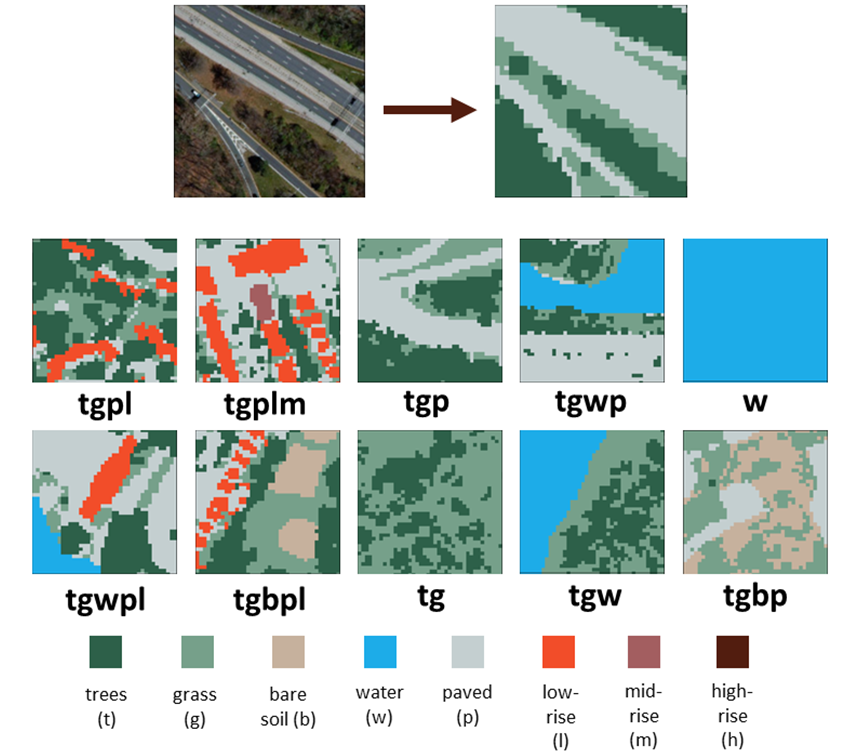
**Appendix**

**Table A1.** Planning districts in Philadelphia and their corresponding abbreviations.

|  |  |
| --- | --- |
| **Planning District** | **Abbreviation** |
| Central Northeast | CNE |
| Central | CTR |
| Lower Far Northeast | LFNE |
| Lower Northeast | LNE |
| Lower North | LNO |
| Lower Northwest | LNW |
| Lower South | LS |
| Lower Southwest | LSW |
| North Delaware | NDEL |
| North | NOR |
| River Wards | RW |
| South | STH |
| Upper Far Northeast | UFNE |
| Upper North | UNO |
| Upper Northwest | UNW |
| University Southwest | USW |
| West Park | WP |
| West | WST |



**Figure A1.** Examples of pixels of common STURLA classes symbolized on a land cover/building height data raster. Each color within a STURLA cell indicates the presence of a different urban structure component: trees (*t*), grass (*g*), bare soil (*b*), water (*w*), pavement (*p*), low-rise buildings (1 – 3 stories) (*l*), mid-rise buildings (4 – 9 stories) (*m*), and high-rise buildings (9+ stories) (*h*).



**Figure A2.** The two routes traveled during the data collection campaign. Each route is approximately ~150 km long.

**Table A2.** Information on instrumentation used for mobile monitoring campaign.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Instrument** | **Variables Measured** | **Units of Measurement** | **Measuring Range/Uncertainty** | **Detection Limit** | **Time Resolution** |
| Trimble Juno 3B with R1 Receiver | latitude | decimal degrees | 1 – 3 m | - | 1 second |
| longitude |
| Microaeth MA200 | black carbon | µg/m3 | ± 0.1 µg/m3 | 0.03 µg/m3 | 5 seconds |
| Grimm Portable Laser Aerosol Spectrometer, Model 11-C | particulate matter (mass concentrations) | µg/m3 | ± 5% | 0.1 µg/m3 | 6 seconds |

**Table A3.** Daily weather information for each day of sampling, including average temperature, range of relative humidity, start and end times, and sampling duration.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Date** | **Route** | **Weather** | **Average Temperature (°F/°C)** | **Relative Humidity Range** | **Start time** | **End time** | **Sampling duration** |
| 6/27/2019 | 2 | Partly / Mostly Cloudy | 83.0 / 28.3 | 29 – 66% | 7:16 AM | 5:22 PM | 10 hr. 6 min. |
| 7/1/2019 | 1 | Fair / Partly Cloudy | 75.6 / 24.2 | 37 – 61% | 7:02 AM | 5:33 PM | 10 hr. 31 min. |
| 7/3/2019 | 2 | Mostly Cloudy | 80.3 / 26.8 | 48 – 79% | 7:02 AM | 5:04 PM | 10 hr. 2 min. |
| 7/5/2019 | 2 | Cloudy | 79.3 / 26.3 | 48 – 81% | 7:06 AM | 3:07 PM | 8 hr. 3 min. |
| 7/9/2019 | 1 | Fair | 78.0 / 25.6 | 49 – 81% | 6:36 AM | 4:40 PM | 10 hr. 4 min. |
| 7/10/2019 | 1 | Mostly Cloudy | 80.3 / 26.8 | 43 – 79% | 7:24 AM | 5:11 PM | 9 hr. 47 min. |
| 7/12/2019 | 2 | Partly Cloudy | 78.4 / 25.8 | 42 – 91% | 6:42 AM | 4:14 PM | 9 hr. 32 min. |
| 7/15/2019 | 1 | Partly Cloudy | 79.8 / 26.6 | 36 – 59% | 6:49 AM | 4:11 PM | 9 hr. 22 min. |
| 7/16/2019 | 2 | Partly Cloudy | 81.6 / 27.6 | 43 – 81% | 7:09 AM | 3:51 PM | 8 hr. 42 min. |
| 7/24/2019 | 1 | Partly / Mostly Cloudy | 74.7 / 23.7 | 34 – 87% | 6:57 AM | 3:39 PM | 8 hr. 42 min. |
| 7/26/2019 | 1 | Fair / Partly Cloudy | 79.0 / 26.1 | 34 – 68% | 6:28 AM | 5:01 PM | 10 hr. 33 min. |
| 7/29/2019 | 2 | Fair | 83.8 / 28.8 | 41 – 79% | 7:04 AM | 3:09 PM | 8 hr. 5 min. |

Chart

Description automatically generated

**Figure A3.** Results of pairwise permutational t-tests between STURLA classes comparing average daily pollutant concentrations for BC (left) and PM2.5 (right). Black cells indicate significant differences in pollutant concentrations between classes.

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**Figure A4:**

A. Barplot of PM2.5 model error separated by STURLA class, with bar colors indicating underpredictions (blue) and overpredictions (red). B. Map of PM2.5 model validation error throughout Philadelphia. C. Barplot of BC model error separated by STURLA class, with bar colors indicating underpredictions (blue) and overpredictions (red). D. Map of BC model validation error.

**Table A4.** Summary of measured pollutants, modeled pollutants, and model error by STURLA class.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **STURLA** | **PM2.5 (µg/m3) Predicted** | **PM2.5 (µg/m3) Measured** | **Difference (µg/m3)** | **BC (µg/m3) Predicted** | **BC (µg/m3) Measured** | **Difference (µg/m3)** |
| **bpl** | 10.60 | 14.28 | 3.68 | 2.28 | 2.26 | -0.02 |
| **gbp** | 18.12 | 15.29 | -2.84 | 1.86 | 1.90 | 0.04 |
| **gbpl** | 13.63 | 14.50 | 0.87 | 1.87 | 1.88 | 0.01 |
| **gbpm** | 14.13 | 11.54 | -2.60 | 4.61 | 1.89 | -2.73 |
| **gp** | 15.15 | 13.83 | -1.33 | 2.11 | 1.90 | -0.21 |
| **gpl** | 16.60 | 14.57 | -2.03 | 2.06 | 2.11 | 0.05 |
| **gplm** | 13.31 | 12.39 | -0.92 | 1.64 | 1.75 | 0.10 |
| **gpm** | 12.19 | 10.59 | -1.60 | 2.01 | 1.86 | -0.15 |
| **gwp** | 7.59 | 10.12 | 2.54 | 2.07 | 2.23 | 0.17 |
| **gwpl** | 17.80 | 14.47 | -3.33 | 1.76 | 1.93 | 0.17 |
| **gwpm** | 13.02 | 11.85 | -1.17 | 1.99 | 2.08 | 0.08 |
| **p** | 14.13 | 10.60 | -3.54 | 1.55 | 2.15 | 0.60 |
| **pl** | 12.19 | 12.22 | 0.04 | 0.95 | 2.16 | 1.20 |
| **pm** | 5.40 | 8.77 | 3.37 | 0.85 | 1.71 | 0.86 |
| **tg** | 15.20 | 14.46 | -0.74 | 0.90 | 1.42 | 0.53 |
| **tgbp** | 14.25 | 13.85 | -0.40 | 1.67 | 1.71 | 0.04 |
| **tgbph** | 13.67 | 14.26 | 0.58 | 0.92 | 1.26 | 0.34 |
| **tgbpl** | 22.21 | 13.64 | -8.57 | 1.73 | 1.72 | -0.01 |
| **tgbplh** | 14.00 | 14.16 | 0.17 | 1.31 | 1.35 | 0.04 |
| **tgbplm** | 12.40 | 12.61 | 0.21 | 1.25 | 1.42 | 0.17 |
| **tgbplmh** | 11.47 | 12.02 | 0.55 | 1.37 | 1.60 | 0.23 |
| **tgbpm** | 10.98 | 11.55 | 0.58 | 1.50 | 1.52 | 0.03 |
| **tgbwp** | 12.06 | 12.70 | 0.63 | 2.31 | 1.96 | -0.35 |
| **tgbwpl** | 14.42 | 14.20 | -0.23 | 2.04 | 1.71 | -0.33 |
| **tgp** | 15.67 | 14.58 | -1.10 | 1.62 | 1.65 | 0.03 |
| **tgph** | 13.43 | 13.74 | 0.31 | 1.09 | 1.39 | 0.30 |
| **tgpl** | 11.68 | 13.32 | 1.64 | 1.58 | 1.65 | 0.07 |
| **tgplh** | 14.17 | 13.75 | -0.42 | 1.48 | 1.39 | -0.09 |
| **tgplm** | 12.00 | 13.43 | 1.43 | 1.43 | 1.47 | 0.03 |
| **tgplmh** | 12.36 | 12.15 | -0.20 | 1.31 | 1.34 | 0.02 |
| **tgpm** | 11.58 | 11.65 | 0.07 | 1.52 | 1.61 | 0.09 |
| **tgpmh** | 12.20 | 12.48 | 0.28 | 1.62 | 1.53 | -0.09 |
| **tgwp** | 12.95 | 12.54 | -0.41 | 1.58 | 1.77 | 0.19 |
| **tgwph** | 12.94 | 13.06 | 0.12 | 0.89 | 1.41 | 0.51 |
| **tgwpl** | 6.85 | 8.93 | 2.08 | 1.65 | 1.69 | 0.04 |
| **tgwplh** | 14.12 | 13.64 | -0.48 | 1.90 | 1.58 | -0.33 |
| **tgwplm** | 18.30 | 12.88 | -5.42 | 1.06 | 1.37 | 0.31 |
| **tgwpm** | 9.80 | 10.97 | 1.17 | 2.00 | 1.81 | -0.19 |
| **tp** | 12.42 | 10.98 | -1.44 | 3.22 | 2.68 | -0.55 |
| **tpl** | 14.98 | 12.91 | -2.07 | 5.45 | 3.76 | -1.69 |
| **tplm** | 15.49 | 14.08 | -1.41 | 2.63 | 1.60 | -1.02 |
| **tpm** | 13.03 | 11.27 | -1.76 | 1.27 | 1.61 | 0.34 |
| **twp** | 13.31 | 11.20 | -2.11 | 3.74 | 2.19 | -1.56 |
| **twpl** | 13.79 | 12.20 | -1.59 | 1.87 | 2.30 | 0.42 |
| **twpm** | 12.70 | 12.82 | 0.13 | 2.82 | 2.41 | -0.41 |
| **wp** | 14.07 | 11.03 | -3.05 | 1.88 | 2.29 | 0.41 |

**Table A5.** Summary of measured pollutant concentrations, predicted pollutant concentrations, differences between predicted and measured, and validation error by Philadelphia planning district.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Planning District** | **Mean Predicted PM2.5** | **Mean Measured PM2.5** | **P – M**  **(PM2.5)** | **Validation Error (P/M)** | **Mean Predicted BC** | **Mean Measured BC** | **P – M**  **(BC)** | **Validation Error (P/M)** |
| **Central** | 12.62 | 12.74 | -0.12 | 0.994 | 1.54 | 1.49 | 0.05 | 1.040 |
| **Central Northeast** | 13.60 | 13.88 | -0.28 | 0.981 | 1.65 | 1.57 | 0.08 | 1.062 |
| **Lower Far Northeast** | 13.74 | 14.11 | -0.37 | 0.975 | 1.68 | 1.63 | 0.05 | 1.046 |
| **Lower North** | 13.40 | 13.55 | -0.15 | 0.991 | 1.62 | 1.56 | 0.06 | 1.040 |
| **Lower Northeast** | 13.71 | 14.03 | -0.32 | 0.978 | 1.65 | 1.59 | 0.06 | 1.040 |
| **Lower Northwest** | 13.59 | 13.83 | -0.24 | 0.984 | 1.64 | 1.55 | 0.09 | 1.078 |
| **Lower South** | 12.83 | 12.85 | 0.02 | 1.036 | 1.78 | 1.66 | 0.12 | 1.134 |
| **Lower Southwest** | 13.59 | 13.84 | -0.25 | 0.988 | 1.72 | 1.65 | 0.07 | 1.069 |
| **North** | 13.54 | 13.75 | -0.21 | 0.986 | 1.64 | 1.59 | 0.05 | 1.036 |
| **North Delaware** | 13.73 | 14.01 | -0.28 | 0.983 | 1.70 | 1.65 | 0.05 | 1.038 |
| **River Wards** | 13.63 | 13.85 | -0.22 | 0.988 | 1.71 | 1.66 | 0.05 | 1.052 |
| **South** | 13.56 | 13.94 | -0.38 | 0.975 | 1.68 | 1.62 | 0.06 | 1.043 |
| **University Southwest** | 13.20 | 13.38 | -0.18 | 0.989 | 1.61 | 1.56 | 0.05 | 1.037 |
| **Upper Far Northeast** | 13.74 | 14.09 | -0.35 | 0.976 | 1.66 | 1.60 | 0.06 | 1.047 |
| **Upper North** | 13.62 | 13.95 | -0.33 | 0.976 | 1.65 | 1.58 | 0.07 | 1.044 |
| **Upper Northwest** | 13.55 | 13.85 | -0.30 | 0.979 | 1.64 | 1.57 | 0.07 | 1.049 |
| **West** | 13.58 | 13.88 | -0.30 | 0.979 | 1.64 | 1.57 | 0.07 | 1.040 |
| **West Park** | 13.53 | 13.60 | -0.07 | 0.997 | 1.67 | 1.59 | 0.08 | 1.057 |