

Responses to referees comments, anonymous Referee, RC1

Below, we address the different comments given by Anonymous Referee RC1. We provide our responses to the comments, describe the overall actions that we suggest as a response to the referee's comments and finally in detail describe the text that we suggest to be removed or revised to a new, revised version of the manuscript.

The line numbers that we use in this document refer to the line numbers in the original pdf-file of the submitted manuscript as used by the referees.

RC1 general comments

"The manuscript is well written and appears to be scientifically sound. Some of the explanations can be improved, and suggestions are given below."

"In my opinion, possibly the most important sentence in the paper is on Line 469 in 4.1, stating that the exceedance maps derived using the methods in this paper are very different from those used by the EU, based on AOT40. This is worth repeating at the beginning and end of the paper."

"Figures 5 and 8 and Table 2 could be moved to the Supplementary Information (SI) to consolidate the manuscript for improved readability."

Authors responses.

We thank referee 1 for this positive overall judgement.

Also in the opinion of the authors, the result on the difference in the maps for exceedance based on POD and AOT40 is important. However, equally important is the result the ozone impacts on European forest carbon sequestration will be much larger when calculated based on the impacts on the gaps between gross growth and total removals, compared to when based only on the impacts on gross growth. In many modelling studies, the impact on gross growth is used, which results in an underestimation of ozone impacts on forest carbon sequestration.

We have been intending to stress both these two important results in the article.

Action taken

No action.

The referee suggests to move Figures 5 and 8 and Table 2 to the SI.

Figure 5 concerns an important improvement made in the current article, by transferring dose-response relationships based on impacts on the percent annual biomass loss used in the Mapping Manual to dose-response relationships for the estimated impacts on gross annual increment. Even though the dose-response did not change very much, this represents an important methodology improvement, since impacts on percent annual biomass loss can not be used in combination with forest statistics, which need information about impacts on gross annual increment rates.

We suggest that Figure 5 remains in the main text.

Figure 8 concerns changes in the annual C sequestration in the living biomass C stocks, with and without the exposure to present O₃ doses. We consider this as an important figure, since it can be used as information for the individual European countries.

We suggest that Figure 8 remains in the main text.

Table 2 concerns the percent reductions in gross annual increment rates, caused by the present O₃ exposure, used for the different European countries. This is important information in order to understand the size of the O₃ impacts on the annual C sequestration for the different countries (Figure 8).

We suggest that Table 2 remains in the main text.

RC1 specific points

Line: 170

Referees comment.

That is not what is in LRTAP Ch. 3. Either explain the modifications applied to the LRTAP formulation or provide a more current reference.

Authors response.

Yes, the referee is correct.

This is what is in the Mapping Manual:

$$(III.1) \ g_{sto} = g_{max} * [\min(f_{phen}, f_{O3})] * f_{light} * \max\{f_{min}, (f_{temp} * f_{VPD} * f_{PAW})\}$$

And this is what is used in the current article:

$$g_{sto} = g_{max} \cdot f_{phen} \cdot f_{light} \cdot \max\{f_{min}, (f_{temp} \cdot f_{VPD} \cdot f_{PAW})\}$$

What is in the Mapping Manual is the more general equation that can be used for all different types of vegetation. The f_{O3} is used only for agricultural crops, so it was not

included here. Furthermore, we replaced the f_{SW} with f_{PAW} . The latter is interpreted as f “Plant Available Water” and is essentially the same as f_{SW} (“Soil Water”).

Action taken.

We added text to clarify this in the sentence starting on line 166.

Line: 202

Referees comment.

1 nmol seems a bit arbitrary, particularly if it is applied to all species. Perhaps discuss in 1 or 2 sentences how this number has been justified previously, and whether adjusting it up or down makes much of a difference.

Authors response.

A main strategy for this article was to apply the methods for calculating POD1SPEC that have been agreed in the LRTAP convention ICP Vegetation Mapping Manual for different tree species across Europe and then explore the consequences of the estimated PODySPEC, in combination with the dose – response relationships also accepted in the Mapping Manual, for the carbon sequestration by European forests. In that context, we did not want to modify the methods from the Mapping Manual.

However, the comment by the reviewer is interesting and in fact, one of the authors (PEK) has explored the consequences for using alternative values for the threshold value for possible ozone impacts on forests in Sweden. It turned out that the choice of threshold value had relatively small influence.

Reference: Karlsson, P.E., Danielsson, H., Pleijel, H., Andersson, C. 2024. Exceedance of critical levels for ozone impacts on Swedish forests - Evaluation of methodology for POD1SPEC calculations. IVL Report C 829.

However, as the aim of this study was to apply, rather than discuss the methods used in the Mapping Manual to calculate POD1SPEC we have not included further discussion of this issue but have clarified that the use of POD1SPEC is consistent with the metric recommended by the UNECE Mapping Manual (LRTAP, 2017) on line 140.

Action taken.

We added some text to clarify this.

Line: 326

Referees comment.

Verify whether you mean 3a, e and f (and not a, c and f). Define AOT40.

Authors response.

The following relevant panels are included in Figure 3:

3a, POD1SPEC for coniferous species

3c, POD1SPEC for broadleaf species

3e, AOT40, Norway Spruce

3f, AOT40, Beech

So, in fact all these four panels are relevant when comparing the geographical distribution of the estimated values for POD1SPEC and AOT40, respectively.

So, thank you to the referee for spotting this error.

Action taken.

The text was revised.

Text added or removed

New text: Fig. 3a, c, e and f

Line: 398, Fig. 6.

Referees comment.

This figure could be improved significantly with some additional labels. I recommend putting the numbers right next to the bars (933, 954, 571, 363, and the difference of 80 between the first two) to facilitate making links to the text. I would also label the two arrows (e.g. a, b), which would let you be specific in the text to explain that $a = 80 = 9\%$, $b = 283$, and $a/b = 28\%$.

Authors response.

We agree that the suggestions made by the referee might facilitate understanding the results presented in the figure 6. However, in general journals recommend that diagrams should not contain too many symbols within the frames of the diagrams. The authors could however not find a recommendation of this with the Authors instructions of Biogeosciences. Furthermore, we face the risk that the diagram could be confusing if there are too many symbols inside the diagram frame. And, as the referee also states, all these values are available in the main text.

Action taken.

We will consult the editor about advice on this matter. If the editor agrees, we will change the Figure 6 according to the suggestions made by the referee.

Line: 405

Referees comment.

This paragraph is somewhat confusing. Add a sentence (or replace L407-409) stating that the difference between SVSC due to harvest & natural removal is 283 with O₃, but 363 without, which is 28% higher. Change L408 to “This is a decrease by 28% in the presence of (industrial) O₃.”

Authors response.

The authors have worked very hard with this paragraph in order to make it as clear and logical as possible. First, we state the annual increase gross stem volume increment in the presence of O₃ and then in the absence of O₃ and finally the difference between these values in percent (+9 %). After that we state the annual increase in the forest standing stocks in the presence of O₃ and then in the absence of O₃ and we then state the difference between these value (+28 %). We then conclude with summarizing the difference between the % increases caused by the absence of O₃, +9 % in the case of annual increase gross stem volume increment and +28 % in the case of the annual increase in the forest standing stocks.

We appreciate the suggestion by referee 1, but as we were quite satisfied with the original text, we would suggest not to change the original text.

Action taken.

No action

Line: 418

Referees comment.

The absolute difference

Authors response.

Agree.

Action taken.

Text corrected

Text added or removed

The word “absolute” was added in line 418

Line: 419

Referees comment.

a much larger relative impact

Authors response.

Agree

Action taken.

Text corrected

Text added or removed

The word “relative” was added in line 418

Line: 468

Referees comment.

dry areas in the Mediterranean; I think Iberia would be more precise

Authors response.

Agree

Action taken.

Text changed

Text added or removed

“Mediterranean” was changes to “the Iberian peninsula”

Line: 616

Referees comment.

This actually reads like a Summary, not a Conclusion

Authors response.

We do not quite agree with the referee, we regard this as the main conclusion from the work presented in the article.

Action taken.

No action

Line: 628

Referees comment.

as stated, this is incorrect – be precise: would increase sequestration to living biomass (i.e. a rate of change, not an absolute change)

Authors response.

Agree.

Action taken.

Text corrected

Text added or removed

From “The absence of ozone exposure would increase European forest stem volume growth rates by 9%, but it would increase European forest living biomass C stocks by 31%.”

To “The absence of ozone exposure would increase European forest stem volume growth rates by 9%, but it would increase European forest living biomass C stocks increment rates by 31%.”

RC1, Technical Comments:

Line: 30

Referees comment.

superfluous “and”

Authors response.

Corrected

Line: 87

Referees comment.

is often

Authors response.

Corrected

Line: 170

Referees comment.

(Eq [2]): missing)

Authors response.

We do not understand this comment, equation is already labelled [2]

Action taken.

No action

Line: 254

Referees comment.

Fig. 2: label ANL on the figure

Authors response.

OK, includes also ATF.

Action taken.

ANL as well as ATF was added to Figure 2.

Line: Fig. 3:

Referees comment.

to make this figure more readable: 1. Add labels to each panel (e.g. (a) accumulated conifers, (b) range (conifers), and 2. In (e) and (f), round the numbers on the color scale to nice integers

Authors response.

OK, figure 3 will be modified according to the referee's suggestions.

Line: 333

Referees comment.

change “from the” to “since “

Authors response.

OK

Text added or removed

changed “from” to “since “

Line: Fig. 6.

Referees comment.

“ob” should be spelled out in the caption. Superfluous “-” after natural

Authors response.

OK

Action taken.

“ob” should be spelled out in the caption, “-” removed in the figure

Line: Fig. 8.

Referees comment.

No reason for the y-axis in b) to go to 40; go to 20 to improve resolution

Authors response.

We have to make some space for the legend, but we suggest the y-axis to go to 30

Action taken.

Figure 8b modified

Line: 484

Referees comment.

overestimated

Authors response.

OK

Action taken.

Corrected

Line: 486

Referees comment.

at

Authors response.

Corrected

Line: 504

Referees comment.

superfluous); define rv

Authors response.

OK

Action taken.

“)” removed, text added to define “rv”