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SI Section 1: Correcting R-Line Simulated NO_x impacts

R-Line simulation results for NO_x were not in agreement with the estimates of the true mobile source impact (SI Fig. 9). The true mobile source impact is estimated as the difference between the Near-Road (monitoring) Network (NRN) hourly NO_x concentration (AQS Site ID# 27-053-0962) and the average of the non-NRN NO_x concentrations within 10 miles of the NRN site (NO_x AQS Site IDs# 27-003-1002 & 27-037-0020 and $PM_{2.5}$ AQS Site IDs# 27-171-3201 & 27-139-0505 & 27-003-1002 & 27-053-0963 & 27-123-0871 & 27-123-0868). The difference between the NRN concentration and the average of the background concentrations for each hour was considered as the hourly mobile source impact at the NRN site. We could then estimate the hourly NOx spatial fields by evaluation of the initial model concentration at the NRN site with the true mobile source impacts. Each hour of the day was grouped against the corresponding mobile source impact for that hour (SI Fig. 10 for hourly comparisons), so that 24 unique comparisons could be made (SI Table 7). From here, we used 24 linear corrections to correct the corresponding hourly R-Line simulations. This calibration approach reduced maximum simulated NO_x concentrations throughout the study period (SI Fig. 11), but other performance metrics, including average percent differences between the simulated mobile-source impacts and the “true” mobile-source impact determined from observations, did not show improvements, and oftentimes the performance metric was worse (SI Table 8). This is likely attributed to the correction approach which would be driven by the high-concentration simulated values by the model.

The initial horizontal dispersion coefficient, σ_z, a measure of the plume spread, used in this is 2 meters, the default value suggested in R-Line. This value is on the high end of mobile source σ_z and slight increases in σ_z has little influence on the output concentrations.

SI Section 2: Participant Selection Criteria

Residents of randomly selected blocks (921 of the 2443 census blocks in the study neighborhoods) in the study neighborhoods were recruited to participate in the study. All homes on the selected blocks were first post carded with a brief study description (which did not include any information of the concurrent air pollution sampling) and contact information for the research team. Once contacted, researchers explained the study in detail to the participants, individually, and those who chose to participate set an appointment with the survey team. The well-being assessments occurred in three stages, an entry survey, 7 days of episode level data collection, and an exit survey (SI Table 9 for complete demographic breakdown of the study participants). The entry and exit surveys are used to collect information on cognitive SWB, socio-demographic parameters, neighborhood perceptions, and other variables that been known to influence SWB.

SI Section 3: Statistical tests on regressions between air quality (observed $PM_{2.5}$ and mobile-source simulated NO_x) and emotional well-being (EWB) indicators

Significance on the correlation coefficients between air quality (observed $PM_{2.5}$ and mobile-source simulated NO_x) and the six EWB indicators was determined using

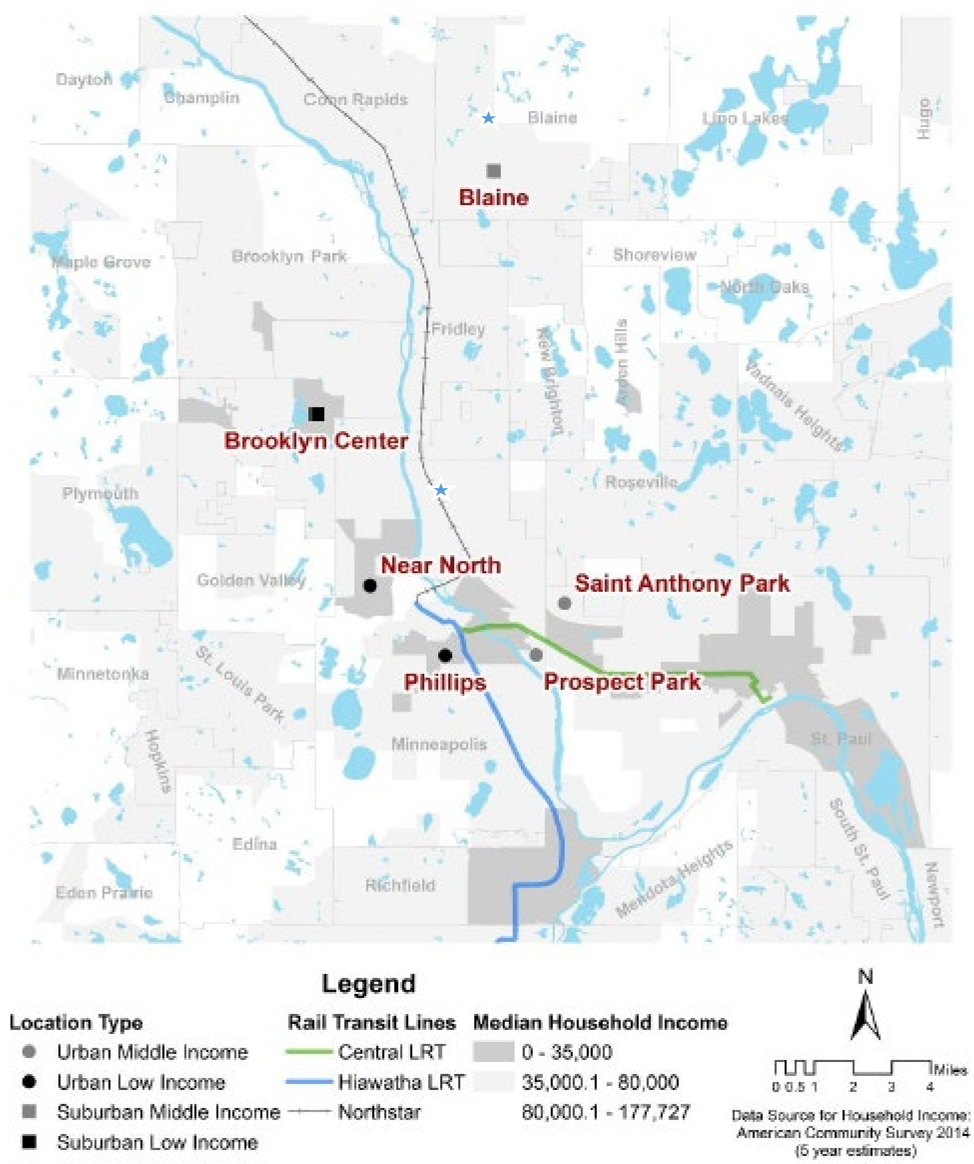
$$t = r * \sqrt{\frac{n-2}{1-r^2}}$$

Where t is the t-statistic, r is the square root of r^2, and n is the number of neighborhood assessments (6). None of the regressions were found to be statistically significant at $\alpha = 0.05$ (SI Table 10).

SI Section 4: NAAQs Exceedances on emotional well-being (EWB)

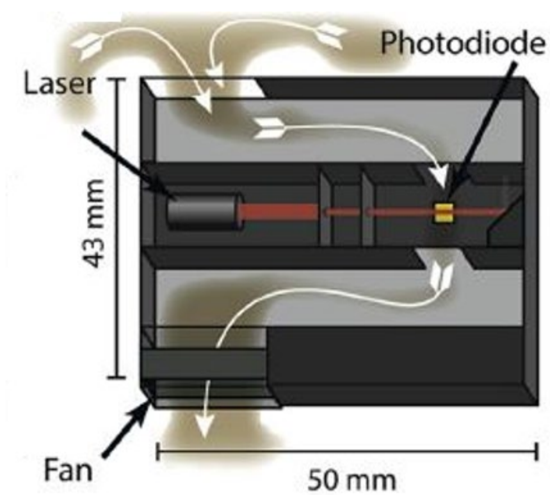
There were four simulated hours when the mobile source NO_x impact exceeded the hourly NO_2 NAAQs (100 ppb) in the neighborhoods when a concurrent EWB assessment existed (SI Table 11). The NAAQs exceedance in Near North resulted in higher happiness and net affect, but lower tiredness, stress, sadness, and pain (SI Table 12). This was the exact opposite of what was expected, and each of the responses was statistically significant (α=0.05). In Prospect Park, the statistically significant relationships between NO_x exceedances, and EWB were negative responses with happiness and net affect. Each of the companion EWB assessments during NO_x exceedance events were recorded as either at-home or leisure recreation activity types, which may both be indoor and subject to a variety of other confounding variables like the ongoing activity (watching TV, family time, reading, etc.). There were no $PM_{2.5}$ daily NAAQs exceedances when at least one EWB assessment existed for any of the neighborhoods.

SI Fig. 1: Minneapolis-St. Paul city map with the study neighborhoods identified. The different shadings and lines represent household income and rail access, respectively. The blue stars are the locations of the Minnesota Pollution Control Agency (MPCA) air pollution monitoring sites that were used for low-cost sensor (LCS) evaluation and calibration.

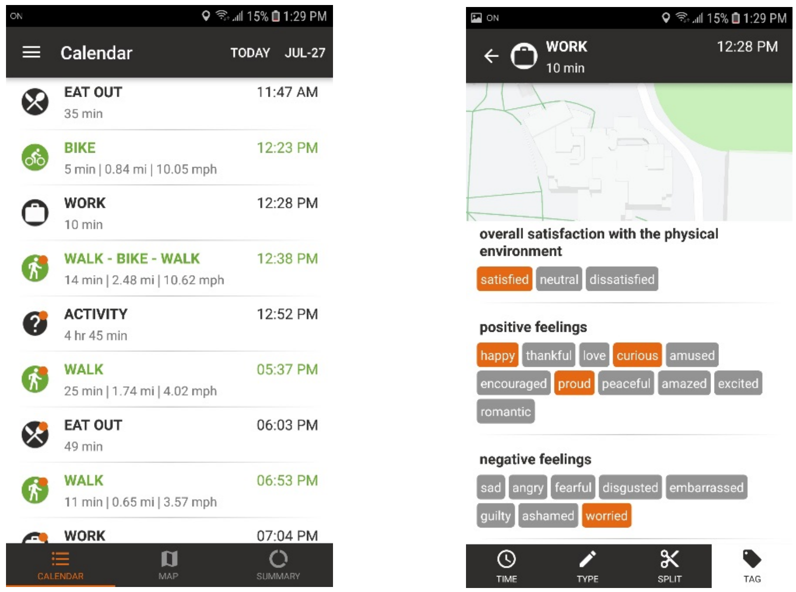


SI Fig. 2: Sample of the low-cost sensor set up (within the red circle) in St. Anthony Park. In each neighborhood, monitors were ziptied to fences or other stationary spots outside the house that were isolated and away from emission sources. Monitors were elevated to approximately the inhalation height in each neighborhood.

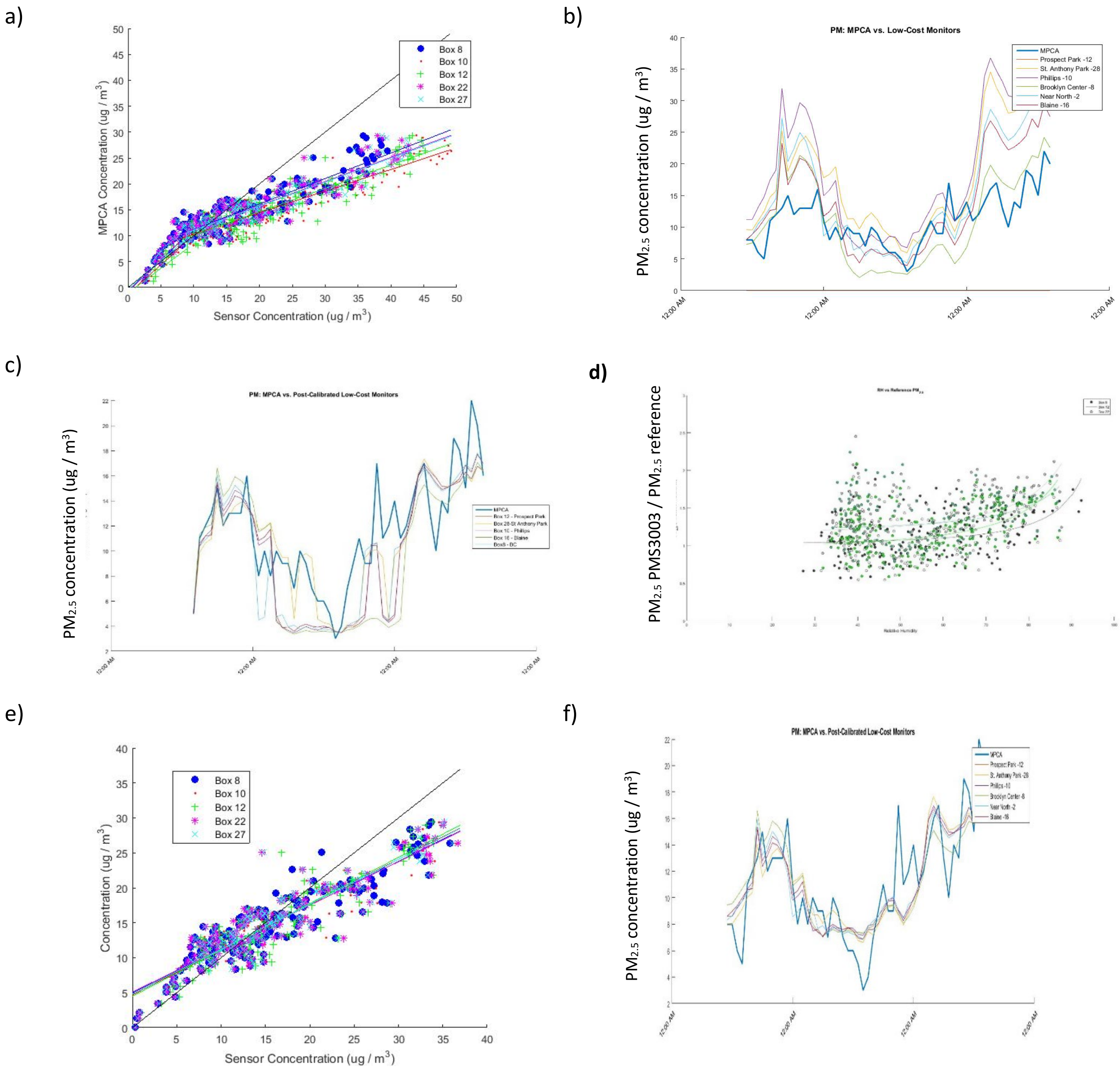
SI Fig. 3: Schematic of the Plantower PMS3003 (which measures PM_1, $PM_{2.5}$, and PM_{10}) as originally published in Kelly et al. (1). The figure is republished with permission from Kelly and Elsevier Publishing . The output waveform produced by the photodiode estimates mass concentration from particle size (pulse amplitude) and number concentration (pulse frequency)



SI Fig. 4: Sample interface of Daynamica, the smartphone application used to assess well-being. Residents of the study neighborhoods responded to well-being surveys after completing activities throughout the day.



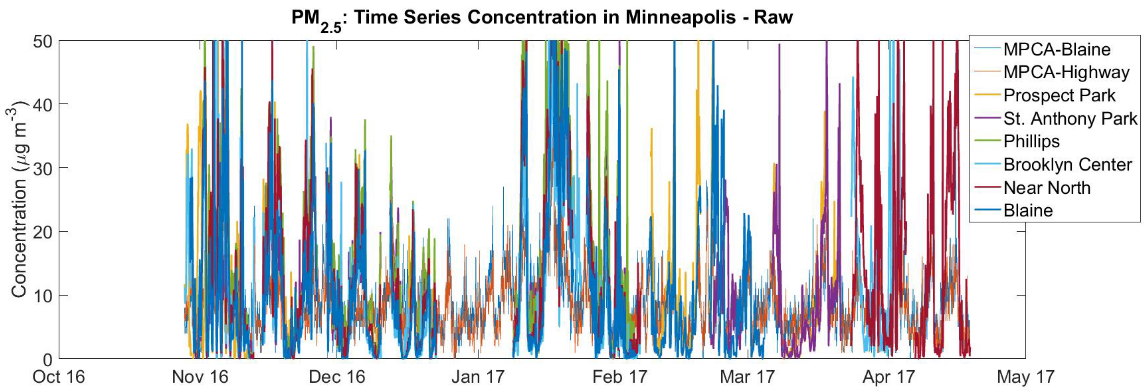
SI Fig. 5: Sample calibration results of the Plantower PMS 3003 sensor co-located with a Beta Attenuation Monitor (BAM) at a Minnesota Pollution Control Agency (MPCA) site (AQS Site ID# 27-053-0962). (a) Pre-calibration scatter: Comparison of 5 low-cost sensors (LCS) with BAM measurements. The best fit is a piecewise continuous fit. (b) Pre-calibration time series: $PM_{2.5}$ time series where the thick blue line is the BAM measurement and the thin lines are the LCS measurements. (c) Piecewise correction without relative humidity correction: The adjusted Plantower results following a piecewise adjustment (i.e., a fit was determined, and values below the split point were given one linear calibration, and sensor concentrations' above the split point were given a different calibration). (d) Relative humidity correction method: RH vs. $PM_{2.5}$ fit using Zheng, et al. (2). (e) Post-RH Correction scatter: Comparison of 5 LCS with BAM measurements following the RH correction. (f) Post-RH Correction Calibration time series.


a)
MPCA Concentration (ug / m3)
Sensor Concentration (ug / m3)
Box 8
Box 10
Box 12
Box 22
Box 27
b)
PM: MPCA vs. Low-Cost Monitors
PM2.5 concentration (ug / m3)
MPCA
Prospect Park -12
St. Anthony Park -28
Phillips -10
Brooklyn Center -8
Near North -2
Blaine -16
12:00 AM
c)
PM: MPCA vs. Post-Calibrated Low-Cost Monitors
PM2.5 concentration (ug / m3)
MPCA
Box 12 - Prospect Park
Box 28 St Anthony Park
Box 10 - Phillips
Box 16 - Blaine
Box8 - BC
12:00 AM
d)
PM2.5 PMS3003 / PM2.5 reference
e)
Concentration (ug / m3)
Sensor Concentration (ug / m3)
Box 8
Box 10
Box 12
Box 22
Box 27
f)
PM: MPCA vs. Post-Calibrated Low-Cost Monitors
PM2.5 concentration (ug / m3)
MPCA
Prospect Park -12
St. Anthony Park -28
Phillips -10
Brooklyn Center -8
Near North -2
Blaine -16
12:00 AM

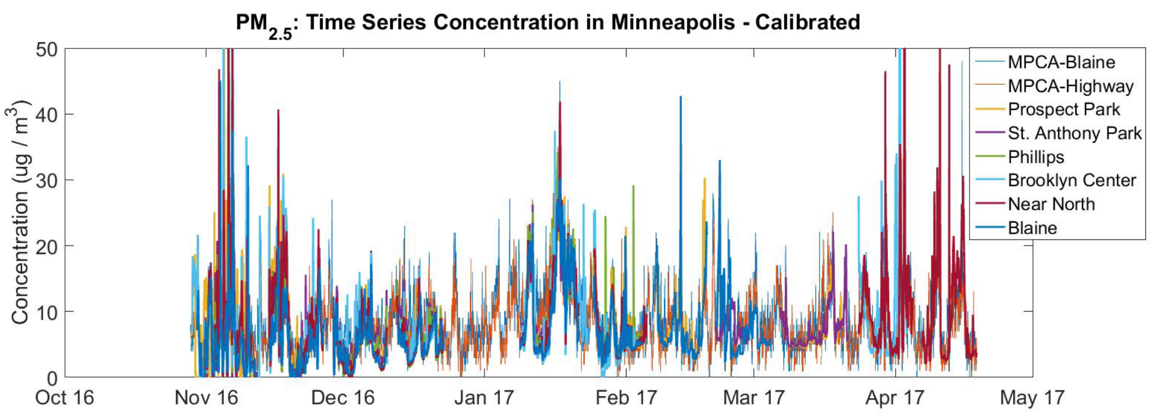
SI Fig 6

SI Fig. 6: Low: Low-cost sensor raw and post-RH-corrected calibration time series in Minneapolis throughout the study period. The thicker lines represent low-cost sensor concentrations while the thin blue and orange lines are from two regulatory monitors (AQS Site IDs# 27-003-1002 & 27-053-0962) in the study domain: (a) Raw $PM_{2.5}$ and (b) Calibrated $PM_{2.5}$

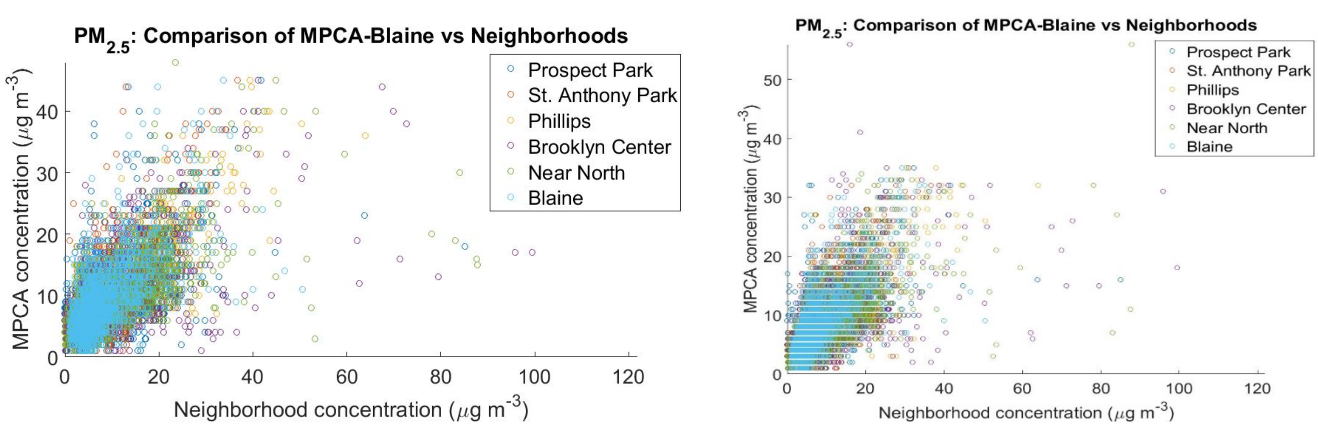
a)



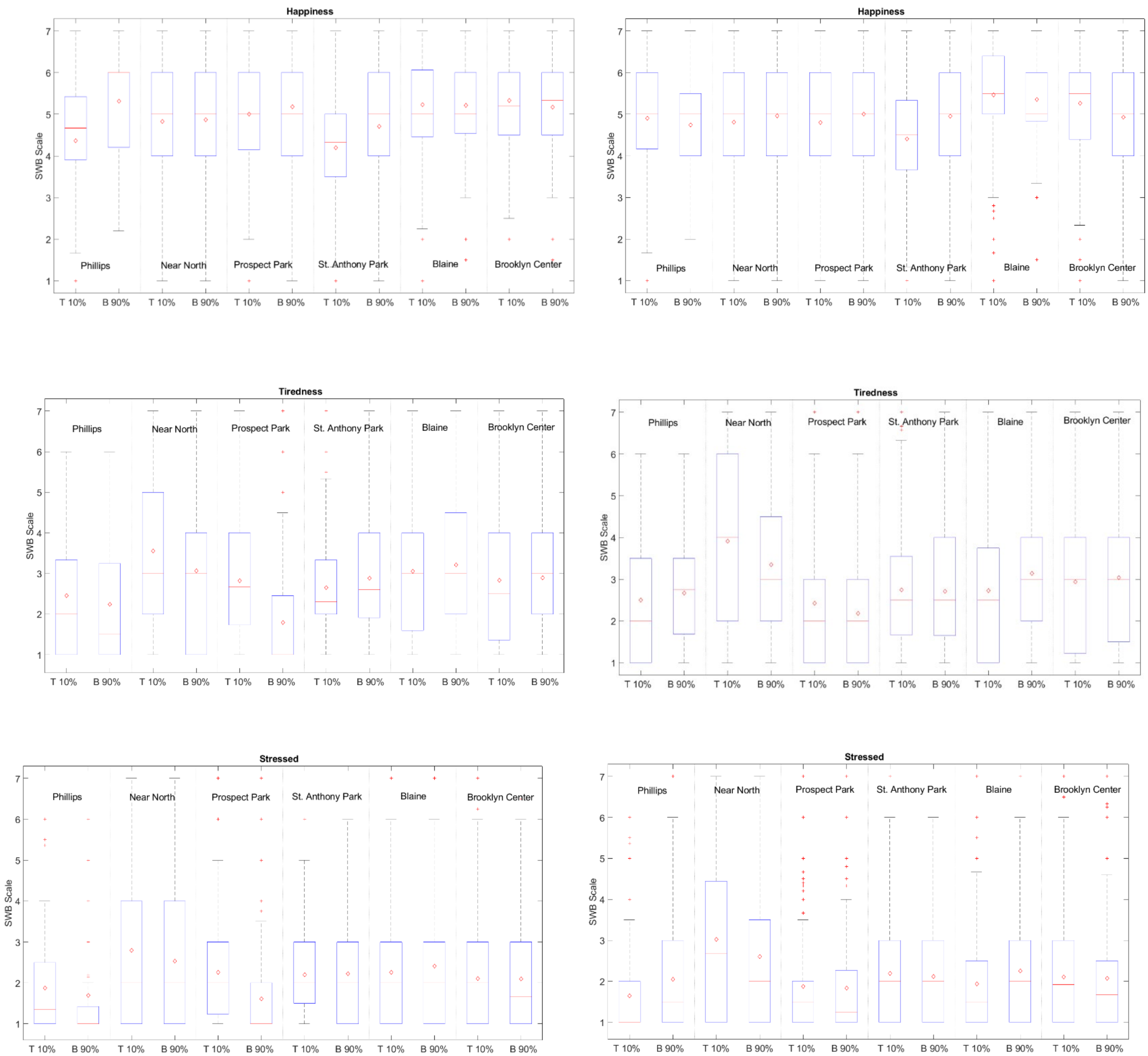
b)

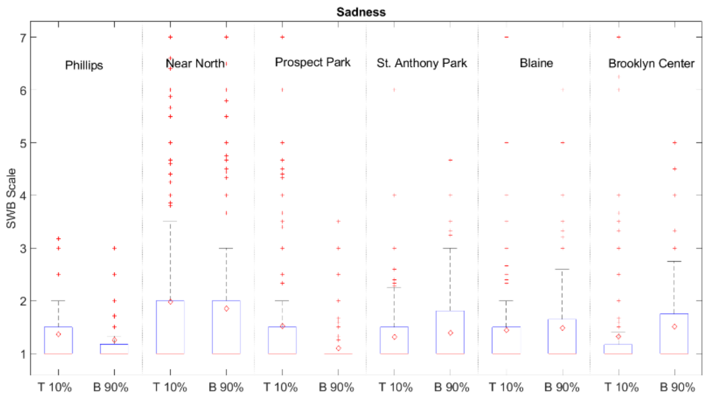


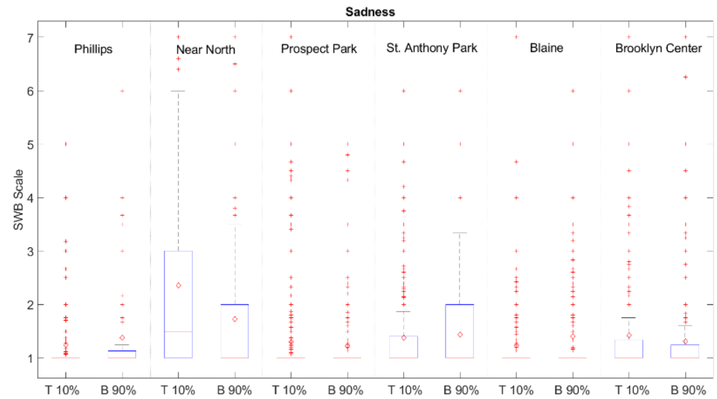
SI Fig. 7: Comparison of 1-hour neighborhood low-cost sensor $PM_{2.5}$ measurements against regulatory site (MPCA-Blaine and MPCA-NRN) measurements

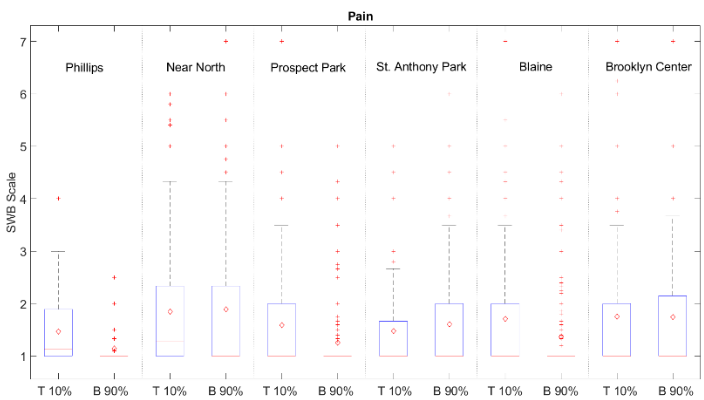


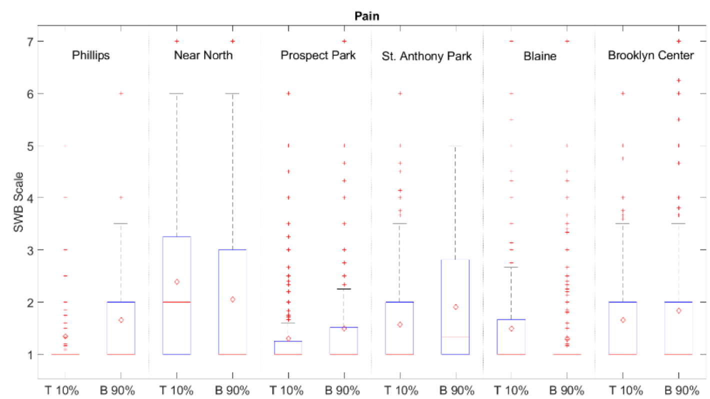
SI Fig. 8: Boxplots of the top 10% of pollution (low-cost sensor (LCS) $PM_{2.5}$ and R-Line simulated NO_x) on each of the six emotional well-being (EWB) indicators in the six study neighborhoods. The left column is for LCS $PM_{2.5}$ responses, and the right column is R-Line simulated NO_x home-based responses.

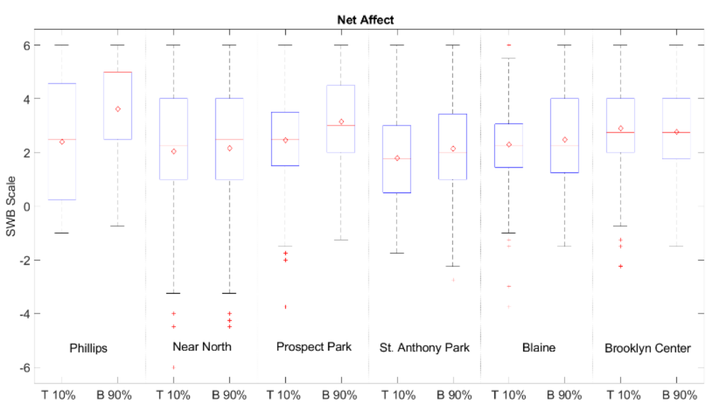


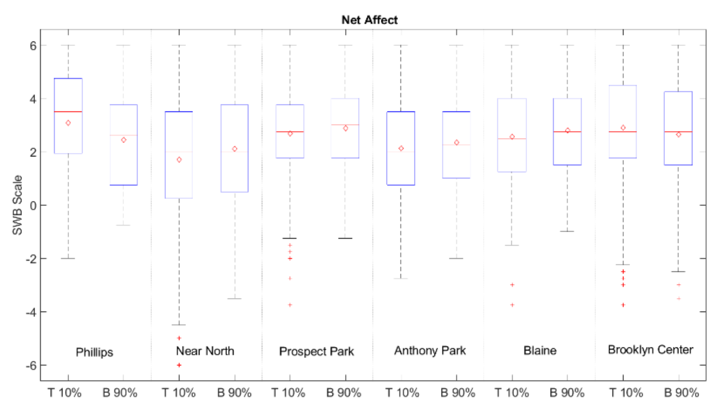

Sadness
SWB Scale
Phillips
Near North
Prospect Park
St. Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%


Sadness
SWB Scale
Phillips
Near North
Prospect Park
St. Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%

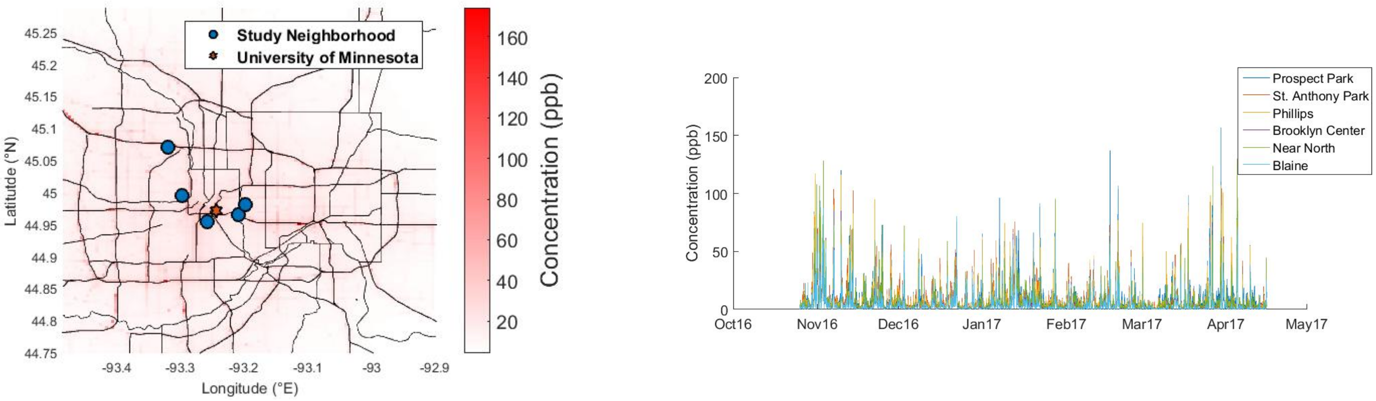

Pain
SWB Scale
Phillips
Near North
Prospect Park
St. Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%


Pain
SWB Scale
Phillips
Near North
Prospect Park
St. Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%

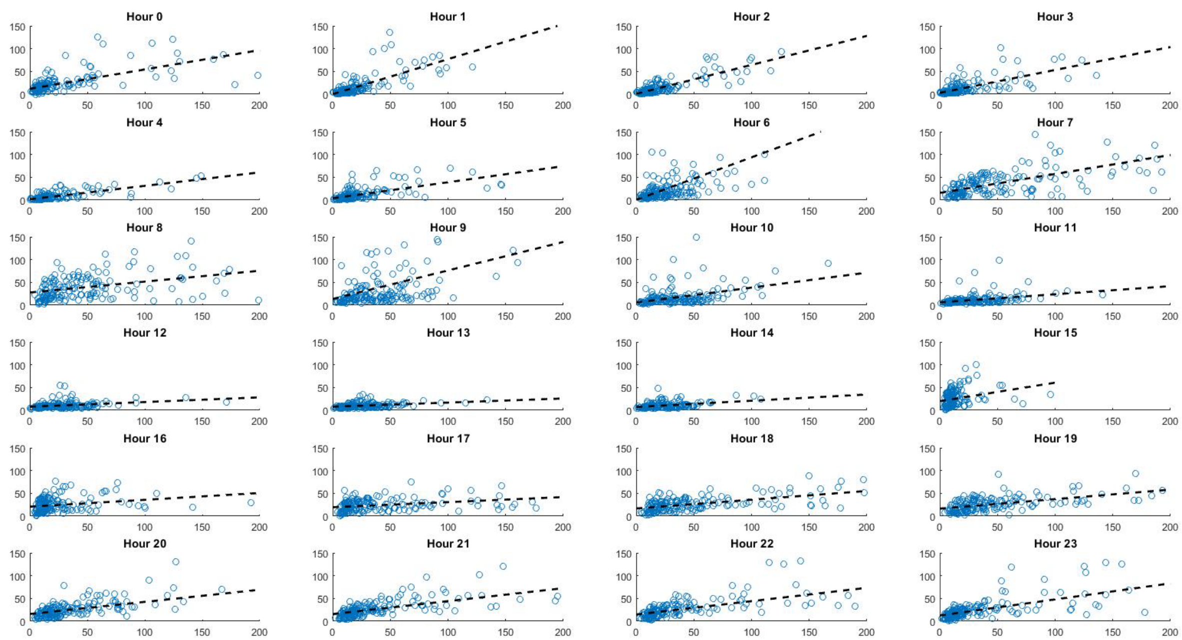

Net Affect
SWB Scale
Phillips
Near North
Prospect Park
St. Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%


Net Affect
SWB Scale
Phillips
Near North
Prospect Park
Anthony Park
Blaine
Brooklyn Center
T 10%
B 90%

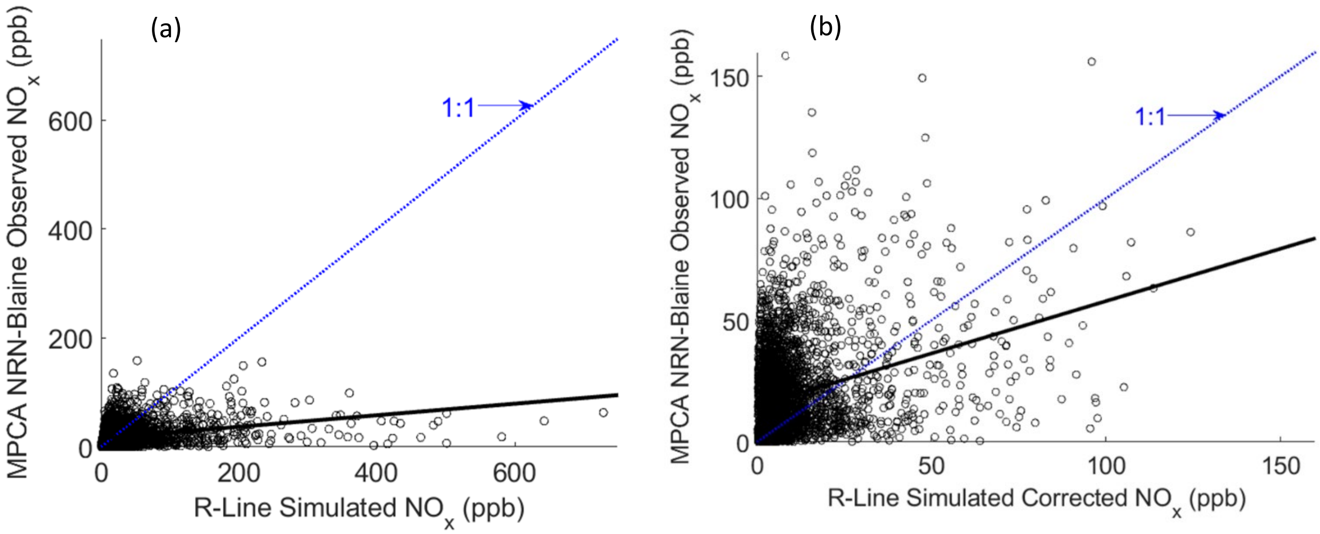
SI Fig. 9: Average R-Line simulated mobile source NO_x impacts before correction during the study period



SI Fig. 10: Hourly R-Line simulated NO_x concentrations (x-axis) against the true mobile source impact (Near Road minus background measurement). The slope of the regression is used to adjust the R-Line NO_x outputs



SI Fig. 11: Comparison of (a) R-Line initial simulated NO_x and (b) R-Line following calibration simulated NO_x against the estimated mobile-source impact at a Near-Road (Monitoring) Network (NRN) site (AQS Site ID# 27-053-0962) in Minneapolis. The mobile-source impact was estimated as the difference between the NRN site and a background NO_x observation (AQS Site ID# 27-003-1002).



$$NO_{\mathrm{x,observed}} = 0.11 * \mathrm{NO}_{\mathrm{x,R-Line\ simulated}} + 15.9$$

$$r^2 = 8.4x10^{-2}$$

$$NO_{\mathrm{x,observed}} = 0.43 * \mathrm{NO}_{\mathrm{x,R-Line\ simulated}} + 14.9$$

$$r^2 = 9.5x10^{-2}$$

SI Table 1: Air Quality System (AQS) regulatory $PM_{2.5}$ and NO_2 monitors in the study domain. The asterisk (*) next to the site name indicates it is not a source-oriented site.

Site name	AQS Site ID#	Pollutants measured	Additional details
Blaine-Anoka Airport	27-003-1002	$PM_{2.5}$, NO_2	Housed at airport
Harding High School*	27-123-0871	$PM_{2.5}$	Urban neighborhood
Ramsey Health Center	27-123-0868	$PM_{2.5}$	Very near highway
Andersen School*	27-053-0963	$PM_{2.5}$	Urban neighborhood
St. Louis Park City Hall	27-053-2006	$PM_{2.5}$	Commercial, high-volume roads
Near-Road I-35/I-94	27-053-0962	$PM_{2.5}$, NO_2	Near-road site
Apple Valley*	27-037-0470	$PM_{2.5}$	Suburban neighborhood
B.F. Pearson School*	27-139-0505	$PM_{2.5}$	Suburban neighborhood
Near-Road I-35	27-037-0480	$PM_{2.5}$, NO_2	Near-Road I-35

SI Table 2: Summary of LCS regressions from the co-location approach to calibrate LCS $PM_{2.5}$ with a Beta Attenuation Monitor (BAM) at the NRN site (AQS Site ID# 27-053-0962). A linear fit was used to correct the raw $PM_{2.5}$ data following an RH-correction as outlined by Zheng et al. (2). The asterisk (*) indicates that the sensor in the neighborhood changed to a different, but not necessarily new sensor that week. The "*x*" in the regression equation is the RH-corrected LCS $PM_{2.5}$ observation.

Calibration No.	Dates	NRN Average (Range) $PM_{2.5}$	Prospect Park	
			r^2	regression
1	11/11/16-11/13/16	8.1 (1-24)	0.83	1.3*x-0.99
2	11/25 – 11/27	10.9 (4-27)	0.76	1.1*x-0.05
4	12/21-12/23	9.0 (2-22)	0.81	0.64*x+3.18
5	1/20-1/23	10.0 (4-21)	0.48	0.87*x+1.85
6	2/3-2/6	10.1 (3-22)	0.81	0.67*x+4.4
7	2/17-2/19	9.7 (-1-28)	0.85	0.65*x+1.7
8	3/3-3/5	9.9 (3-17)	0.42	0.52*x+5.0
10	4/3-4/5	6.1 (-1-13)	N/A	
11	4/17-4/19	5.8 (0-13)	N/A	

St. Anthony Park		Phillips		Brooklyn Center		Near North		Blaine	
r^2	regression	r^2	regression	r^2	regression	r^2	regression	r^2	regression
0.79	1.6*x-2.5	0.80	1.6*x-2.4	0.83	1.5*x-1.8	0.83	1.5*x-1.81	N/A	
0.59	0.99*x-0.90	0.74	1.2*x-0.90	N/A		0.76	1.1*x-0.77	0.72	1.1*x-0.06
0.83	0.56*x+3.59	0.82	0.68*x+2.8	0.80	0.52*x+4.0	0.80	0.61*x+3.4	0.81	0.56*x+3.7
0.61	1.0*x+0.56	0.58	1.1*x-0.20	0.72	1.2*x-1.8	0.54	0.98*x+0.84	0.58	0.97*x+0.78
0.58	0.50*x+5.0	0.60	0.49*x+5.1	0.60	0.42+6.5	0.69	0.53*x+5.2	0.67	0.54*x+5.2
N/A	N/A	N/A		N/A		N/A		0.82	0.62*x+1.9
0.42	0.54*x+4.8	N/A		N/A		N/A		0.44	0.51*x+5.0
N/A		N/A		0.63	0.75*x+2.1	0.65	0.79*x+2.0	N/A	N/A
N/A		N/A		0.56	0.48*x+2.9	0.58	0.49*x+2.8	N/A	N/A

SI Table 3: Summary statistics of the comparison between the neighborhood low-cost sensor (LCS) $PM_{2.5}$ measurements against regulatory site measurements for the entire study period. The asterisk (*) denotes the location of the closest neighborhood to the regulatory site

	Near Road Network: I-35/I-94			**Blaine**		
	R^2	Slope	Intercept	R^2	Slope	Intercept
Prospect Park	0.29	0.49	4.5	0.30	0.46	4.2
St. Anthony Park	0.34	0.69	2.9	0.44	0.68	2.4
Phillips	0.61*	0.62	3.7	0.58	0.57	3.5
Brooklyn Center	0.35	0.41	5.5	0.33	0.38	5.0
Near North	0.45	0.45	4.8	0.47	0.45	4.1
Blaine	0.29	0.62	4.2	0.49*	0.63	3.2

SI Table 4: Study-average observed $PM_{2.5}$ concentrations (95% confidence intervals) from low-cost sensors and simulated mobile-source NO_x concentrations (95% Confidence Interval) modeled in R-Line.

	Low-cost sensor $PM_{2.5}$ ($\mu g\ m^{-3}$)	**R-Line NO_x (ppb)**
Prospect Park	7.8 (7.5-8.0)	8.2 (7.8-8.6)
St. Anthony Park	7.4 (7.2-7.6)	8.0 (7.7-8.4)
Phillips	7.5 (7.2-7.8)	8.2 (7.8-8.6)
Brooklyn Center	8.0 (7.7-8.4)	6.4 (6.1-6.7)
Near North	8.2 (7.9 -8.5)	7.4 (7.1-7.7)
Blaine	6.7 (6.4-6.9)	3.8 (3.6-4.0)

SI Table 5: The concentration cutoff between the top 10% of $PM_{2.5}$/mobile-source NO_x hours and the 90% cleanest hours in each neighborhood.

	Phillips	Near North	Prospect Park	St. Anthony Park	Blaine	Brooklyn Center
NO_x cutoff (ppb)	10.5	17.4	20.1	17.5	7.2	11.5
$PM_{2.5}$ cutoff ($\mu g\ m^{-3}$)	18.4	18.5	14.1	13.7	11.4	12.6

SI Table 6: Hourly regression results for the R-Line NO_x corrections. R-Line results were biased high, so the initial outputted model results were corrected based on hour.

Hour	regression	r^2
0	$[NOx]_{corrected} = 0.42 \times [NOx]_{R\text{-}Line} + 12$	0.42
1	$[NOx]_{corrected} = 0.72 \times [NOx]_{R\text{-}Line} + 9.3$	0.45
2	$[NOx]_{corrected} = 1.1 \times [NOx]_{R\text{-}Line} + 5.1$	0.33
3	$[NOx]_{corrected} = 0.95 \times [NOx]_{R\text{-}Line} + 7.8$	0
4	$[NOx]_{corrected} = 2.0 \times [NOx]_{R\text{-}Line} + 4.7$	0
5	$[NOx]_{corrected} = 1.1 \times [NOx]_{R\text{-}Line} + 9.1$	0
6	$[NOx]_{corrected} = 0.41 \times [NOx]_{R\text{-}Line} + 18$	0.44
7	$[NOx]_{corrected} = 0.23 \times [NOx]_{R\text{-}Line} + 24$	0.19
8	$[NOx]_{corrected} = 0.16 \times [NOx]_{R\text{-}Line} + 32$	7.3×10^{-2}
9	$[NOx]_{corrected} = 0.25 \times [NOx]_{R\text{-}Line} + 33$	0
10	$[NOx]_{corrected} = 0.11 \times [NOx]_{R\text{-}Line} + 38$	0
11	$[NOx]_{corrected} = 0.54 \times [NOx]_{R\text{-}Line} + 28$	0
12	$[NOx]_{corrected} = 0.86 \times [NOx]_{R\text{-}Line} + 21$	0
13	$[NOx]_{corrected} = 1.1 \times [NOx]_{R\text{-}Line} + 16$	0
14	$[NOx]_{corrected} = 0.92 \times [NOx]_{R\text{-}Line} + 17$	0
15	$[NOx]_{corrected} = 0.36 \times [NOx]_{R\text{-}Line} + 23$	0
16	$[NOx]_{corrected} = 0.05 \times [NOx]_{R\text{-}Line} + 22$	2.1×10^{-2}
17	$[NOx]_{corrected} = 0.07 \times [NOx]_{R\text{-}Line} + 21$	0
18	$[NOx]_{corrected} = 0.09 \times [NOx]_{R\text{-}Line} + 21$	0
19	$[NOx]_{corrected} = 0.17 \times [NOx]_{R\text{-}Line} + 18$	9.0×10^{-2}
20	$[NOx]_{corrected} = 0.24 \times [NOx]_{R\text{-}Line} + 38$	0
21	$[NOx]_{corrected} = 0.31 \times [NOx]_{R\text{-}Line} + 28$	0
22	$[NOx]_{corrected} = 0.24 \times [NOx]_{R\text{-}Line} + 28$	0
23	$[NOx]_{corrected} = 0.35 \times [NOx]_{R\text{-}Line} + 13$	0.35

SI Table 7: Hourly percent differences comparing R-Line initial and post-calibrated mobile-source NO_x simulations extracted at the Near-road (Monitoring) Network (NRN) site (AQS Site ID# 27-053-0962) against the true mobile source impact assessed at the NRN site. The mobile-source impact was estimated as the difference between the NRN site and a background NO_x observation (AQS Site ID# 27-003-1002). The negative values indicates the model result is biased low relative to the NRN observation.

Hour	Initial simulation percent difference (%)	Post-calibration percent difference (%)
0	-33	65
1	-36	-13
2	-63	4.8
3	-48	14
4	-2.4	-29
5	66	-3.2
6	51	-60.4
7	-4.3	-10

8	-44	-60
9	-63	-30
10	-48	-56
11	-2.4	-10
12	-44	-2.2
13	-48	-14
14	22	-2.4
15	94	-18
16	123	-67
17	105	-23
18	58	-35
19	53	-19
20	55	-8.2
21	43	-2.7
22	13	-3.8
23	-23	18

SI Table 8: Summary of demographic and economic status of the participants for the emotional well-being (EWB) assessments in Minneapolis neighborhoods

Variable	Total	Phillips	Near North	Prospect Park	St. Anthony Park	Blaine	Brooklyn Center
Female	268	48	46	43	55	37	39
Living with Spouse/partner	238	34	27	48	56	40	33
Age (median)	52	44	55	57	58	43	54
Employed Full Time	163	17	18	30	33	30	35
Disabled	79	20	20	8	10	8	13
Children Under 18 Present	122	30	25	11	20	21	15
White	309	42	32	65	74	48	48
Asian	15	4	1	2	3	4	1
Black	43	11	27	0	0	1	4
American Indian	9	9	0	0	0	0	0
Multiple	21	9	2	3	1	2	4
Low income (< 25K)	83	31	24	9	9	3	7
Med income (25-75K)	138	25	28	20	19	17	29
High income (75K +)	176	18	10	41	51	35	21
Total Sample Number	*398*	*75*	*62*	*70*	*79*	*55*	*57*

SI Table 9: t-statistics on the relationship between low-cost sensor (LCS) $PM_{2.5}$ and R-Line mobile source simulated NO_x against emotional well-being (EWB) assessments in the study neighborhoods. None of the regressions are statistically significant at $\alpha = 0.05$.

	LCS $PM_{2.5}$	R-Line NO_x
Happiness	0.87	2.1
Tiredness	0.44	0.48
Stressed	0.95	0.13
Sadness	2.3	0.41
Pain	1.0	0.49
Net affect	0.58	0.75

SI Table 10: NO_x NAAQS exceedances (NO_2 hourly standard) in the neighborhoods for hours when concurrent emotional well-being (EWB) assessments existed.

Neighborhood	Date and time	R-Line simulated NO_x (ppb)
Near North	Nov. 3, 2016 (8:00 pm)	115.1
Prospect Park	Nov. 11. 2016 (7:00 pm)	108.1
Prospect Park	Feb. 19, 2017 (2:00 am)	136.6
Prospect Park	Feb. 21, 2017 (1:00 am)	106.4

SI Table 11: Average difference between emotional well-being (EWB) indicators for hours (including a two-day lag) when the R-Line simulated mobile-source NO_x concentration exceeded the hourly NO_2 NAAQS (100 ppm). Positive values indicate the EWB where NAAQS exceedance occurrences were higher than the non-NAAQs exceedances (i.e., a positive value means the EWB outcome was higher in the NAAQs exceedance days). The asterisk (*) indicates the difference is statistically significant (α=0.05).

EWB indicator	Near North	Prospect Park
Happiness	1.2*	-0.83*
Tiredness	-1.1*	0.30
Stress	-1.4*	5.4×10^{-2}
Sadness	-0.98*	-7.6×10^{-2}
Pain	-0.97*	-2.4×10^{-2}
Net affect	*2.5**	*-0.67**

REFERENCES

1. Kelly KE*, et al.* (2017) Ambient and laboratory evaluation of a low-cost particulate matter sensor. *Environmental Pollution* 221:491-500.
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