (516), 1-17.
Smit and Kingston, 2019. *Air Quality and Climate Change*, 53 (1), 22-26.

# Remote sensing

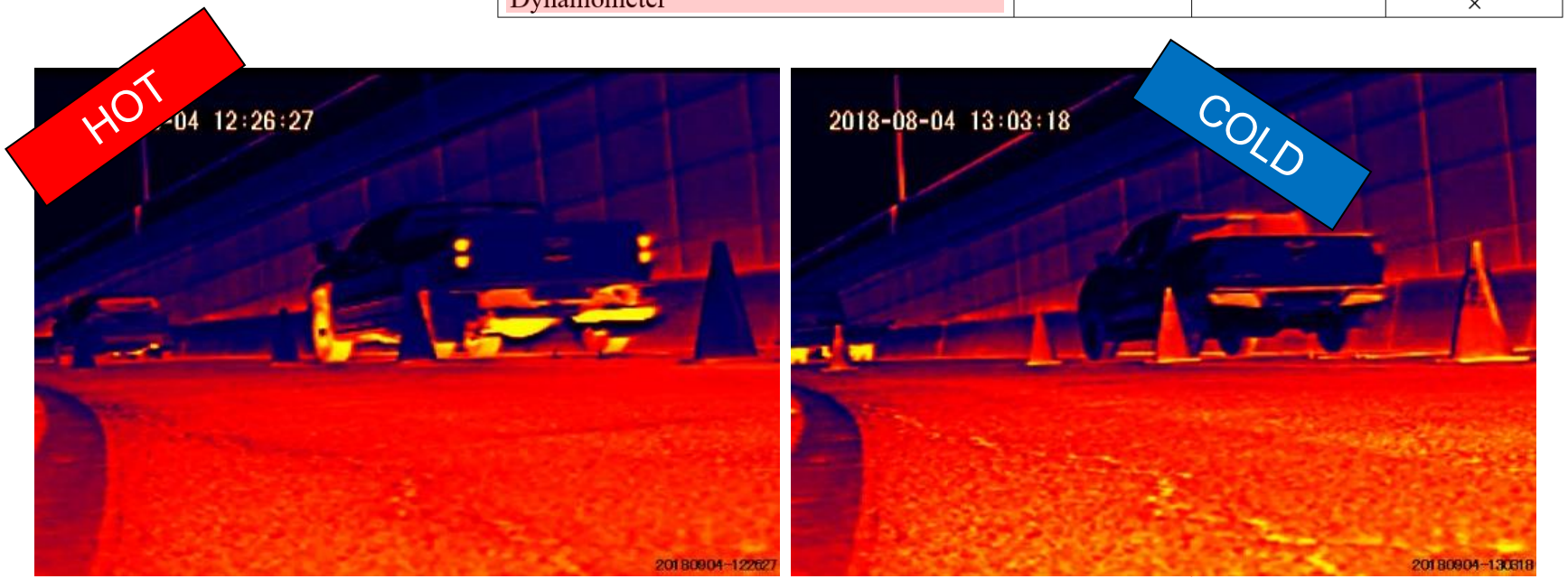
Combined PER-BNE database (100,000+ valid emission measurements) 2009-2019



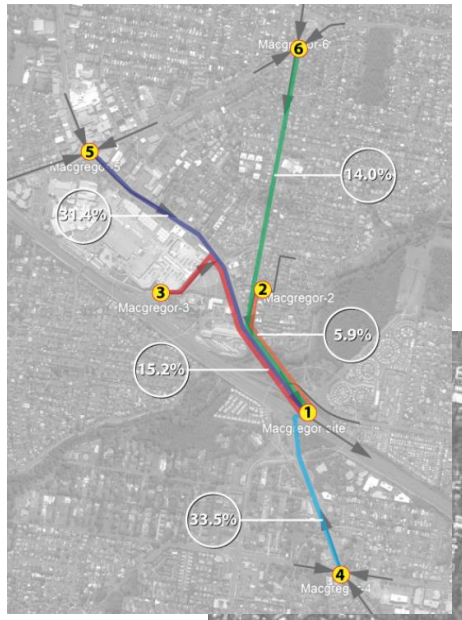
# Remote sensing

Combined PER-BNE database (100,000+ valid emission measurements) 2009-2019

| Equipment | Site | | |
|---|---|---|---|
| | Urban | Freeway | Commercial |
| Accuscan RSD4600 | × | × | × |
| Reconyx MS7 Microfire | × | × | × |
| Noptic Thermal Camera | × | × | × |
| Pneumatic Loop Detectors | × | × | |
| Bluetooth MAC address units | × | × | |
| AQM65, Summa Canisters, Met Station | × | | |
| Dynamometer | | | × |



# Remote sensing





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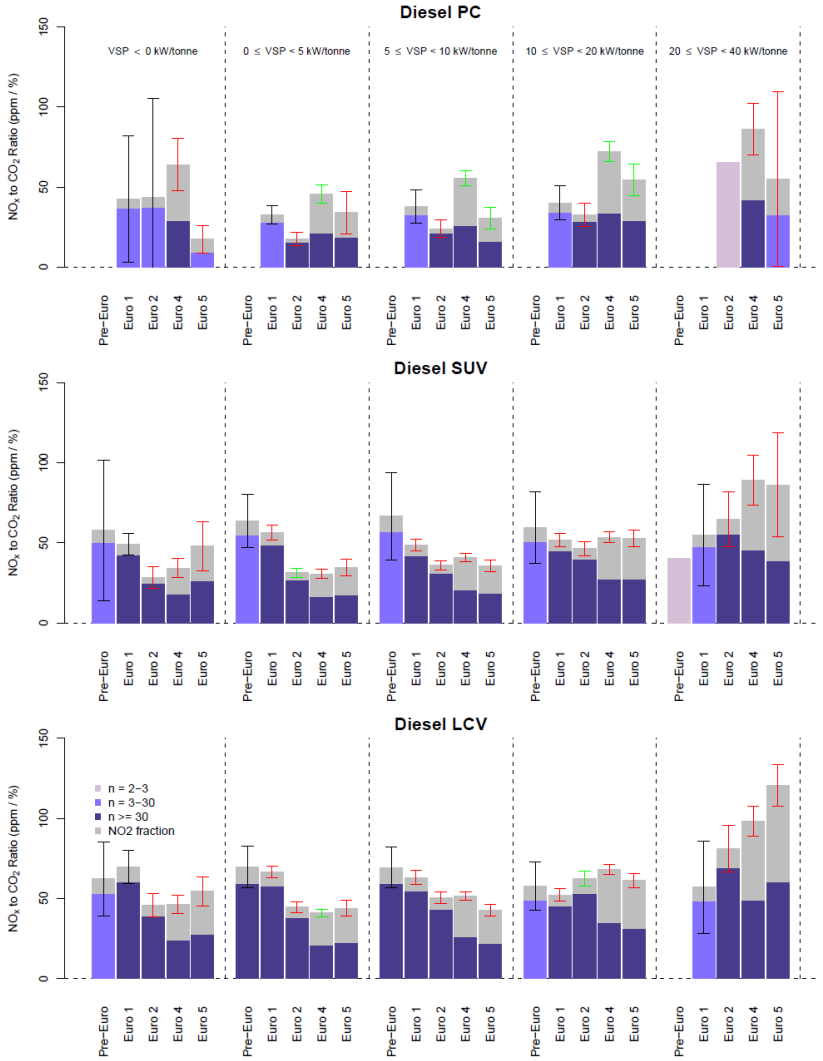
# Over a decade of remote sensing data




- Poor real-world $NO_x$ performance of Euro 4/5 light-duty diesel vehicles observed around the world is also evident in Australian measurements.
- General lack of statistically significant reduction in NOx/CO2 ratio with progressive Euro standards for diesel LDVs.
- UVsmoke - pooled data (Euro 5) for the two most recent years of manufacture (2017-2018) suggest that 1% of one-two year old diesel SUVs and 2% of one-two year old diesel LCVs have malfunctioning or potentially modified DPFs.

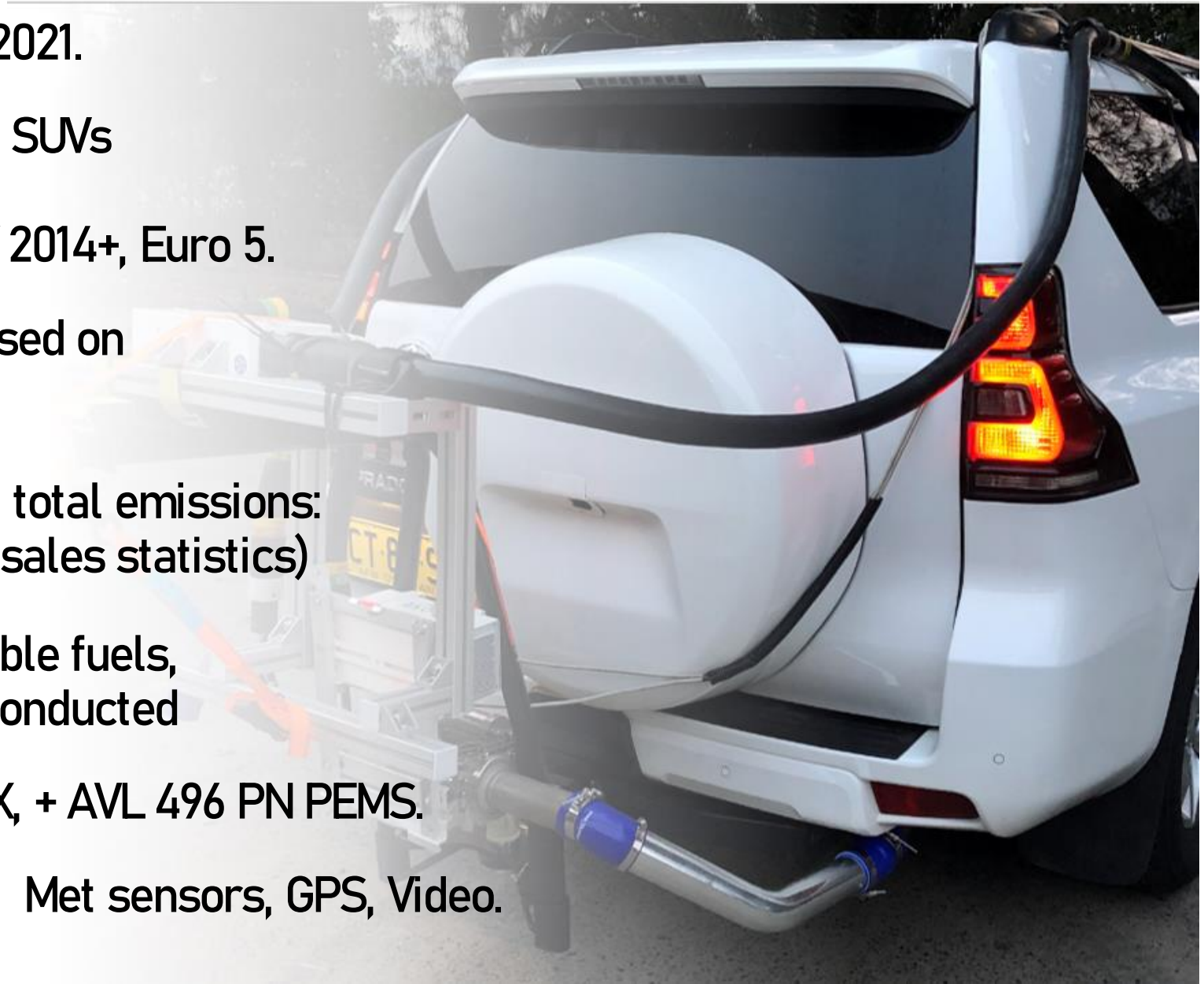
Euro 2 > 2003, Euro 4 > 2007, Euro 5a > 2014, Euro 5b > 2017


BOSCH
ABSLT TPS(%) 82.4
ACC POS D(%) 16.1
ACC POS E(%) 32.2
BARO PRS(KPa) 100.0
BP_A_CMD(KPa) 95.7
CACT 11(°C) 51
CALC LOAD(%) 0.0
CLR DIST(Km) 10887
CLR TIME(h:m) 4:50:55
CLR TRPS 214
Throttle Position
Info Scan

# PEMS

# On-board emissions testing with PEMS

- Completed 9 March 2021.
- 5 compact and large SUVs (petrol/diesel), GVW ~ 2-3 tonne, MY 2014+, Euro 5.
- Sample selection based on vehicle sales and GHG emissions data (contribution to fleet total emissions: 'emission-weighted' sales statistics)
- Commercially available fuels, fuel quality testing conducted
- AVL 493 Gas PEMS iX, + AVL 496 PN PEMS.
- OBD II scanning tool, Met sensors, GPS, Video.



# On-board emissions testing with PEMS

- Test protocol developed - broadly RDE compliant.
  - Cold start test (urban, rural, motorway) D = 88 km
  - 4 hot start tests with 2 hours, then 5, 15, 30 minutes engine off periods (D = 4 km)
  - Coast-down testing
- Data analysis: will include machine learning methods for anomaly detection and data quality control.
- Collaboration and data sharing = welcome.
- robin.smit@transport-e-research.com