

Short-term associations of road density and road features with in-vehicle PM_{2.5} during daily trips in the Washington, D.C. metro area

Supplementary Material

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Tables

Table S1. Meteorological characteristics (n (%)) for $n=45$ person-days of observation.

<i>Variable</i>	<i>Value</i>	<i>n (%)</i>
Precipitation	None	18 (40)
	Some	27 (60)
Snow	None	40 (88.9)
	Some	5 (11.1)
Wind direction	SE	17 (37.8)
	NW	23 (51.1)
	Other	5 (11.1)

Table S2. Correlations of road features with ambient $PM_{2.5}$ and daily meteorology. Variables include: Road density: road density for highways and local roads at 1 km and 500 m resolution (standard deviations); Speed (MPH); DailyPM: daily ambient $PM_{2.5}$ ($\mu g/m^3$); HourlyDevPM: hourly deviations from daily ambient $PM_{2.5}$ ($\mu g/m^3$); WindSpeed (m/s); MaxTemp: maximum temperature ($^{\circ}C$); MinTemp: minimum temperature ($^{\circ}C$); MeanTemp: mean temperature ($^{\circ}C$); and Humid: relative humidity (%)). * $p < 0.05$

Variable	DailyPM	HourlyDevPM	WindSpeed	MaxTemp	MinTemp	MeanTemp	Humid
Road density: Highway, 1 km	0.24*	-0.04	-0.02	-0.06*	-0.12*	-0.09*	0.01
Road density: Local, 1 km	0.13*	0.08*	-0.11*	-0.20*	-0.24*	-0.23*	-0.05*
Road density: Highway, 500 m	0.22*	-0.04*	-0.03	0.02	-0.04	-0.01	0.05*
Road density: Local, 500 m	0.14*	0.08*	-0.13*	-0.17*	-0.22*	-0.21*	-0.02
Speed	-0.09*	-0.04	0.15*	-0.11*	-0.08*	-0.10*	-0.18*
DailyPM		-0.18*	-0.56*	0.19*	-0.25*	-0.01	0.16*
HourlyDevPM			0.13*	-0.09*	0.01	-0.05*	0.15*
WindSpeed				-0.33*	-0.07*	-0.22*	-0.43*
MaxTemp					0.79*	0.96*	0.29*
MinTemp						0.93*	0.40*
MeanTemp							0.36*

Table S3. Quartiles (Q1, Q2, Q3, Q4) for road density (for highways and local roads at 1 km and 500 m resolution) and speed.

Variable	Units	Q1	Q2	Q3	Q4
Road density: Highway, 1 km	SD	(-1.63, -0.61]	(-0.61, -0.1]	(-0.1, 0.45]	(0.45, 3.85]
Road density: Local, 1 km	SD	(-4.58, -0.57]	(-0.57, 0.15]	(0.15, 0.52]	(0.52, 2.6]
Road density: Highway, 500 m	SD	(-1.46, -0.54]	(-0.54, -0.21]	(-0.21, 0.3]	(0.3, 4.15]
Road density: Local, 500 m	SD	(-5.22, -0.53]	(-0.53, 0.19]	(0.19, 0.57]	(0.57, 2.39]
Speed	MPH	(0, 5.34]	(5.34, 20.41]	(20.41, 38.28]	(38.28, 93.76]

Table S4. Unadjusted differences in in-vehicle $\text{PM}_{2.5}$ ($\log \mu\text{g}/\text{m}^3$) comparing each quartile of road density (Q2, Q3, Q4) to the lowest quartile for highways and local roads at 1 km and 500 m resolution from linear mixed models.

<i>Road</i>	<i>Resolution</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>
Road density: Highway	1 km	0.04 (-0.03, 0.12)	0.09 (0, 0.18)	0.09 (0, 0.19)
Road density: Local	1 km	0.03 (-0.05, 0.1)	0.04 (-0.05, 0.13)	-0.02 (-0.13, 0.09)
Road density: Highway	500 m	-0.02 (-0.1, 0.07)	0.02 (-0.08, 0.11)	0.04 (-0.06, 0.15)
Road density: Local	500 m	0.03 (-0.05, 0.1)	0.02 (-0.07, 0.11)	0 (-0.11, 0.12)

Figures

Figure S1. Distributions of daily ambient $\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$) and hourly $\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$) for $n=45$ person-days of observation.

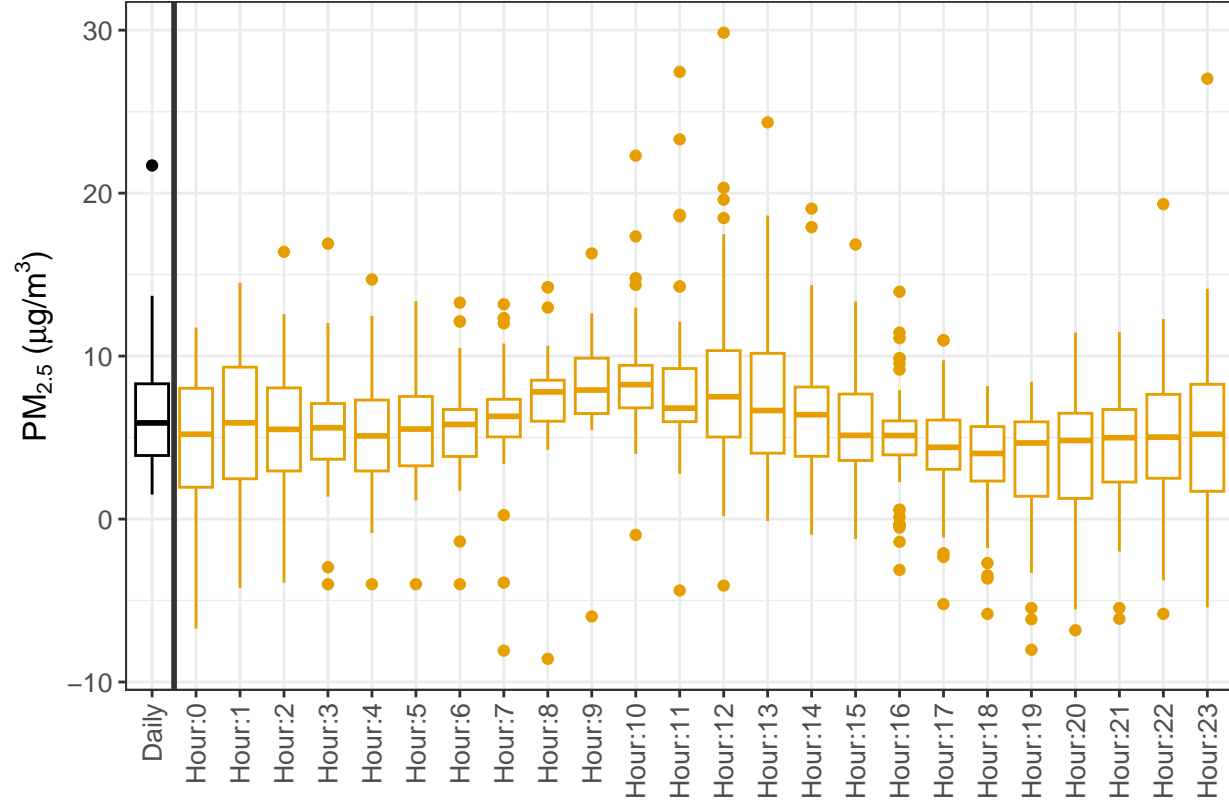


Figure S2. Wind rose plot showing direction of the fastest wind (degrees) sustained over five minutes across $n=45$ person-days of observation.

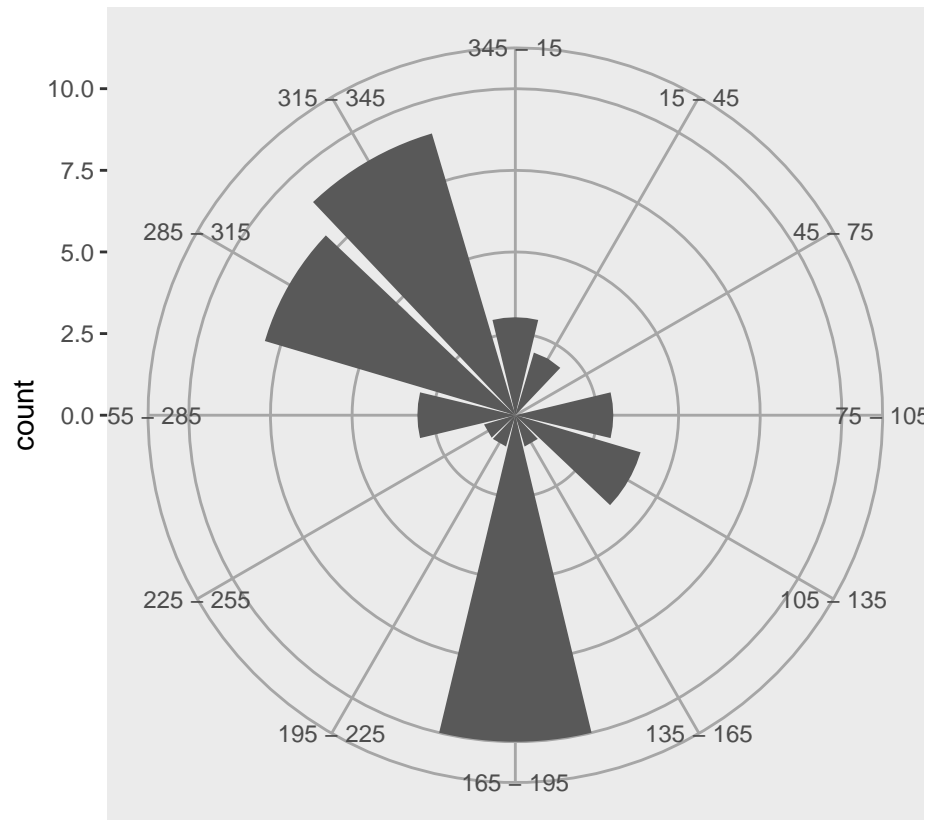


Figure S3. Distributions of in-vehicle PM_{2.5} exposures ($\mu\text{g}/\text{m}^3$) for each participant ($n=25$) on the natural log scale, along with observation time in minutes. Participants are ordered by their median in-vehicle PM_{2.5} exposures across trips.

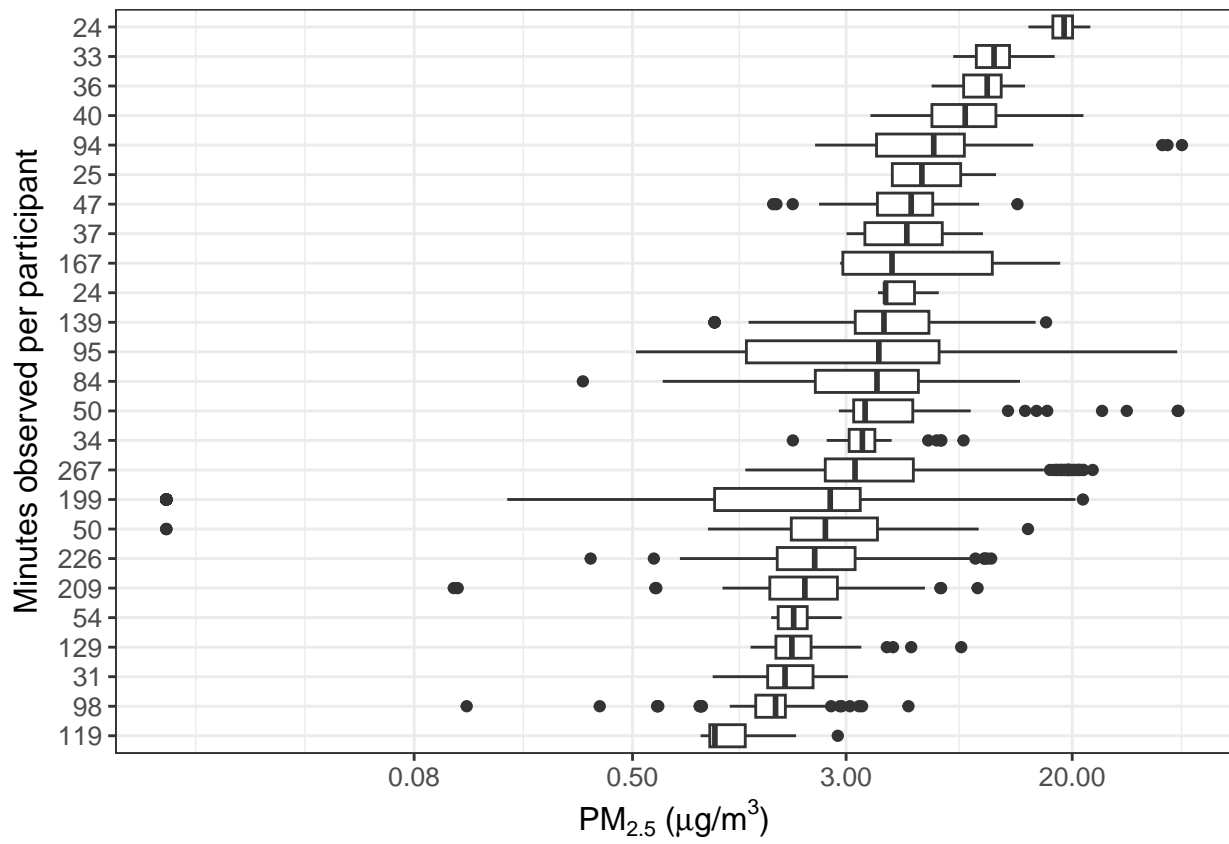


Figure S4. Variation in $\text{PM}_{2.5}$ (in standard deviations (SD) from trip-specific means) over each observed trip ($n=69$).

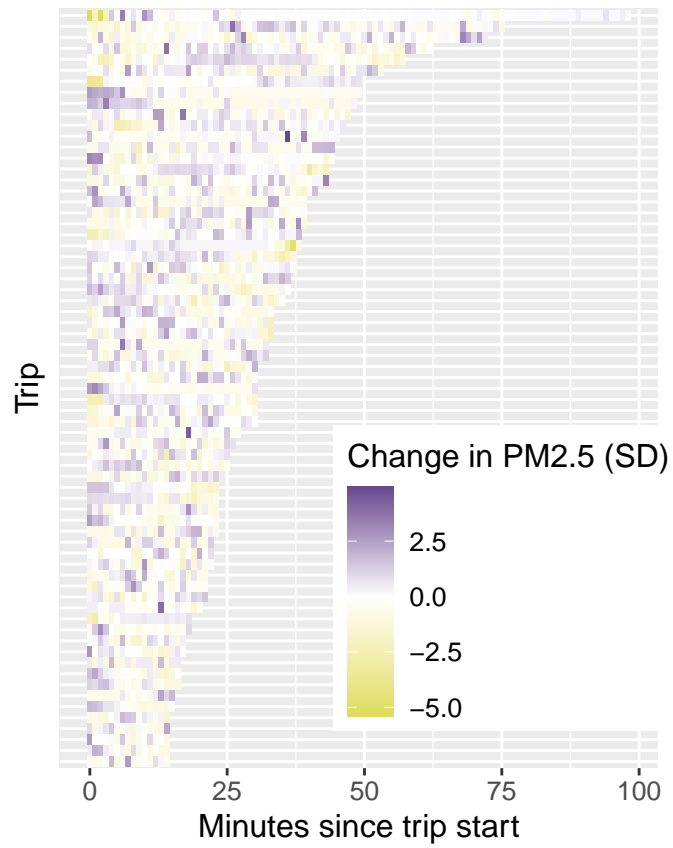


Figure S5. Map of standardized road density in the Washington, DC metropolitan area for A. highways and B. local roads at 500 m resolution.

A. Road density: Highway

B. Road density: Local

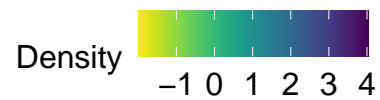
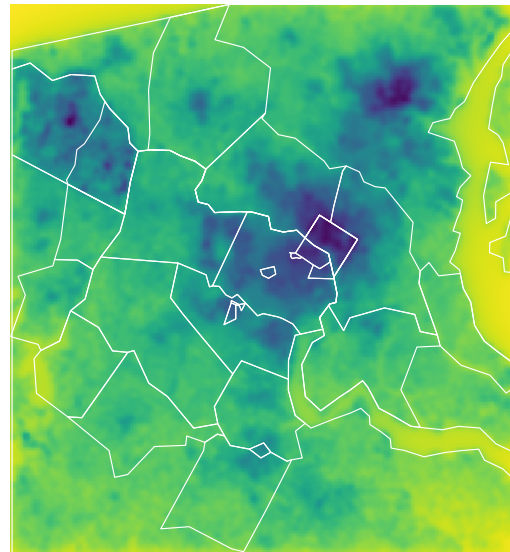
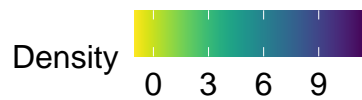
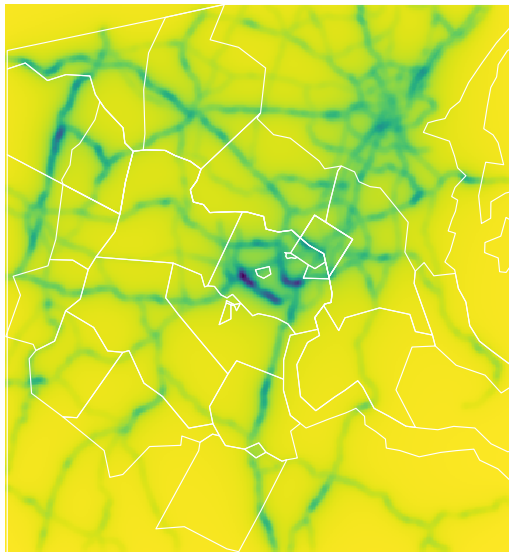


Figure S6. Variation in road density for A. highways and B. local roads at 500 m resolution (in standard deviations (SD)) and over each observed trip ($n=69$).

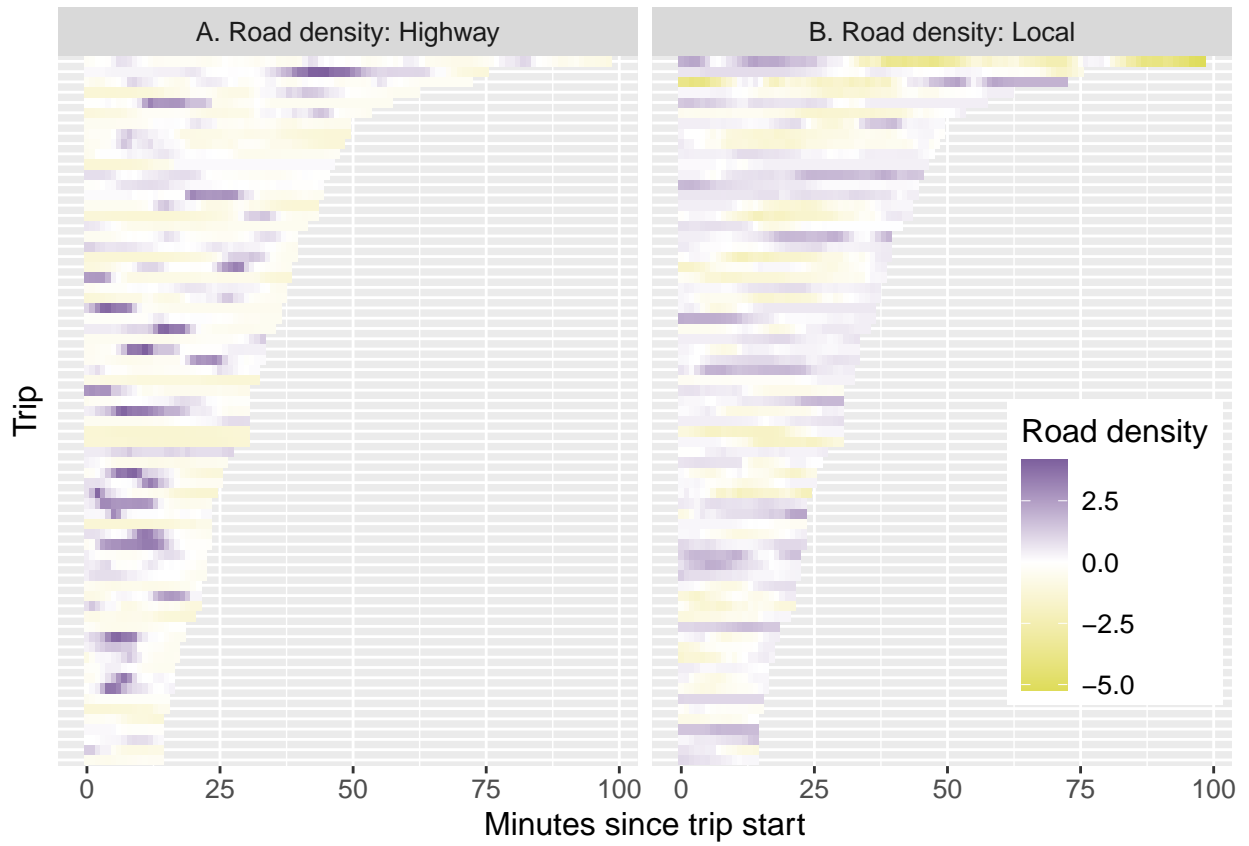


Figure S7. Percentage of observations on each road type per participant ($n=25$).

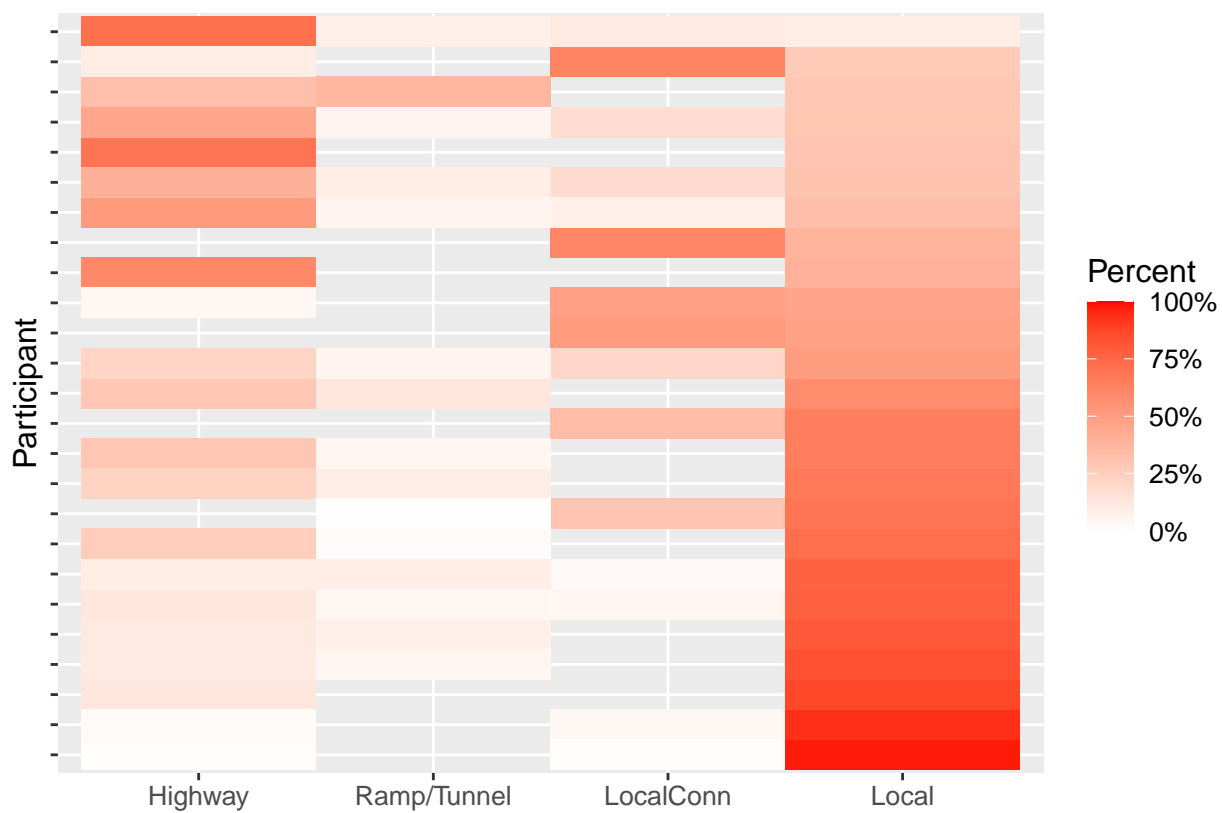


Figure S8. Variation in A. road type (highway, ramp/tunnel, local connecting, and local roads) and B. speed (mph) over each observed trip ($n=69$).

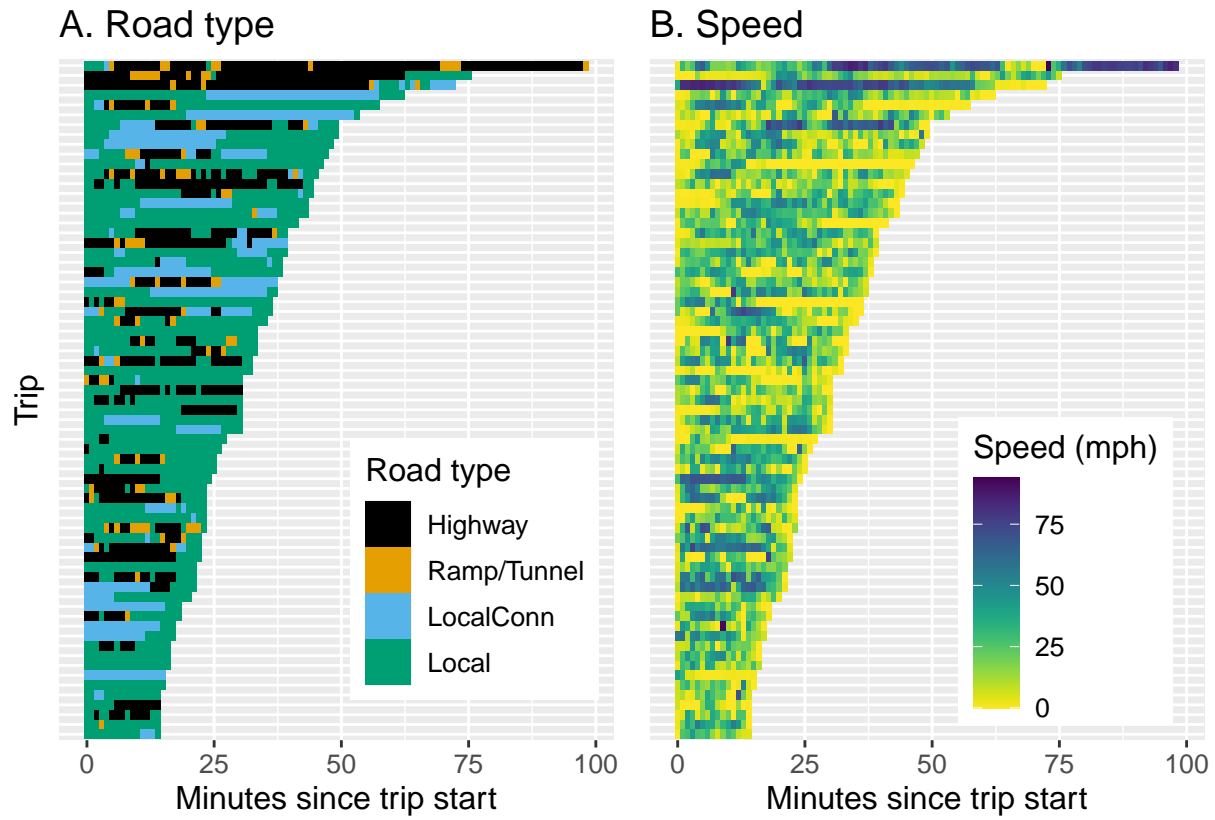


Figure S9. Associations of road density with in-vehicle $\text{PM}_{2.5}$ concentrations from linear mixed models reported as the change in $\log \mu\text{g}/\text{m}^3$ (95% confidence intervals) comparing each quartile of road density (Q2, Q3, Q4) to the lowest quartile (Q1) for A. highways and B. local roads at 500 m resolution. Results include main (unadjusted) models as well as models that separately adjusted for meteorology, ambient $\text{PM}_{2.5}$, rush hour trips, and all road features.

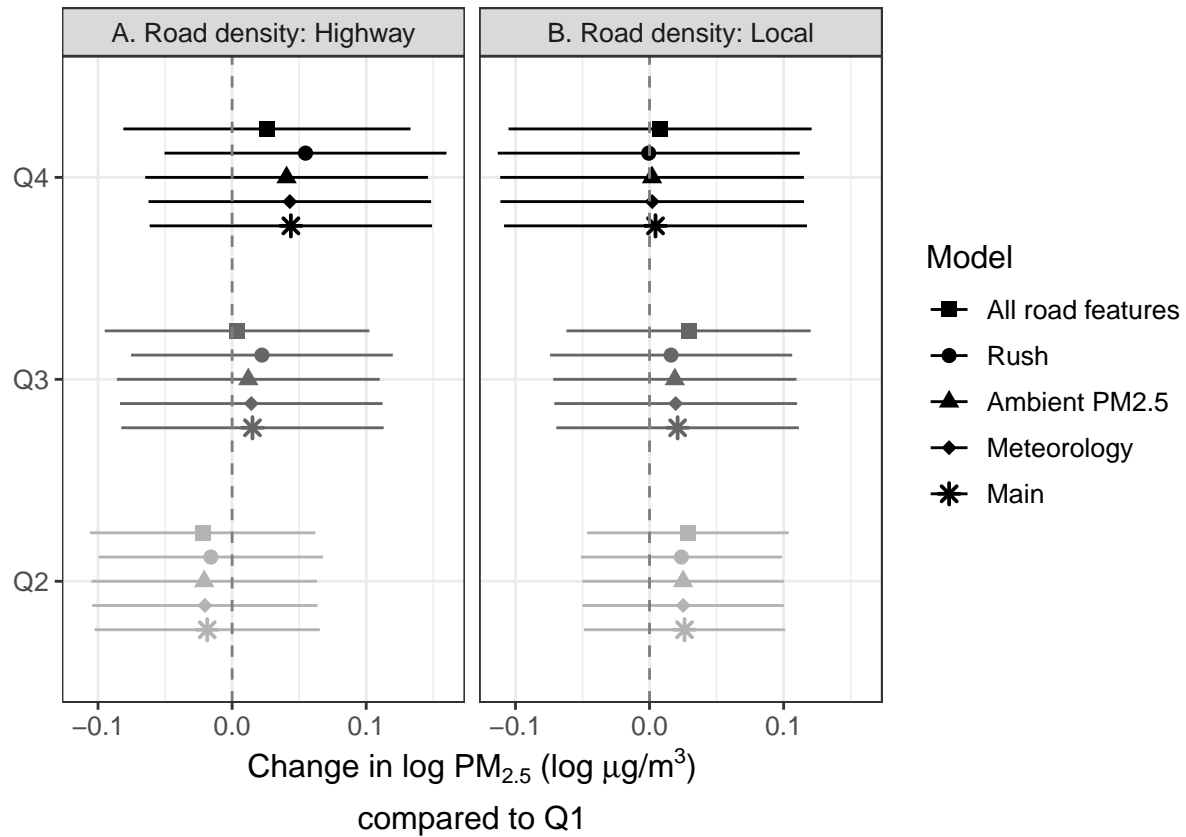


Figure S10. Associations of road density with in-vehicle $\text{PM}_{2.5}$ concentrations from linear mixed models for main models (lag 0) and lags up to 10 minutes, reported as the change in $\log \mu\text{g}/\text{m}^3$ (95% confidence intervals) comparing each quartile of road density (Q2, Q3, Q4) to the lowest quartile (Q1) for A. highways and B. local roads at 500 m resolution.

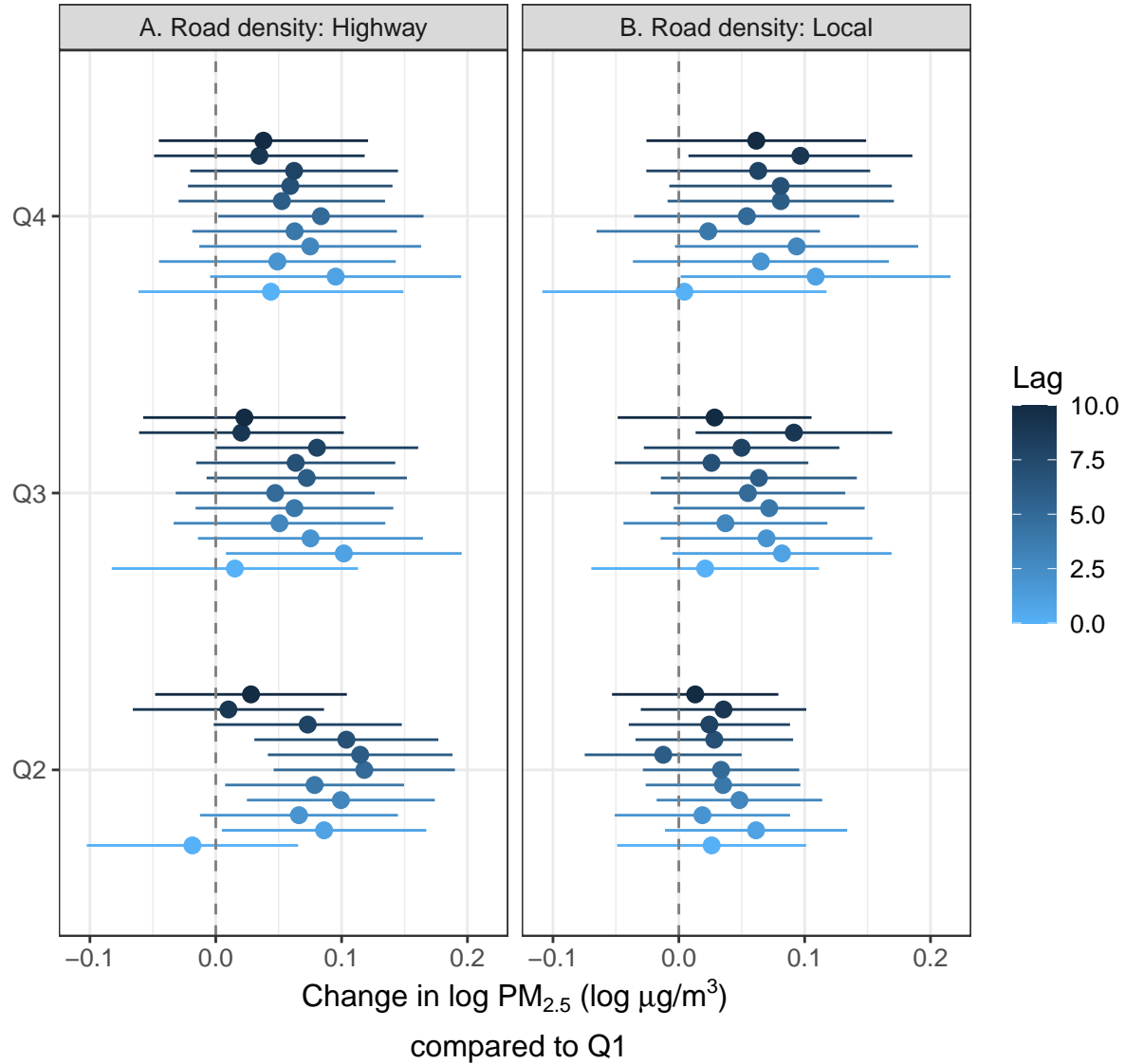


Figure S11. Associations of road type with in-vehicle $\text{PM}_{2.5}$ concentrations from linear mixed models, reported as the change in $\log \mu\text{g}/\text{m}^3$ (95% confidence intervals) comparing travelling on highways, local connecting roads, and ramps/tunnels to local roads. Results include main (unadjusted) models as well as models that separately adjusted for meteorology, ambient $\text{PM}_{2.5}$, and rush hour trips, and all road features.

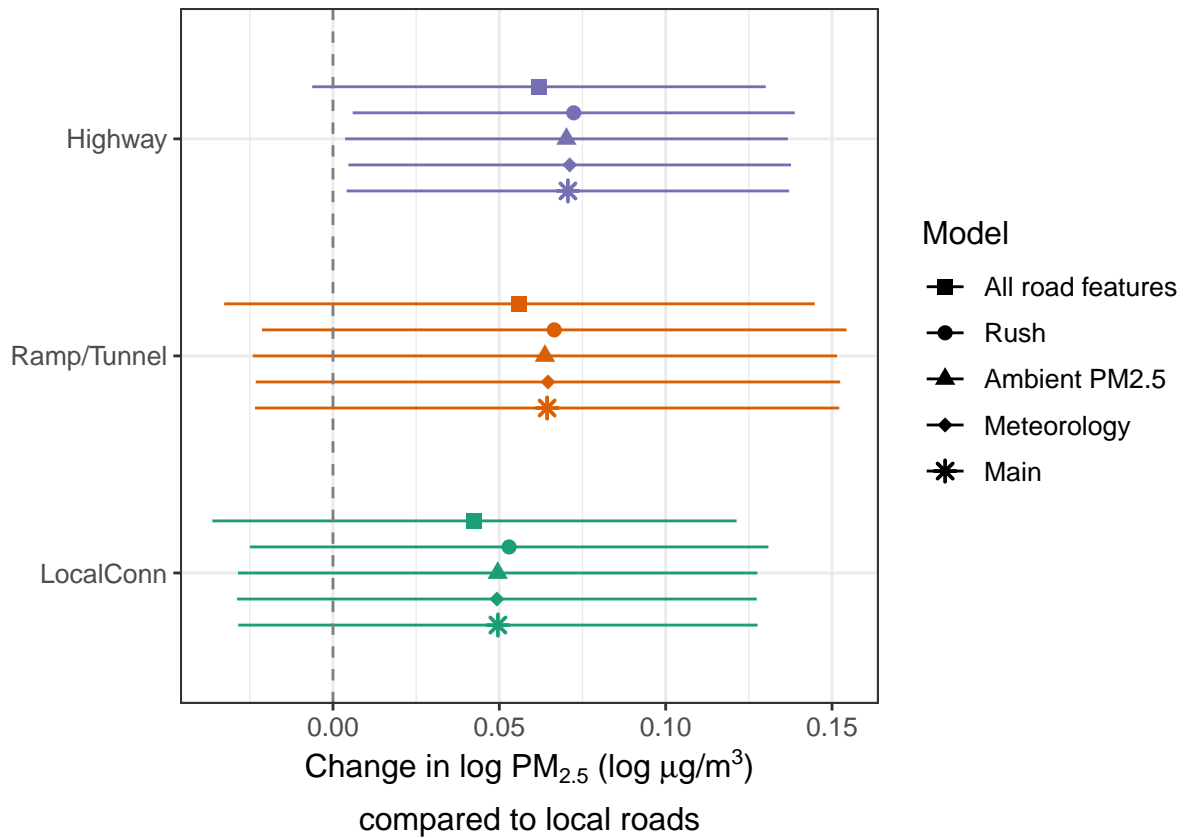


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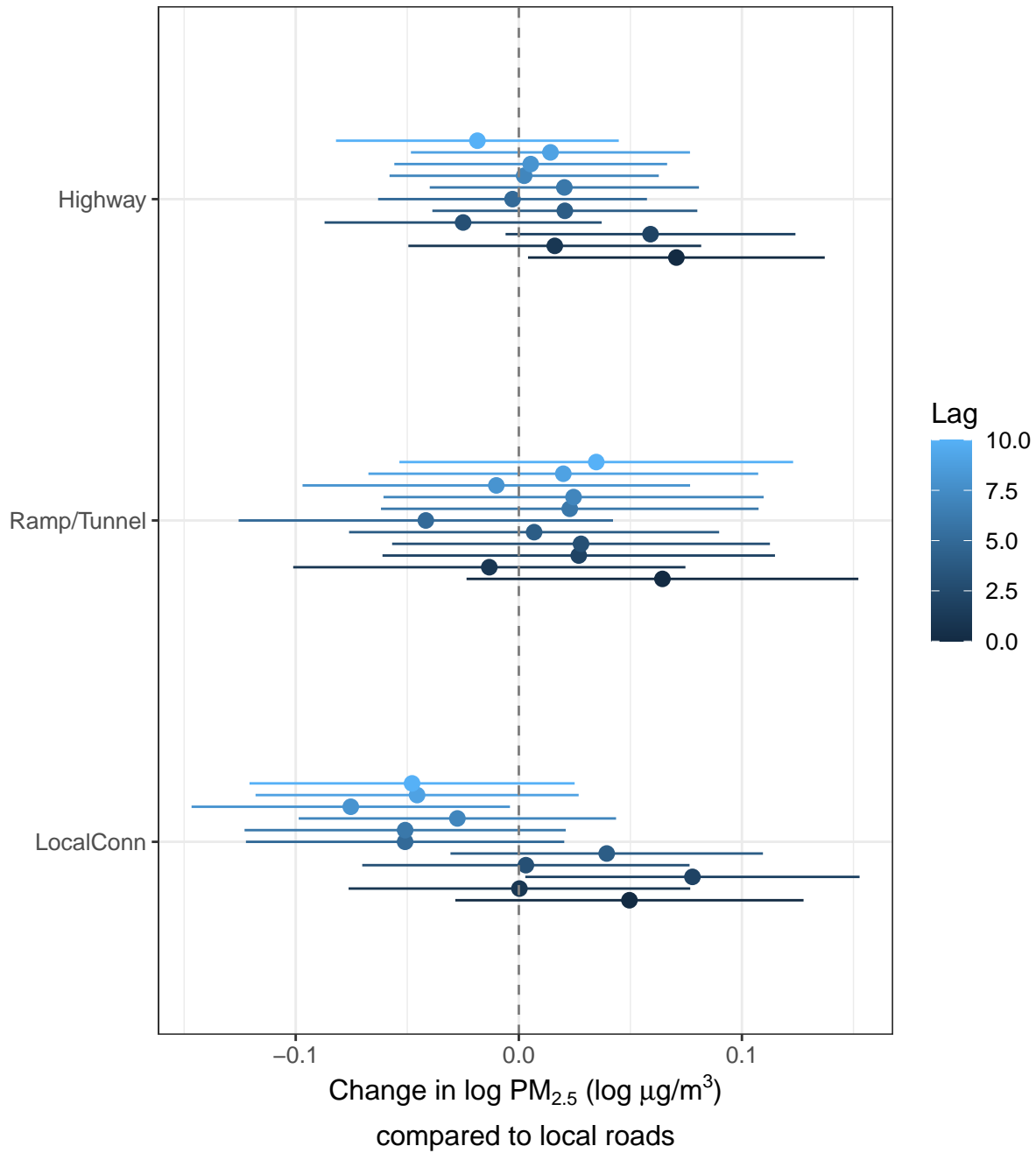


Figure S13. Associations of speed with in-vehicle $\text{PM}_{2.5}$ concentrations from linear mixed models reported as the change in $\log \mu\text{g}/\text{m}^3$ (95% confidence intervals) comparing each quartile of speed (Q2, Q3, Q4) to the lowest quartile (Q1). Results include main (unadjusted) models as well as models that separately adjusted for meteorology, ambient $\text{PM}_{2.5}$, rush hour trips, and all road features.

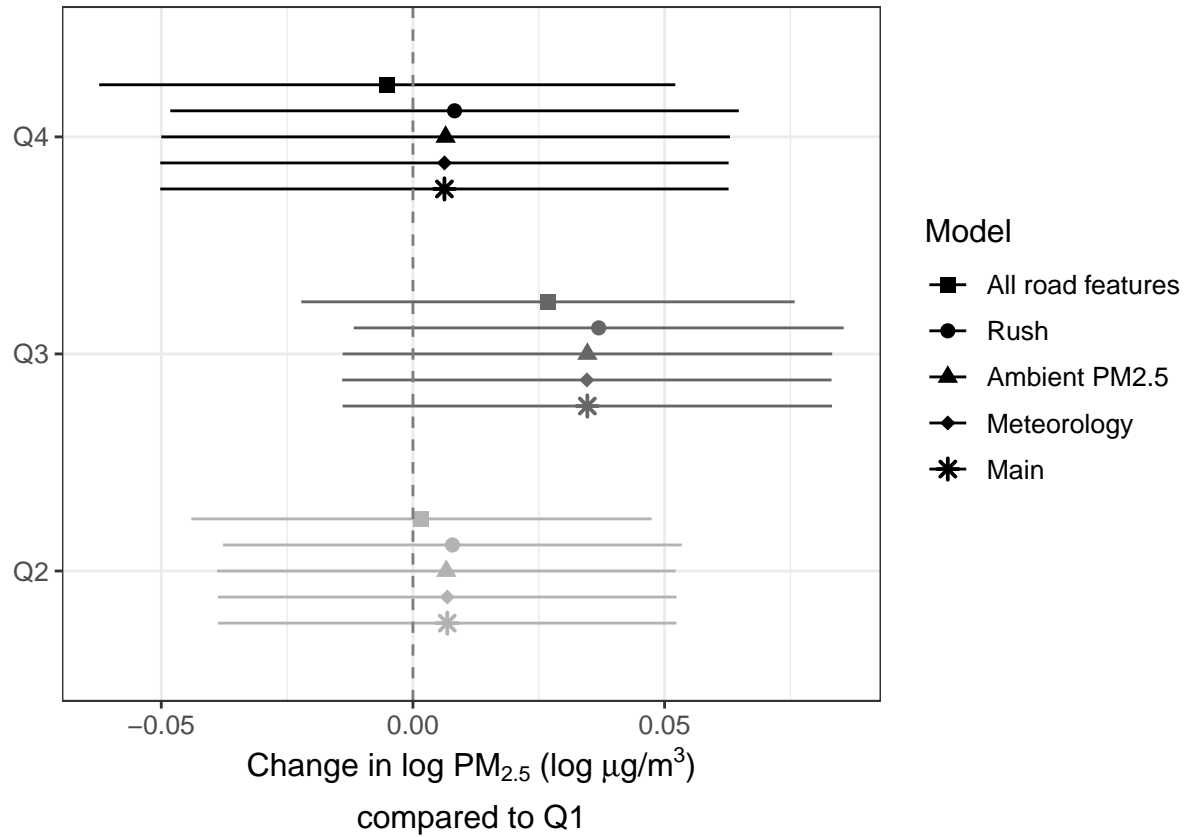


Figure S14. Associations of speed with in-vehicle $\text{PM}_{2.5}$ concentrations from linear mixed models for main models (lag 0) and lags up to 10 minutes, reported as the change in $\log \mu\text{g}/\text{m}^3$ (95% confidence intervals) comparing each quartile of speed (Q2, Q3, Q4) to the lowest quartile (Q1).

