

RC2 Comments and responses

We thank the Reviewer for her/his insightful comments. We appreciate the time and effort invested in providing detailed suggestions. Below, we address each comment in detail and outline the corresponding actions we have taken.

General Comment: A general suggestion to the manuscript readability due to the high number of acronyms and codes declared in the manuscript, is to add an acronym table that condensate abbreviations and, other table in the methodology section with the main characteristics of the mathematical techniques to help the reader to not to be overwhelmed with the immediate information of all these methods and their details.

Reply: We thank the Reviewer for this valuable suggestion. We agree that including such tables will improve the manuscript's readability and help readers better understand the methods used.

Action: We have added an acronym table to condense abbreviations and a table in the methodology section outlining the main characteristics of the mathematical techniques used in the study.

General Comment: Ending the Introduction to make smooth transitions a connector paragraph is needed to have smooth transitions between sections.

Action: We have added the following text to the end of the Introduction to ensure smooth transitions between sections:

"This paper is organized as follows: Section 2 outlines the methodology used to develop ML-AMPSIT, including a detailed description of the machine learning models integrated into the tool and the workflow for performing sensitivity and importance analysis. Section 3 presents the case study involving the coupled WRF/Noah-MP model to demonstrate the application of ML-AMPSIT. The results of the sensitivity analysis are discussed in Section 4, highlighting the effectiveness of different machine learning models in identifying the key parameters for the case study presented in this paper. Finally, Section 5 concludes the paper with a summary of the findings and some insights into potential future work to further enhance the capabilities of ML-AMPSIT."

General Comment: Could be helpful as well an introductory paragraph of the Methods section.

Action: We have added the following text at the beginning of the Methods section:

”In this section, we describe the methodological framework underlying this study. We begin with an overview of the ML-AMPSIT workflow, detailing the process from the selection of the input parameters to the sensitivity analysis phase. We then introduce the Sobol method, a variance-based technique used for GSA. Finally, we provide a description of the machine learning algorithms integrated into the tool, highlighting their main characteristics, how they are implemented and used in ML-AMPSIT and the rationale behind their selection.”

Specific Comment: In Page 7, Eq. (2). Terms definition missing $V_{\{i,j,\dots\}}$

Action: The definition of $V_{i,j,\dots}$ has been added:

”where V_i is the main effect variance, representing the contribution of the i -th input parameter to the output variance, V_{ij} is the second-order interaction effect variance, representing the combined contribution of the i -th and j -th input parameters to the output variance, and so on up to $V_{12..k}$, which represents the interaction effect variance of all k input parameters together.”

Specific Comment: Page 12 Eq(5). Introduce terms in the equation that are not described in the text θ_s and put units into []. What is TOPMODEL?

Reply: We have defined θ_s . TOPMODEL is a surface runoff model, we have added this information in the text, along with a reference. According to the journal’s standard, we think that units should not be put into [] in the text.

Action: We have modified the text as follows:

”where the surface potential temperature $\theta_s = 280$ K, $\Gamma = 3.2$ K km^{-1} , $\Delta\theta = 5$ K, and $\beta = 0.002$ m^{-1} .”

”while the surface runoff parameterization TOPMODEL (Niu et al. 2007) with groundwater option is used for runoff and groundwater processes”

Specific Comment: Paragraph 355, page 13. Give more arguments about the selection of the two locations (one over land and one over water), I know these are very different locations but explain to the reader that you want to have two places that represent different dynamics in the model due to the input parametrizations of each site.

Action: We have added the following text to clarify the choice of the two locations:

”These two locations are chosen to evaluate the effects of varying land parameters over two completely different surfaces and to assess how changes in land properties can influence atmospheric fields also over water. The locations are also strategically chosen near the interface between the land and water regions to better capture the dynamics of the sea/land breeze circulation, which is expected to be most pronounced near this boundary.”

Specific Comment: Section 3.2 Model setup should have a Figure with the characteristics of the domain or at least a table that summarizes the main characteristics of the model domains.

Action: We have added a figure to Section 3.2 that summarizes the main characteristics of the model domain.

Specific Comment: Agree with the minor comment on CC1: ‘Comment on gmd-2024-56’, Benjamin Püschel, 21 Jun 2024 :

”The quality of most figures is not entirely satisfying but could be improved with relatively little effort. For instance: Add a grid to the background of all figures. Increase font size in legends of Figs 3 & 4. Increase font size of labels in Fig 5 and title of subplot c). Add a second y-axis for the p-value in Figs 5, 8, 9 as it is close to 0. Swap x- and y-axis in Figs 12, 13, 14, 15 since height coordinates are usually represented on the y-axis. Increase line

width and use both colors and line styles to differentiate between lines in all plots. This would greatly increase visibility, especially for color-blind people. Is there a reason why the area under the curves is colored in the feature importance timeseries? (Figs 5, 10, 11).”

Action: All the suggestions have been considered and implemented into the manuscript.

Specific Comment: About the references section: It is suggested to add a couple references more from the year 2024 to update the state of the art of the manuscript. Put all the dates in the reference section homogeneously, i.e. all ”....(year).....no: ”(month year).....”

Action: We have added some more recent references referring to the year 2024. In the revised manuscript the references are compliant with the GMD standards.