

Response to editor

We thank the editor for the comments. We have updated our draft according to the referees' comments. We have:

- Extended the model interpretation to include more pedological explanations in the Results section.
- Included an analogous SHAP analysis for the MAOC prediction model in the Supplementary Information and referenced it in the Results section.
- Clarified how frontier line analysis avoids over- and under-estimation of Cdef in the discussion and referenced Shi et al. (2025) as referee suggested in the Discussion section.
- Acknowledged the limitation of the size definition of silt and clay in the Discussion section.
- Clarified the uncertainty propagation of the frontier line fit and spectral model in the Discussion section.
- Clarified that our method uses laboratory based spectroscopy primarily intended to enhance efficiency of MAOC and Cdef estimation on sampled soils and noted the connection and potential contribution to remote-sensing-based approaches in the Discussion section.
- Clarified the advantage of CUBIST model in selecting the most relevant spectral features in the Discussion section.
- Corrected description of model validation method in the Methods section.
- Clarified the offset correction used for spectral pre-processing in the Methods section.
- Updated the figures with improved scale and colours.

- Corrected other minor errors and improved the sentence flow.