Response to reviewer comments on

manuscript SOIL egusphere-2025-166:

“Quantifying spatial uncertainty to improve soil predictions in data-sparse regions”

Thanks to the editor and reviewers for the feedback. We've gone through all the comments and made the changes to the manuscript according to your suggestions. This includes fixing specific points that were raised as well as general improvements to the writing, grammar, and overall readability. The revised version should now better reflect the clarity and structure expected. Below, we address the major and the minor comments in detail.

RC1:

The use of the uncertainty quantification approach through the Last-Layer Laplace Approximation (LLLA) is a novel and much-needed addition to Digital Soil Mapping (DSM). Artificial Neural Networks (ANNs) are often overconfident, but this approach appears to mitigate that risk. The importance of uncertainty quantification in DSM is increasingly recognized. Nowadays, many people use machine learning algorithms without fully considering the risks of overfitting or overconfidence, which highlights the need for accurate uncertainty measurement, whether in interpolation or extrapolation purposes. Overall, I find the general concept of the paper to be quite interesting.

We thank the reviewer for the positive and supportive feedback. We're pleased that you find the concept of using LLLA for uncertainty quantification in DSM both relevant and promising. Your comments align well with our motivation to address overconfidence in ANN-based soil models. Below, we briefly respond to your suggestions for improvement.

1. However, it could be improved by providing more clarity and adding further details to the methodology section.

   Thank you for the suggestion. While no major methodological changes were required, we acknowledge the need for improved clarity. Combined with the comments of Reviewer 2 on this issue, we have expanded and clarified key parts of the Materials and Methods section.

   Lines 155-156:
   “A detailed description of the model tuning protocol is provided in Rau et al. (2024), where the method was first tested in a simplified, controlled soil classification setup.”

   Lines 171-172:
   “To address these limitations and quantify model uncertainty, i.e. epistemic uncertainty, we employ the Last-Layer Laplace Approximation (LLLA) following Daxberger et al. (2021b)”

   Lines 183-184:
   “We already have shown that LLLA effectively identifies areas of high uncertainty in soil classification tasks (Rau et al., 2024), making it crucial for generating uncertainty maps with uneven training data coverage”

2. The results and discussion sections are well written, but the readability would be enhanced if the authors more frequently referenced specific figures. I would recommend this paper for publication in EGU Sphere, pending minor adjustments.

   We have reviewed the Results and Discussion sections and improved figure referencing throughout. We now explicitly link specific parts of the narrative to the corresponding figures (particularly Figures 2 to 5) to enhance readability.

   Lines 192-193:
   "The study was therefore based on two different areas: a well-sampled reference area and a completely unsampled target area (Figure 1)."

   Lines 258-260:
   "When examining the relationship between confidence and prediction accuracy, it can be seen that in areas where the ANN performs poorly (Figure 2 (B)), the confidence values paradoxically remain high (Figure 4 (A))."

   Lines 290-291:
   "A first insight is provided by the violin plot (Figure 5), where the orange-colored part shows the confidence after LLLA."

   Lines 312-314:
   "After applying LLLA (Figure 4 (B)), the confidence decreased significantly in the central areas, where it was wrongly predicted over soil units 5, 9, and 12, indicating that the model recognized uncertainty in those regions."