

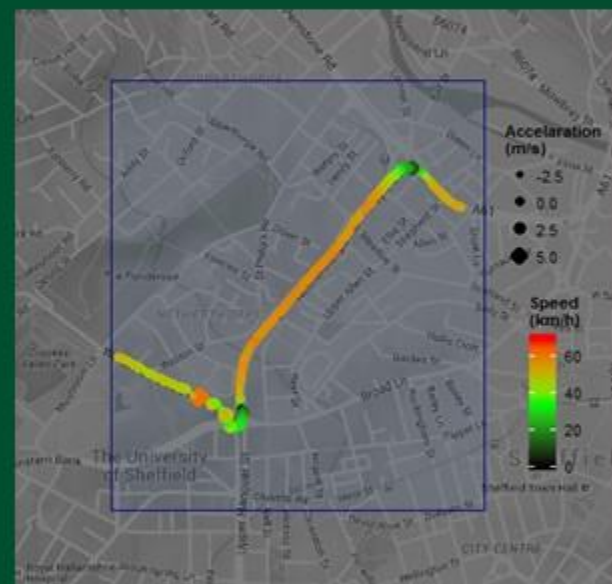
Welsh Air Quality Forum  
Caerphilly Council Chamber 2016

# Air Quality Research Using Telematics Data

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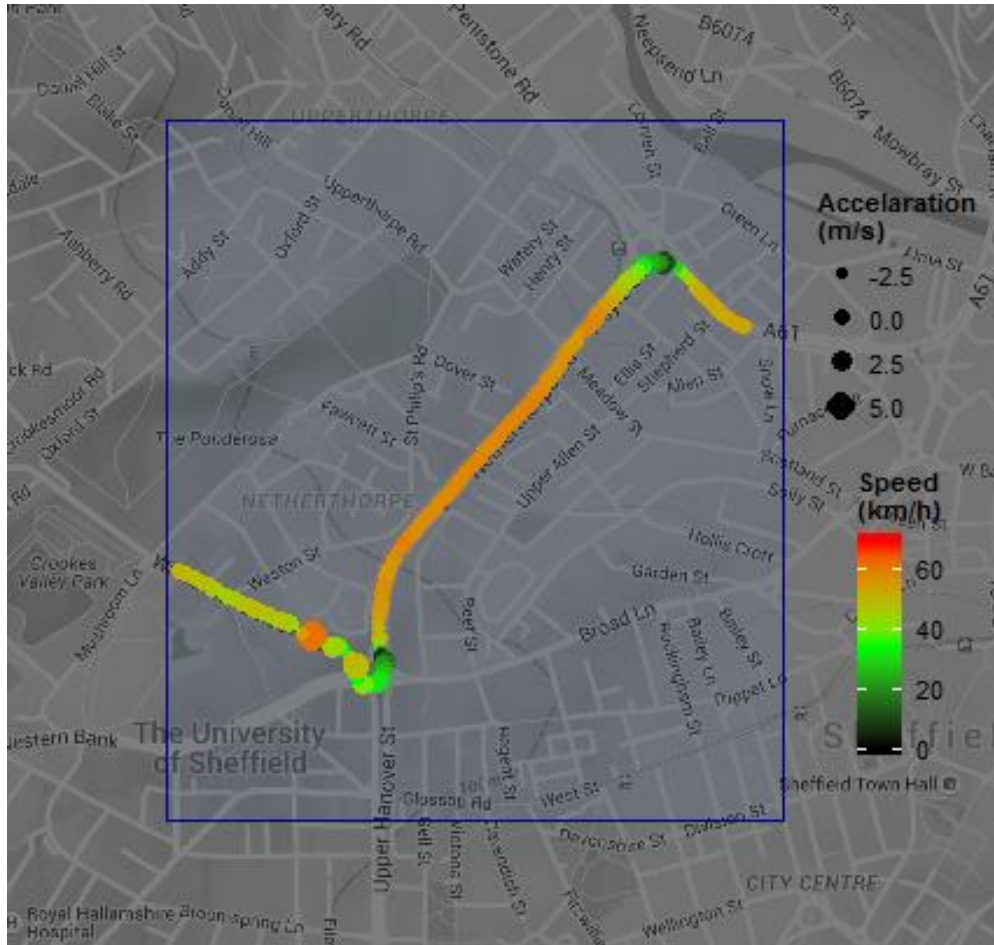
**Dr Luc Pellecuer** | Visiting Researcher ITS & ETS, Montreal, Canada

**Dr Sam Chapman** | Co-founder  **THE FLOOP**

**ITS**

# BIG telematics data

## Vehicle tracking



## Sources:

- ▶ Fleet surveillance e.g.
  - Eddie Stobbart
  - Taxis\*
  - Insurance industry
    - ▶ GPS and CAN link 'black box' tracking
    - ▶ Second-by-second (1Hz) data
    - ▶ Young driver bias
    - ▶ Anonymised

\* Nyhan, M., Sobolevsky, S., Kang, C., Robinson, P., Corti, A., Szell, M., Streets, D., Lu, L., Britter, R., Barrett, S., Ratti, C. 2016. Predicting vehicular emissions in high spatial resolution using pervasively measured transportation data and microscopic emissions model. Atmospheric Environment 140 (2016) 352-363. <http://dx.doi.org/10.1016/j.atmosenv.2016.06.018>

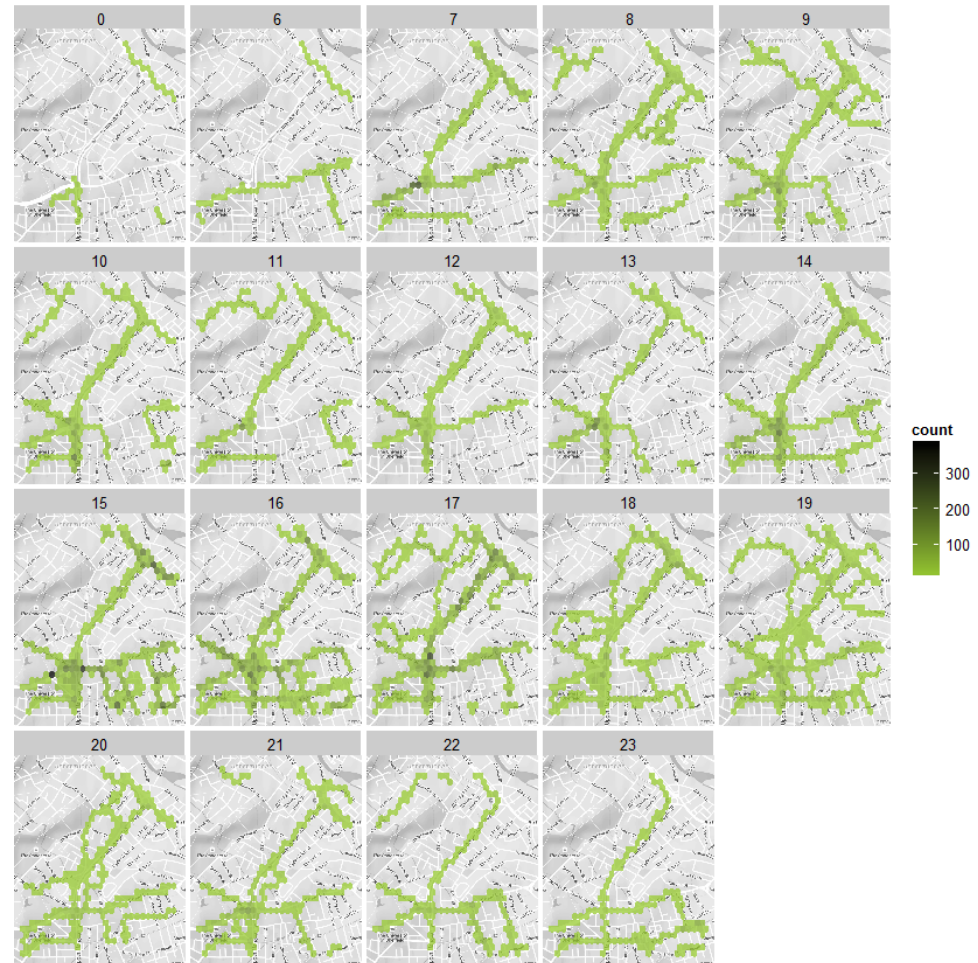
# BENEFITS

## BIG telematics data

Emission assessments account for local, real-driving conditions:

- ▶ Network-wide: No boundaries
- ▶ Vehicle acceleration, deceleration, cruising & idling
- ▶ Variability in traffic flow
  - Month of year
  - Day of week
  - Hour of day
  - Holidays
  - Special events
  - Weather
  - etc

FIGURE | Sample weekday GPS data by hour



# CASE STUDIES

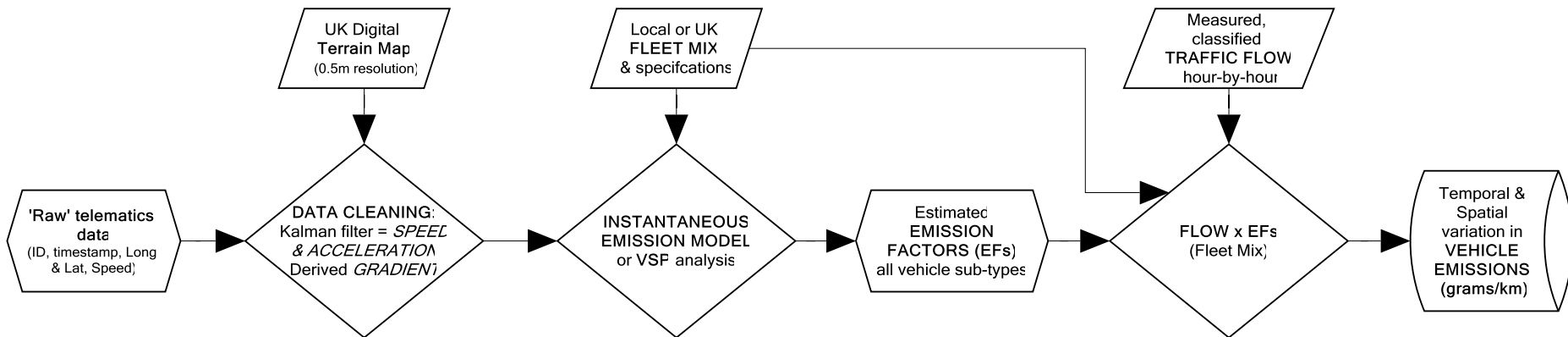
BIG telematics data

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1. **Variable Speed Limits & 'Smart' Motorway operation**
  - ▶ One calendar year
  - ▶ Comparative STANDARD and SMART sections of motorway
  - ▶ Comparison of EMISSION FACTORS in the different controlled & non-controlled conditions
  
2. **Sheffield City Centre**
  - ▶ One calendar year (May 2014 – May 2015)
  
3. **Leeds BREACH area**
  - ▶ One calendar year (May 2015 – May 2016)
  - ▶ Detailed fleet analysis from ANPR study (April 2016)
  - ▶ EFs weighted by Fleet mix & Flow

# METHOD

## BIG telematics data ► vehicle emissions



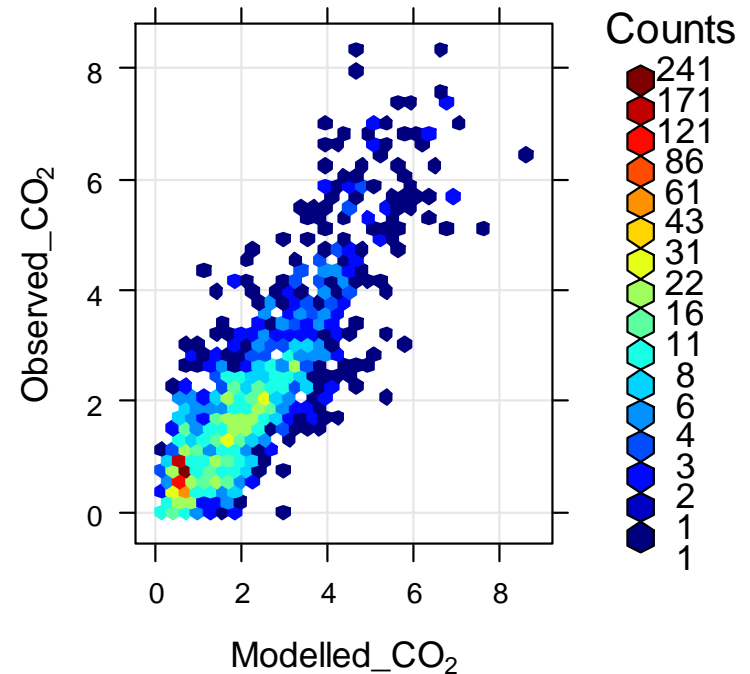
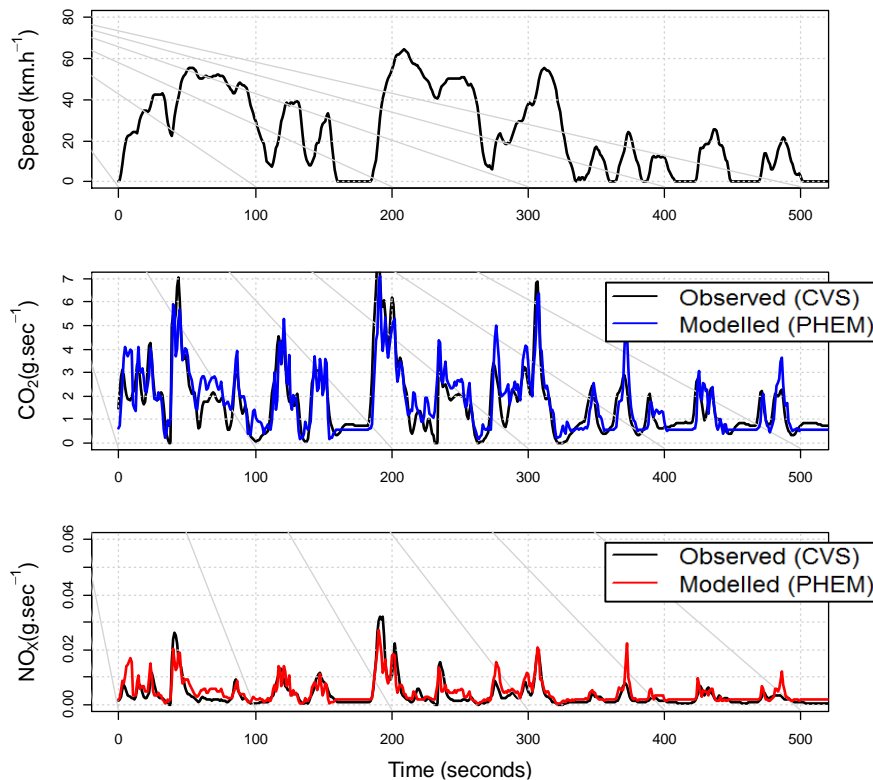


# UNDER-PINNING MODEL

## *Instantaneous Emission Model PHEM\**

Passenger car and Heavy-duty Emission Model

FIGURES | Sample time series, TfL London  
Drive Cycle, Euro 5 small family diesel

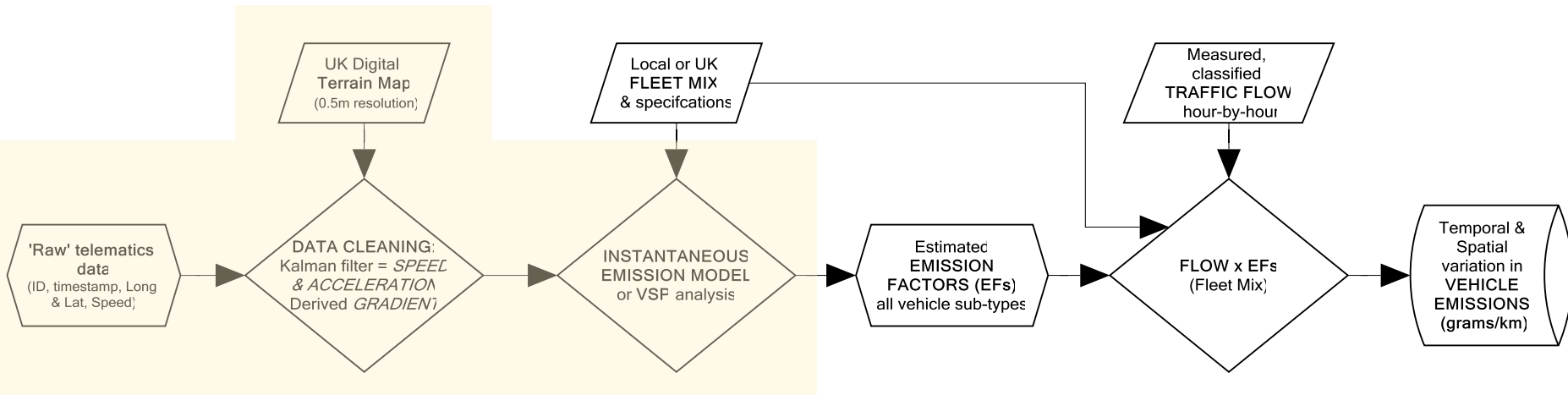


\* Zallinger, M., Tate, J., and Hausberger, S. 2008. An instantaneous emission model for the passenger car fleet. Transport and Air Pollution conference, Graz 2008

Moody, A., Tate, J. 2016. In service CO<sub>2</sub> and NO<sub>x</sub> emissions of Euro 6/VI cars, light- and heavy-duty goods vehicles in real London driving: Taking the road into the Laboratory. The 21st International Transport and Air Pollution (TAP) Conference, Lyon, France, May 24-26, 2016.

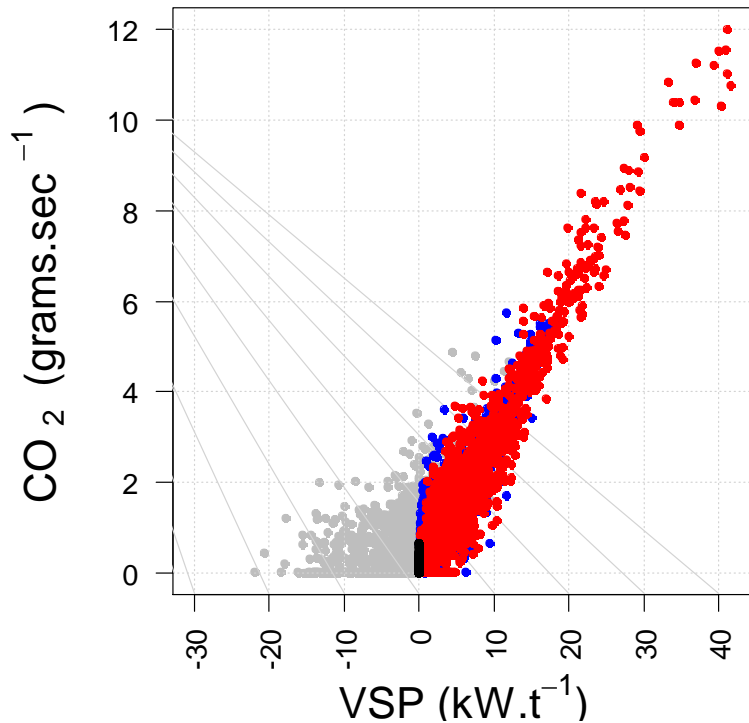
# METHOD

## BIG telematics data ► vehicle emissions

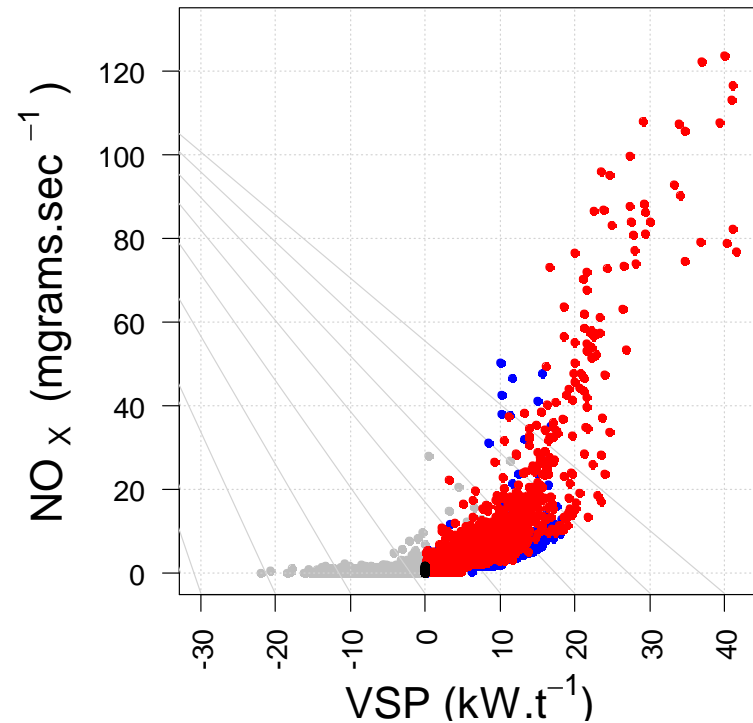


# METHOD

## Vehicle Specific Power



**VSP on CO<sub>2</sub> emission rates for an illustrative Euro 6 diesel small family car**



**VSP on NO<sub>x</sub> emission rates for an illustrative Euro 6 diesel small family car**

- |                |   |
|----------------|---|
| ● Accelerating | Acceleration > 0.1 ms <sup>-2</sup>   |
| ● Cruising     | Vehicle speed > 0.5 ms <sup>-2</sup> and Acceleration in range ± 0.1 ms <sup>-2</sup> |
| ● Decelerating | Deceleration < - 0.1 ms <sup>-2</sup> .   |
| ● Idling       | Vehicle speed < 0.5 ms <sup>-2</sup> and Acceleration in range ± 0.1 ms <sup>-2</sup> |

Moody, A., Tate, J. 2016. In service CO<sub>2</sub> and NO<sub>x</sub> emissions of Euro 6/VI cars, light- and heavy-duty goods vehicles in real London driving: Taking the road into the Laboratory. The 21st International Transport and Air Pollution (TAP) Conference, Lyon, France, May 24-26, 2016.



# BIG telematics data

## Case Study & Sample

SHEFFIELD centre  
near University:

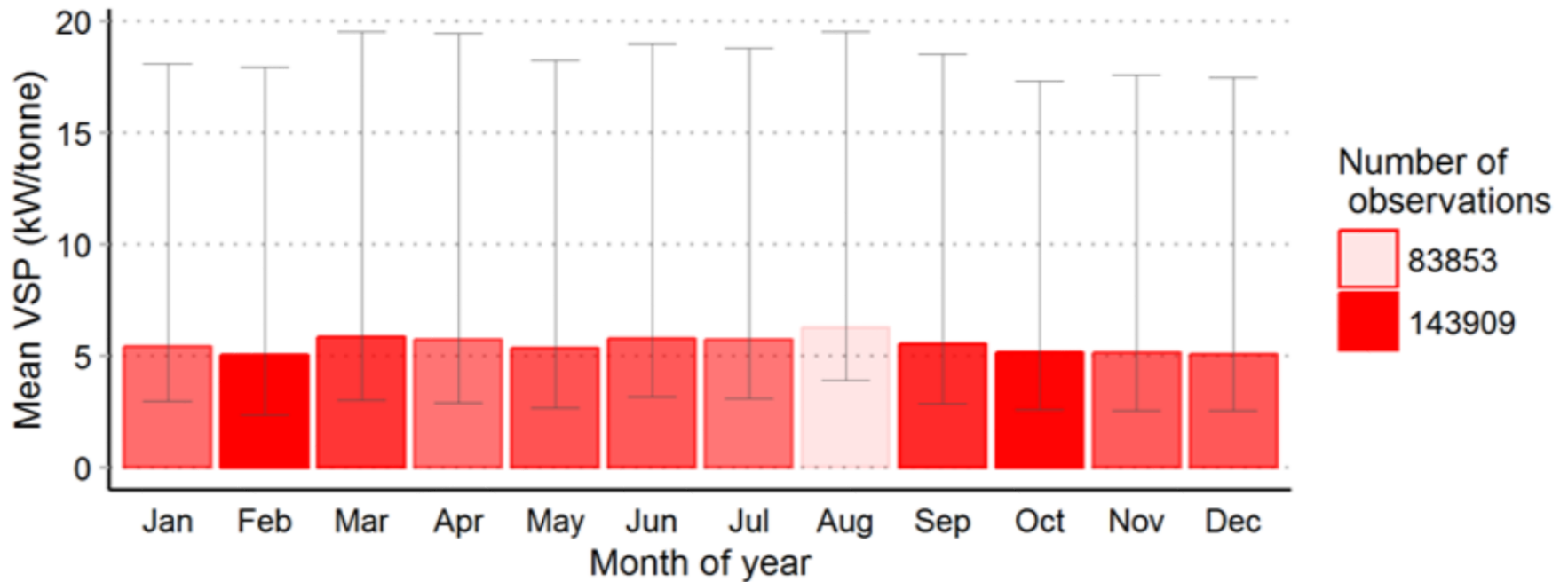
- 1 calendar year  
01/05/2014 to 30/04/2015
- Area 1.8 km<sup>2</sup>
- 34 425 journeys
- 2 440 580 records
- 15 000 km



# RESULTS

*MONTH* of the year

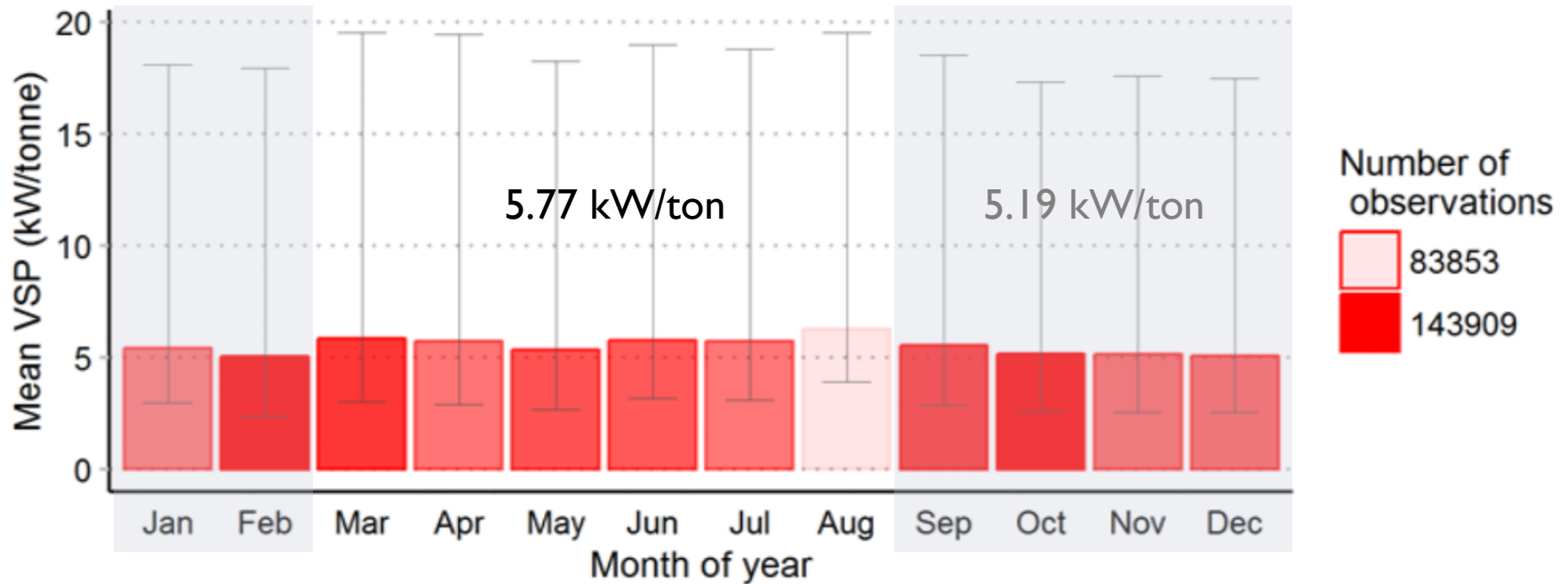
FIGURE | Variation in positive VSP with MONTH of the year



# RESULTS

*MONTH* of the year

FIGURE | Variation in positive VSP with MONTH of the year

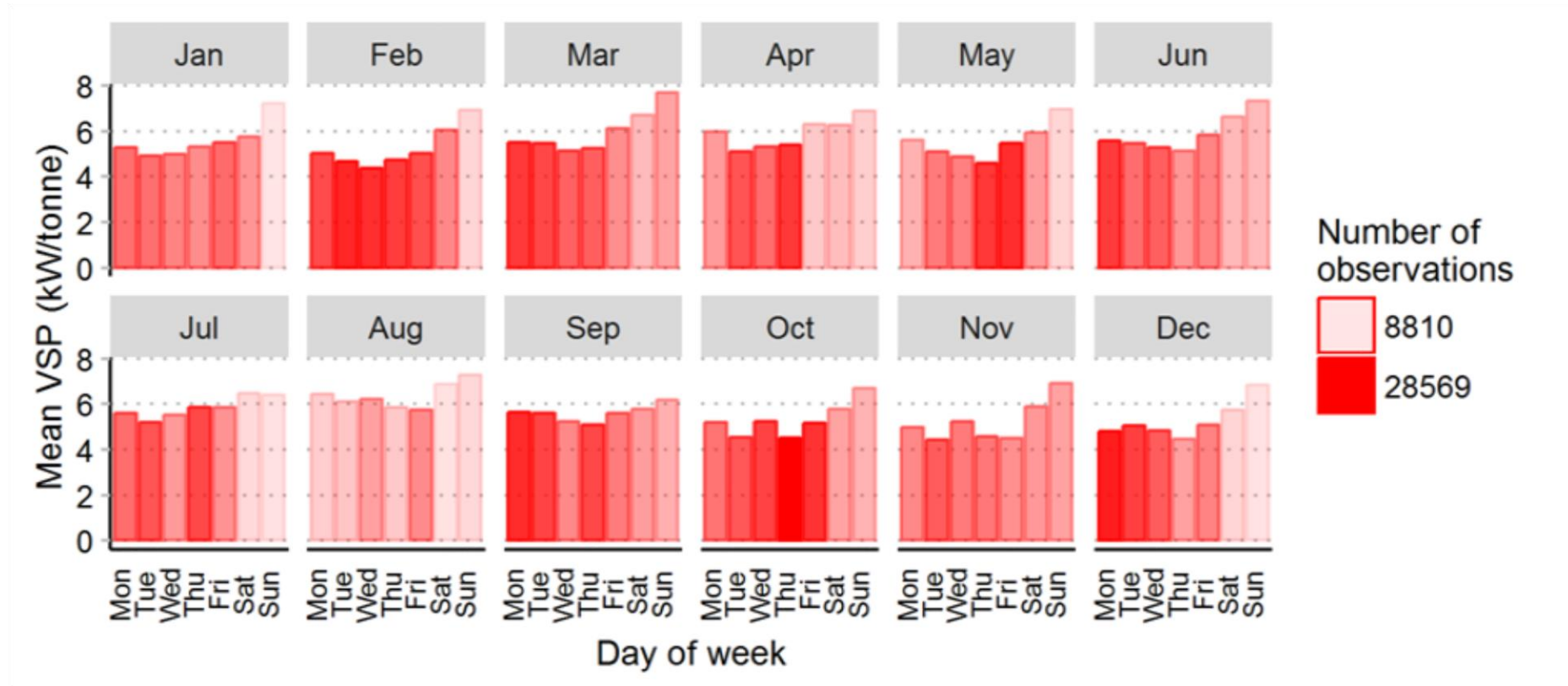


Natural driving behaviour: Less constrained by poor weather conditions?  
Average positive VSP +11% 'summer' months

# RESULTS

DAY of week

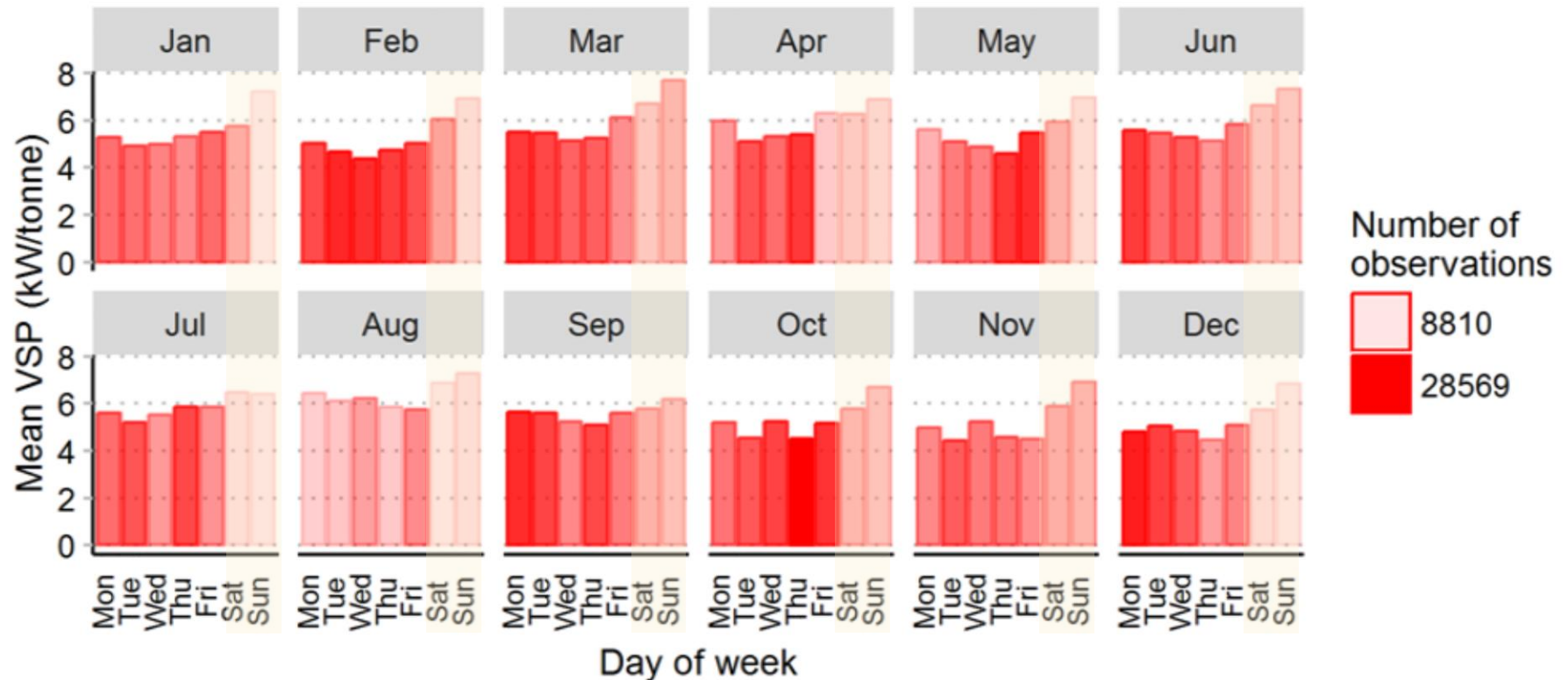
FIGURE | Variation in positive VSP with DAY of the week



# RESULTS

DAY of week

FIGURE | Variation in positive VSP with DAY of the week



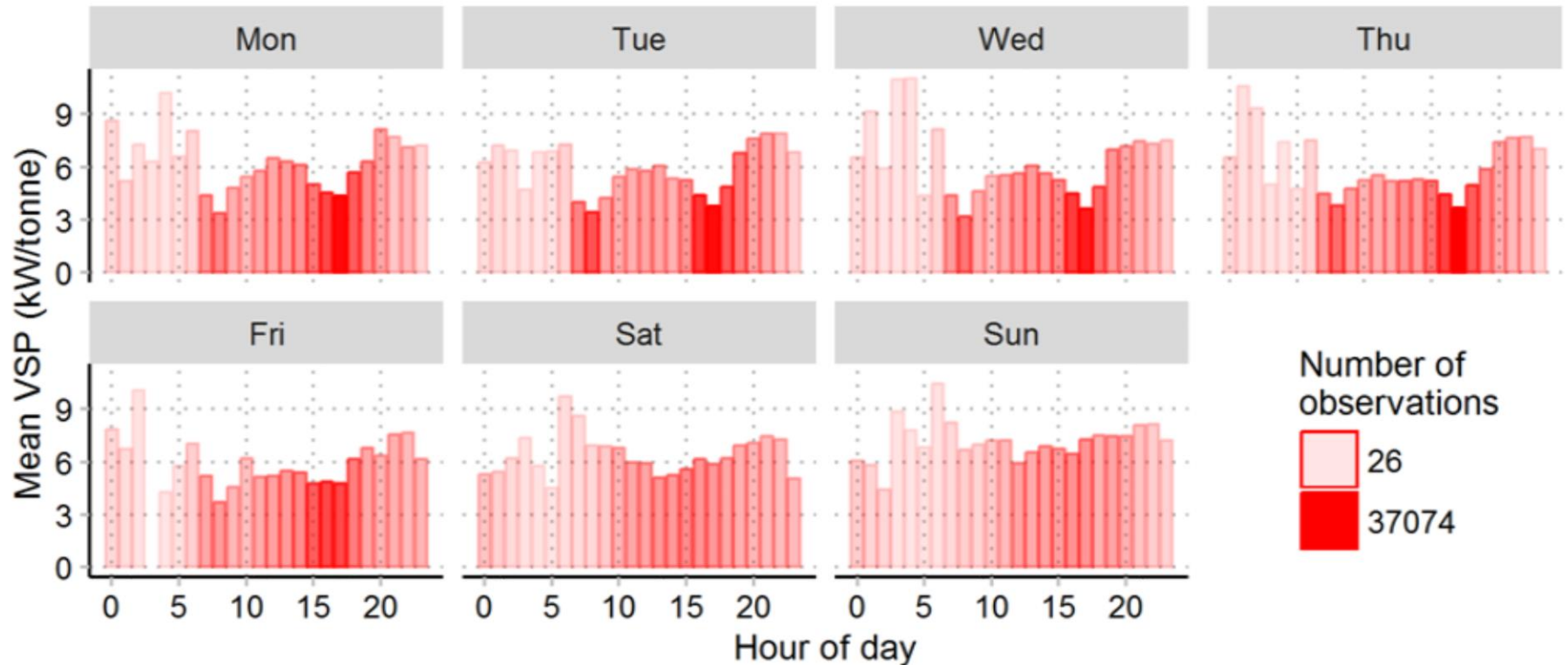
Weekend driving: Less constrained by traffic?

Average positive VSP +24% on weekends

# RESULTS

*HOUR of day*

FIGURE | Variation in positive VSP with HOUR of the day

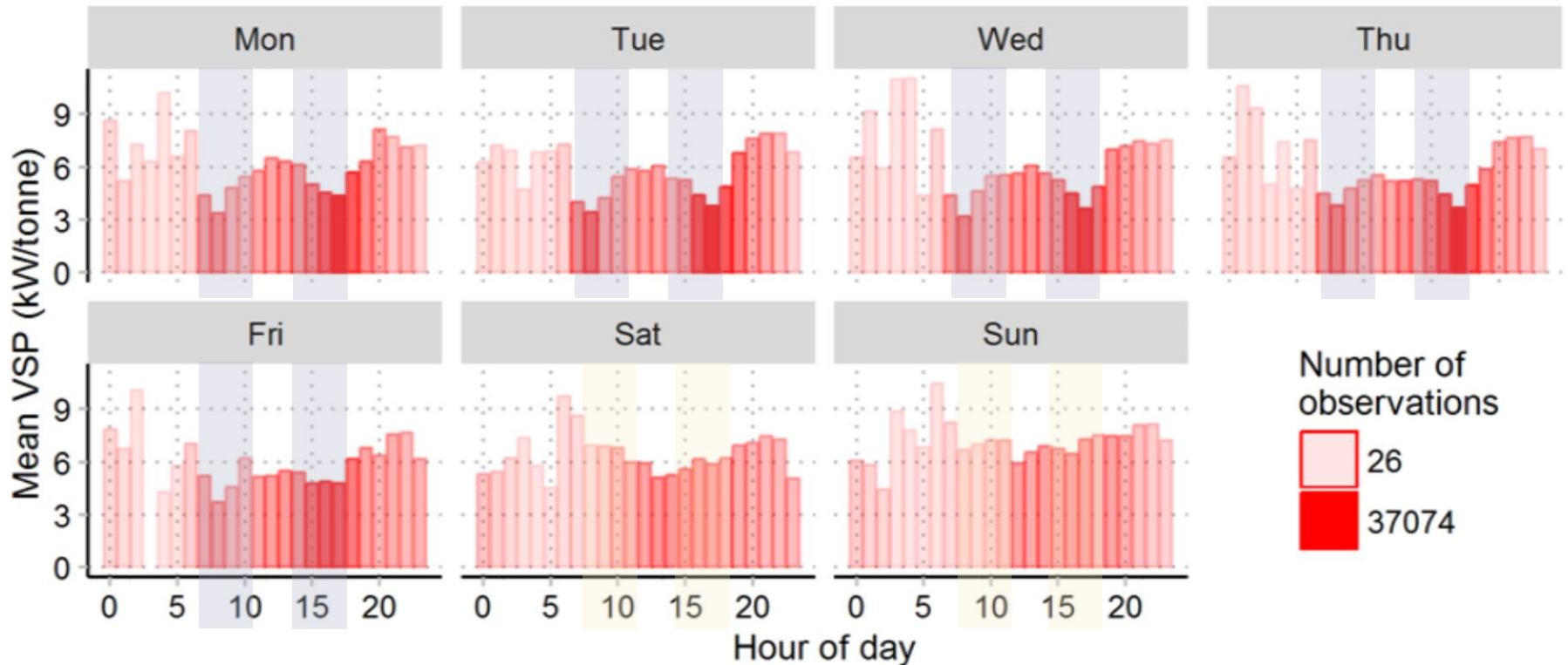




# RESULTS

*HOURLY* of day

FIGURE | Variation in positive VSP with HOURLY of the day



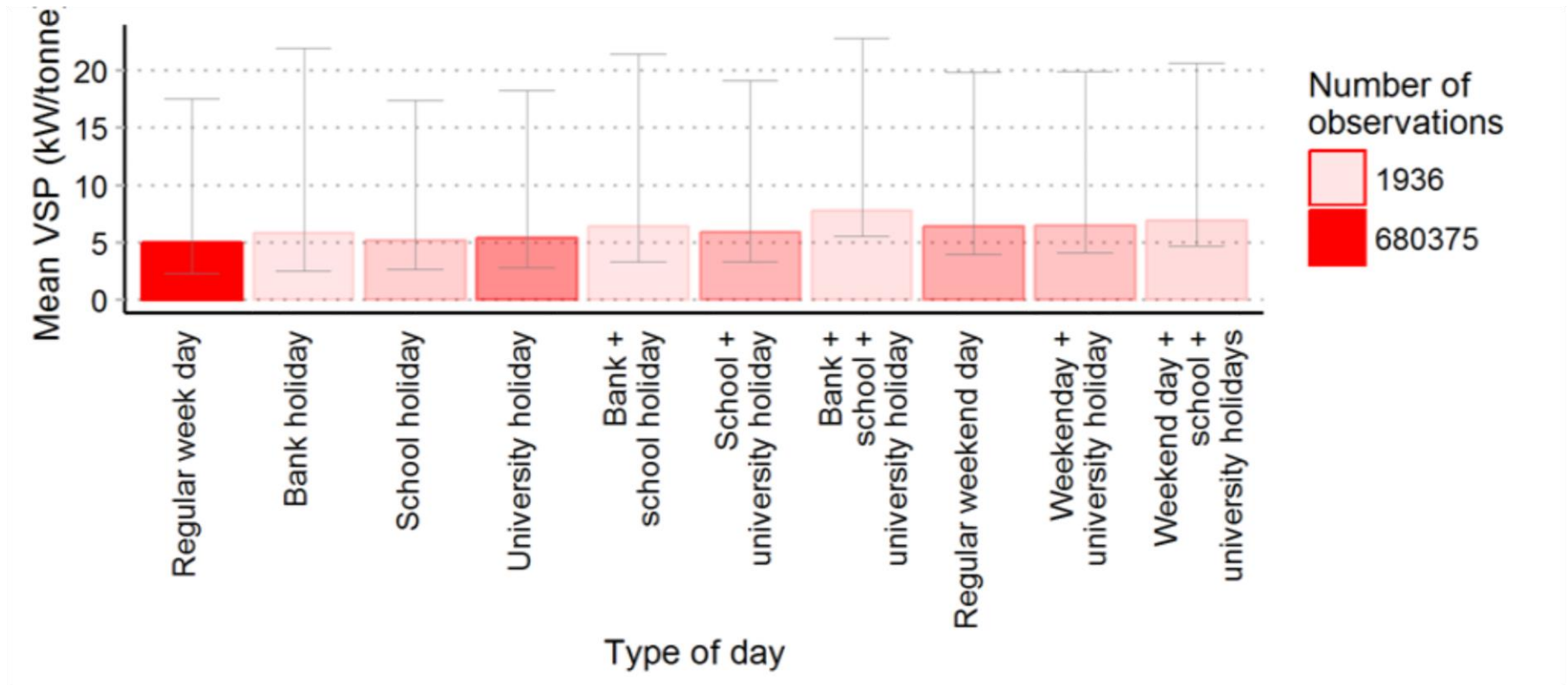
Driving in peak periods: Behaviour constrained by available road space?

Average positive VSP -31% during weekday, peak periods

# RESULTS

## HOLIDAYS

FIGURE | Variation in positive VSP with type of DAY / HOLIDAY



# RESULTS

## *Influence WEATHER conditions*

FIGURE | Variation in positive VSP with RAINFALL

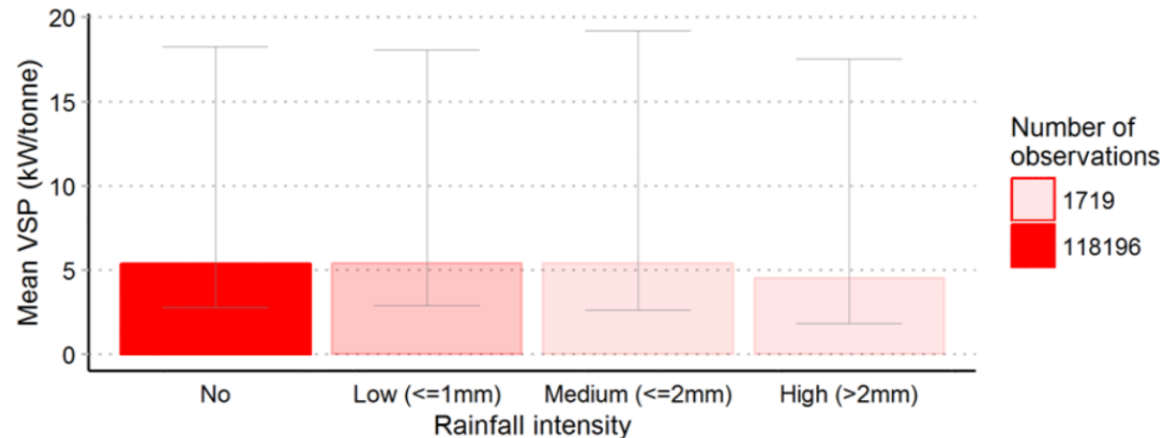
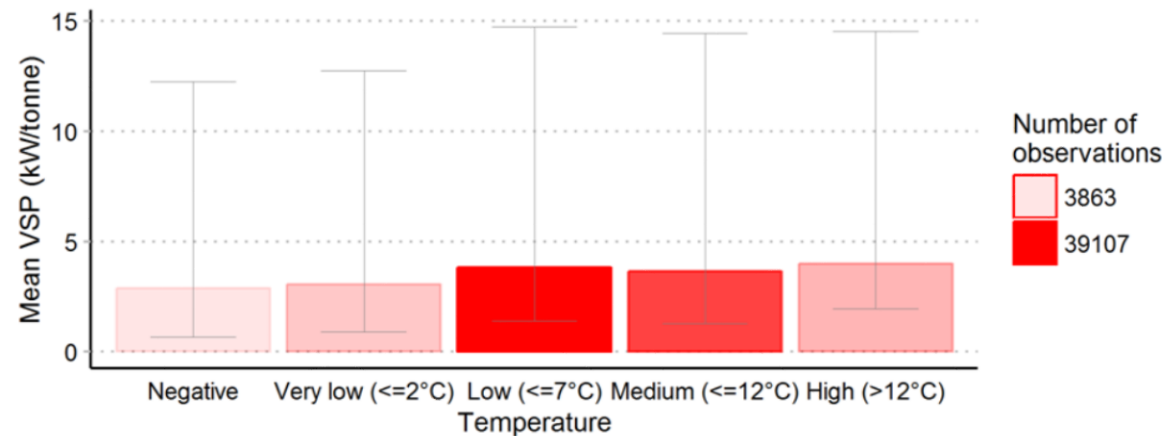


FIGURE | Variation in positive VSP with TEMPERATURE



# OUTLOOK

BIG telematics data

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## CASE STUDIES

- ▶ Traffic management interventions
  - ▶ Variable Speed Limits (VSL) & 'Smart' motorways
  - ▶ Demand management to alleviate congestion
  - ▶ Smoothing traffic flow including ecoDriving
- ▶ Complex, unstable, congested networks
  - ▶ Challenging to observe & model traffic flow

## FUTURE, 2020?

- ▶ Network wide, system approach
- ▶ Real-time: fusing telematics, IEM & in-situ flow monitoring
- ▶ All vehicle types: Buses (e.g. iBus London) and HGVs

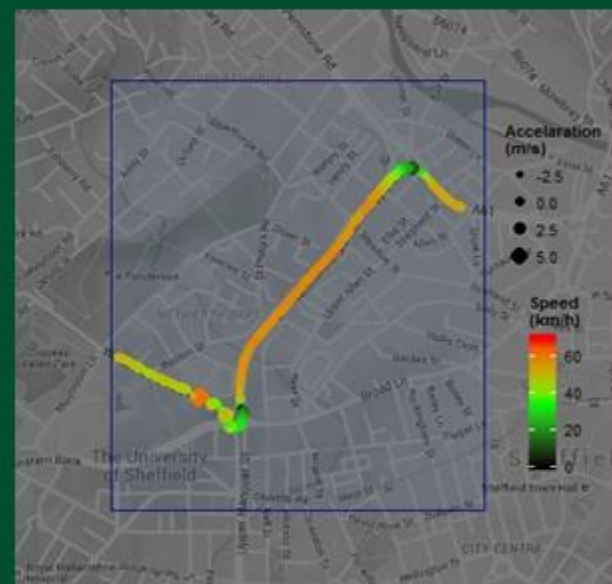
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