Referee 1

To the Editors and Authors,

This paper evaluates the climate impact of carbon sequestration, surface albedo, and turbulent energy exchange for three forest management scenarios of pine forests in Finland using a climate model. The topic is highly relevant and properly examined.

Unfortunately, the manuscript suffers from poor language with low precision, and the current manuscript appears as a draft missing the clearness and conciseness needed at a final stage before publication. Sadly, this is reducing the dissemination of the content of the study. I recommend that the current version of the manuscript is rejected. However, I strongly recommend that the authors improve and revise major parts of the current manuscript before the new version should be submitted.

The Abstract suffers from a poor language lacking fluency and precision. I recommend that the authors improve the entire abstract. For example, some sentences expressed almost exactly the same, and there were lack of definitions (e.g., for JSBACH_FOM). The Abstract was also quite long. I recommend that the authors make the Abstract shorter and rewrite it to ensure that the content and the findings of the study are presented in a clear way.

Overall, I think the Introduction needs major revision. Generally, the language lacks fluency and precision, and parts of the content are not particularly relevant for the current study. I recommend that the authors work to improve the text and form the content in a way that aligns with the topic of the study (i.e., different climate impacts of forest managements). Particularly, since the authors' study compares climate impact from carbon against biophysical climate forcings, I think they should address the role of carbon in relation to forest management. For the subparagraph about albedo, they must improve connection between albedo and forest management. For example, in this subparagraph they elaborate a lot about "other land cover types" and albedo. I don't find this relevant at all or important for the current topic. Therefore, I recommend removing these parts. I am also missing more information about the role of turbulent fluxes as climate agents in boreal forests and/or for forest management as they have not been properly and sufficiently addressed. For example, are the exchange mechanisms of sensible and latent heat cooling or warming the climate? Why and how? How are these fluxes related to forest management? Moreover, the introduction does not address the concept of climate modelling for forests/forest management at all. This should be properly presented, e.g., by elaborating on forest-climate modelling of energy budgets and forest scenarios.

Whereas the text and the presentation are better in Methods and Discussion (still some textual errors), the Results suffer from too many details, making it difficult to extract the main findings of the study. I recommend that many of the figures are moved to Appendix, and that the surrounding text related to these figures are removed or shortened. Since the topic of the study is climate impacts of forest management, i.e., effects of carbon sequestration, shortwave albedo, and latent and sensible heat, I strongly recommend focusing and highlighting the findings related only to these impacts in the Results.

As I believe major parts of the study must be revised to improve language fluency and precision, there are several specific comments – such as language errors, lack of definitions, incorrect use of punctuations, and unclear wording – that I have not commented on or included in the specific comments following henceforth. Specific comments.

We thank the referee for the general assessment and appreciate the feedback on the ways to improve the quality of this manuscript. We consider the criticism fair, and the authors will carry out the suggested major revisions. The points raised in the general assessment are answered below, and the more specific comments are responded afterwards.

Firstly, regarding poor language, low precision, clearness, and conciseness. We acknowledge the concern raised by the referee on these areas, and the need to improve these areas. For the majorly revised version, we will carry out a thorough analysis of the text with a strong emphasis on language, precision, and clearness, so readers have easier time understanding the contents and the dissemination would be improved.

Secondly, regarding the abstract. We acknowledge that the abstract is lengthy, as well as the fact that the effects of poor language also impact the abstract. The abstract will be made shorter and rewritten for the revised manuscript, and the authors will make sure that all the necessary definitions are found from the abstract.

Thirdly, regarding the introduction. The authors acknowledge the need for major changes based on the referee's comments. We agree that some aspects of the abstract are not that relevant in terms of the study's scope, such as the talk about other land cover types. While it can be important to acknowledge these kinds of details of forests, they are not relevant here as we are only comparing forests with other forests. In the current version, the connection between forest management and albedo is covered insufficiently. The role of turbulent heat fluxes will also be explained better, while also acknowledging here that the emphasis on turbulent heat fluxes in this manuscript will be reduced in the revised version, based on the limitations brought up by the other referee. When it comes to the concept of climate modelling for forests/forest management, we will make it clearer that we did not make simulations with a full earth system model with climate component interacting with the land ecosystems. We only used the climate model outputs as driver data for the land-ecosystem model JSBACH_FOM, which we have used in this study in offline mode, meaning it is not linked to the atmosphere.

Also, regarding the methods and discussion. Despite the referee stating that the text and presentation are better here, we will apply a strong emphasis on clearing the remaining errors. We acknowledge that some elements in the results section are not needed here for understanding the main message of this manuscript, so the revised manuscript will have some elements moved to the appendix.

Finally, regarding the final paragraph of the general assessment. The authors understand the reason why the referee has not commented on the specific parts of the text suffering from language errors, lack of definitions, incorrect punctuations, or unclear wording. The text will go through major revisions, where these specific problems areas will be properly focused on, and the revised manuscript will have a higher standard. Despite the limitations of the submitted manuscript, we thank the referee for making several helpful specific comments on the biggest problem areas, which we provide answers to next.

L2-3: This sentence lacks fluency. Please improve. I suggest "Carbon sequestration plays a central role for climate change mitigation in forest management. However, other climate impacts – such as turbulent fluxes and surface albedo – can significantly alter the climate mitigation of forests".
Response:
We agree with the assessment of that sentence, and the suggestion provided is a good alternative, and will be applied to the revised manuscript.

L5: What is JSBACH_FOM? This is not clear to me. Please explain/define.
Response:
This is the land ecosystem model used in this study, which outputs all the results presented in our manuscript. We acknowledge that it was not clarified explicitly in the abstract, and this will be improved for the revised manuscript.

L7-8: Please rewrite these sentences.
Response:
These sentences will be rewritten for the revised manuscript.

L29: Please define the term albedo.
We will better define it, for example: Betts (2000) showed that the high absorption of solar radiation by forests—resulting from their low albedo (i.e., their relatively low reflectivity of incoming sunlight)—can offset part of the cooling benefit gained from carbon sequestration.

L38-49: There are plenty of relevant studies, e.g.:
- Bright, R. M., et al. (2014). "Climate change implications of shifting forest management strategy in a boreal forest ecosystem of Norway." Glob Chang Biol 20(2): 607-621.
- Kellomäki, S., et al. (2021). "Effects of different management options of Norway spruce on radiative forcing through changes in carbon stocks and albedo." Forestry: An International Journal of Forest Research 94(4): 588-597.
- Kellomäki, S., et al. (2023). "Effects of thinning intensity and rotation length on albedo-and carbon stock-based radiative forcing in boreal Norway spruce stands." Forestry: cpac058.
- Bright, R. M., et al. (2024). "Relevance of surface albedo to forestry policy in high latitude and altitude regions may be overvalued." Environmental Research Letters 19(9): 094023.
- Ramtvedt, E. N., et al. (2026). "Greater increase in surface albedo following clear-cutting than wildfire in pine dominated northern Swedish boreal forests." Agricultural and Forest Meteorology 376: 110924.
Response:
These studies are extremely relevant for the scope of this article, and we will use them as references when we discuss the topic of how forest management can influence the climate impacts of forests.

L39: I believe the same albedo values apply to pine, spruce, and birch forests in Sweden and Norway as well. Consider rephrasing this, so it is shown that this also governs the general forests in Fennoscandia. Are the values reported for summer or winter? Please specify.
Response:
We will use more precise language in the revised manuscript and improve the clarity on what albedo values (summer or winter) we are referring to.

L38+40: I think these two sentences express almost the same. Please rewrite for better fluency and to avoid repetition.
Response:
These two sentences will be rewritten for the revised manuscript to improve fluency and to avoid repetition.

L41: "tree species" should be change to "tree species composition" for better precision of Language.
Response:

We agree, and “tree species” will be changed to “tree species composition” for the revised manuscript.

L43-44: Please review this sentence. How does the snow “accumulates” unevenly? Do you mean vertically or horizontally? Please specify. I don’t think “perfectly” is the correct adverb here. Please improve the precision and be careful of what you mean.
Response:
We will explain this in more detail. Our goal is to explain how snow generally does not fully cover the canopy, if the canopy is viewed at an angle instead of directly from above, due to layered structure of the branches. Solar angles during winter are such that dark parts of canopy are exposed and absorb radiation. Branches and needles are also poor at keeping the snow cover stable, as wind and changes in temperature can cause the snow to fall from canopy with relative ease.

L45-47: Are you sure that only the effect of decreasing snow cover is causing this? This is a bit vague. I think this is more complex. What about seasonal snow cover duration for Example?
Response:
Our aim here was to also refer to the seasonal snow cover duration but referring to this as “snow cover decrease” was a poor way of conveying this message. For the revised manuscript, we will expand this and emphasize the true meaning.

L47: Can this (“which will potentially reduce the differences in winter albedo between forests and other land cover types”) be documented by a reference? I find this a bit speculative. Moreover, do you know the without-snow winter albedo of these other land cover types?
Response:
We acknowledge that a reference would be beneficial here, and it is speculative. Especially now, since there are no values stated explicitly. We will rewrite this part for the revised manuscript to avoid the speculative tone, and also reduce the focus on these “other land cover types” and focus more on the albedo differences between dense and not so dense forest.

L58: What species of Finnish pine forests. Please be precise and add species name.
Response:
The species name will be specified in the revised manuscript. The station is located in a rather homogenous Scots pine (Pinus sylvestris L.) stand.

L73: What is MPI ESM?
Response:
It refers to the Max Planck Institute's Earth System Model. This issue of no definition will be corrected for the revised manuscript.

L90-97: I don’t understand this. What is your definition of albedo? I thought it was shortwave solar radiation? But you don’t define it. Spectral wavelengths are missing. Why is VIS and NIR albedo calculated? I think the heading for this subsection is misleading because the subsection does not address radiation balance at all, only albedo.
Response:
This part of the manuscript has been poorly written. Here, we somewhat confuse i) what we are interested in, and ii) how the land-ecosystem model calculates these parameters. Internally, the model calculates absorbed and reflected radiation separately for visible and near infrared radiation, which is the reason why the manuscript took the route of displaying them separately, and they are explained here somewhat confusingly. For the revised manuscript, section 2.1.2 will be rewritten with better clarity.

L133: Why do you include data from all these climate models? This is never motivated, so the readers are left wondering why.
Response:
We include the data from these three climate models to display that the authors acknowledge the uncertainties of modeling future climate, and that there are differences between the different climate models. We will put stronger emphasis on the word selection here, to better convey this message to the readers.

Fig. 2, 3, and 4: ***Consider changing the numbers on the x-axis to e.g., every 20 year*** *(instead of every 5 year as currently presented) for better readability. Also consider to place these figures next to each other for easier comparison.*
Response:
Both of these suggestions considering figures 2, 3 and 4 are valuable, and they will be implemented in the revised manuscript. These changes will greatly improve the readability of these harvest scenario figures.

L272: Figure A1 and A2 should not only be mentioned, but it should properly be described what the trends in woody carbon pool ++ show.
Response:
We will discuss figures A1 and A2 with greater detail in the revised manuscript.

Fig. 6: I don't think changes in LAI are that interesting or relevant for the aim of this study. I recommend moving this figure and related text to the Appendix.
Response:
While LAI does provide additional information about the growth stage and differences between the forest management scenarios, we do agree that it is not mandatory to have it in the results section, as it is not considered a major result and fits better under supporting information. This change will be made for the revised manuscript.

L280: Section 3.2.1: I am not sure it is a good idea to present the albedo separately for VIS and NIR. In the context of climate impact, we are interested in the broadband integrated albedo (i.e., SW = NIR+VIS). I think the current presentation with NIR and VIS albedo can be confusing for the broader group of readers (without expertise in radiation), at least when the terms are not defined and clearly presented. I recommend changing this part.
Response:
We agree with this assessment and the different albedo bands will be combined for the revised manuscript. Our model, JSBACH, outputs albedo separately for VIS and NIR albedo, which drove our decision to include both, even though we also included the broadband albedo. Using both VIS and NIR albedo increases complexity for little gain.