Determination of Uncertainty in Emissions Rate Estimates

For the set of BEACO$_2$N emissions for each 7.8 g CO$_2$ / vkm bin of PeMS-derived emissions rates, we find a BEACO$_2$N-derived emissions rate estimate. To do this, we take all BEACO2N traffic emission corresponding to the timestamps given by PeMS-derived emissions rates in this bin and further bin these points based on vkm, as shown in Figure 3. For each vkm bin, we then find the median emissions value and the variance of emissions values, σ^2. We assume the error in our estimate of the median emissions for each vkm bin to be

$$\delta ems = \frac{\sigma}{\sqrt{n}} .$$

We then fit median emissions values to the line

$$ems = \frac{gCO_2}{vkm} vkm,$$

to find $\frac{gCO_2}{vkm}$, using δems as weights in the MATLAB fitlm function, and take the reported SE in slope to be the error in our calculated $\frac{gCO_2}{vkm}$.
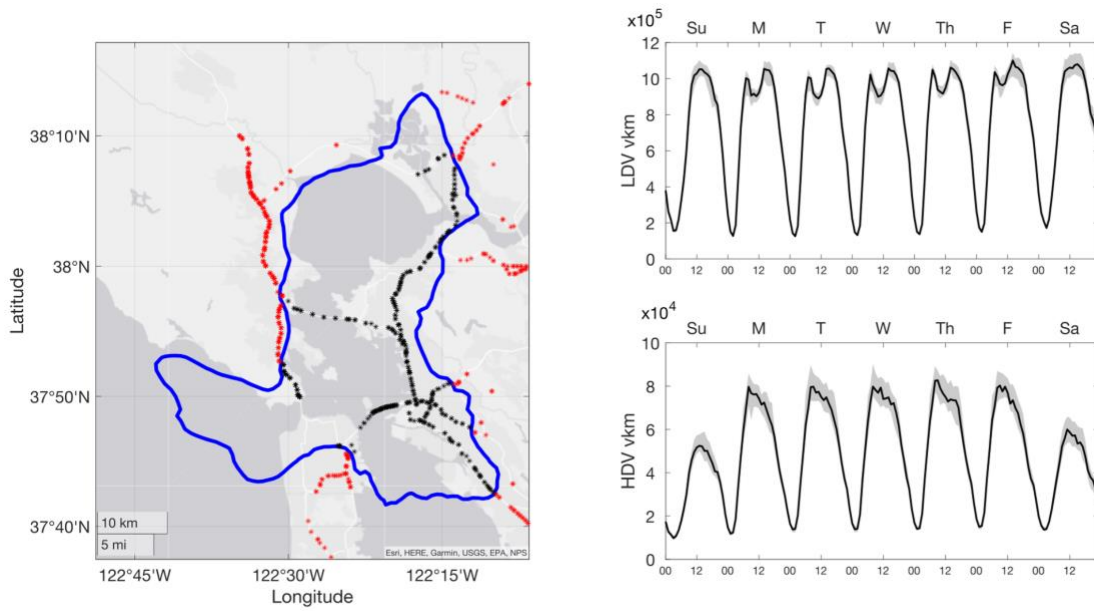
Fig. S1. Left: Locations of Caltrans PeMS monitoring stations (black and red). The solid blue line marks the 40% contour of the BEACO$_2$N cumulative influence function during January – June 2020. Right: LDV vkm, HDV vkm, and total highway CO$_2$ emissions estimated based on PeMS-EMFAC.
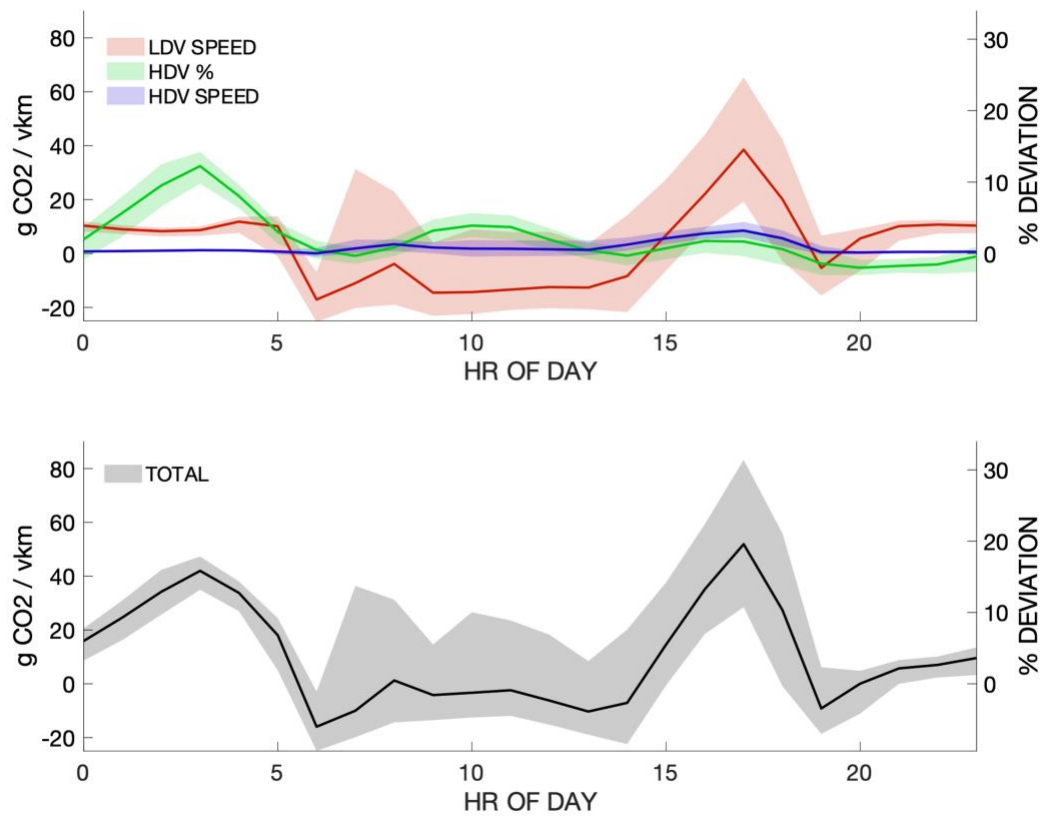
Fig S2. (Top) PeMS-EMFAC-derived emissions rate deviations from baseline of 6% of all vehicles HDV, and vehicle speed constant at 105 kph resulting from car speed, truck percentage, and truck speed for the average day on the week shown in Figure 3. (Bottom) Total deviation in emissions rate by hour of day. % Deviation (right axis) shows percent deviation for all curves from emissions rate of 6% HDV at 105 kph.
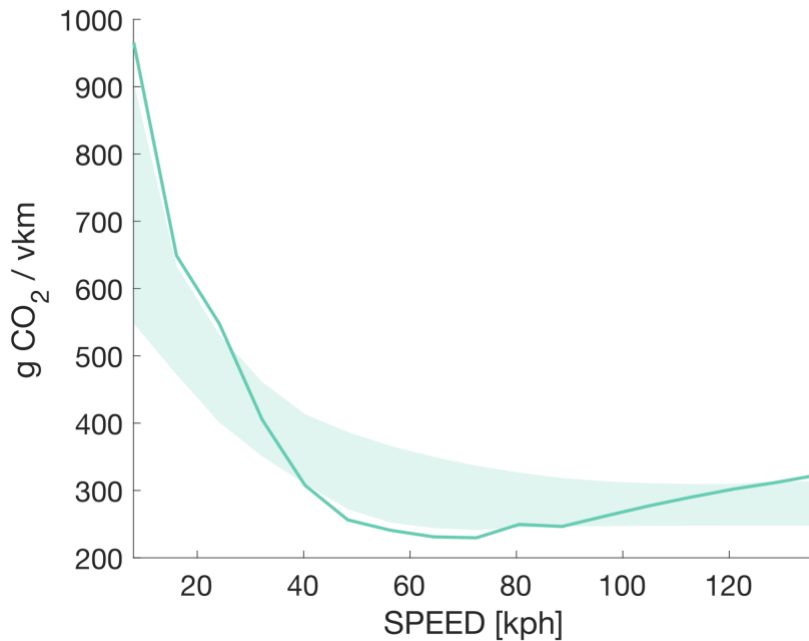
Fig. S3. The range of possible emissions rates that can occur for a particular hourly averaged speed. The dark line indicates the emissions rate corresponding to driving the speed indicated on the x axis at a constant velocity. The shaded region represents *er* distribution resulting from vehicle travel at non-constant speeds. For each speed, we calculate all possible emissions rates (g CO_2 / vkm) that could be generated assuming that the vehicle fleet (here, 8% HDV as is common during AM rush hour) drives at 2 different speeds between 8 kph and 130 kph for the times required to result in the average speed represented on the x axis. The spread for each speed then represents the 16th-84th percentiles of possible emissions rates.

Text S3. Figure S3 shows the hourly variation in the relative contributions of LDV speed, HDV percentage, and HDV speed to the deviation in CO_2 / vkm from the reference value of 265 g CO_2 / vkm. The solid line is the mean, and the shaded envelope represents the day-to-day variance. In the morning and mid-day, HDV percentage and LDV speed have opposite impacts on CO_2 / vkm, leading to small variations in CO_2 /vkm over the day, despite substantial variations in the separate effects of speed and HDV %. During evening rush hour, low vehicle speeds result in higher emission rates, leading to large positive deviations. High day-to-day variance in vehicle speed contributes to high day-to-day variance in emission rates. At times near midnight, large, positive deviations are observed, mostly as a consequence of high HDV percentage, but also because traffic flows at rates higher than 104.6 kph, leading to higher emission rates. Night-to-night variance in HDV percentage is low, thus variance in nighttime predicted CO_2 / vkm is small. HDV speed has little impact on CO_2 / vkm.

Table S1. Breakdown of EMFAC vehicle classes we characterize as LDV or HDV based on length. "1" denotes LDV and "0" denotes HDV.

EMFAC Vehicle Class	Grouping for this work
All Other Buses	0
LDA	1
LDT1	1
LDT2	1
LHD1	1
LHD2	1
MCY	1
MDV	1
MH	0
Motor Coach	0
OBUS	0
PTO	0
SBUS	0
T6 Ag	0
T6 CAIRP heavy	0
T6 CAIRP small	1
T6 OOS heavy	0
T6 OOS small	1
T6 Public	0
T6 instate construction heavy	0
T6 instate construction small	1
T6 instate heavy	0
T6 instate small	1
T6 utility	0
T6TS	0
T7 Ag	0
T7 CAIRP	0
T7 CAIRP construction	0
T7 NNOOS	0
T7 NOOS	0
T7 POAK	0
T7 Public	0
T7 SWCV	0
T7 Single	0
T7 other port	0
T7 single construction	0

T7 tractor	0
T7 tractor construction	0
T7 utility	0
T7IS	0
UBUS	0