# Supplementary material to: Household $PM_{2.5}$ in a South African urban and rural setting: a comparative analysis using low-cost sensors

Matthew Benyon[a, b, c, *], Ngwako Kwatala[d], Tracey Laban[e], Thandi Kapwata[e,f], Chiara Batini[g, h], Samuel Cai[b], Lisa K. Micklesfield[i], Rikesh Panchal[a, b], Siyathemba Kunene[d], Sizwe B Zondo[d], Brigitte Language[j], Bianca Wernecke[k], Scott Hazelhurst[d,l], F. Xavier Gómez-Olivé[m], Joshua Vande Hey[a, b, c], and Caradee Y Wright[e, k]

***Corresponding author**:

E-mail : mb932@leicester.ac.uk

Address: Space Park Leicester, 92 Corporation Road, Leicester, LE4 5SP, UK

[a]School of Physics and Astronomy, University of Leicester, Leicester, United Kingdom, LE1 7RH

[b]Centre for Environmental Health and Sustainability, University of Leicester, Leicester, United Kingdom, LE1 7RH

[c]Institute for Environmental Futures, University of Leicester, Leicester, United Kingdom, LE1 7RH

[d]Sydney Brenner Institute for Molecular Bioscience, University of the Witwatersrand, Private Bag 3, 9 Jubilee Road, 2050, Gauteng, South Africa.

[e]Climate Change and Health Research Programme, Environment and Health Research Unit, South African Medical Research Council, Private Bag x385, 1 Soutpansberg Road, Pretoria, 0001, South Africa

[f]Department of Environmental Health, University of Johannesburg, Johannesburg, South Africa

[g]Genetic Epidemiology Group, Department of Population Health Sciences, University of Leicester, Leicester, United Kingdom, LE1 7RH

[h]University Hospitals of Leicester NHS Trust, Groby Road, Leicester, United Kingdom, Groby Rd, Leicester, LE3 9QP

[i]SAMRC/Wits Developmental Pathways for Health Research Unit, Department of Paediatrics, School of Clinical Medicine, Faculty of Health Sciences, University of the Witwatersrand, Private Bag X3, Wits, Johannesburg, 2050, South Africa

[j]Unit for Environmental Science and Management, North-West University, Potchefstroom, South Africa

[k]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, 0001, South Africa

[l]School of Electrical and Information Engineering, University of the Witwatersrand, 1 Jan Smuts Avenue, Braamfontein 2000, Johannesburg, South Africa

[m]MRC/Wits Rural Public Health and Health Transitions Research Unit, School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, 1 Jan Smuts Avenue, Braamfontein 2000, Johannesburg, South Africa

Table S1 Calibration model results

| Sensor | $\beta_0$ | $\beta_1(PM_{2.5})$ | $\beta_2$ (Temp.) | $\beta_3$ (RH%) | $R^2$ | MAE | RMSE | MNB | cvMAE | nRMSE | R2 CV | MAE CV | RMSE CV | Households installed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 86.9 | 3.82 | -2.46 | -0.04 | 0.90 | 6.59 | 9.67 | 0.17 | 0.17 | 0.01 | 0.89 | 6.94 | 9.66 | H1AS |
| 10 | 22.0 | 3.67 | -0.27 | -0.14 | 0.92 | 4.56 | 6.62 | 0.14 | 0.14 | 0 | 0.93 | 4.46 | 6.61 | H2AS H8AW |
| 11 | 15.2 | 3.14 | -0.12 | -0.08 | 0.92 | 5.01 | 7.26 | 0.14 | 0.14 | 0 | 0.92 | 4.91 | 7.25 | H3AS H4AW H8SS |
| 3 | 33.0 | 2.98 | -1.08 | 0.18 | 0.94 | 4.89 | 7.13 | 0.12 | 0.12 | 0 | 0.95 | 4.8 | 7.10 | H5AS |
| 12 | 21.4 | 3.39 | -0.26 | -0.11 | 0.91 | 5.53 | 8.12 | 0.15 | 0.15 | 0 | 0.91 | 5.63 | 8.13 | H6AS H10AW H9SS H11SW |
| 9 | 29.7 | 4.44 | -0.35 | -0.22 | 0.86 | 6.41 | 9.2 | 0.18 | 0.18 | 0 | 0.87 | 6.42 | 9.19 | H7AS H5AW H11SS H6SW |
| 13 | 73.1 | 3.2 | -2.15 | -0.33 | 0.89 | 5.69 | 7.86 | 0.11 | 0.11 | 0 | 0.89 | 5.62 | 7.86 | H9AW H10SS H8SW |
| 13 | 15.5 | 3.08 | N/a | -0.1 | 0.87 | 6.11 | 8.57 | 0.12 | 0.12 | 0 | 0.87 | 6.09 | 8.56 | H8AS |
| 17 | 15.0 | 4.35 | -0.28 | 0.06 | 0.92 | 3.72 | 5.44 | 0.19 | 0.19 | 0.01 | 0.93 | 3.83 | 5.43 | H9AS |
| 14 | 55.3 | 3.48 | -1.55 | 0.03 | 0.92 | 5.70 | 8.25 | 0.14 | 0.14 | 0 | 0.93 | 5.81 | 8.24 | H10AS |
| 5 | 3.25 | 2.87 | 0.04 | 0.3 | 0.92 | 5.30 | 7.64 | 0.12 | 0.12 | 0 | 0.92 | 5.26 | 7.64 | H11AS H7AW H3SW |
| 1 | 60.2 | 4.02 | -1.62 | -0.35 | 0.88 | 6.67 | 8.91 | 0.15 | 0.15 | 0 | 0.88 | 6.54 | 8.91 | H1AW H1SS H1SW |
| 2 | 46.7 | 2.96 | -1.38 | -0.2 | 0.93 | 4.78 | 7.06 | 0.11 | 0.11 | 0 | 0.93 | 4.92 | 7.05 | H2AW H7SS H2SW |
| 7 | 5.25 | 3.71 | 0.06 | 0.34 | 0.90 | 5.92 | 8.28 | 0.13 | 0.13 | 0 | 0.9 | 5.83 | 8.27 | H3AW H4SS H7SW |
| 8 | 44.9 | 2.93 | -1.32 | -0.22 | 0.93 | 5.10 | 7.55 | 0.11 | 0.11 | 0 | 0.92 | 5.29 | 7.55 | H6AW H3SS H5SW |
| 6 | 59.0 | 3.19 | -1.77 | -0.36 | 0.90 | 5.83 | 8.16 | 0.13 | 0.13 | 0 | 0.90 | 5.78 | 8.15 | H11AW H5SS H10SW |
| 4 | 68.3 | 3.64 | -2.08 | -0.22 | 0.89 | 5.82 | 8.18 | 0.10 | 0.10 | 0 | 0.87 | 5.93 | 8.18 | H2SS H4SW |

*Table S2 Arithmetic mean 24-hour indoor temperatures as measured by Bonolo's*

| | Summer | Winter |
|---|---|---|
| Soweto (Urban) | 25.8℃ (24.0-27.1) | 21.1℃ (18.6-25.7) |
| Agincourt (rural) | 29.6℃ (25.4-32.1), | 22.0℃ (20.3-23.4) |

*Model performance*

*Table S3 Validation metrics for the first model and the final (optimised) model. RMSE is in log-transformed scale.*

| | *First model* | | | *Final model* | | |
|---|---|---|---|---|---|---|
| | *R2* | *RMSE* | *Adjusted R2* | *R2* | *RMSE* | *Adjusted R2* |
| *Training* | *0.86* | - | *0.70* | *0.83* | - | *0.80* |
| *LOOCV* | *0.38* | *0.60* | - | *0.74* | *0.32* | - |
| *5-fold* | *0.43* | *0.64* | - | *0.79* | *0.32* | - |
| *10-fold* | *0.55* | *0.63* | - | *0.74* | *0.30* | - |