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# *Interactive comment on* "Spatial variation and linkages of soil and vegetation in the Siberian Arctic tundra – coupling field observations with remote sensing data" *by* Juha Mikola et al.

**Anonymous Referee #1**

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The presented manuscript analyses spatial variation of plant and soil properties and their relations to each other for a field site in the Siberian Arctic tundra. Furthermore, it is tested to what extent remote sensing data can be utilised to capture variation in these properties and, consequently, to extrapolate vegetation and soil effects on ecosystem carbon fluxes to the large scale. The study highlights difficulties in predicting soil properties from NDVI, since they are not linked to vascular plant LAI, but moss biomass, which cannot be captured well by remote sensing. Instead, a classification of vegetation and soil properties according to land cover types is recommended to capture their spatial variation. The manuscript is well written and of good scientific quality. However, some details of the methodology and the results should be explained more clearly in



order to make the manuscript easier to understand for readers who are not familiar with remote sensing techniques. I recommend to publish it with minor revisions, as outlined below.

General comments

(1) The abstract is too long in my opinion, the middle part contains many details and figures which are not essential for the message of the study. I therefore recommend to shorten it by around 50%.

(2) A schematic of the individual working steps described in the methods section and how they relate to each other may be helpful to understand the approach (e.g. how are data from field sampling combined with remote sensing),

(3) As far as I understood Sect. 2.5, the 9 land cover types (LCTs) were determined through personal judgement in the field. Subsequently, a statistical classification approach (random forest) was applied to construct a model which predicts these LCTs based on remote sensing data. The authors report that 109 features of the remote sensing images were used in this model to predict the LCTs. However, no information is provided on what exactly these features are and why such a large number of input variables is needed. Please explain (a) what properties these 109 features represent (in general terms). (b) how you tested the model for overfitting, i.e. couldn't you have produced a similar prediction of LCTs with less input variables? (I am aware that the number of original features was reduced from 262 to 109, but this still seems a lot to me) (c) why the features lead to a superior recognition of LCTs than the NDVI-based information.

(4) Figures 3 to 6 show how vegetation and soil properties depend on LCT, while Figs. 11 and 12 show relations between moss biomass/vascular LAI and NDVI, and soil properties and NDVI, respectively. While around half of the relations in Figs. 11 and 12 are relatively weak ($R$ squared $< 0.3$), the others do suggest that NDVI provides information about vegetation and soil properties. Moreover, the LCT classification does

show some weak relations to soil and vegetation properties, too, and the external accuracy of the statistical model which predicts LCT is only 49%. Hence, it is not obvious to me why the derivation of vegetation and soil properties via LCTs is better than the NDVI-based derivation. It would be nice if you could provide a more quantitative prediction of soil and vegetation properties based on LCTs. Early growing season NDVI, for instance, explains 23% of moss biomass. Would it be possible to come up with a comparable figure for the LCT approach, e.g. given the 50% accuracy in predicting the LCT, and the standard deviation in moss biomass within an LCT, how much of the variance is explained?

(5) I am missing a few words on the outcome of the decomposition experiment in the discussion section. What is the implication for ecosystem carbon fluxes?

Specific comments

p3,l1 Could you please expand the sentence by one or two examples stating which soil properties affect ecosystem carbon exchange and how they do that?

p4,l25 Please add a few words on why this sampling point pattern was chosen (increasing distances between points with larger distance from EC tower). In particular, explain how this pattern is suitable to capture soil and vegetation properties at different spatial scales (from smaller to larger distances) for the study area.

p5,l4 Please explain shortly why these soil properties were measured? How do they relate to carbon exchange fluxes?

p10,l30 & p11,l12 & p14,l1 Shouldn't moss biomass relate to topography via wetness? At least Sphagnum should show a link to low elevation. Figure 8 seems to show a good correlation between topography and dry/wet areas, which correlate well with vegetation type. Therefore, the explanation regarding microtopography seens not very satisfactory to me. Please explain this in more detail and maybe show a map of the topography of the study area for comparison.



p11,l15f If remote sensing reflectance cannot capture well moss biomass and associated soil properties, how can remote sensing be successfully used to classify LCTs, which also largely depend on vegetation properties? This means, how can the random forest classification distinguish between the 7 LCTs which differ mostly in vegetation properties? Please provide more details on the 262/109 features (see also general comment 3 & 4).

Comments on style

p4,l13 "..the soil is in continuous.." - the "in" seems to be misplaced here.

p4,l20 What do you mean by the word "manuscript" in the cited studies? At least Tuovinen et al do not appear in the bibliography. Could you please correct that and use "submitted" instead?

p6,l12 Please explain the abbreviation "GCP", e.g. putting it in brackets in line 10.

p9,l29 It is not clear what "user and producer accuracies" are.

p13,l10 Please provide a reference to the figure/table which illustrate this finding at the end of the sentence. This should be done also for the rest of the discussion.

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