RESPONSE TO THE EDITOR: POINT-BY-POINT

28 Sep 2026
Topic editor decision: Reconsider after major revisions
by **Evangelia Diapouli**

Public justification (visible to the public if the article is accepted and published):

Dear authors,
Thank you for the revised manuscript and answers you have provided. While you have made significant effort to enhance the quality of the manuscript based on the reviewers' comments, I believe there are still some major revisions that need to be made. Please find below my comments, based also on the comments provided by the two reviewers.

1. As mentioned by Reviewer 2, "the literature review is strongly focused on the existing state of knowledge in Madrid, and the research gap to be addressed by the study is clearly identified". While the value of this study for the city of Madrid is clearly identified, I think there is also a global value which relates to demonstrating the use of LCS and citizen-based monitoring for short-term exposures in different microenvironment. Please consider highlighting this aspect of the study in the Introduction.

RESPONSE TO THE EDITOR: The following paragraph has been added: Few publications have used citizen science approaches involving low-cost sensors (LCS) to measure $PM_{2.5}$ in transport microenvironments (Yang H., 2026), highlighting their potential usefulness. Other studies have applied this methodology in vulnerable environments (Kubis K., 2026). Given the low cost of these sensors, they may be useful for citizen associations or groups of people susceptible to air pollution to assess their actual exposure in these environments. Using a citizen science approach, these measurements can provide complementary information on personal exposure where official monitoring data are limited or unavailable.

Yang, H. Citizen Science in Air Pollution Monitoring: Methodological Approaches, Effectiveness, and Integration with Health Research. Curr Envir Health Rpt 13, 36 (2026). DOI 10.1007/s40572-026-00559-1

Kubis K, Edwards J, Ryan PH, Ambient and personal air monitoring using low-cost sensors to identify elevated air pollution in vulnerable communities, Science of The Total Environment, 1032, 181837, 2026, DOI: 10.1016/j.scitotenv.2026.181837

2. Figures 1 and 2 are very similar. Please keep only Figure 2, which is more informative.

RESPONSE TO THE EDITOR: Figure 1 has been removed

3. Please make sure that all corrections mentioned in the “Response to reviewers” file are also included in the revised manuscript. I mention, indicatively, comments 3, 4, 6, 7 by Reviewer 1. Especially regarding comment #6, you could include more information on Table 1, similar to Tables 2 and 3.

Reviewer 1

3- Line 138-140: Please include scatter plots and/or time series comparison showing the relationship between the AirBeam 3 and the reference TEOM measurements before and after the calibration, with the regression line, regression equation, R^2 etc. A visual representation would help readers assess the agreement between the two instruments and identify any systematic bias or outliers.

RESPONSE TO THE EDITOR: A new figure has been added.

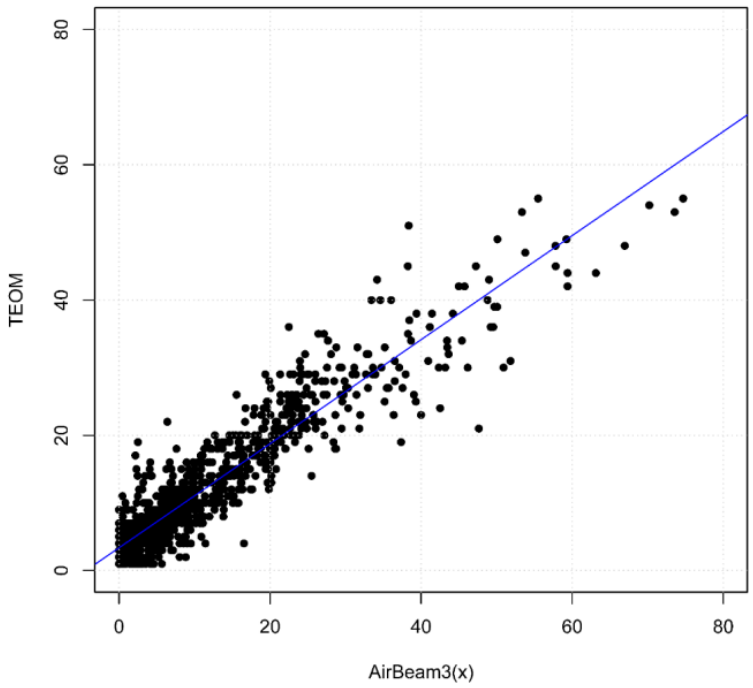


FIGURE A. Dispersion of concentration data of $PM_{2.5}$. $PM_{2.5}$: Small-sized particles with a diameter of 2.5 micrometers. TEOM: Tapered Element Oscillating Microbalance method

4- Line 142-149: This paragraph is difficult to follow because it combines multiple statistical analyses in a single paragraph without clearly explaining the purpose of each method. The manuscript should explicitly state the objective of each analysis and how they complement one another.

RESPONSE TO THE EDITOR: They have been completely revised to provide more detailed methodological information. These paragraphs replace the previous ones:

Hourly government data were obtained from the Madrid City Council's open data portal (Ayuntamiento de Madrid (b)). The available data on the Madrid City Council website are validated hourly averages derived from ten-minute averages, rounded in both the ten-minute and hourly averages. This involves applying a low-pass filter in each averaging process. Additionally, we asked the Madrid City Council for the original data, and we were provided with ten-minute c$PM_{2.5}$ averages, so they were also available for analysis. The provided values are rounded to the nearest whole number.

AB3 sensor data were collected from 12:44 on December 5, 2023, to 15:34 on January 20, 2024, at a data collection frequency of 1 minute, resulting in a total of raw 65,198 one-minute records. Each record contains data on date, time, latitude, longitude, temperature (in Fahrenheit), PM_1, PM_{10}, $PM_{2.5}$ concentration (in micrograms per cubic meter), and relative humidity (percentage).

Out of the 65,198 records obtained with the AB3, invalid measurements were discarded. Hourly averages of $PM_{2.5}$, temperature, and relative humidity, as well as ten-minute averages of these parameters, were then obtained, resulting in a total of 1,054 valid hourly records and 6,321 valid ten-minute records.

To analyze the relationship between AB3 values and government hourly data, an initial analysis was conducted, obtaining the correlation coefficient between the hourly averages obtained from both instruments. All linear model fitting calculations were performed using RStudio (R. Core Team. R.

An empirical model was established between 10-minute averages from AB3 measurements, and 10-minute averages obtained by government fixed station (TEOM). This involved a two-step process: first, studying the correlation and differences between both records, and then determining eight adjustment models through a training model, which were contrasted with the test set.

Based on this study, two models were established for subsequent observations. The first model (Model A) considers temperature and relative humidity, as well as an intercept, allowing for precise adjustment. The second model (Model B) is based solely on $PM_{2.5}$ observations, with

an intercept, establishing confidence intervals. This second model allows for establishing minimum $PM_{2.5}$ levels from future observations.

Using a different approach, to study the agreement between both datasets the Bland and Altman method was used [4], which involves plotting the difference between AB3 and TEOM hourly measurements against their mean and calculating the mean differences and their confidence intervals. To assess the validity of AB3, its ROC curve was constructed for the TEOM 10 µg/m³ threshold (political limit of European Union), and predictive values for AB3 at that cutoff point were calculated using Stata v16.1 statistical software [5].

1- **Ayuntamiento de Madrid: Portal de datos abiertos. Calidad del aire. Estaciones de control., https://datos.madrid.es/portal/site/egob/menuitem.c05c1f754a33a9fbe4b2e4b284f1a5a0/?vgnextoid=41e01e007c9db410VgnVCM2000000c205a0aRCRD&vgnextchannel=374512b9ace9f310VgnVCM100000171f5a0aRCRD (accessed 26 September 2026).**
2- **R. Core Team. R: A Language and environment for statistical computing [Internet]. R Foundation for Statistical Computing, Vienna. https://www.r-project.org, 2024 (accessed 26 October 2024).**
3- **Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet. 1986 Feb 8;1(8476):307-10. PMID: 2868172.**
4- **Stata, statistical software, https://www.stata.com/ (accessed 26 October 2024).**

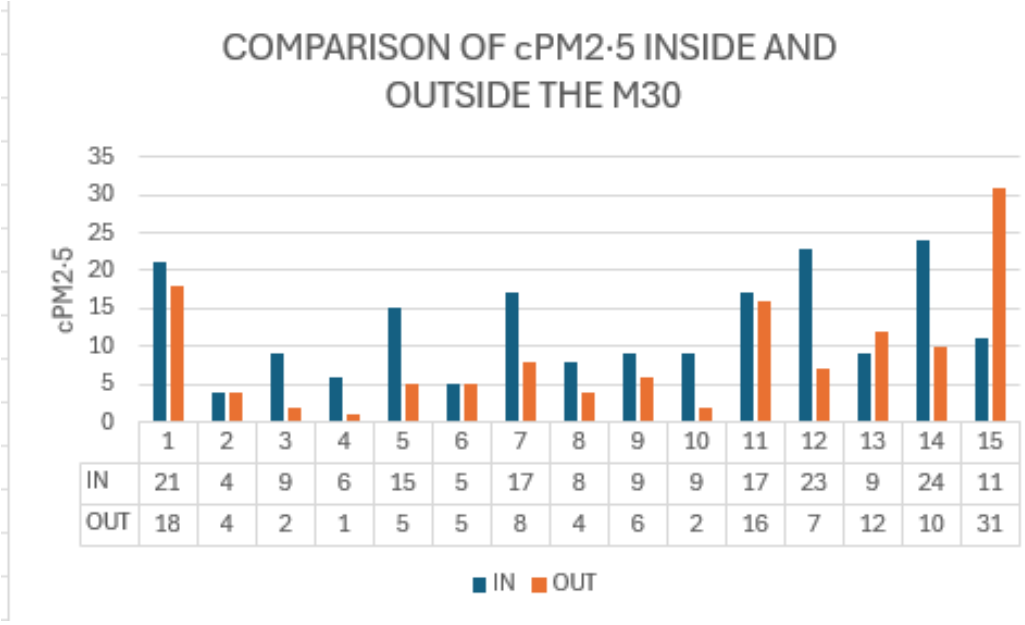
6- Line 157-166: Please provide a detailed log of each field measurement (preferably in the Supplementary Material), including the sampling date, time, route, tunnel section, duration, enter/exit time, and other relevant metadata

could include more information on Table 1, similar to Tables 2 and 3.

RESPONSE TO THE EDITOR: A new column has been added showing the outdoor $cPM_{2.5}$ data measured simultaneously with the measurements taken inside the tunnel. A new comparative figure showing the two sets of data has also been added.

	Date	Tunnel entry time	Temperature (ºF)	$PM_{2·5}$ Mean (SD)	HR	$PM_{2·5}$ Outdoor
1	2024/1/26	17.45	70	21 (14)	48	18
2	2024/9/16	11.38	85	4 (6)	22	4
3	2024/9/17	9.25	76	9 (14)	44	2
4	2024/9/26	10.16	77	6 (8)	63	1
5	2024/9/27	18.03	81	15 (13)	42	5
6	2024/9/27	19.52	83	5 (6)	33	5
7	2024/9/30	8.33	68	17 (21)	51	8
8	2024/9/30	13.56	81	8 (14)	38	4
9	2024/10/24	8.57	69	9 (17)	72	6
10	2024/10/24	9.52	72	9 (9)	66	2
11	2024/10/24	17.44	76	17 (32)	62	16
12	2024/11/4	8.56	71	23 (19)	67	7
13	2024/11/4	13.52	71	9 (6)	70	12
14	2024/10/15	8.30	77	24 (15)	74	10
15	2024/10/30	12.01	72	11 (9)	66	31

TABLE 1. Spot measurements of cPM2·5 into road tunnel (M30). Mean travel time through the tunnel: 14 min. SD: standard deviation



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IN	21	4	9	6	15	5	17	8	9	9	17	23	9	24	11
OUT	18	4	2	1	5	5	8	4	6	2	16	7	12	10	31

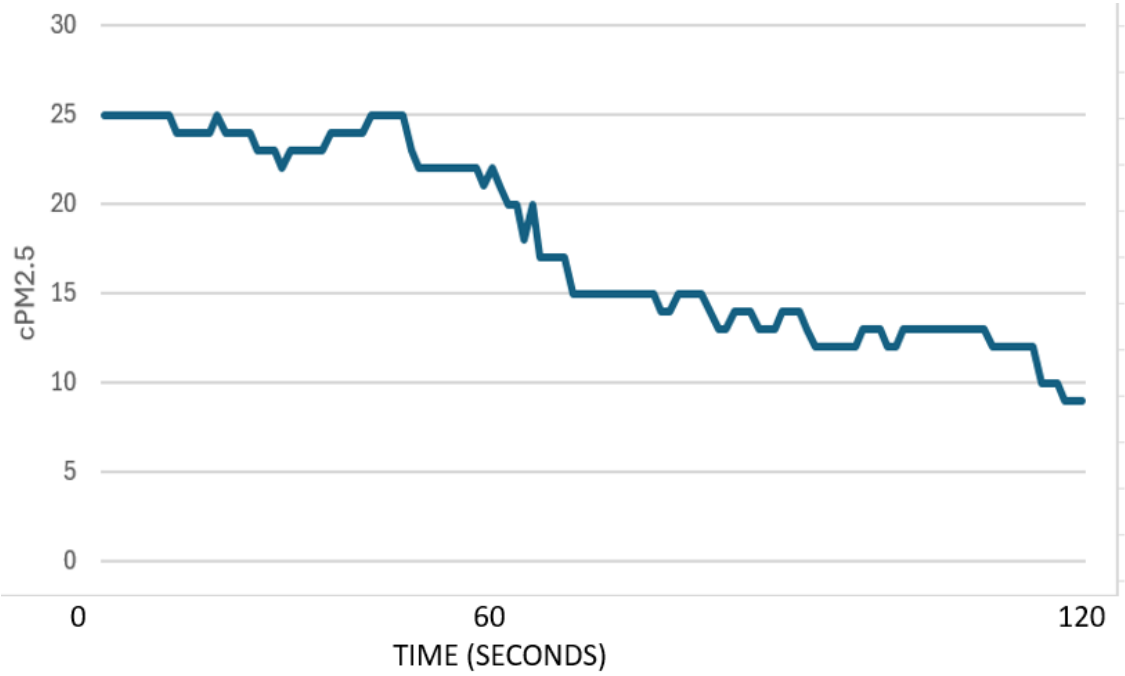
FIGURE B. $cPM_{2.5}$ inside the M30 (IN) and outside (OUT). $cPM_{2.5}$ in $\mu g/m^3$

7-Line 168-174: Please indicate which figure or table corresponds to the analysis described in this section. More generally, throughout the manuscript, every major analysis should reference the corresponding figure or table (e.g., Figure X or Table Y).

RESPONSE TO THE EDITOR: A reference to Figure 1 has been added.

4. The x-axis is still missing in Figure 4. The caption is shown (in the upper part of the graph) but the axis values are not visible

RESPONSE TO THE EDITOR: The figure has been corrected.



5. I agree with comment #4 made by Reviewer 2. Especially the text related to health impacts should be moved to the Introduction, since it includes references to other published works with no possible connection to this work. All other references (including results from in-vehicle and subway measurements) may be kept in this section, provided that they are compared and discusses in parallel to the current study results.

RESPONSE TO THE EDITOR: The text on health impacts has been moved to the Introduction.

6. Please provide a more appropriate answer to comment # 6 by Reviewer 2. The reviewer suggests "additional graphical representations of the results", while his/her comment also relates to plotting measurements from reference instruments and LCS and not to the location of the national monitoring network stations.

RESPONSE TO THE EDITOR: Figures A and B have been added.

7. In general, I suggest strengthening of the Results and Discussion sections with the presentation of more data (especially summary results) and a more direct comparison of the outcome of this study with other published works.

RESPONSE TO THE EDITOR: The text has been revised in accordance with your suggestions.