Manuscript title: “Predicting the spatial distribution of soil organic carbon stock in Swedish forests using remotely sensed and site-specific variables.”

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Reviewer comments

General comment

The manuscript is well written and generally clear, with an appropriate structure and the information provided in tables and figures is useful and necessary, although I have some specific comments for the presentation of some figures. The length of the paper is appropriate, as the presentation of the results is synthetic, and the discussion gives a concise explanation of the observed results supported by other findings in the SOC literature.

This research paper investigated the key variables for predicting soil organic carbon (SOC) stocks in the litter layer, mineral soil, and total SOC of forest soils in Sweden, and maps its spatial distribution using random forest models. The study compares the accuracy of global models (calibrated for the whole study area, Sweden) and local models for north, central and southern Sweden. The calibration data originated from the Swedish National Forest and as predictor variables they compared three different sets: 1) only site variables observed at the sampling plots, 2) remote sensing variables, and 3) all variables.

My main comment may be more a suggestion for the follow-up study. Mapping some of the site variables that were more decisive for SOC prediction (soil moisture class, vegetation type, soil type and soil texture) and including them as covariates for mapping may improve the model accuracy for mapping. However, as these variables will be themselves estimated with statistical models, there may be an increase in the uncertainty due to error propagation. Hence, the uncertainty of the map for a model including all variables may be a conservative estimate. Also, in that future scenario, consider that if you calibrate the model with the data observed at the plots but map it with the gridded estimates of the site variables, the accuracy may also overestimated. If you calibrate the model with the gridded predictions for soil moisture class, soil texture, etc., perhaps they may not be as relevant covariates, and maybe the accuracy of the model will not be the highest.

I recommend acceptance after minor revisions, for the following sections.

Specific comments

L51-53: Maybe you can include geostatistics as part of the modelling methods.

L55: consider changing “modelling over a large landscape” to “large extent”.

L66: include soil with “the inclusion of the location coordinates”.

L86-94: This paragraph is somewhat confusing. Does the NFSI run every year or every 5 years? Maybe give a reference for the NFSI or the NFI datasets.

L99-L100: Please, indicate if the content of inorganic carbon in mineral soil is negligible in the study area.

L104: what type of interpolation? Splines? Linear?

L150: the soil moisture class is later shown as a very important variable. Perhaps you could describe it a bit more. It refers to the frequency of the year it is dry/moist due to the proximity of the water table, or also influenced by soil texture (e.g., soil drainage class)?

L153: The field layer refers to the understory?

L159: did you also used the QRF models to predict the 5^{th} and 95^{th} percentiles and create the 90% prediction interval?

L201-203: I would have used a larger buffer, but I imagine that you assessed that this length was appropriate. Later in the results, I miss some information on how the local maps overlapped, whether or not there was some edge effect. In figure 6 it seems that there were not large differences in the boundaries.

L222-225: This sentence is not very clear. You split the dataset into a calibration (80%) and independent validation (20%). And then you apply the tenfold cross-validation, repeated 5 times, on the calibration subset, right?

L276-285: Here, the results for the independent validation are a bit short compared with the report for the cross-validation, or if you refer to the independent validation as "local models after cross validation" (L282), maybe that it not very clear. I was looking at Table 4 and the numbers don't seem to correspond completely. Please revise this (e.g., R^2 for allV at independent validation 12-36 % and 17-32 % at cross-validation).

L292-293: This sentence is not completely clear. Please specify that the local models had better performance than the global models in term of RMSE within each set of variables.

L360-362: Could you provide the map of standard deviation?

L491-495: The relevance of soil texture as predictor of SOC stock is also explained by the physico-chemical SOC stabilization mechanisms. Clay minerals and clay and silt sized particles generally have a positive correlation with mineral SOC stocks, as the association of organic matter with mineral surfaces, and occlusion inside aggregates hinders microbial decomposition and enhances SOC accumulation. There are many references in the literature on this topic. For example:

Lützow, M.V., Kögel-Knabner, I., Ekschmitt, K., Matzner, E., Guggenberger, G., Marschner, B. and Flessa, H., 2006. Stabilization of organic matter in temperate soils: mechanisms and their relevance under different soil conditions–a review. *European journal of soil science*, *57*(4), pp.426-445.

L550-554 & 559: Consider my comment on how there would be error propagation and the final uncertainty of the SOC predictions may be increased when maps of these site attributes are included as predictors for mapping. However, I would also include these maps as predictor variables when they are available.

Technical comments

L20: "Random Forest models".
L43: Place the abbreviation of carbon (C) before in the text, in line 35 when you use it for the first time.
L228: "buil**t"**.
L294: "best local model**s"**.

L326: 40K (capitalize the K).
L372: “When predictions were carried out”.
L385: “outperform”
L386-387: Please indicate that you refer to the best local models.
L397: “remained low”
L475: “organic matter”

Figure 6: Please, indicate in the caption which in the figure (left/right) are the global and the local models. Also, maybe you could include a figure with the standard deviation or the 5^{th} and 95^{th} percentiles (predicted with the quantile random forests regression) so we can also visualize the uncertainty. The colour scale for the total SOC stock (in less extent) but mainly for the mineral SOC stock is not very clear, as there are different tonalities of green and brown for different value ranges. Could you use a different sequential palette, like for the predictions of the humus layer? (maybe multi-hue sequential palette). For example, the package *colorspace* has many options.

Supplementary material S1: Maybe you can expand the supplementary material one more page and make the plots larger on their y axis. They are not very clear like this.