

# ***Interactive comment on “Environmental Conditions for Alternative Tree Cover States in High Latitudes” by Beniamino Abis and Victor Brovkin***

**Anonymous Referee #2**

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This paper covers a very interesting and important topic. Since we can measure tree cover from remote sensing, several papers have shown potential bistability in forest cover. It is of major importance to find environmental conditions which can trigger a shift from one state to another. This paper aims to link the tree cover distribution to observed environmental conditions and thereby conclude that 5% of the boreal area is potentially bistable.

I found the paper difficult to read, mainly due to the many abbreviations. I think that the authors could delete loads of them and just write down the whole names. Further my major concern is the structure of the results. It is unclear what is expected, some parts are discussion already, while some crucial results are not introduced. The authors

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should take more time to present their results. I have a set of minor and more major points

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Abstract: 1) Please try to minimize the abbreviations. Is it needed to mention them already in the abstract? 2) The aim it to study the impact on the tree cover fraction by eight environmental factors. I think you do not prove that it is the impact; you only link them following a statistical approach? So I would be in favour to change the aim;

Methods 3) It is unclear to me why the authors didn't use a seasonal variable in here. I think that seasonality in the temperature and rainfall will probably tell more than the averages and minimum values. 4) What is permafrost distribution? I am not a specialist on this, but it would be helpful to add more information on the selected environmental variables and also add units in table 1 5) Pg 3, line 30: How many RS-cells is 0.05degree? 6) Also add all abbreviations in table 1 7) Pg 4, line 3: Of course both data sets are highly correlated, but more interesting is to see the anomalies; 8) Pg 5, line 13: just call EV environmental variables. These changes will highly improve the reading 9) Pg 6, line 1, we associate every grid cell? Which grid cell is this the 0.05 degree or the RS-grid cell?

Results 10) Pg 7, Line 3: Here you start referring to the table by not interpreting what we see but only saying that we have uncertainty bands. I think that you first need to introduce what we see highest explained variance is found for NA\_E. (In the text this is mentioned as NAE.. please just use the whole name, you also do this later on with Eastern North Eurasia for instance). And that this differs per region etc. Then you should also make a column with average values for all data. A question I do have is if the differences in explaining variance per region are dependent on the range of the environmental variables. With a larger range you would expect a large explaining variance. 11) Results-vs Discussion: I realize that the above section should not be too much discussion. From pg7, L13-15 to pg8 L1-20 onwards you have a mix of results and discussion. These should be separated and should have a new section in the discussion chapter. 12) Phase-space results: Again take more time to introduce Fig2a.

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Is it not only the phase-space but also the KDE? Also mention in the text what these intersections are. Mention what the colours are and how we need to interpret Fig2a. After that introduce Fig2b. 13) I also like to see a correlation matrix how the different EV's are correlated with each other. It is now unclear why you show Eastern North Eurasia with the combination of the two and why not a combination of other variables. I think that MAR and mean\_TMIN are highly correlated as they are placed on one line, meaning overlap of information. 14) 3.3: I do not understand the part at page9 L5-10. I can see that you are interested in grid cells having similar EV's but not similar tree cover. However I am confused how to read table 3, why is that you have four columns? If you mention a number of classes (page9, L8), what do you mean? 15) It is very interesting to see how these data are clustered. I have problems with reading the different colours in the legend. Also some symbols have a black line and others not, but unclear if this relates to the fire or non-fire disturbed states or does it relate to single stable vs bistable data points?. Can you also see some spatial patterns of data which have the same bistability, but now currently in a different mode? 16) Figure 4: It is Silverman's test (to words) 17) Treeless state: I agree with your statement that tree cover below 20% is difficult to measure with RS. Therefore I have my doubts about the results of Fig.4 Why is it that you use in that detail the tree cover fractions below 20%? What do you want to show with these figures. There is not much text about figure 4, so is it needed or can you directly introduce figure 5. Although for this figure, the same holds for the data <20%. Discussion 18) Do not understand your statement on pg14, L6; what kind of feedbacks? You didn't study this, so why is it that they might or might not play a role? 19) I found the discussion on N-cycling, decomposition, fertilisation a bit too much detail in comparison to the work you have presented. You have now linked it to soil type, and if you would be more interested in Nitrogen then you could have used modelled maps from DGVM's (as LPJ-Guess) or use maps or soil organic matter. I think that there are more important things to discuss, for instance why individual set of EV's are different between the regions, why fire is that important, which regions are more sensitive to a change in temperature than others, or a change

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in permafrost depth etc. etc. So keep the discussion more related to your own findings.

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