

Author's Response to RC2

Dear Editor and Referee:

We are particularly grateful for your careful reading, and for giving us many constructive comments on this work! Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our research. We have studied the comments carefully and have made corrections which we hope meet with approval.

According to the comments and suggestions, we have tried our best to improve the previous manuscript **EGUSPHERE-2025-1900** ("[Filling Data Gaps in Soil Moisture Monitoring Networks via Integrating Spatio-temporal Contextual Information](#)"). Here is a summary of the major changes to the new manuscript, and then answer the reviewer's questions one by one.

- a) The descriptions of the data sources and observation variables have been clarified in Section 3.1, including additional explanations of the monitoring stations and the collected variables (e.g., soil moisture and rainfall observations).
- b) Terminology and abbreviations used in the manuscript have been revised and clarified. In particular, the definitions of missing data patterns and model parameters (e.g., p , d , and q in the ARIMA model) have been explicitly explained when first introduced.
- c) Some ambiguous expressions have been corrected for clarity, such as the description of soil moisture measurements at 3 cm depth and the estimation procedure using the ARIMA model.
- d) Descriptions related to certain software libraries have been adjusted or removed according to the reviewers' suggestions, and the methodological descriptions have been revised accordingly.
- e) The English language has been carefully revised throughout the manuscript to improve clarity, readability, and consistency of expression.

We hope these revisions address your concerns and contribute to improving the quality and reproducibility of our work.

Best regards,

Zushuai Wei and all co-authors

Author's Response to the Comments of Referee #2

Question 1.1

Q1.1: L25 indicator of global climate change (needs to be backed by references).

Response: Thank you for the helpful suggestion. We agree that this statement requires appropriate references. Relevant citations have now been added in the revised manuscript to support the role of soil moisture in reflecting climate variability and land–atmosphere interactions (Galvincio, J. D. et al., 2024).

Question 1.2

Q1.2: L30 such missing not only (what is missing).

Response: Thank you for the helpful comment. The phrase “such missing” was ambiguous. We have revised it to “these data gaps” to clearly indicate that the sentence refers to missing soil moisture observations in the monitoring network.

Question 1.3

Q1.3: L50 what is MC?

Response: Thank you for pointing this out. In the previous version, “MC” referred to matrix completion. However, during the revision process, the sentence containing this abbreviation was removed to simplify the description of related methods. Therefore, this abbreviation no longer appears in the revised manuscript.

Question 1.4

Q1.4: L95 Completely Random Missing (MCR), the acronym seems out of order? Also, Non-Random Block Missing (NMR)?

Response: Thank you for pointing this out. The abbreviations were indeed inconsistent with the word order. We have revised the terminology to ensure that the acronyms correctly correspond to the phrase structure. Specifically, “Completely Random Missing (MCR)” has been revised to “Missing Completely Random (MCR)”, and “Non-Random Block Missing (NMR)” has been revised to “Non-Random Missing Block (NMB)” for clarity and consistency.

Question 1.5

Q1.5: L148 there has been no mention of the involvement of rainfall observations previously; is that also collected at each site? Please describe the type of stations and data collected, and how you determine which variables are relevant for your application. (e.g., why not use other soil moisture observations from other depths if not missing).

Response: Thank you for this helpful comment. We have revised the manuscript to clarify the data sources and the types of observations collected at the monitoring sites. In Section 3.1 (Data Description), we now explicitly describe the station types and the observed variables, including soil moisture and rainfall measurements.

In addition, we explain the rationale for selecting the variables used in this study. Although soil moisture observations are available at multiple depths, only the surface soil moisture measurements are used in the experiments to ensure data consistency and avoid introducing additional missing patterns.

The relevant description has been added in Section 3.1 of the revised manuscript.

Question 1.6

Q1.6: L154 should be mentioned earlier. Please describe if there are other variables collected.

Response: Thank you for the suggestion. We agree that the description of the observed variables should appear earlier in the manuscript. Therefore, we have revised Section 3.1 (Data Description) to clearly introduce the variables collected at the monitoring sites, including soil moisture and rainfall observations.

The corresponding explanation has been added earlier in Section 3.1 in the revised manuscript.

Question 1.7

Q1.7: L190 SM and PP at 3 cm, I guess it's PP and SM at 3cm depth?

Response: Thank you for pointing this out. We agree that the original wording may cause confusion. In the revised manuscript, the expression has been corrected to clearly indicate that the 3 cm depth refers only to soil moisture measurements. The sentence has been revised to " SM at 3 cm depth and PP".

Question 1.8

Q1.8: L202 need to describe what p, d, and q are.

Response: Thank you for the suggestion. In the revised manuscript, we have clarified the meaning of the parameters in the ARIMA(p, d, q) model. Specifically, p, d, and q represent the orders of the autoregressive, differencing, and moving average components, respectively.

Question 1.9

Q1.9: L235 Please add reference and description of things like Scikit-learn library, Keras, etc.

Response: Thank you for the suggestion. In the revised manuscript, the description related to the Scikit-learn library has been removed following the comments from Reviewer 1. Therefore, the corresponding reference is no longer necessary in the revised version.

Question 1.10

Q1.10: L352 Paragraph needs English language revision (also throughout the manuscript), e.g., two back-to-back sentences start with however.

Response: Thank you for the comment. We have carefully revised the paragraph in Line 352 and corrected the sentence structure to improve clarity and readability. In addition, the entire manuscript has been carefully proofread and revised to improve the English language and avoid repetitive sentence structures such as consecutive sentences starting with “However”.