

# On Simulation and Optimization of Freeway Network Operations

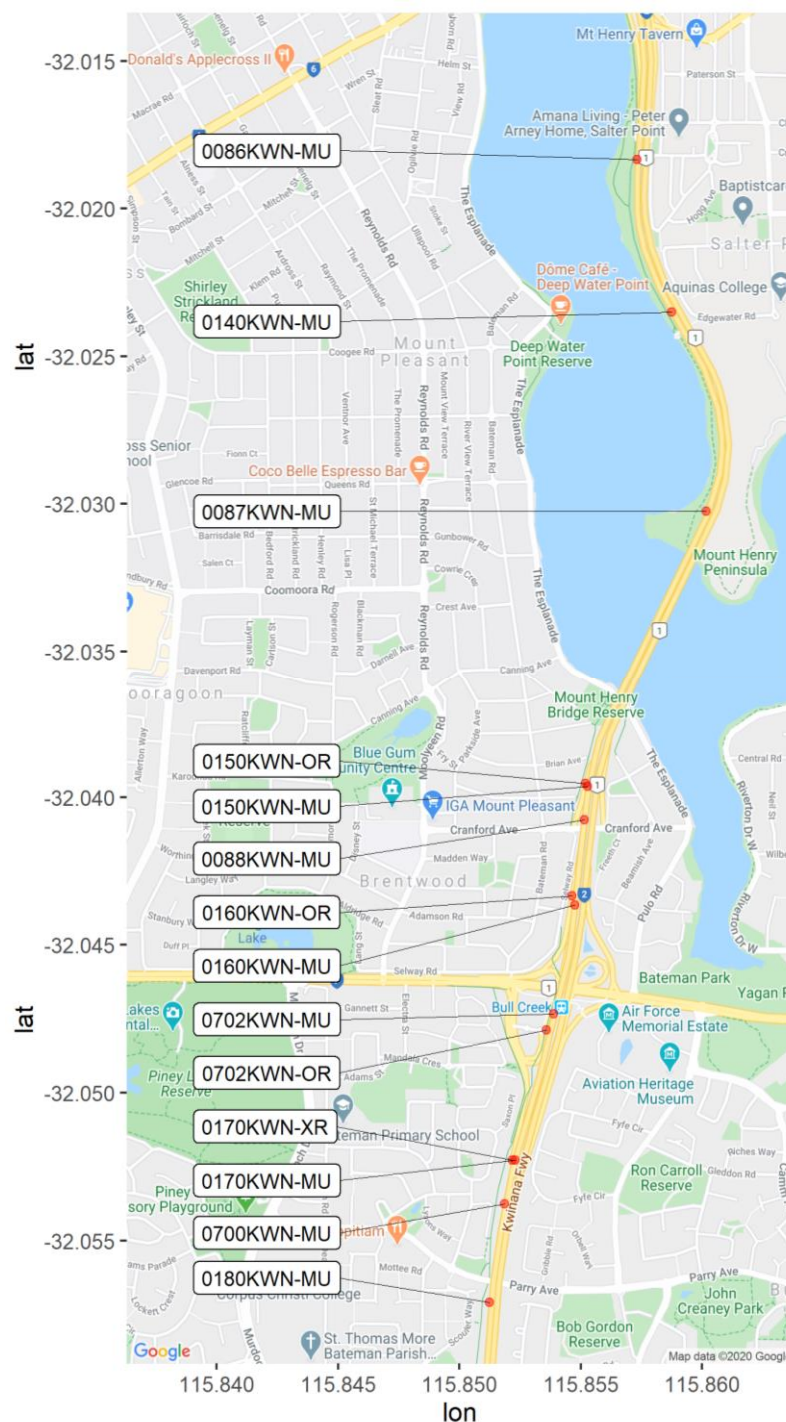
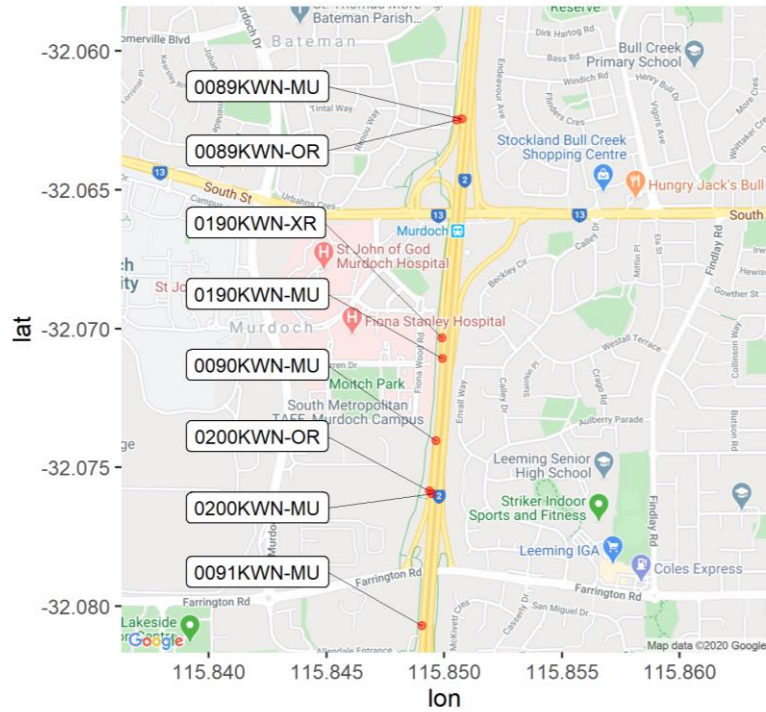
**B. Wiwatanapataphee & Yong Hong Wu**  
**Curtin University of Technology**



# Progress from last PSG meeting

- Further data analysis on lane flow/speed distribution
- Implementation of the computer network model
- Simulation and calibration of traffic flow model

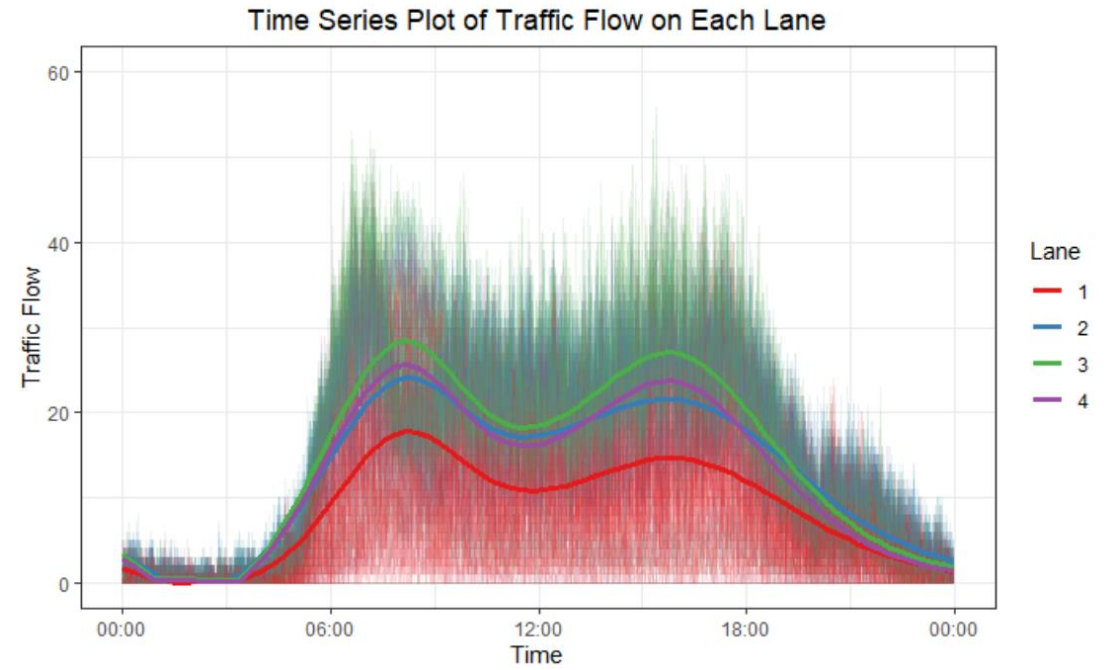
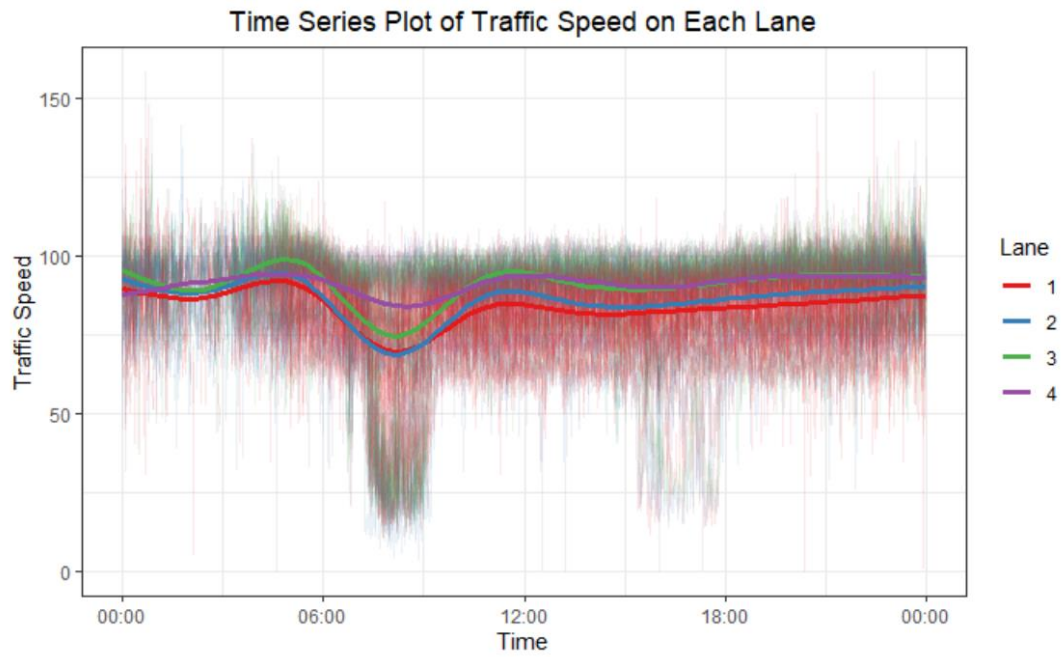
# 1. Updated computer network model : Kwinana Freeway Network with 156 Detectors



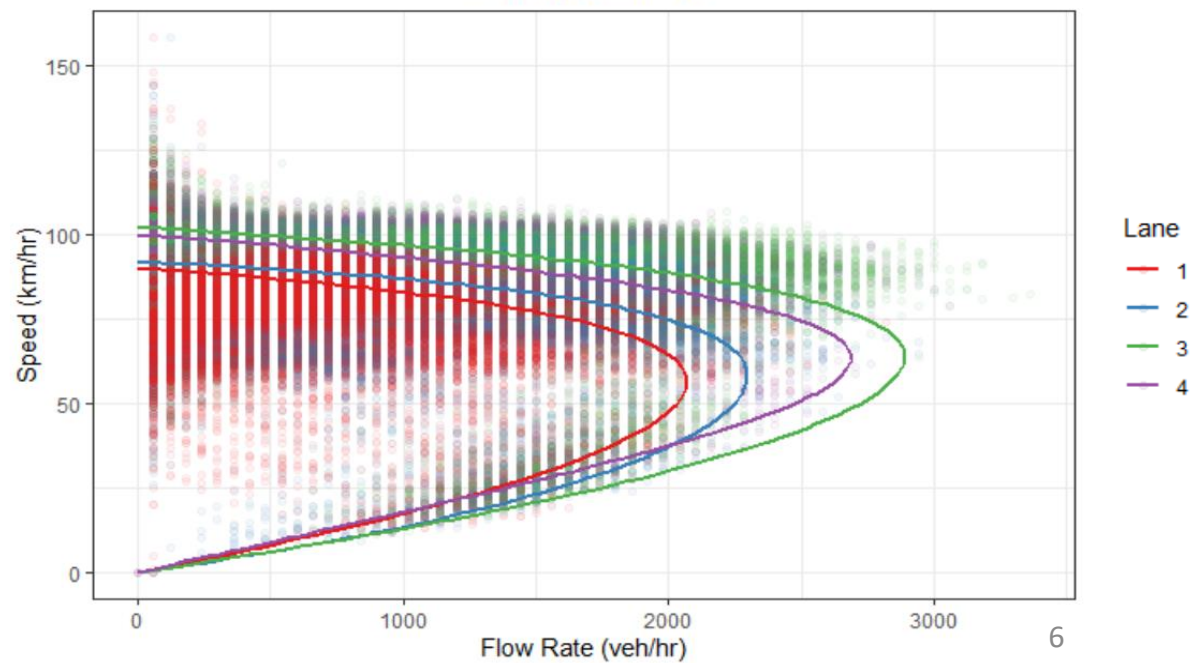
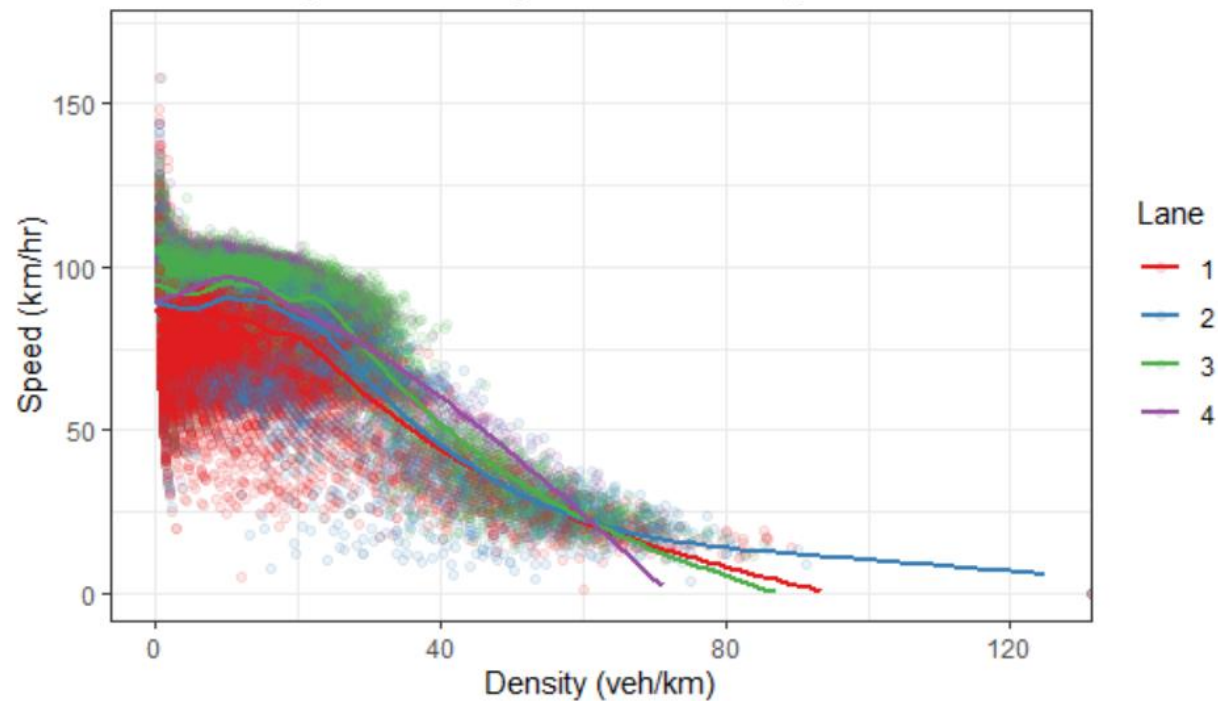
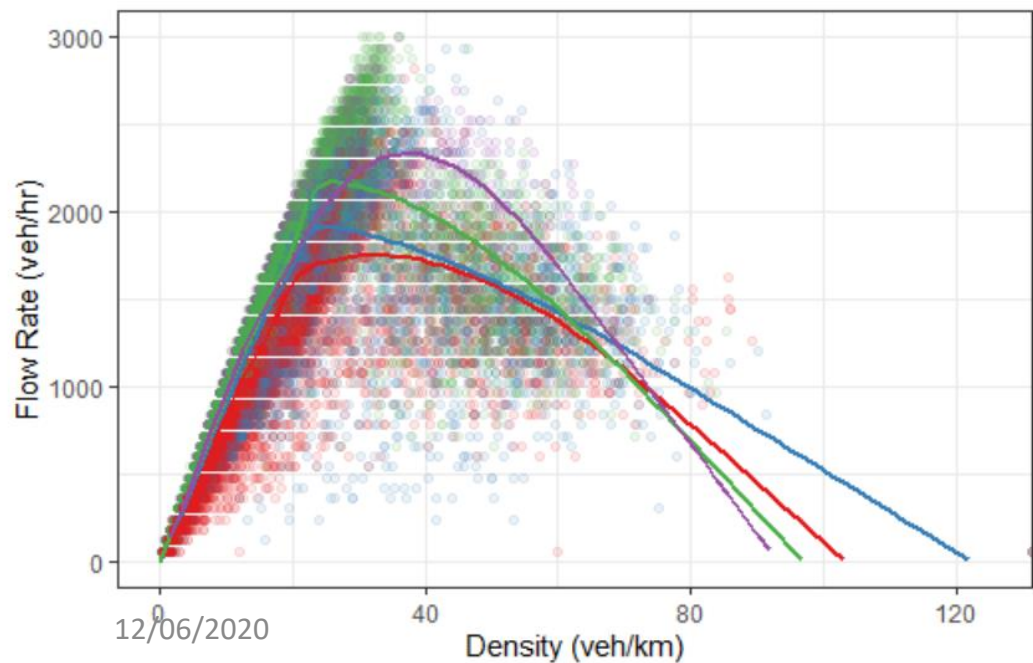


# DATA ANALYSIS

## Lane-Traffic Distribution



# Fundamental Diagrams (31 Oct 2018)

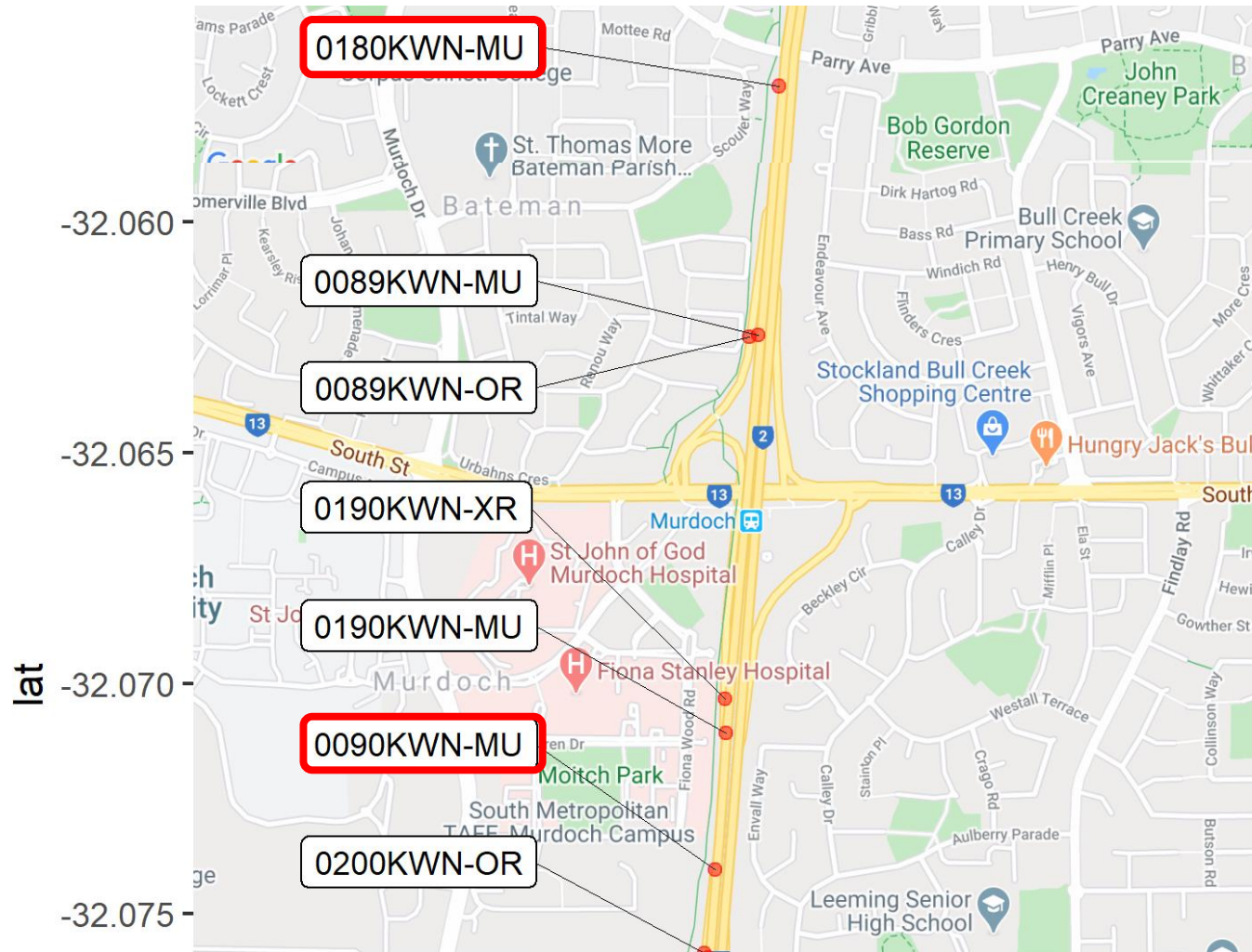


## Variation of speed on successive Mondays



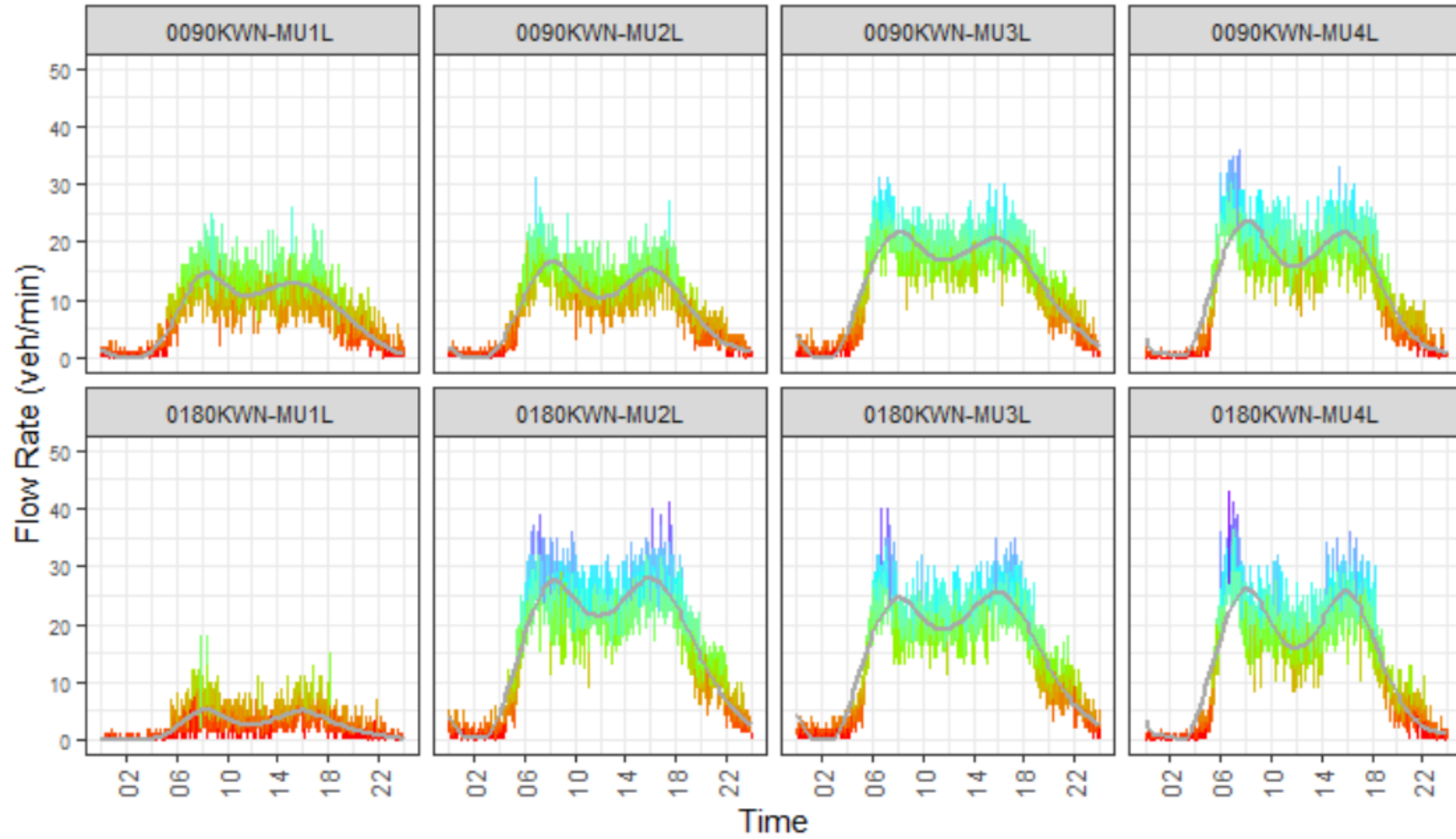
## Variation of speed on successive Saturdays



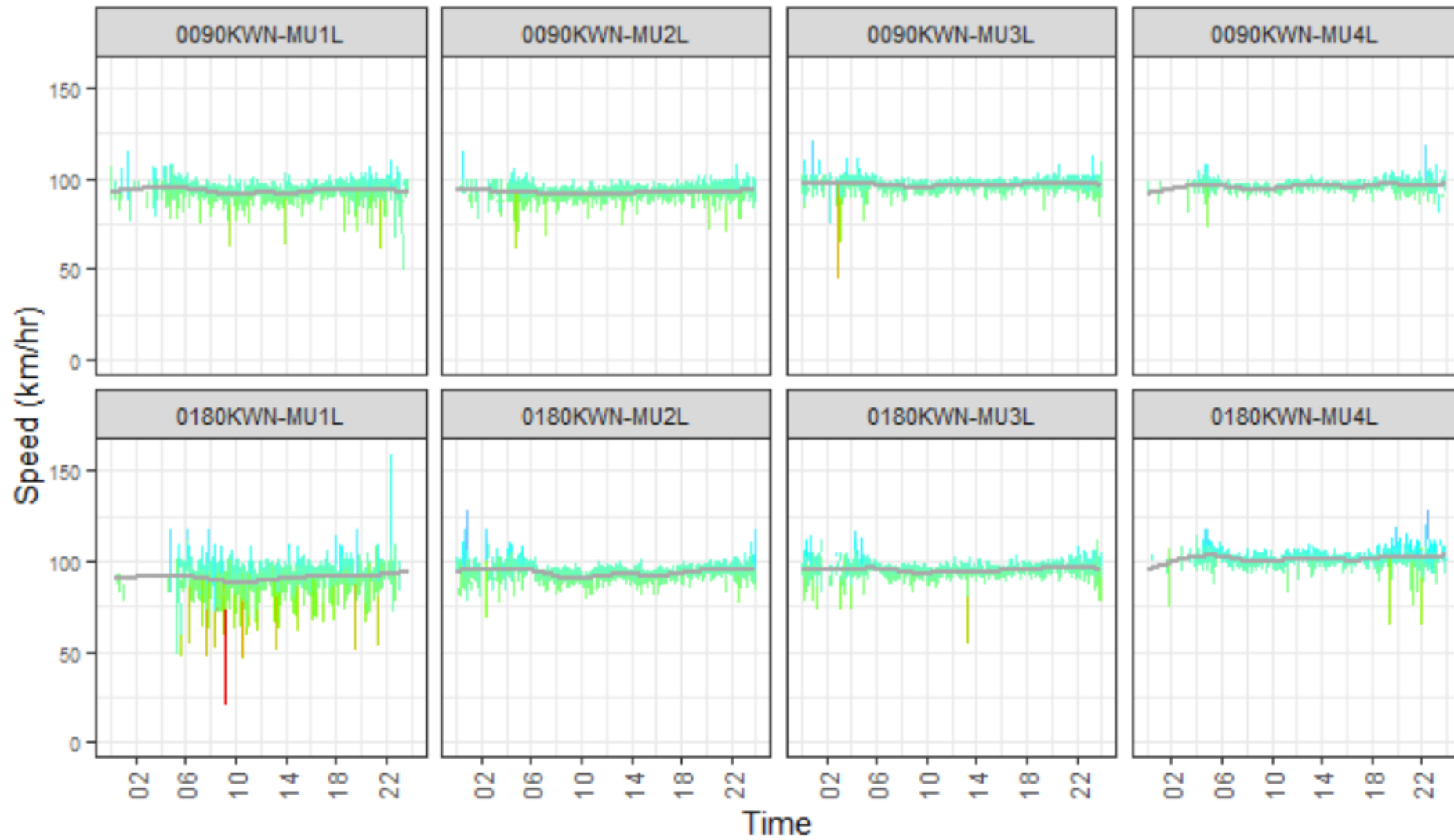


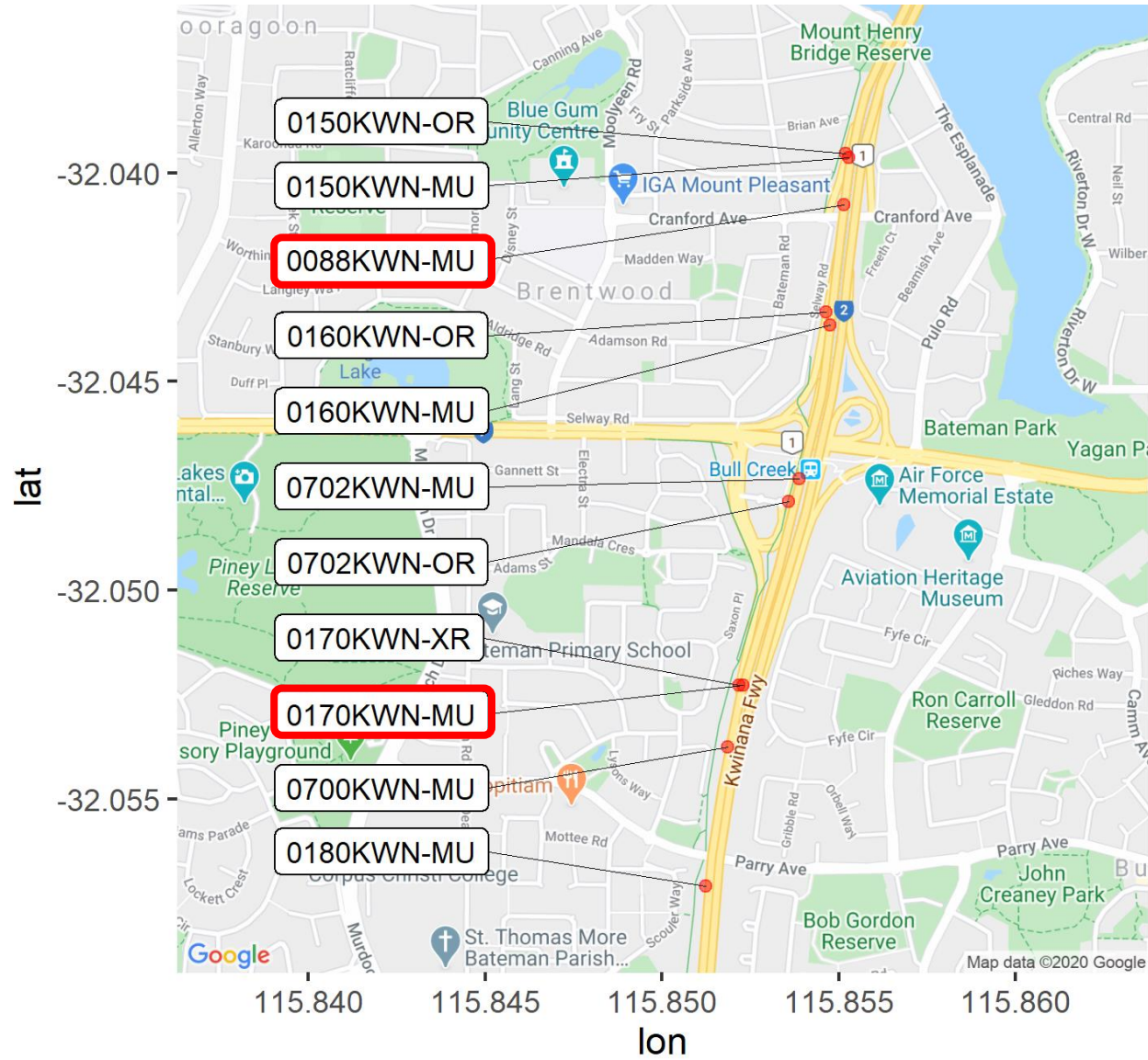


Time Series Plot of Traffic Flow on 31 Oct 2018

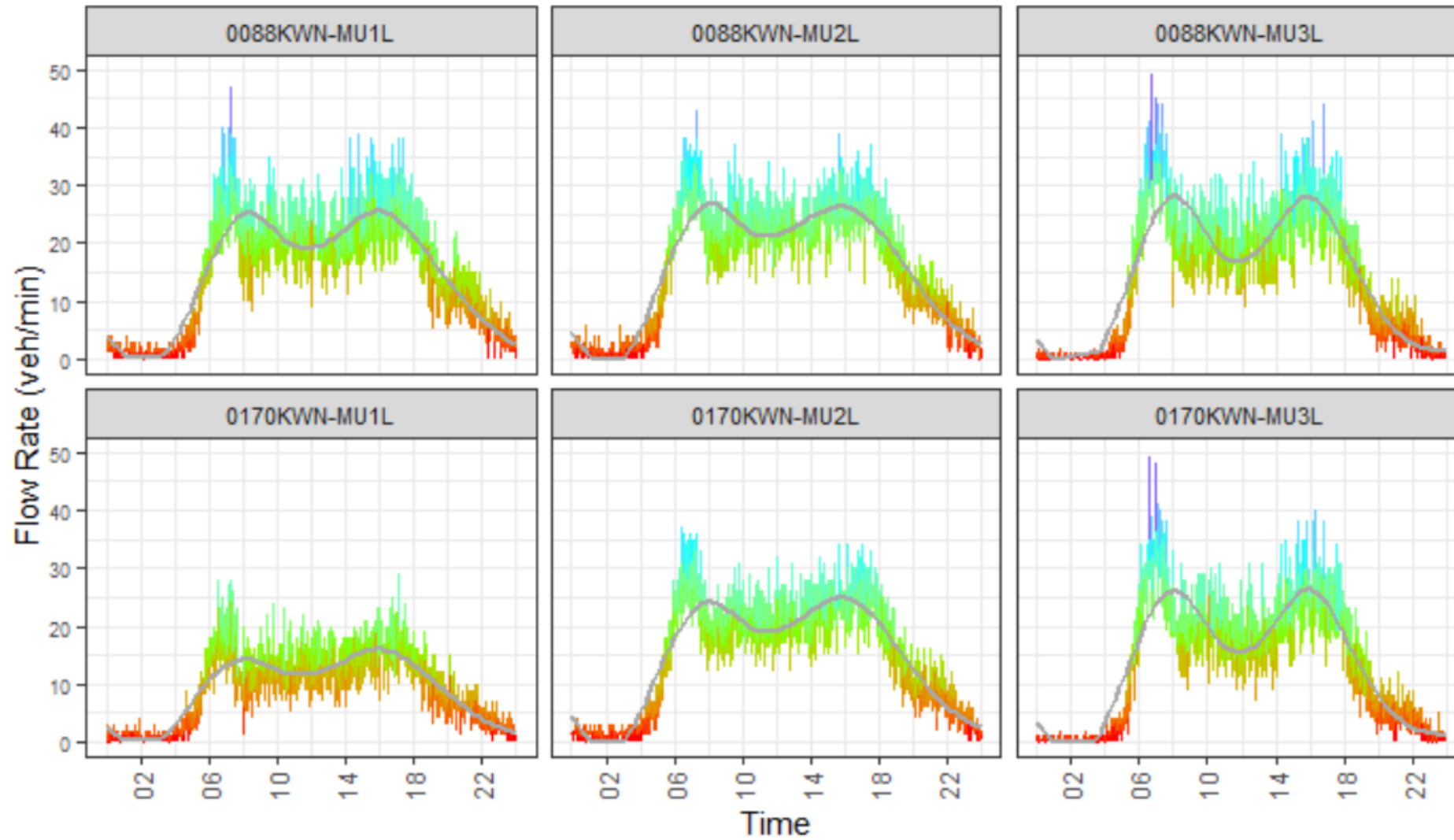


### Time Series Plot of Traffic Speed on 31 Oct 2018

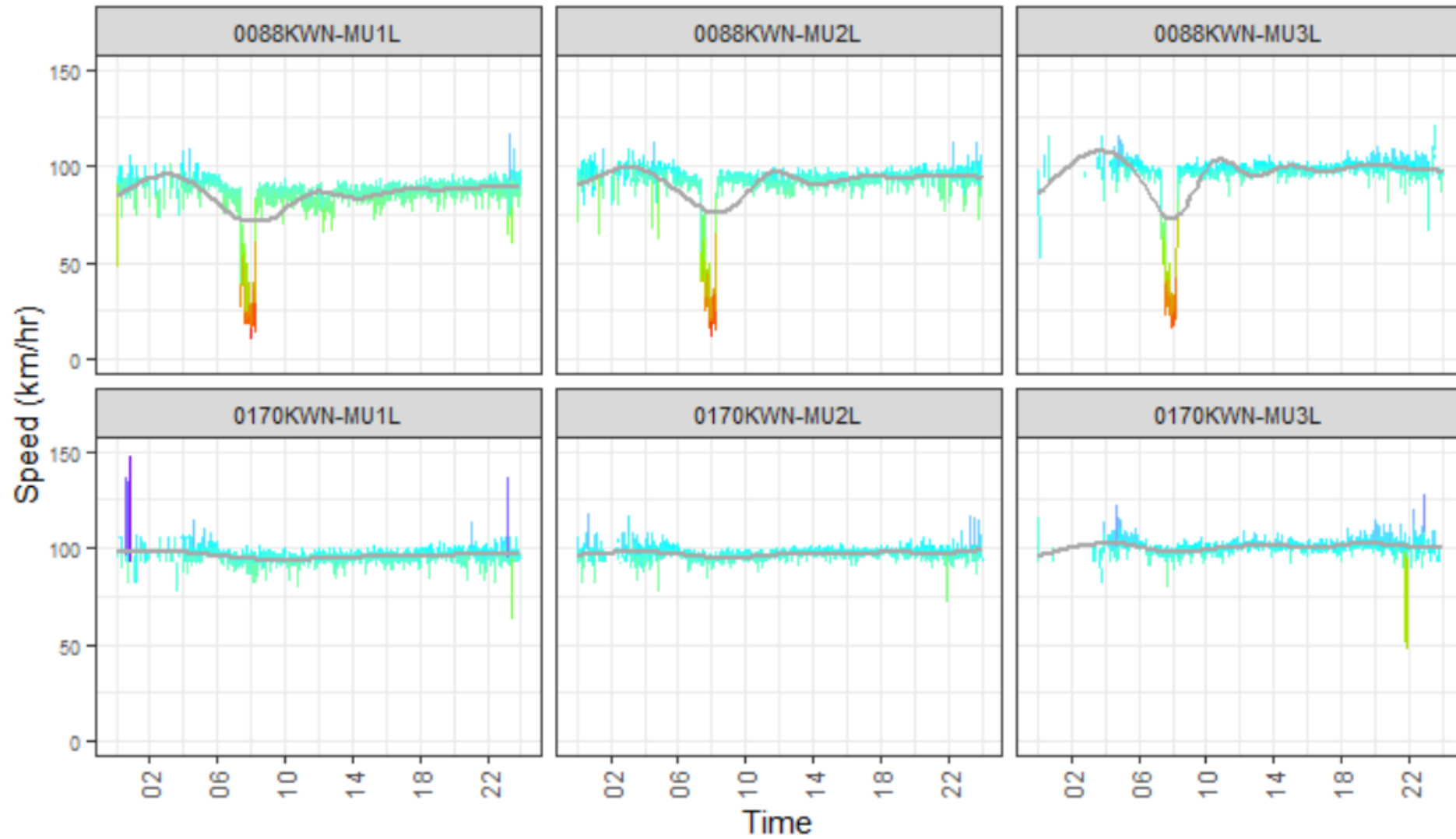


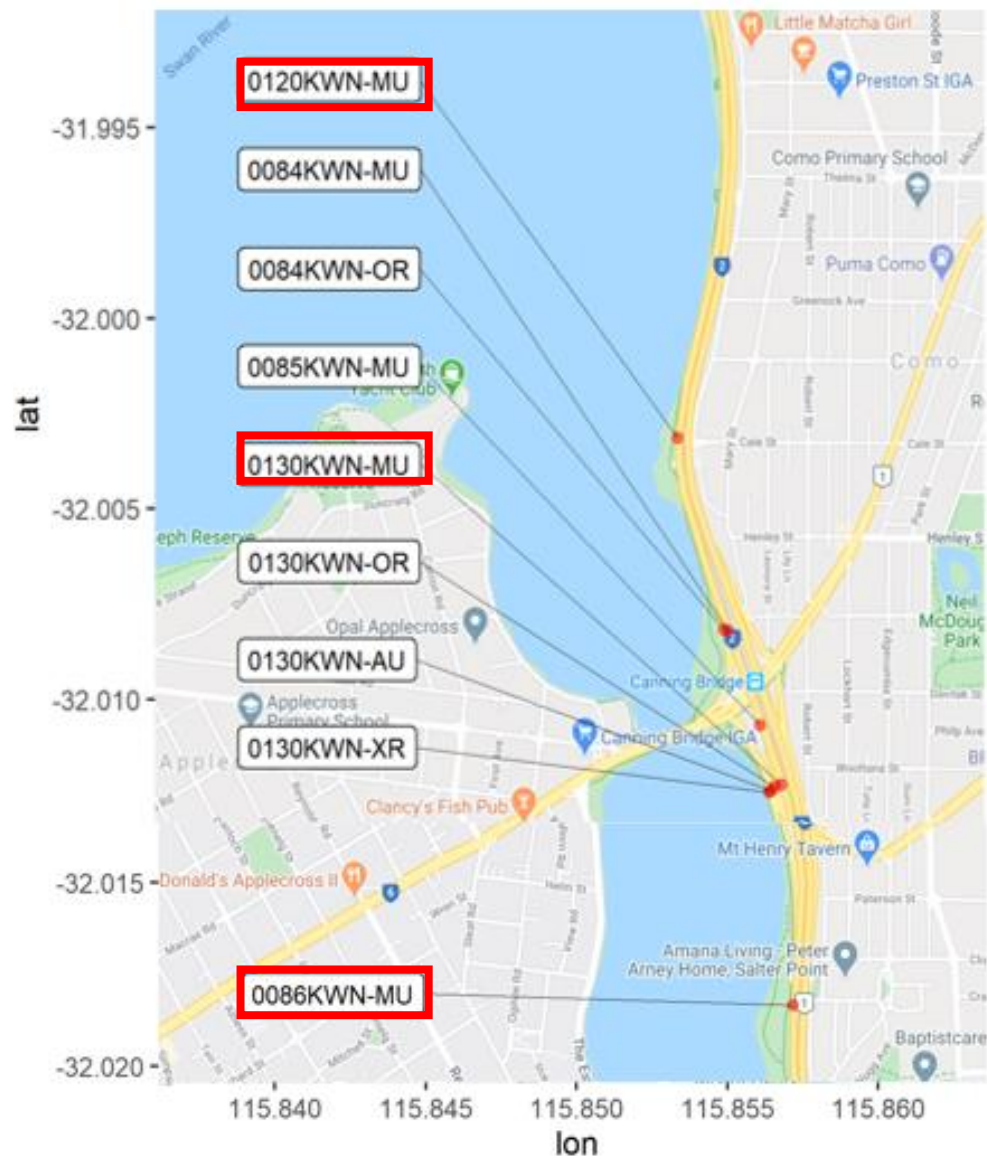


## Time Series Plot of Traffic Flow on 31 Oct 2018

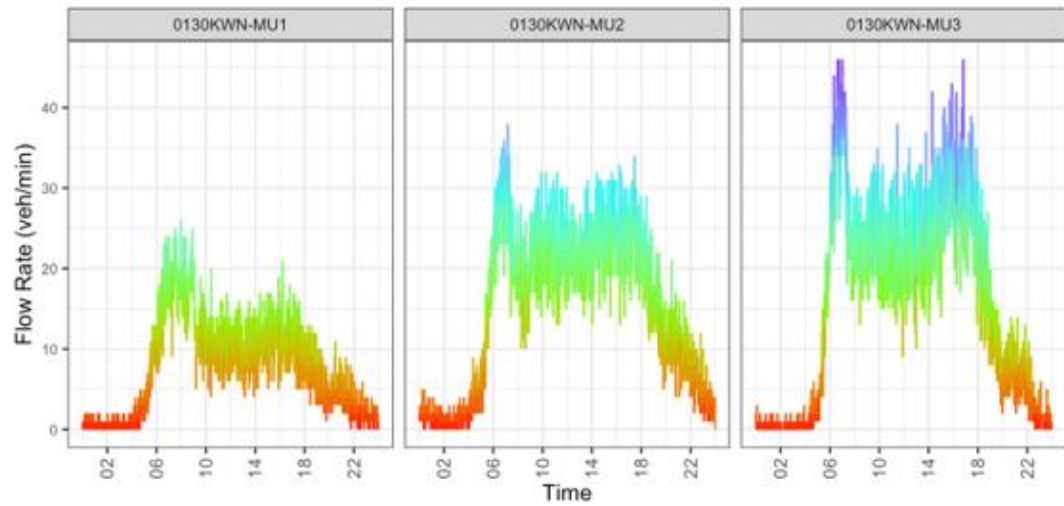


### Time Series Plot of Traffic Speed on 31 Oct 2018

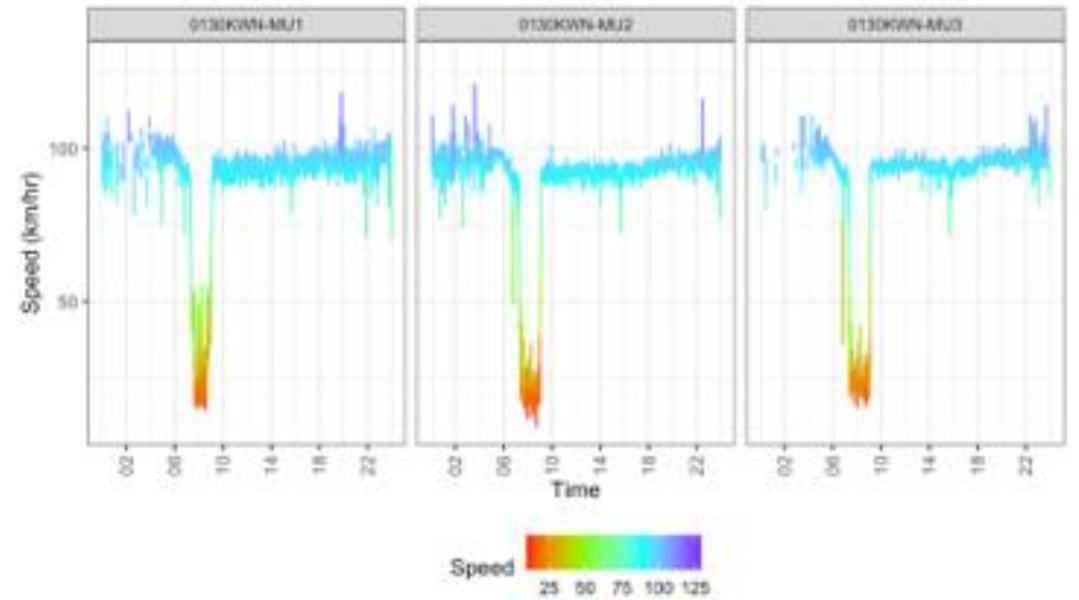




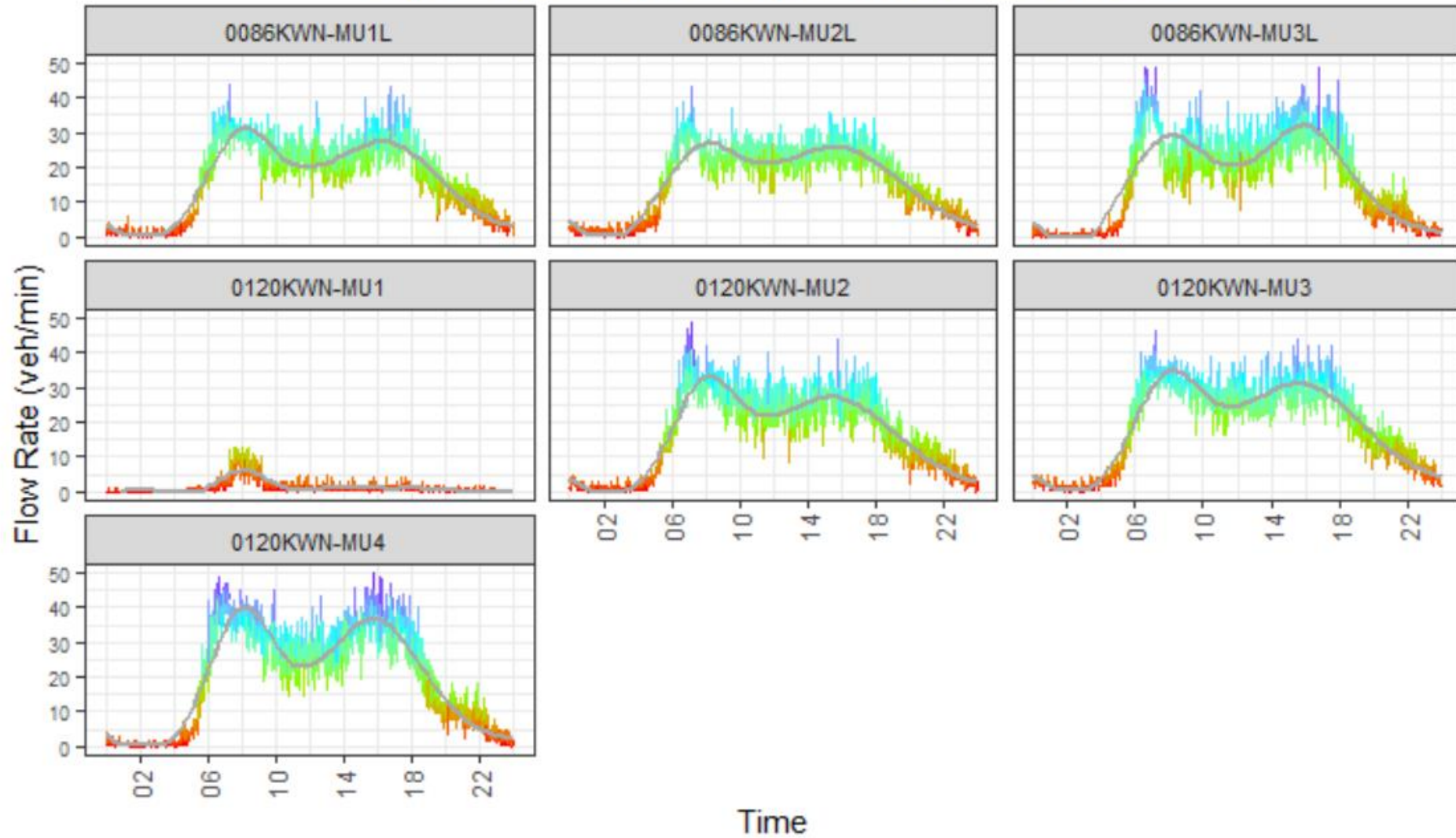
Time Series Plot of Traffic Flow on 31 Oct 2018 at 0130KWNMU



Time Series Plot of Traffic Speed on 31 Oct 2018

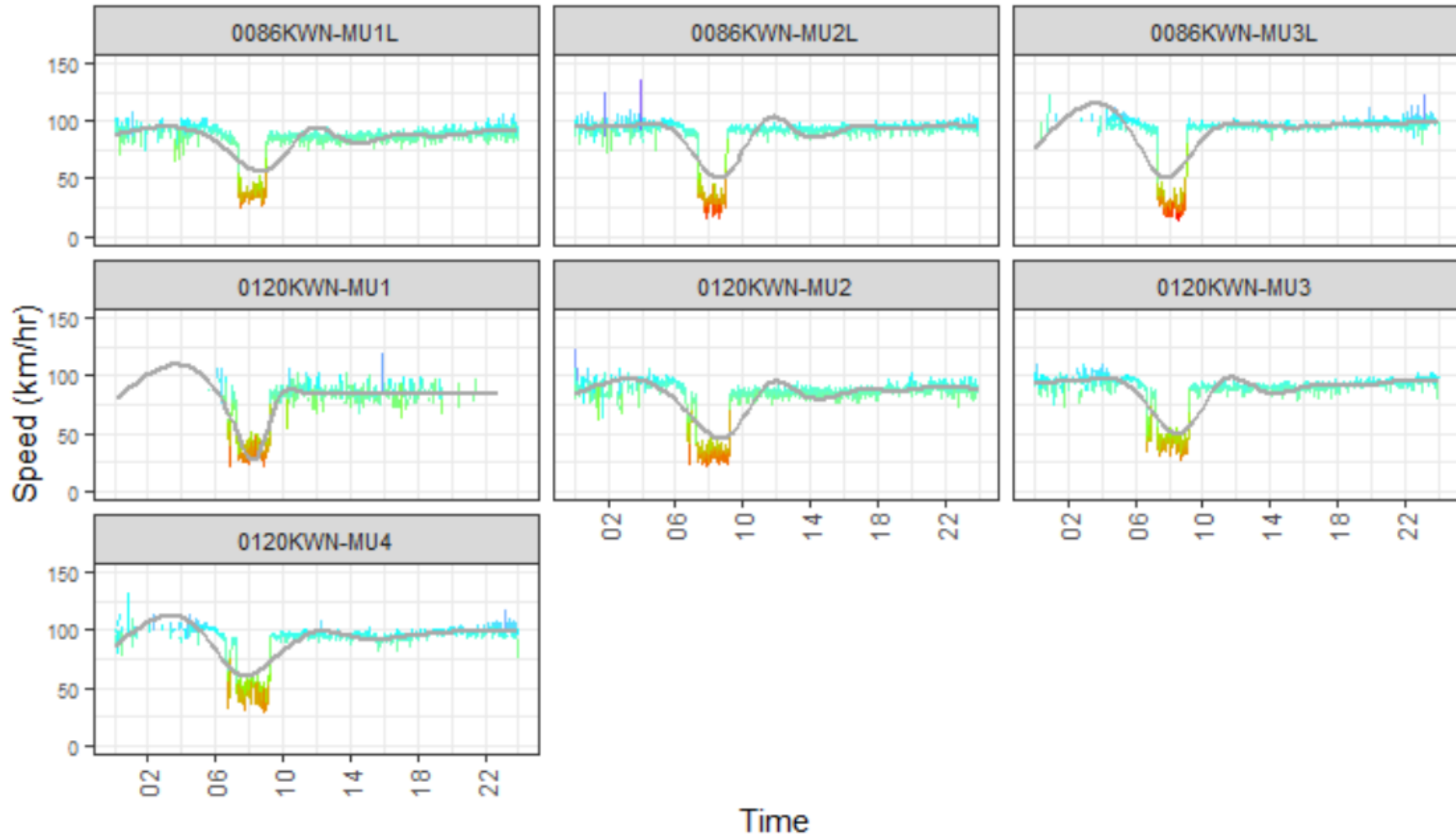


# Time Series Plot of Traffic Flow on 31 Oct 2018



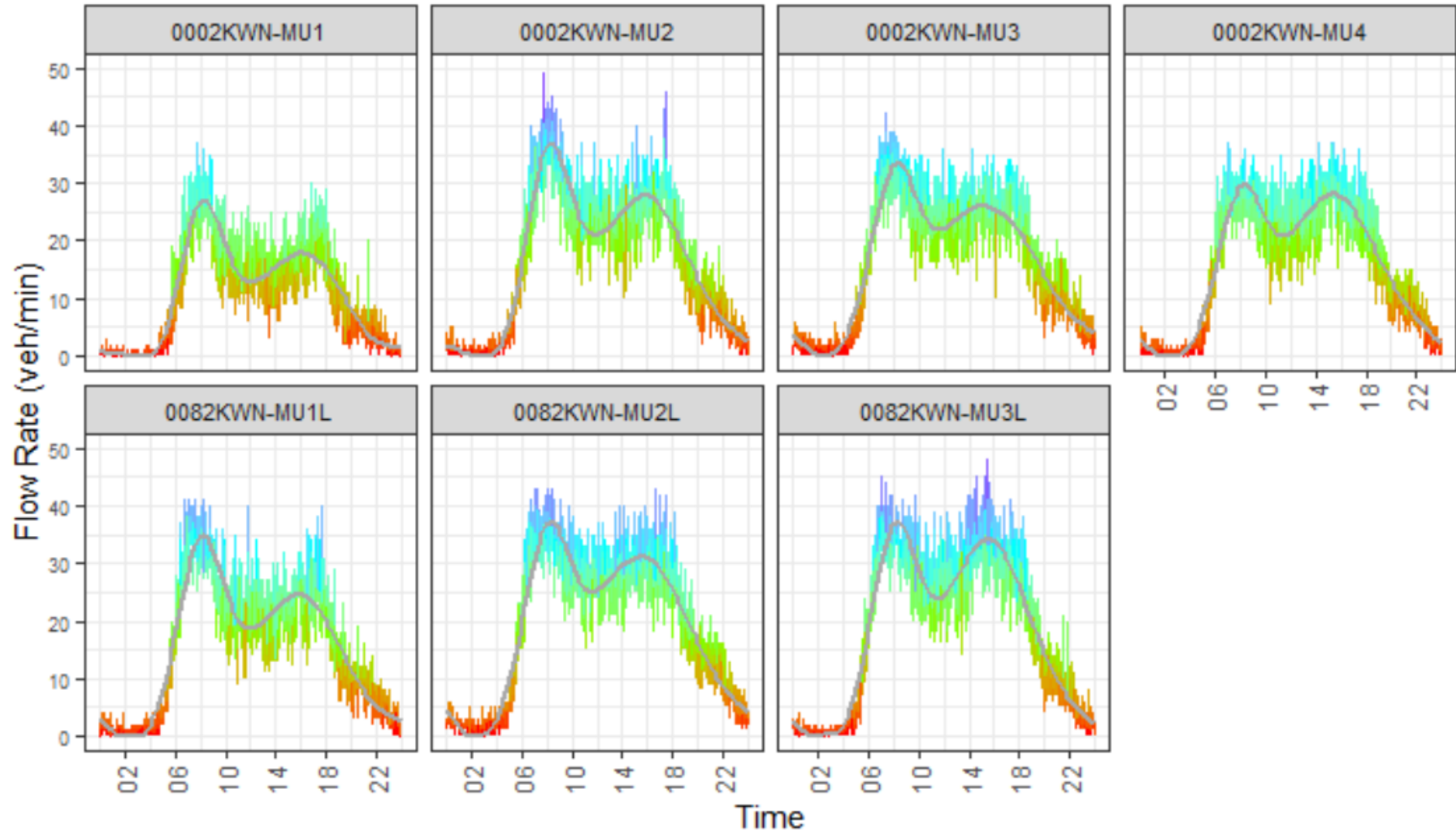


### Time Series Plot of Traffic Speed on 31 Oct 2018

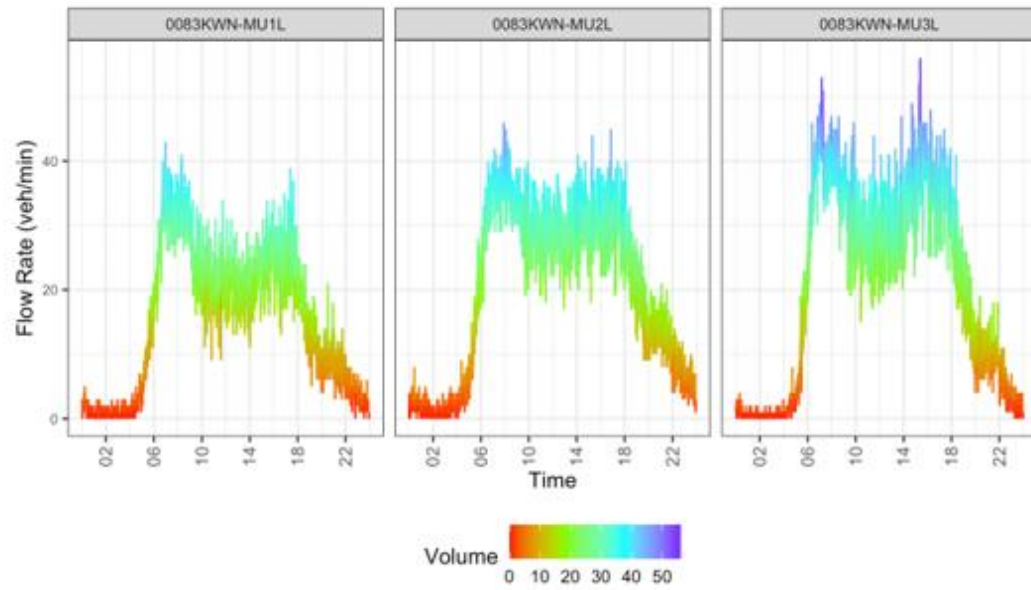




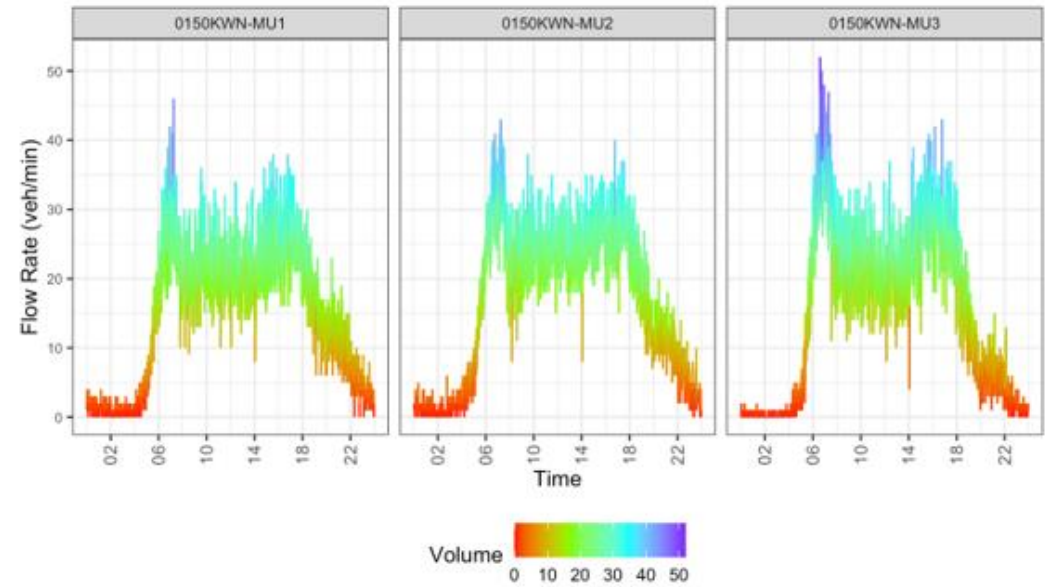
# Time Series Plot of Traffic Flow on 31 Oct 2018



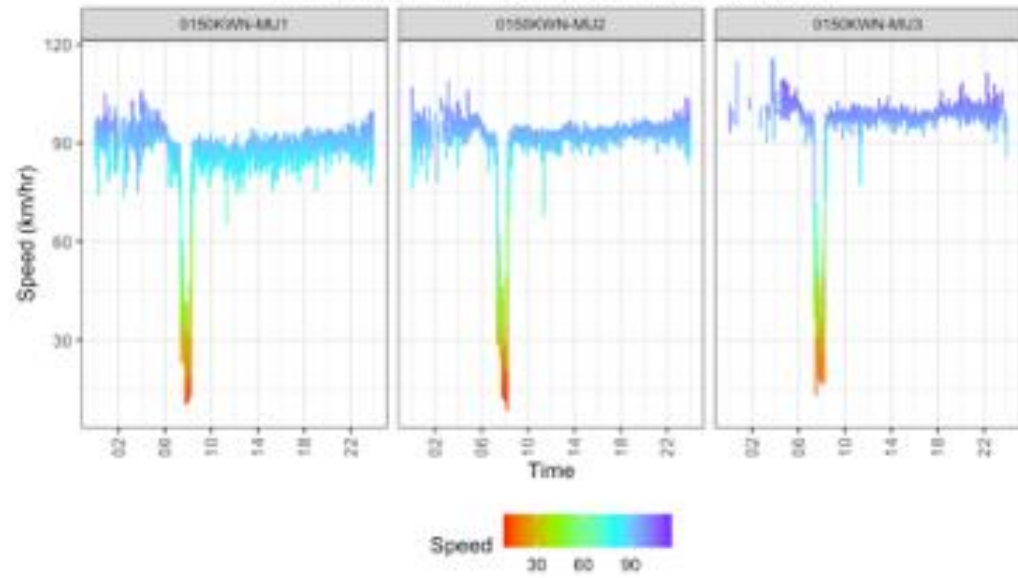
Time Series Plot of Traffic Flow on 31 Oct 2018 at 0083KWNMU



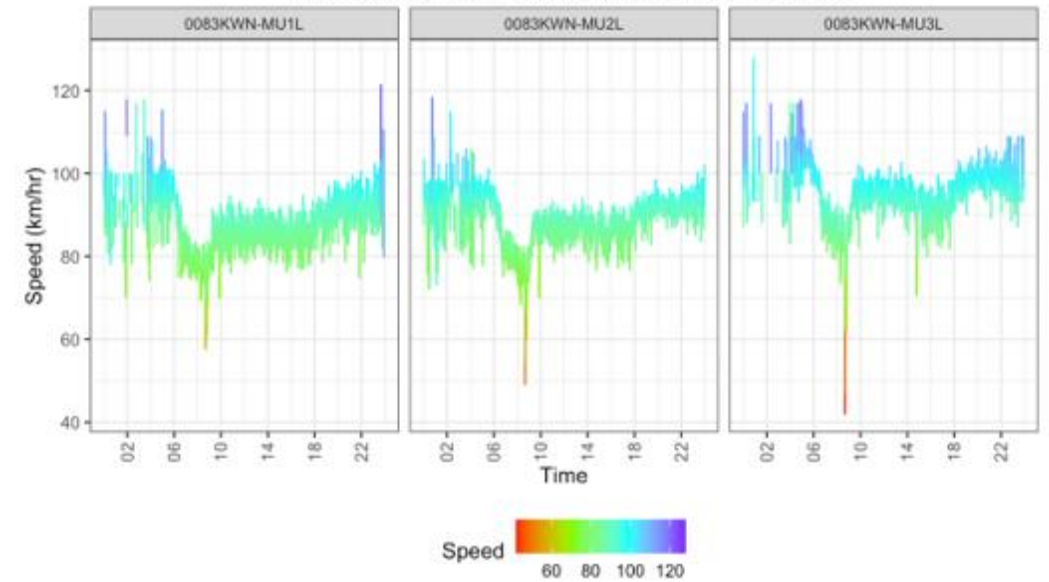
Time Series Plot of Traffic Flow on 31 Oct 2018 at 0150KWNMU



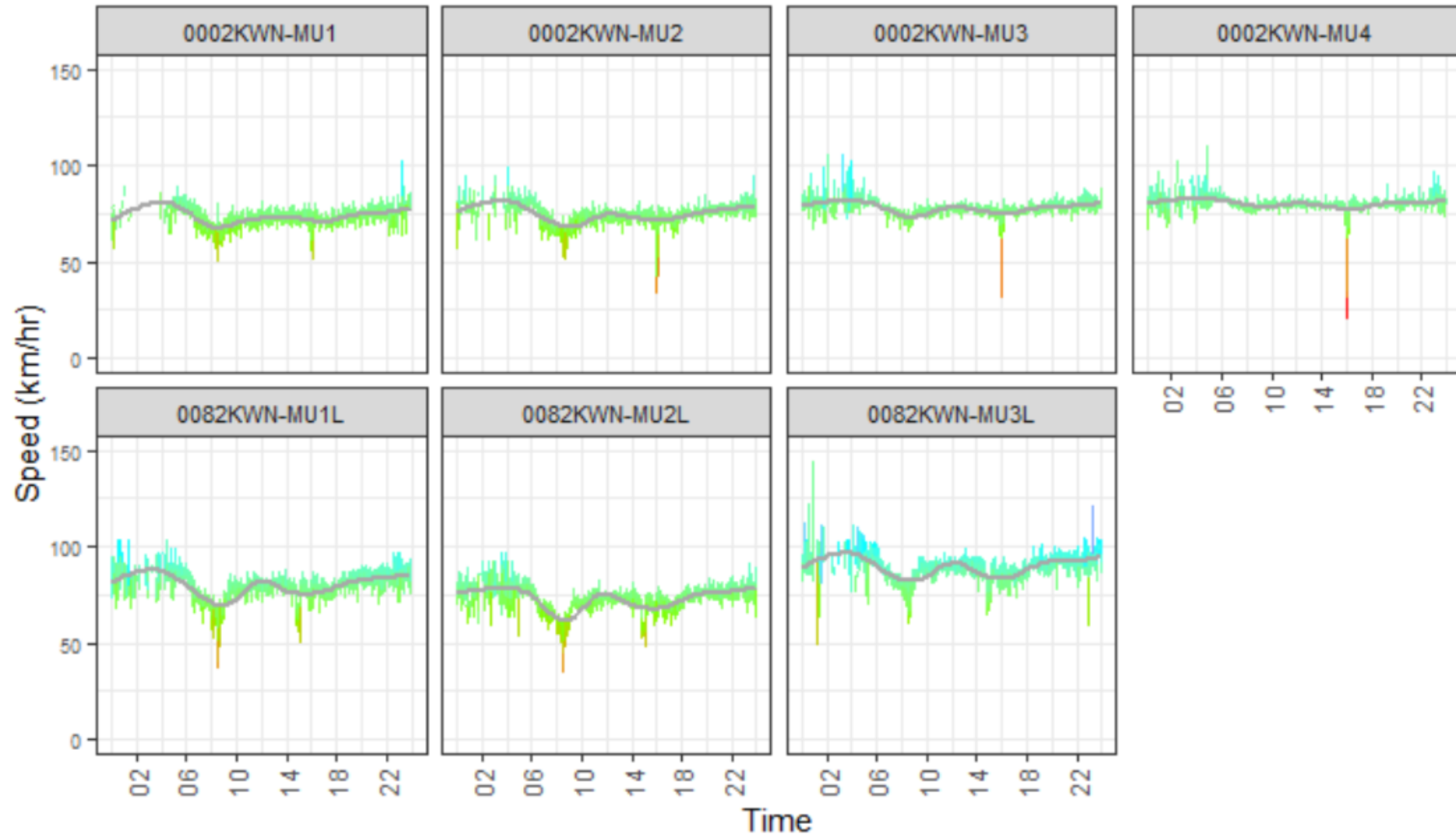
Time Series Plot of Traffic Speed on 31 Oct 2018



Time Series Plot of Traffic Speed on 31 Oct 2018



### Time Series Plot of Traffic Speed on 31 Oct 2018





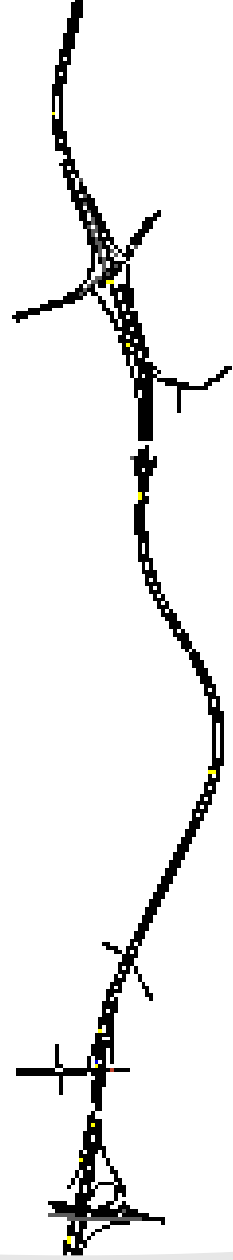
SIMULATION  
KWN-Fwy Traffic Model



Study region is the Kwinana Freeway from Farrington RD to Narrow Bridge about 13 kilometres consisting 13 sections with 8 on-ramps, 4 off-ramps and 9 bottlenecks .







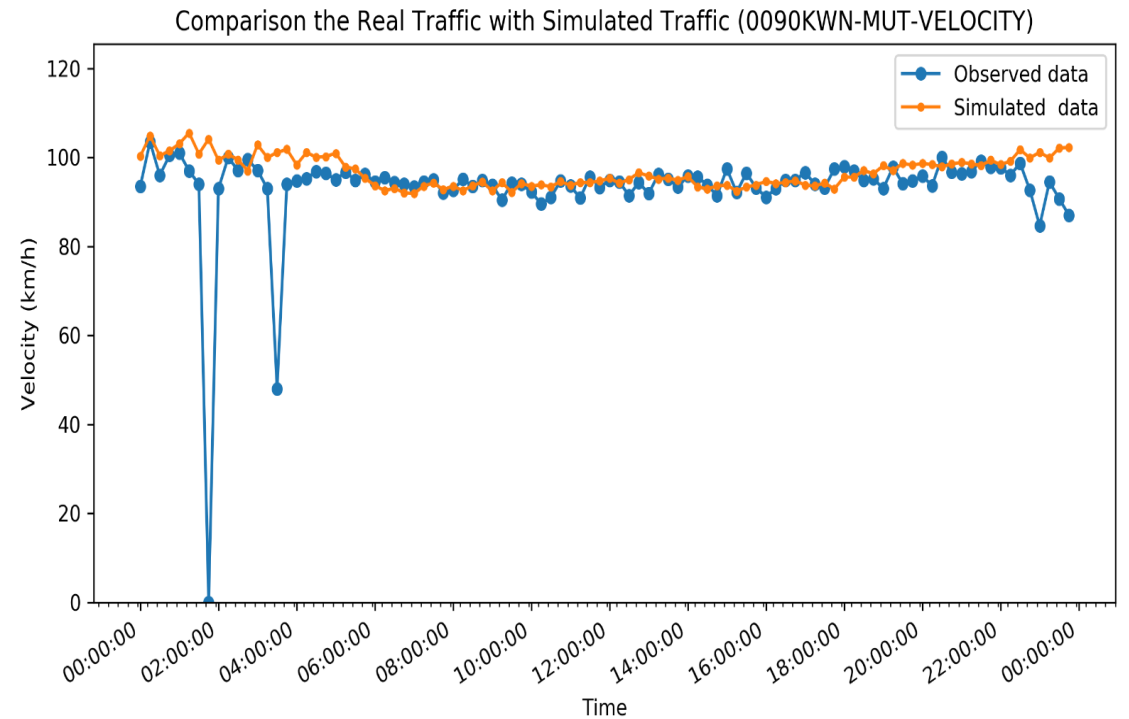
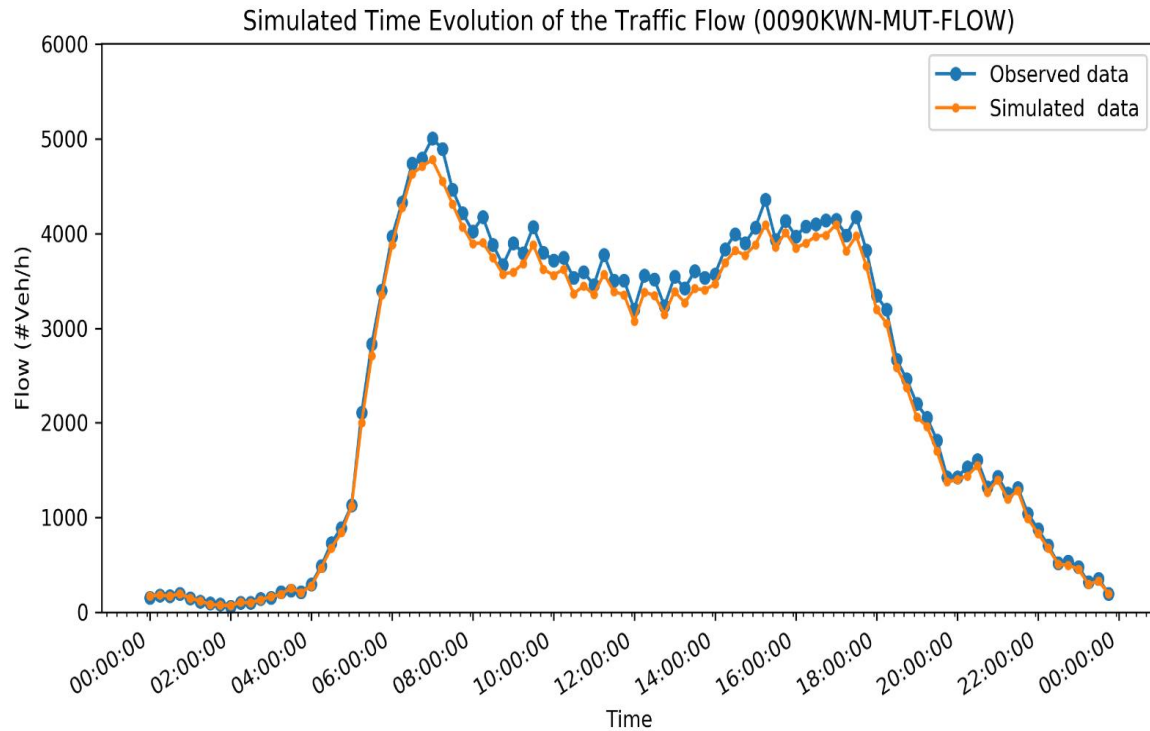


# Calibration of Traffic Model

# Lane Flow & Lane Speed Calibrations

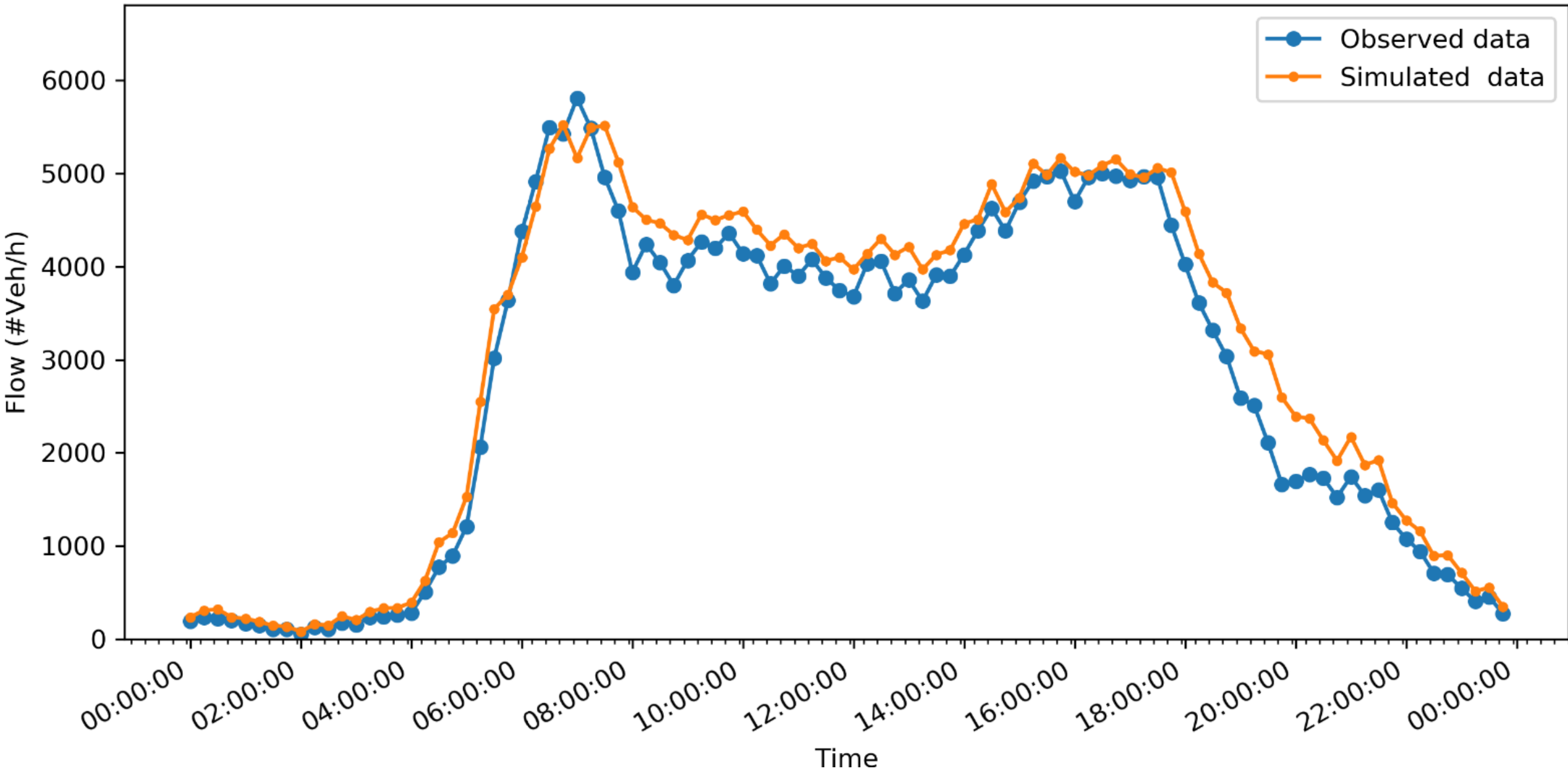
--- Observed data

— Simulated data

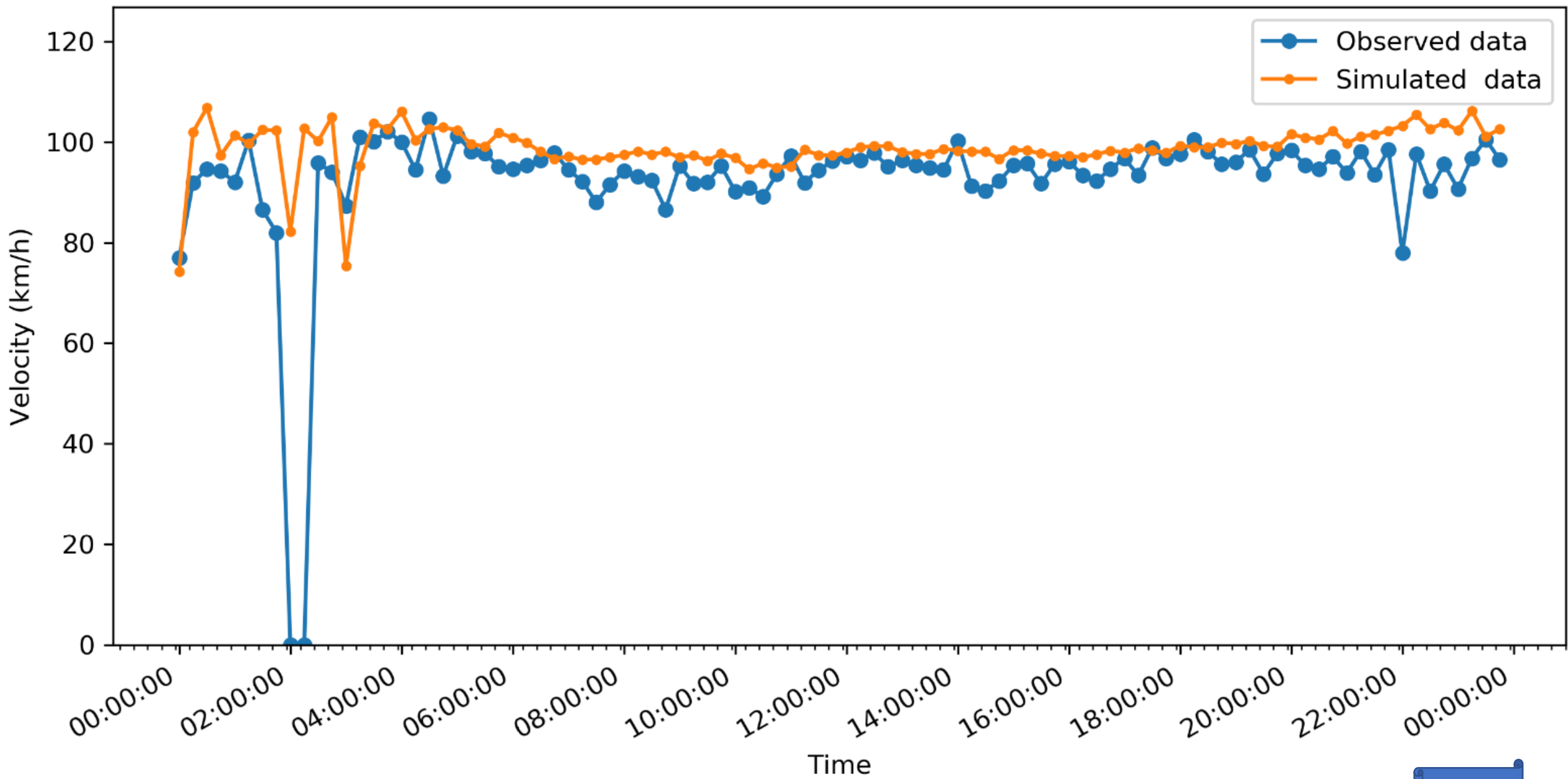


$$y_i = \frac{x_i - \min(\text{observed}, \text{simulated})}{\max(\text{observed}, \text{simulated}) - \min(\text{observed}, \text{simulated})}, \quad MSE = \frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2, \quad RMSE = \sqrt{MSE}$$

Simulated Time Evolution of the Traffic Flow (0180KWN-MUT-FLOW)



# Comparison the Real Traffic with Simulated Traffic (0180KWN-MUT-VELOCITY)



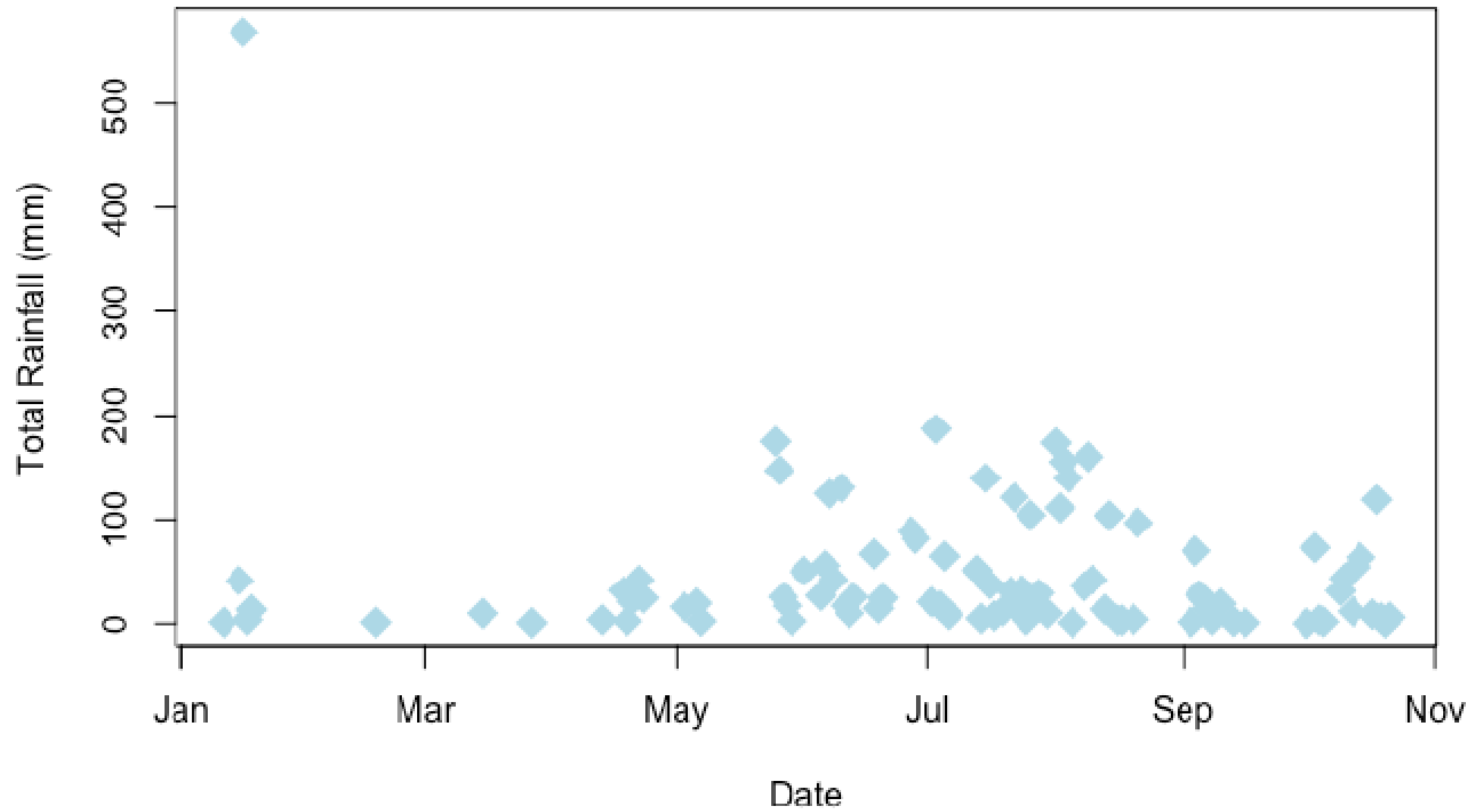
# **Effect of Rainfall on Traffic Flow in Perth**

Type	Light Rain	Moderate Rain	Heavy Rain	Rainstorm	Downpour	Extraordinary Storm
Daily Precipitation (mm/d)	0.1~9.9	10~24.9	25~49.9	50~99.9	100~250	>250

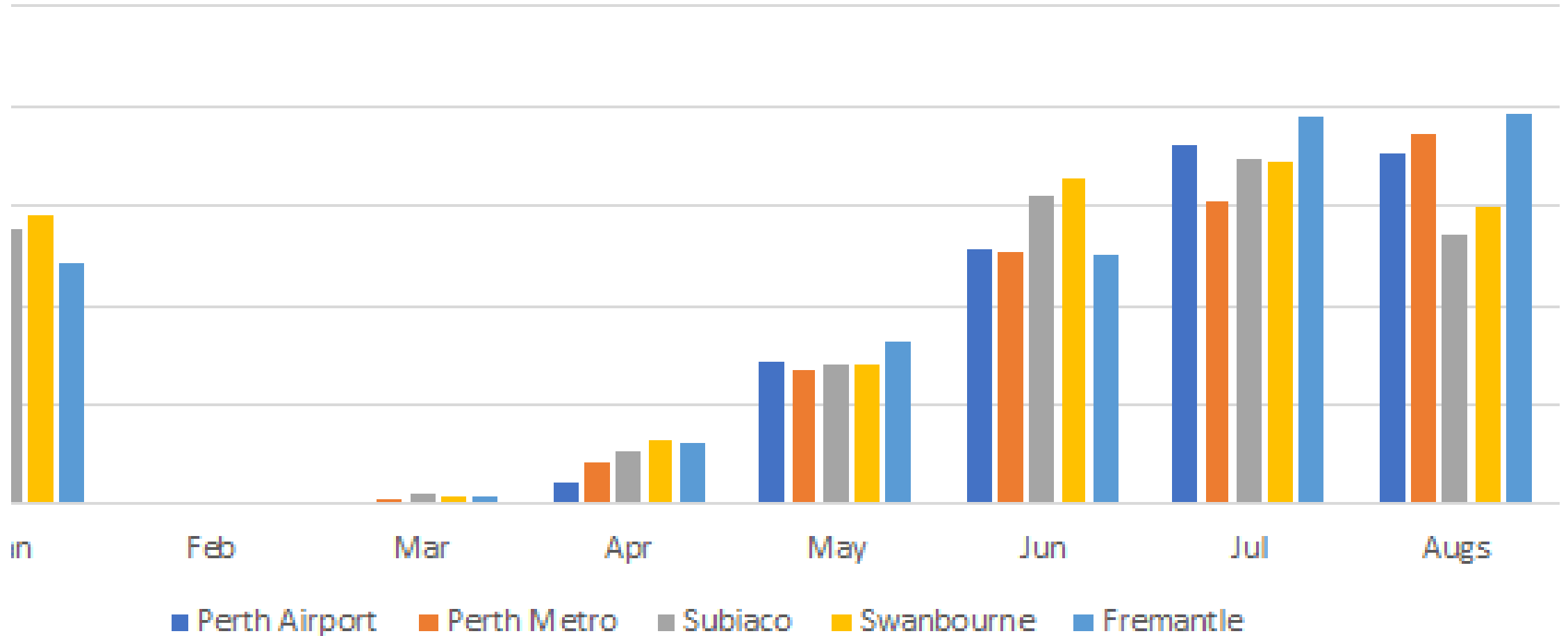
Table 1. Classification of Standard of Rainy Days by Meteorological Department

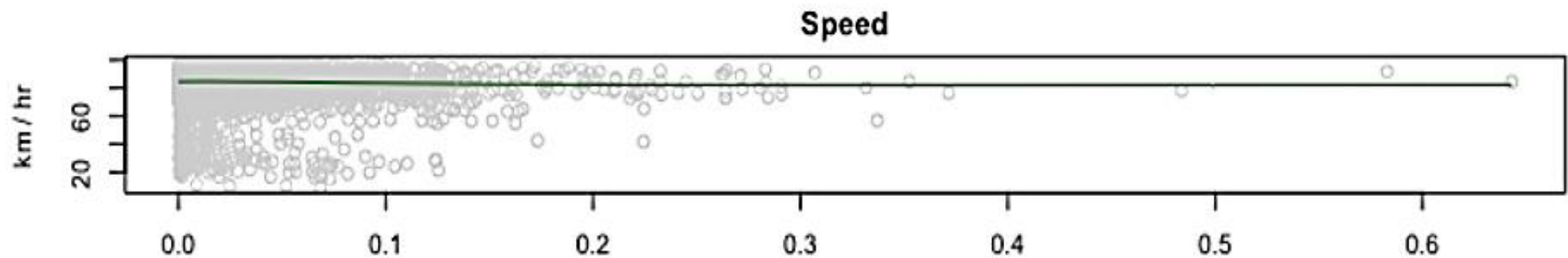
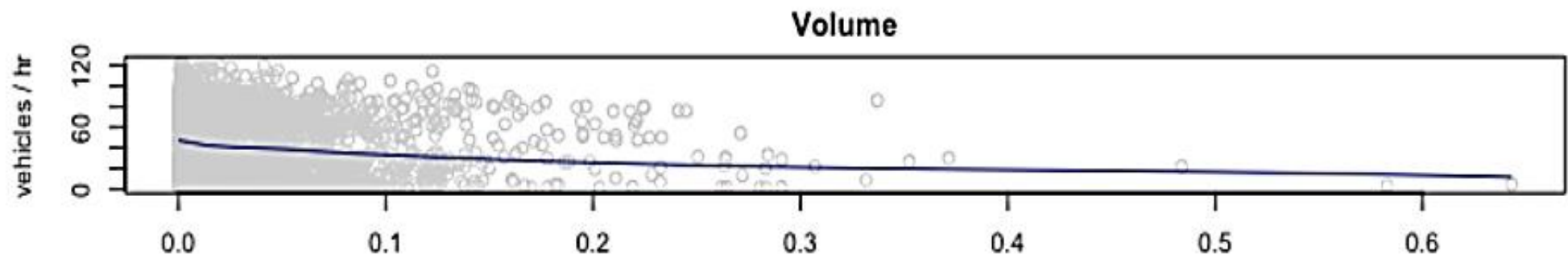
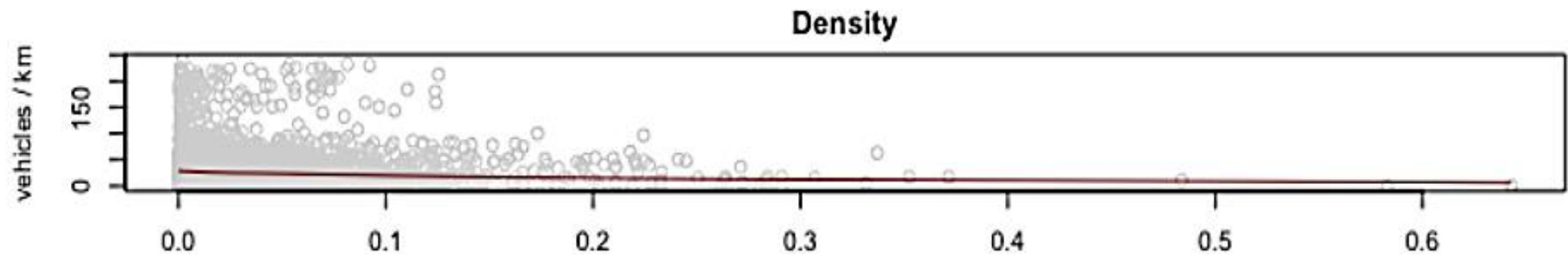


## Rainfall vs Date



# Figure 1 Spatial distribution of precipitation in Perth



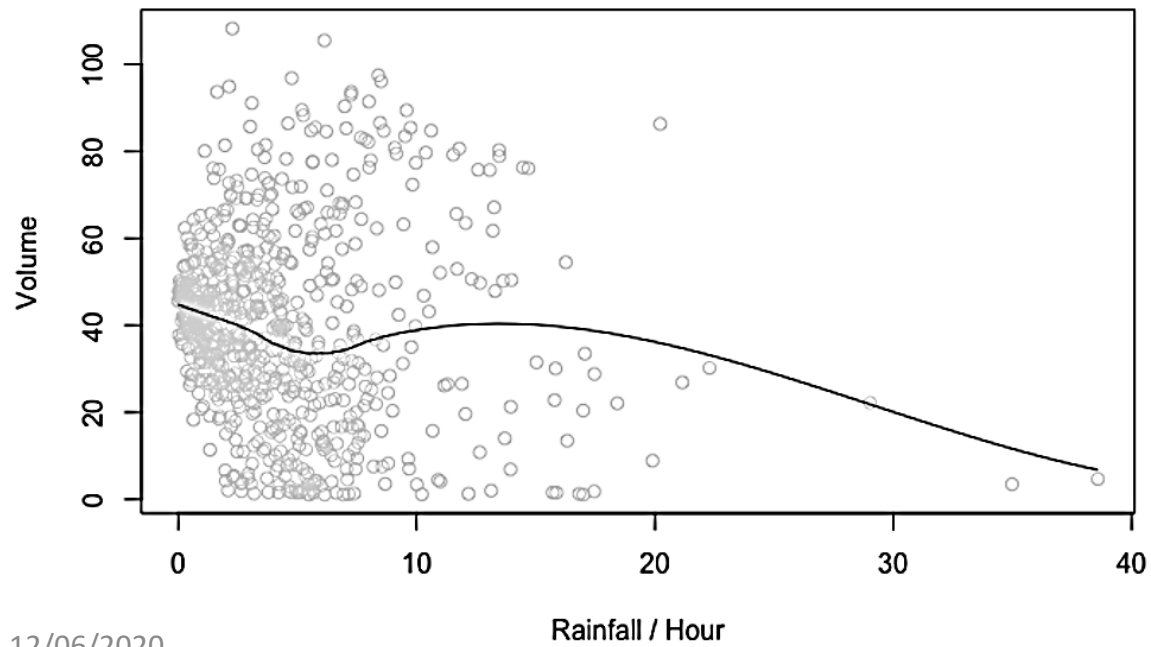
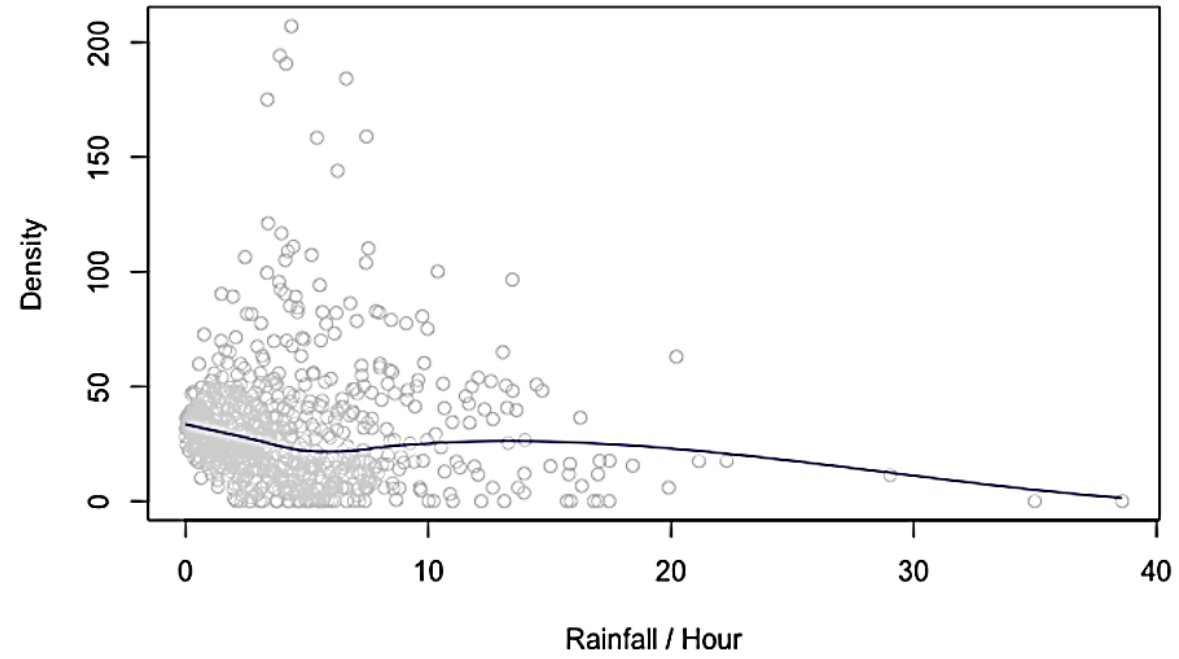
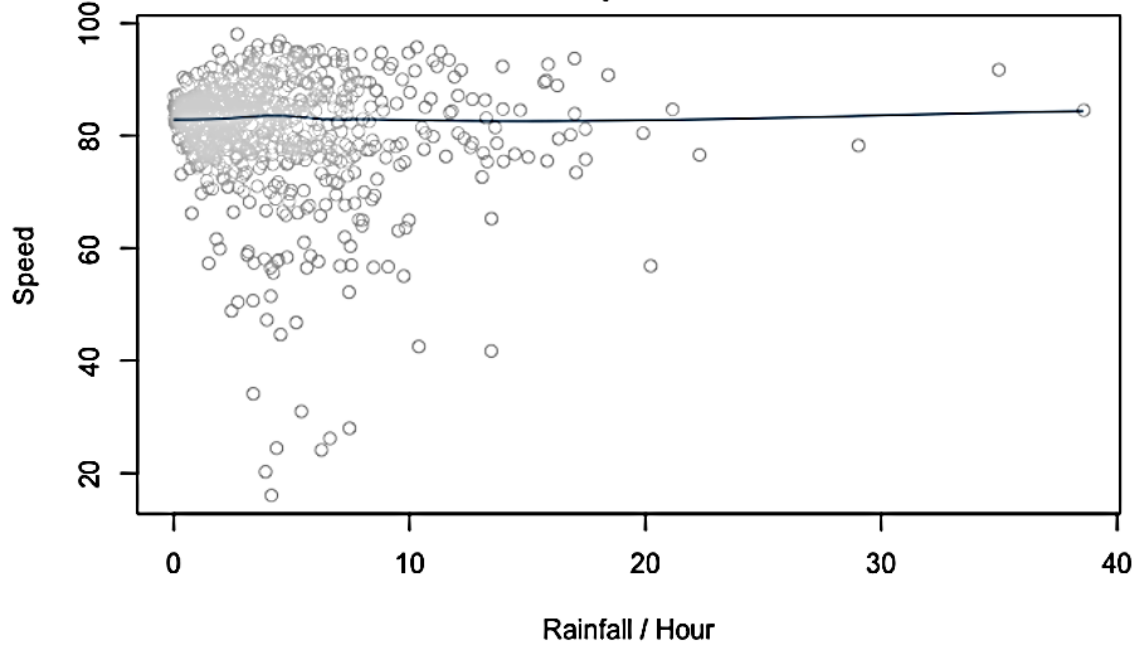


Rainfall (mm / min)

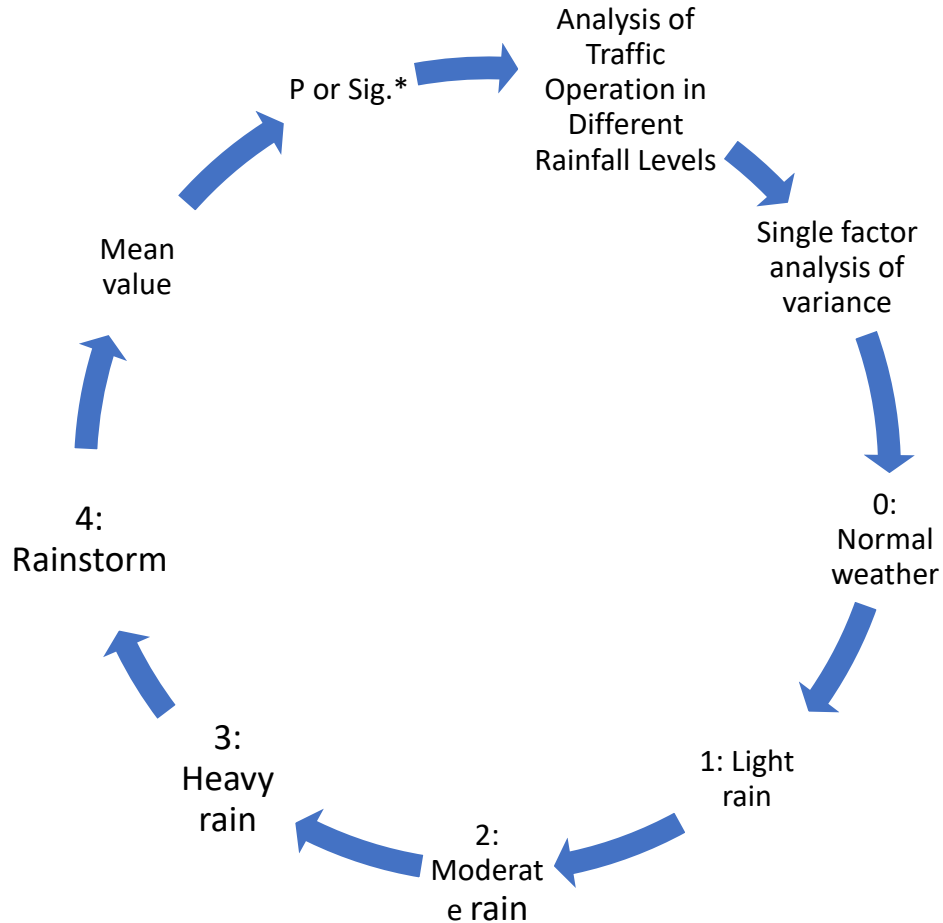
To get more value out of the rainfall data and cross check the data set, we separate the traffic data based on four rainfall levels: no rain, light rain, medium rain, heavy rain.

Taking the aggregated values of each set according to rainfall gives data summarised by:

	No Rain			Light Rain			Medium Rain			Heavy Rain		
	Volume	Speed	Density	Volume	Speed	Density	Volume	Speed	Density	Volume	Speed	Density
Min	1	8.8	0	1.02	18.07	0	1	17	0	1	8.8	0
Q1	8.9	76.7	5.87	9.73	76.53	5.87	12.15	76.7	5.87	7.73	76.73	5.46
Median	35.8	84.33	21.9	48.45	84.46	27.28	56.43	84.73	34.36	31.92	84.13	17.99
Mean	42.51	81.45	33.1	45.65	81.37	35.2	47.11	81.99	35.28	40.25	81.25	31.93
Q3	71.5	91.63	46.93	75.53	92	48.02	75.27	92.24	48.1	68.87	91.33	46.15
Max	123.8	99.07	240.9	121.47	99.07	226.08	123.8	98.33	240.9	120.2	99.07	231.75

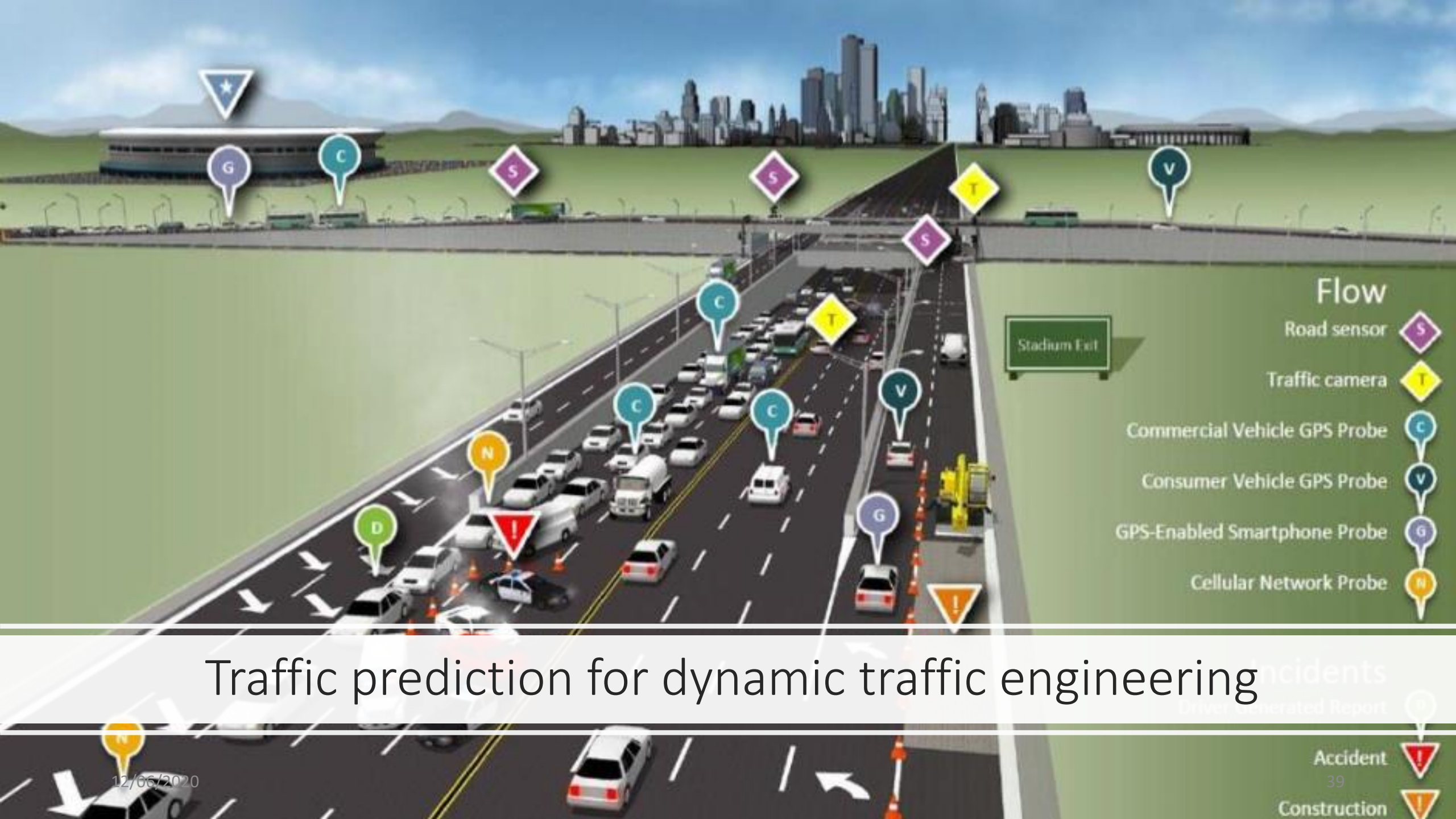


## Speed-volume Relationship by Weather Condition



		N	mean value	Std.Dev.	Std.Error	Confidence		Min	Max
						Min	Max		
speed	0	111	67.8631	8.12866	0.77154	66.3341	69.3921	52.20	92.00
	1	38	64.5658	8.92625	1.44803	61.6318	67.4998	51.20	91.50
	2	12	54.3667	8.75976	2.52872	48.8010	59.9324	42.50	75.10
	3	5	48.1000	15.05440	6.73253	29.4075	66.7925	32.10	65.80
	4	1	50.8000					50.80	50.80
	Total	167	65.4491	9.76742	0.75583	63.9568	66.9414	32.1	92.00
volume	0	111	8286.0450	1141.79950	108.37481	8071.2716	8500.8185	4450.00	9875.00
	1	38	8181.3684	813.78287	132.01301	7913.8846	8448.8522	6721.00	9418.00
	2	12	7785.9167	880.39004	254.14671	7226.5435	8345.2898	6656.00	9159.00
	3	5	7444.0000	1943.08402	868.97359	5031.3425	9856.6575	4627.00	9047.00
	4	1	5978.0000					5978.00	5978.00
	Total	167	8187.2575	1103.66131	85.40388	8018.6397	8355.8753	4450.00	9875.00

ANOVA						
		square sum	df	mean square	F	Sig.*
speed	Btw Groups	3869.867	4	967.467	13.097	0.000
	Within Groups	11966.951	162	73.870		
	Total	15836.817	166			
volume	Btw Groups	10660435.39	4	2665108.849	2.254	0.066
	Within Groups	191538900.5	162	1182338.892		
	Total	202199335.9	166			



# Traffic prediction for dynamic traffic engineering

- Flow**
- Road sensor
  - Traffic camera
  - Commercial Vehicle GPS Probe
  - Consumer Vehicle GPS Probe
  - GPS-Enabled Smartphone Probe
  - Cellular Network Probe

- Incidents
- Driver Generated Report
- Accident
- 39
- Construction

12/06/2020



thank  
you