

Response to Comments from Editors and Referees

Information of previously submitted manuscript

- Manuscript number: egosphere-2023-1344
- Title: Evaluation of Calibration Performance of a Low-cost Particulate Matter Sensor Using Collocated and Distant NO₂
- Authors: Kabseok Ko, Ramesh R. Rao, and Seokheon Cho
- Status: Under Review

The authors would like to thank the referees for their careful reviews and valuable insights. We prepared our response to each of the editors' and referees' comments and revised our manuscript by reflecting all feedback.

Referee #3

The authors appreciate Referee #3's kind and valuable comments.

[Major Comments]

1. Unfortunately, the study structure and data do not support the authors' claims due to the lack of a robust dataset and an unclear strategy between model training and model evaluation data groups.

(Response)

Thank you for your kind and valuable comments. We acknowledge the need for a clearer representation of our strategy for training and testing calibration models within the paper's structure. To address this concern, we restructured the paper by emphasizing a more explicit delineation of our approach in training and testing the calibration models.

Specifically, we understand the potential for confusion with a per-month analysis based on MLR methods in the context of training and testing calibration models. The aim of monthly analysis was to illustrate the impact of NO₂ as a new feature vector on calibration performance in a monthly manner. To rectify this ambiguity, we have refined the structure by reorganizing the discussion of the monthly analysis method into the subsection "Feature Vector Selection for Calibration Models" within the Methods section.

2. The article is confusing and hard to follow. Too much detail is given for non-relevant information but not enough for evaluation.

(Response)

Thank you for your thorough feedback on the manuscript.

We streamlined the presentation by consolidating certain portions into a tabular format and creating a dedicated subsection, called "Instrument Intercomparisons," within the Methods section. We implemented these changes to improve the overall clarity and accessibility of our work.

We carefully reorganized the manuscript to enhance readability and ensure that we present key methodological details more cohesively.

1) We restructured Sections 2 and 3 as follows:

2. Methods

2.1 Measurement data

2.1.1 PurpleAir PA-II units

2.1.2 Air quality measurement data from EPA

2.1.3 Selection of PA-II units and reference monitoring sites

- Note: We merged Subsection 2.3 with Subsection 3.1

2.1.4 Data preprocessing of PA-II units

2.2 Instrument intercomparisons

- Note: We merged Subsections 3.2 and 3.3. We also eliminated redundancy by creating a table for summary statistics of daily and hourly PM_{2.5} measurement data, and removing detailed explanations of maximum, minimum, mean, and standard deviations of various measurement data.

2.3 Feature vector selection for calibration models

- We merged Subsections 3.3 and 3.4. We then shifted the merged text into this subsection and simplified the contents for greater cohesion from the viewpoint of feature selections.

2.4 Calibration models

2.4.1 Multiple Linear Regression (MLR)

2.4.2 Random Forest (FR)

2.5 Performance evaluation metrics

3. Results and discussion

3.1 Calibration performance

3.1.1 MLR-based calibration model

3.1.2 RF-based calibration model

3.2 Effect of distant NO₂ on calibration performance

3.3 Applicability of other PA-II units

3.4 Effect of training period

3.5 Uncertainty analysis

2) We added two Tables describing the selected feature vectors used in analyzing our MLR- and RF-based calibration models, which had previously been written as text in our original manuscript. In the original manuscript, this included Lines 311-318 and 354-362.

3) We added a subsection on performance evaluation metrics to improve readability.

3. The authors argue against multivariable linear regression analyses but use MLR without offering a reasonable justification for its use nor explain why its results from RF and MLR are comparable.

(Response)

Thank you for your comment. We'd like to clarify our approach regarding the use of Multivariable Linear Regression (MLR) and Random Forest (RF) methods in our study.

We're not against MLR methods. Please refer to the following sentences in our manuscript: "A per-month analysis with a combination of features, including T, RH, and NO₂, showed an effect on calibration for the PA-II unit. It can be challenging to apply the per-month linear fitting result to calibrate PA-II units because month has a different slope and intercept defined for the linear fitting. Moreover, their values differ over two years even for the same month. For example, notably, the linear fitting result in Apr. 2018 exhibited a higher RMSE than the linear fitting result yielded in Apr. 2019. On the contrary, the calibration performance in Aug. 2018 was worse than that in Aug. 2019." Here, we are saying that we don't think performing MLR-based calibrations on a monthly basis is a good approach to proofreading. In addition, the monthly MLR analyses were primarily conducted for feature selection rather than calibration, specifically to confirm the viability of NO₂ as a feature for improving calibration performance. In evaluating the impact of NO₂, we considered MLR and RF algorithms.

Our findings revealed a significant enhancement in the calibration performance of both MLR and RF models after incorporating NO₂ concentrations. This inclusion notably reduced the performance disparity between MLR and RF models, which resulted in enhancement of calibration performance for both methodologies.

[Minor Comments]

1. Title misspelled "Collocated".

(Response)

We modified “colocated” to “collocated”.

2. Line 47: "however" seems to be misplaced.

(Response)

We updated as follows:

However, low-cost PM sensors are not suitable for regulatory purposes because the data reported can be questionable in terms of accuracy, precision, and reliability.

3. Line 121: This sentence is poorly constructed and confusing.

(Response)

We rewrote the sentence as follows:

Therefore, PA-II units may have abnormal data due to failure and aging drift, so data quality control is required before calibrating the PA-II units.