

1 Dear Editor,

2 We have revised our manuscript according to the comments of the reviewers and Copernicus
3 Editorial Board. This letter contains a point-by-point reply to the comments, including links (line
4 numbers) to the revised manuscript. We referred the line numbers of two revised manuscripts with
5 and without revised parts. Line number of the manuscript with revised parts (marked-up) is shown
6 in parentheses.

7 Besides, we added our own revisions for the ring width index (RWI), described in the end of the
8 letter, because we added new data. After the update of the RWI dataset, there were no significant
9 changes in the results of our study and their interpretations.

10 Reviewer #1.

11 We numbered all comments and replied to them.

12 (1) In the introduction, discussion and particularly the conclusion, the authors mostly discuss
13 earlier findings from Spasskaya Pad, and hardly touch upon potential similarities or dissimilarities
14 with other regions. This makes it very hard for the reader to assess to what extent the findings
15 presented here may hold lessons for the other boreal forests on permafrost. In my view, your results
16 hold important lessons for the potential impacts of increased precipitation variability in northern
17 forests, also beyond Siberian larch forests! Precipitation variability is increasing rapidly in this
18 region (see also <https://doi.org/10.1016/j.jhydrol.2021.126865>) so it is important to discuss what
19 your findings imply for the future functioning of Siberian larch forests and potentially boreal
20 forests in general. You also demonstrate a clear “legacy effect” that could be related to recent
21 insights regarding duration of the impacts of extremes (see for instance
22 <https://onlinelibrary.wiley.com/doi/pdfdirect/10.1111/gcb.16078>). You still find divergence in
23 NDVI over ten years after an extreme event. This is a major legacy effect, that has important
24 implications for knowledge on Arctic greening/browning and should be stressed more strongly in
25 the conclusion and abstract!

26 Response: We added more explanations in the abstract, introduction, discussion section 4.4,
27 and conclusions. In the abstract, the implication of our results was added as described in the reply
28 to the comment (5). In the introduction, we explained the greening and browning trends over high-
29 latitude regions and what factors can control them on L. 38-51 (L. 38-51). Browning was mainly

30 observed in dry regions, including our study site. Besides, introduction was thematically
31 restructured as described in the reply to the comment (8). We explained the long-term effect of the
32 extreme wet event in our study site, which can be potentially observed in other dry regions, in the
33 discussion on 520-529 (L. 475-484) and conclusions on L. 552-554 (L. 504-506).

34

35 (2) The described aim of the research is to assess how the local forest has changed over time,
36 but throughout the methods you have decided a priori to split up the data into a pre-2007 and post-
37 2007 segment based on an extreme event. Hence, it seems more appropriate to either first
38 statistically evaluate and demonstrate whether there is a significant trend break. I do not doubt this
39 would be the case if you would try it, but it would provide a back up for your methodological
40 choice. Alternatively (maybe this is easier) you could reframe the research aim to explicitly
41 investigate the effect of this wet event. This would make sense, since the subdivision of forest
42 types within the transect seems to already be based on forest damage and regeneration stadia, and
43 the introduction already extensively discussed observed effects of the 2007 wet period.

44 Response: Yes, we agree with the comment. Our study is not only the extreme wet event,
45 and we would like to show the historical variation of the larch forest using NDVI. The larch forest
46 at our study and also northeastern Siberian taiga site have been suffered from drought and recently
47 wet event. We would like to show how drought and wet event affect the NDVI. But for the most
48 visible and impacted change in the correlation between NDVI and ecosystem parameter (especially
49 soil moisture) was the wet event. It is not possible to change the statistical analysis at this moment,
50 therefore we reframed the research aim to investigate the effect of wet event as described by the
51 reviewer on L. 103-108 (L. 83-88).

52 (3) The ecophysiological meaning of the d15N, d13C and C/N ratio data, as well as the
53 methods through which they were derived, are completely lacking. The reader will need more
54 background to understand the presented patterns and the methods are not reproducible here.

55 Response: We added the explanations. Please read the replies to the comments (15), (16),
56 (26).

57 (4) I have some concerns about confounding effects of seasonal availability of landsat ndvi
58 data in shaping the temporal dynamics of ndvi and affecting relationships with other site data. In

59 the line comments, I have added some examples and suggestions on how to deal with this. I think
60 with an additional figure or potentially addition of covariates/interactions such issues could be
61 resolved quite well.

62 Response: When we use the satellite image data, there are many problems such as temporal
63 resolution and combination of different sensors. Please read the replies to the comments (14), (19),
64 and (20). We tried to describe as much as possible.

65
66 Answers to the Line comments:

67 (5) L. 29: Could you reflect briefly on the implications of your results to place them in a
68 wider context? Parts of the Siberian Arctic show record browning in recent decades, as you
69 undoubtedly know better than anyone. Perhaps you could reflect on the potential role of moisture
70 dynamics, drought and waterlogging in this browning trend? (Just a suggestion).

71 Response: Yes. As you know, boreal forests in northeastern Siberia are experiencing
72 browning, because of not only by temperature-induced drought but also waterlogging and nitrogen
73 dynamics as we showed in our manuscript. We added the sentence to the abstract on L. 31-32 (L.
74 31-32).

75
76 (6) L. 31-32 "occupy a large forest area, approximately 27 % (Fao, 2020)" --> I assume you
77 mean 27% of the world's forest cover? Could you rewrite this to make it clearer what the statistic
78 refers to? Also consider writing "FAO" instead of "Fao" as you also write it in the reference list.

79 Response: Thank you very much. We changed Fao to FAO. According to FAO, 27% is the
80 percentage of boreal forest in the total forest cover, on L. 35 (L. 35).

81 (7) L. 39 "and change the ecosystem" --> Could you provide a few concise examples and
82 references?

83 Response: We removed the sentence after restructuring introduction.

84 (8) L. 31 - 66: Please consider adding some thematic structuring to the introduction; the
85 introduction seems to give an overview of earlier work that is mostly focused on C-exchange,
86 while the knowledge gap described on L. 65-66 focuses on NDVI and foliar parameters.

87 Response: We thematically structured the introduction as the following: boreal forests on L.
88 34-51 (L. 34-51) -> dry Siberian forests on L. 52-67 (L. 52-63) -> not only drought but also
89 extreme wet event affects the forest on L. 68-84 (L. 64-74) -> knowledge gap about NDVI
90 observations on L. 85-91 (L. 75-81) -> aim of the study on L. 102-108 (L. 82-88).

91

92 (9) L. 67 - 70: The research aim is described as "assessing how the forest has changed",
93 which seems unnecessarily vague. Could you provide more specific aims or research questions
94 and (optionally) hypotheses? Setting more specific aims may also help provide structure and
95 direction to the introduction paragraph above.

96 Response: The sentence on L. 103-104 (L. 83-84) described the outline of our aim, and this
97 looks vague. We changed the paragraph as shown on L. 103-108 (L. 82-88).

98 (10) L. 78: "consists of deciduous species" --> any information which ones? do they occupy
99 a significant share of the canopy compared to dominant larch vegetation?

100 Response: The deciduous species are larch and birch. To avoid misunderstanding, we
101 changed the description on L. 116-118 (L. 96-98).

102 (11) L. 80 " and other grasses" --> please remove "other" (as the shrubs mentioned before
103 are not grasses)

104 Response: Removed on L. 118 (L. 98).

105 (12) L. 95: "Regenerating forests RF-2 had moderate forest conditions between RF-1 and
106 DF" --> what do you mean by moderate forest conditions?

107 Response: We described the difference between the RF-2 and RF-1 on L. 130-131 (L. 110-
108 111) and removed the sentence on L. 134 (L. 113-114).

109 (13) L. 108 - 110: " The transect plots, which consist of pixels not attributed to quality pixels
110 (clear terrain, low-confidence cloud, and low-confidence cirrus) in the quality assessment bit index
111 band according to Landsat Surface Reflectance product guides, were excluded from the analysis. -
112 -> due to the structure of this sentence it reads to me as though all transect plots ndvi values were

113 excluded from analysis, but as the text continuous you describe how it was used in further analysis,
114 so I assume you only removed pixels (or transect plots?) that were flagged in the QA product?
115 Perhaps you could rephrase this more clearly (e.g. that "pixels flagged in the quality assessment
116 bands were omitted from analysis"? or that "transect plots that contained pixels flagged in the
117 quality assessment bands were omitted from analysis"?).

118 Response: We rephrased the sentence on 148-150 (L. 128-130).

119 (14) L. 120: can you provide an assessment of fit among the different sensors, e.g. on days
120 for which multiple products are available? how accurate is the estimate for the one sensor based
121 on another sensor compared to the actual value? Roy et al 2016 recommend to use a locally
122 parameterized regression, although it would be understandable if insufficient overlap in
123 acquisitions among different sensors prevents establishment of specific regression parameters for
124 your site.

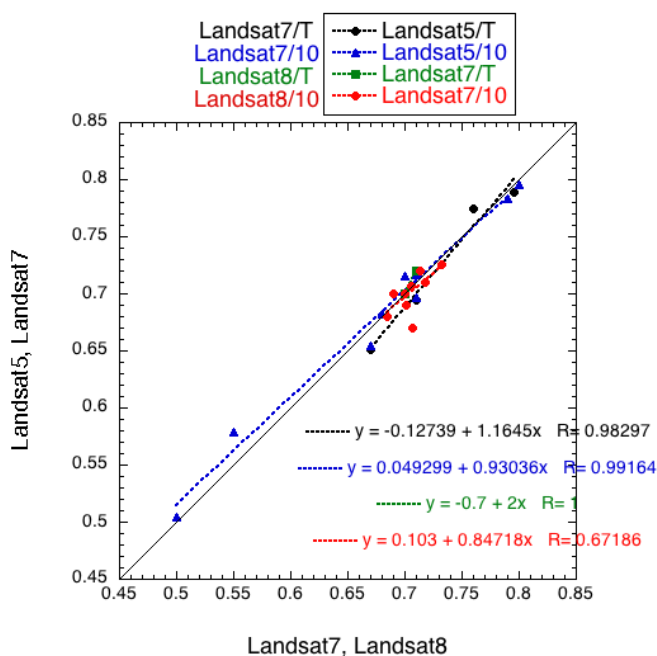
125 Response: We understand that local parameterization is important, because it is not possible
126 to combine different sensors perfectly. However, unfortunately, we cannot show the sufficient data
127 of assessments for publication. In our study, three Landsat images (Landsat 5 TM (L5), Landsat 7
128 ETM+ (L7), and Landsat 8 OLI (L8)) were available. L7 had the longest observation period, but
129 actually data quality was not so good, compared to L5 and L8 (after the scan-line corrector failure
130 of L7 in 2003). After the selection of image data and conversion by Roy et al. (2016) and Ju and
131 Masek (2016) as described in Methods 2.2, and we again selected the NDVI data for comparisons
132 between L7 and L5 for the period 1999-2011, and L8 and L7 for 2013-2019, by the following
133 conditions.

- 134 • For transect plots, all 34 transect plots were observed. For 10-km plot, more than 96%
135 of pixels in L5 and L8, and more than 75% of pixels in L7 were observed.
- 136 • There was one day difference in the acquisition dates between L5 and L7 and between
137 L7 and L8, and NDVI signals were close.
- 138 • If the average value for the short period in summer (NDVI shows usually small change
139 in July to beginning of August) was calculated, we used the average value.

140 Eleven data (including transect and 10-km plot) for comparison between L7 and L5 and twelve
141 data (including transect and 10-km plot) between L8 and L7 were identified. The results were close
142 to the 1:1 line (see the figure below).

143 There are many problems on statistical procedure if we show these assessments in our paper. But
144 we believe that the conversions by Roy et al. (2016) and Ju and Masek (2016) can be used
145 realistically.

146 We put some sentences to Methods 2.2 L. 160-163 (L. 140-143) and Discussion 4.1 L. 365-
147 367 (L. 337-339).



148

149 (15) L. 133-136: this paragraph lacks context of the ecological or physiological meaning of
150 isotope ratios and C/N ratio. More explanation and literature is needed for the non-expert reader
151 to assess what the d15N, d13C, C/N ratios and ring widths actually mean and what questions you
152 are answering by including these data (alternatively, you could also already explain how the
153 different types of datasets relate to the research aims in the final introduction paragraph)

154 Response: We revised and added some sentences for explanation and literature on L. 184-
155 199, 209-211 (L. 164-179, 189-191).

156 (16) L. 133-136: There seems to be no explanation of how the d15N, d13C and C/N ratios
157 were derived, Add methodology (which tissues were sampled, how many grams, how were they
158 analyzed, on which instrument, against which isotope standards at what precision?). If the data

159 come from an existing dataset or study, please cite it so the reader can understand how the values
160 were derived.

161 Response: We put the outline of methodology in Methods 2.3 L. 200-207 (L. 180-187) and
162 the methodology details in the caption of Figure S1.

163 (17) L. 150: can you explain why you chose a pearson correlation, rather than a spearman
164 correlation or crosscorrelation function (which in my experience are more appropriate choices for
165 relatively short timeseries)? Not that I doubt the outcome of your analysis (you present very clear
166 visual and temporal patterns), but the backing of your choices could be stronger.

167 Response: Since we obtained a simple linear relationship between two parameters, the most
168 common test (Pearson correlation test) was used. We added the short description on L. 221-222
169 (L. 201-202).

170

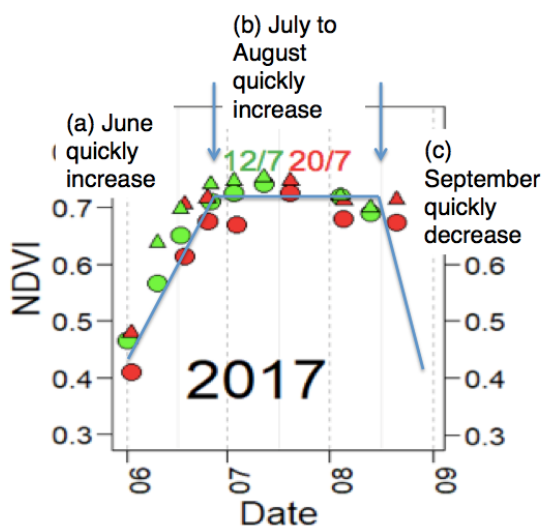
171 (18) L. 152: "differences between the two groups" --> which groups are you referring to?
172 there are more than two types of forests mentioned in earlier in the methods. It is also unclear to
173 me why an unpaired test was selected if data from the same years or acquisitions is available for
174 different forests. I am probably misunderstanding what you are describing here, so perhaps that is
175 an indication that better explanation is needed.

176 Response: Two groups mean two different forest types among four (TF, RF-1, RF-2, and
177 DF), but we changed the description about the statistical tests on L. 223-228 (L. 203-205). It is
178 better to use tests comparing 4 forest types at the same time in order to avoid Type I errors. So,
179 we changed statistical method to Kruskal-Wallis test with pairwise Wilcoxon rank sum test. We
180 preferred this test to ANOVA because of a relatively small number of samples in the forest types.

181 In the manuscript supplemental, we replaced the old Tables S3, S4 with two new tables, and
182 the old Table S5 was removed. Consequently, we changed the table number on L.229 (L. 205),
183 296 (274), 311 (288), 326 (298), 327 (299), 330 (302), 344 (316), 383 (355).

184 (19) L. 163-165: "The seasonal maximum of each year was observed from 25 June to 13
185 August, except for 1999 (shown in Table S2). The maximum transect NDVI in 1999 was observed
186 on 27 August (0.75 ± 0.02 , $n = 34$) because the Landsat data in 1999 were limited to the latter half

187 of August. " --> landsat scene availability throughout the summer can be highly limited. to what
 188 extent is the seasonal maximum an artefact of data availability (e.g. it would obviously fall in June
 189 if no data from July and August are available, even if the true maximum would fall in july or
 190 august). Please add an indication or statistical backing (maybe in SI) of how the timing of the
 191 seasonal maximum relates to scene availability, because otherwise it cannot be called "year to year
 192 variation" and it would be unclear whether the time series you describe in fig. 2a is robust, or
 193 merely an artefact of seasonal timing.



194
 195 Response: The figure above is an example of the time course of NDVI in 2017 summer
 196 period. Red triangles and circles are L7 data for transect and 10-km plots, and green triangles and
 197 circles are L8 transect and 10-km plots. We divide the growing season to three stages (a) to (c). In
 198 June (a), NDVI values quickly increased, and during the late June - the mid-August (or in the
 199 beginning of September) (b), NDVI values are relatively stable because vegetation has the
 200 maximum biomass. Finally, during the late August-September (c), NDVI values decrease due to
 201 the leaf senescence. Although the timings of (b) (start and end) varied depending on the weather
 202 and soil moisture conditions, maximum biomass stages (b) continued more than one and half
 203 months. We obtained NDVI on this stage as seasonal maximum (the manuscript's supplemental
 204 Table S1). The example of NDVI in 2017 (shown in this response letter) is the highest temporal
 205 resolution, and other years are lower temporal resolution than that in 2017. But the data in most
 206 years had more than 3 data acquisition days in the period of (b). Only one acquisition day during
 207 the period of (b) was for 1999 and 2003. For 2003 the observation day was 21 July, and we used
 208 this value. For 1999, it was on 27 August. We recognized this NDVI value as seasonal maximum,

209 since this day was in the period of (b). Because of large amount of precipitation in August in 1999,
210 we observed high soil moisture in August 1999 (Figure 3c), and recognized in the period of (b).

211 We added some sentences on L. 176-182 (L. 156-162).

212 (20) L. 191 - 192: "To consider the historical variation in the NDVI of typical forests in our
213 study area, the TF NDVI and observed parameters were compared (Fig. 2 and 3)." --> I would
214 strongly urge you to account for landsat scene availability throughout the season, for instance by
215 adding the date within the season as a covariate or interaction. This would give additional
216 information of the association with other parameters may vary across the season and would
217 account for the possibility that the temporal dynamics of ndvi are influenced more by scene
218 availability than annual dynamics in site conditions.

219 Response: As we already described in the reply to the comment (19), seasonal maximum
220 during the NDVI stable period was determined in each year, and we believe that the NDVI can be
221 compared with ecosystem parameters.

222 (21) L. 197: "TF NDVI did not show any correlation with summer temperature" --> you
223 present correlations of NDVI values at different seasonal timings (june / july / august) to overall
224 JJA temperatures. wouldn't it make more sense to compare the ndvi to mean temperatures of degree
225 days up until the moment of ndvi acquisition?

226 Response: We believe that in the temporal dynamics, the soil moisture and nitrogen
227 availability may be the main environmental factors affecting the NDVI. The summer temperature
228 does affect the NDVI, but in short time periods, e.g., drought events in 2001-2002.

229 (22) L. 218: the header of the next section accidentally ended up in the figure caption here.

230 Response: Thank you very much. The next title was mistakenly added. It was removed on
231 L. 287 (L. 265).

232 (23) L. 275: "In most years before 2007, the NDVI values in RF and DF were higher than
233 those in TF" --> could this be related to topography; i.e. DF and RF are damaged by floods since
234 they occur in depressions and hence suffer less from drought but more from flooding? the role of

235 terrain is hardly touched upon but potentially very important. It might also be helpful to present
236 some indication of terrain variability; what is the magnitude of elevation differences between
237 typical DF and Tf sites, for example?

238 Response: Yes. Before the wet event, soil moisture at RF and DF were higher than TF
239 because of lower elevation. This topographic condition at RF and DF makes lower possibility of
240 drought. We did not observe the altitude in situ, but the difference in elevation between north and
241 south ends by Google Earth Pro was about 5 m. We added the explanation on L. 345-348 (L. 317-
242 320).

243 (24) paragraph 4.1: Please discuss whether waterlogging may have influence ndvi directly,
244 independent from tree properties, due to its influence on near infrared reflectance.

245 Response: Yes. Water shows lower NDVI. We had already described about the possibility
246 of surface water on L. 353-354 (L. 325-326). We also added some explanation on L. 354-355 (L.
247 326-327).

248 (25) L. 312 - 317: I know it is very likely the case, but here you seem to derive causation
249 from the presented correlations. Tone down these causal statements (e.g. "which likely
250 contributed" instead of "which contributed"), or provide more backing for why carbon storage in
251 previous years should be the cause of NDVI dynamics in this period.

252 Response: We changed the expressions, e.g. on L. 388-393 (L. 360-365).

253 (26) L. 327 - 328: "The mechanism by which plant $\delta^{13}\text{C}$ responds to changes in light and
254 water availability has been well explained in previous studies (e.g., Farquhar et al., 1989). " --> I
255 don't doubt it, but it is very difficult to place your findings on isotope ratios in the appropriate
256 context without some minimum amount of explanation of their meaning and key processes driving
257 isotope fractionation in trees. Please add this (or see comments regarding lines 133-136) at some
258 point so the reader can understand the meaning of the presented work on isotope and c/n ratios to
259 some degree without having to refer to cited work.

260 Response: The $\delta^{13}\text{C}$ value of plant tissue (e.g. leaf) is expressed by the following equation:

261
$$\delta^{13}\text{C} = \delta^{13}\text{C}_{\text{atm}} - a - (b-a)(C_i/C_a).$$

262 $\delta^{13}\text{C}_{\text{atm}}$ is $\delta^{13}\text{C}$ of atmospheric CO_2 , a (4.4‰) and b (27‰) are isotope fractionations of
263 diffusion and enzymatic reaction of photosynthesis (Rubisco), and C_i and C_a are inter-cellular and
264 atmospheric CO_2 concentrations. When water availability decreases, stomatal conductance
265 increases, which results in the decrease of CO_2 incoming to the intercellular, and C_i decreases,
266 resulting in C_i/C_a decrease and $\delta^{13}\text{C}$ increase. When water availability increases, $\delta^{13}\text{C}$ decrease.
267 For the light condition, when light condition increases, more CO_2 is photosynthetically reacted,
268 and C_i decreases, then $\delta^{13}\text{C}$ increase. Under low light condition, C_i increases and $\delta^{13}\text{C}$ decrease.

269 We already described what was happening at our site during the drought. The years 2001
270 and 2002 were severe drought period (low precipitation and low soil moisture). Under such
271 condition, it is reasonable to consider that stomatal conductance decreased. This is also
272 demonstrated by $\delta^{13}\text{C}$ values. Larch tree is deciduous, therefore C photosynthesized in the year
273 makes needles in the next year. Carbon fixed during the drought 2001-2002 makes needles in
274 2002-2003.

275 It is not possible to describe the detailed explanations above in our main text, but we add the
276 equation and short explanations in the Methods 2.3 after the explanation for comment (16). Besides
277 the following explanation, we also revised the structure of 4.3.1 Water availability, according to
278 the comment (2), and to avoid misunderstanding (see the reply to the next comment).

279

280 (27) L. 329: "Under drought stress during 2001–2002, there was a decrease in needle
281 stomatal conductance" --> this is another example of a conclusive statement that does not seem to
282 be backed up by data or a reference. Please check the entire discussion for statements like these
283 and either back them up or tone them down ("has likely decreased stomatal conductance, as
284 suggested by $\delta^{13}\text{C}$ values")

285 Response: Referee said this statement does not seem to be backed up by data. But for us,
286 "drought -> reducing stomatal conductance ($\delta^{13}\text{C}$ increase) -> usually decrease in carbon
287 assimilation" are almost 100% sure. We would like to describe that after 2007 "wet condition ->
288 increase in stomatal conductance ($\delta^{13}\text{C}$ decrease) -> usually increase in carbon assimilation but
289 actually decrease in carbon assimilation". We observed low NDVI in wet condition, which is
290 probably caused by lower nitrogen availability. To avoid misunderstanding, we changed the
291 structure of 4.3.1, and added some sentences on 402-434 (L. 374-394).

292

293 (28) L. 354 - 346: "Therefore, the decrease in the TF NDVI in wet years may be due to
294 factors other than the carbon assimilation process" --> here you should probably discuss the direct
295 influence of water on near infrared reflectance and ndvi.

296 Response: As already described in the response to comment (27), we also revised the
297 manuscript. About the effect of surface water, we already described in the response to comment
298 (24).

299 (29) L. 400 - 401: "However, the TF NDVI and RWI were not significantly correlated after
300 2007, whereas there was a significant positive correlation before 2007. " --> please consider
301 alternative explanations. For instance, the use of detrending methods in tree ring width series can
302 remove long-term decreases or increases from the time series, and your RWI likely only reflects
303 year-to-year variation in ring width. In this sense, do you think the RWI series reflect any long-
304 term decreases due to for instance waterlogging events and compromised growth over longer
305 timescales?

306 Response: As describe by the reviewer, RWI reflects more long-term. There are many
307 interesting things on tree growth. For example, dead trees from waterlogging were affected by not
308 only the waterlogging but also drought several years ago (Tei et al., 2019 Ecohydrology). But
309 radial growth of tree is not our aim in our study. Therefore, we cut some sentences on L. 487-491
310 and revised L. 486-487 (L. 445-446).

311

312 (30) L. 432-434: "To better understand changes in the forest, long-term observation of
313 variations in soil N availability depending on soil moisture and other factors is necessary" -->
314 Perhaps we would also need better understanding and forecasting of precipitation extremes or
315 weather extremes in general?

316 Response: Yes, of course. For the studies of ecosystem change, we need the predictions of
317 climate and weather. But these are totally beyond our aim. So, we did not add the explanation.

318 (31) L. 435-452: In general, I think the conclusion presents some statements that rely on
319 interpretation quite a lot, and presents a lot of statements that are merely repetition of the results.
320 I do not disagree with your interpretations (I think they are well found), but it should be clear for
321 the reader which statements are interpretations and which are not (e.g. by adding "which we

322 attribute to .."). Also see my main comment; the conclusion does not go beyond the distinct
323 physiological response observed in this ecosystem and does not discuss implications. To be of
324 value to a wide readership, please try to "zoom out" a bit beyond Spasskaya Pad. Maybe mention
325 and discuss the importance of findings such as the long-term alteration of relationships between
326 moisture availability and tree performance, or provide recommendations for future studies.

327 Response: We revised the conclusions on L. 534-564 (L. 489-506). The obtained results and
328 their interpretations were explained together, and the expressions of the interpretations were
329 changed. The implication of the results was also added.

330

331 (32) Table 1: The added value of this table relative to the clear patterns in fig 2b, are unclear
332 to me. I also find it unclear why only TF and Rf1 are presented. Due to nestedness (transect plots
333 within years within groups), the p-values should be corrected for pseudoreplication. A visual
334 overview might be stronger here and you could consider replacing or omitting this table.

335 Response: We removed the Table 1 from the manuscript and revised sentences on L. 304-
336 305 and L. 400-401 (L. 372-372), which mentioned the Table 1.

337

338 (33) Figures 4 & 5: "p-values and R2 describe the significance and the degree of variability
339 of the regression models, respectively" --> degree of variability is probably not the appropriate
340 term here, I assume this is a coefficient of determination?

341 Response: Yes, this is the coefficient of determination. To avoid misunderstanding, we
342 revised the description on L. 286-287 (L. 264-265) and L. 340-341 (L. 312-313), the caption of
343 Figure S4.

344

345 (34) SI tables S4-S5: How reliable are the p values derived for differences among degraded
346 forest and other forest types, if there were only two transect plots with data for degraded forests?
347 I also find it hard to understand why the others use pairwise tests rather than anova/kruskal-wallis
348 tests with post-hoc tests? Throughout the supporting tables S4-S10, you perform very large
349 amounts of t-test and if you want to use these values to support your findings, you should discuss
350 the role of Type I errors.

351 Response: We changed the statistical test. Please read the response to the comment (18).

352

353

354 **Reviewer #2.**

355 In "Historical variation in normalized difference vegetation index compared with soil
356 moisture at a taiga forest ecosystem in northeastern Siberia" the authors investigated the variation
357 in NDVI among forest conditions (typical mature, TF; regenerating-1, RF-1; regenerating-2, RF-
358 2; and damaged forests, DF) and field-observed parameters (from 1998 to 2019) such as RWI, soil
359 moisture, changes of larch needles ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, C/N), air temperature, and precipitation. The
360 authors determined that prior to the 2007 extreme wet event, wet areas like DF and RF had higher
361 NDVI values than dry TF sites due to greater water availability. However, following 2007, the TF
362 had a greater NDVI than the DF and RF, although being visibly unaffected by the wet event.

363 Studying historical variations in NDVI compared with soil moisture at a taiga forest
364 ecosystem in north-eastern Siberia is important for several reasons. Firstly, NDVI data can provide
365 valuable information about temporal and spatial changes in vegetation distribution, productivity,
366 and dynamics, which allows for the monitoring of habitat degradation and fragmentation. Secondly,
367 the comparison of historical variations in NDVI with soil moisture can provide insights into the
368 impact of extreme weather events on vegetation, such as the extreme wet event in 2007, which
369 resulted in high tree mortality and a decrease in NDVI at affected sites. Understanding the
370 ecological effects of climatic disasters such as drought or fire can be assessed using NDVI data,
371 making it a valuable tool for monitoring changes in vegetation due to climate change. Overall,
372 studying historical variations in NDVI and soil moisture in a taiga forest ecosystem can provide
373 valuable insights into the impact of extreme weather events on vegetation and the effects of climate
374 change on vegetation dynamics. Therefore, this paper has the potential to make an important
375 contribution to the body of knowledge concerning the impacts of global change on sensitive and
376 complex permafrost ecosystems.

377 It is my opinion that the authors used sound methods to address the study aims and presented
378 the research findings clearly and concisely and they used appropriate figures to illustrate the NDVI
379 values of the forest types and the trends in the transect and 10-km plot, which could be useful for
380 researchers and policymakers. However, I agree with referee 1 about their main points raised as
381 well as the minor comments provided. To avoid repetition and in the interest of brevity, I will not

382 be going over them again in this review, but I strongly advise the authors to make the corrections
383 already suggested. Instead, I will just add a few points concerning the discussion section that I
384 would like to see addressed before publication. When the authors revise these issues, I recommend
385 the study for publication in Biogeosciences.

386 In the discussion, the authors considered the probable reasons for the differences in NDVI
387 values among the forest types, such as the change in vegetation and the presence of surface water
388 and saturated soil. However, the section could benefit from a more critical evaluation of the results
389 and their implications. For example, the article does not address the limitations of using NDVI as
390 a proxy for vegetation health and productivity, which could impact the accuracy of the results.
391 NDVI measures the amount of chlorophyll in the uppermost layers of vegetation. This means that
392 it may not accurately represent the health and productivity of plants with lower canopies or those
393 that are hidden from view. The limitations of using NDVI as a proxy for vegetation health and
394 productivity may be particularly relevant in taiga/permafrost ecosystems due to their complex
395 vegetation structure and sensitivity to environmental changes.

396 Additionally, the article does not explore the broader ecological implications of these
397 findings, such as how changes in vegetation health and productivity may impact ecosystem
398 services or the ability of forests to sequester carbon. Finally, while the article notes the potential
399 for using the observational data for analyses of ecosystem changes at the plot and regional scales,
400 it does not explicitly state what these analyses might entail or why they would be valuable. A more
401 explicit discussion of the practical applications of the research could make the findings more
402 accessible to a wider audience.

403 Response: We added the explanations for the limitations of using NDVI on L. 85-91, L. 365-
404 367 (L. 337-339), L. 520-523 (L. 475-478). The NDVI was shown to be affected not only by the
405 overstory vegetation but also the understory vegetation. But our study was mainly focused on the
406 typical larch forest, which was not visibly damaged by the extreme wet event. The typical forest
407 presumably showed higher contribution of the overstory (larches) to the NDVI than damaged
408 forests. The NDVI and larch needle C/N showed a significant correlation, so it is likely that NDVI
409 showed the overstory conditions.

410 We also added some descriptions about explicit discussion of the practical applications in
411 the discussion 4.4 L. 520-532 (L. 475-487). This phenomenon observed at our study site might

412 happen in other dry regions. The implication of our results was also shown in the abstract L. 31-
413 32 (L. 31-32) and conclusions on L. 552-554 (L. 504-506).

414

415

416 Copernicus editorial.

417 (1) I noticed that your Figure 1(a) contains a map.

418 For the next revision, I kindly ask you to clarify whether you have created the maps or were
419 they created by a map provider?

420 If the maps were not created by you, please provide in your revised file that the copyright is
421 denoted in the figure itself. If this is not possible, please provide it in the caption.

422 Response: We added descriptions about the providers of the maps used in Figures 1 (a) and 1 (b)
423 in the caption of Figure 1 on L. 137-138 (L.117-118) and on Figure 1a itself.

424 (2) Before file upload, please consider submitting data sets, model code, or video supplements
425 to reliable repositories, receive DOIs, and cite these assets in your manuscript including entries in
426 the reference list.

427 Response: We added information about the datasets used in our study in the “Data availability”
428 and “References” sections.

429

430 Authors’ revisions.

431 We updated the ring width index (RWI) dataset after adding a greater number of larch tree paired
432 increment core samples. As a result, the results of our study, namely the descriptions of Pearson
433 correlation (r , p -value) and linear regression models (R^2 , p -value) between the TF NDVI and RWI,
434 after the update were not significantly different from those before the update, so there were no
435 changes in their interpretations. The revisions were made in the results section 3.3.2 on L. 289-297
436 (L. 267-275), the discussion section 4.3.3 on L. 473 (L. 433), Figures 3b and 4a, and in the
437 supplemental Figure S4g, Table S2 and S5-S7.