

Responses to referees comments,

Anonymous Referee #2

Below, we address the different comments given by Anonymous Referee #2. We provide our responses to the comments, describe the overall actions that we suggest as a response to the referees 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.

Referee #2 general comments

“Karlsson and others estimate annual ozone uptake by European forests. This is important work and I feel that the manuscript is meritorious but could be further improved in key areas.”

Authors response.

We thank referee 2 for this positive overall judgement.

Referees comment.

The abstract wanders a bit and I’m not entirely sure what statements like ‘limited to the north by mid-Sweden and south Norway and Finland’ mean in practice.

Authors response.

With this sentence we are trying to describe the results presented in the maps of Figure 3a and c. It is difficult to describe the geographical pattern of the highest POD in just a few words. This was the best that we could describe the results in this respect.

Action taken.

The text in the abstract has been modified to remove over wordy sentences improving clarity of the text.

Referees comment.

I don’t have too many critiques of the results and workflow because I feel that it is state of the art (and the authors know how models can be improved) and other suggestions would likely be arbitrary and not meaningfully impact final results.

Authors response.

Thank you.

Referee 2 specific points:

Line: 29

Referees comment.

‘as well as for and the’. Note minor usage errors like this throughout the manuscript

Authors response.

Thank you for spotting this error!

Action taken.

Corrected

Text added or removed

Text corrected on line 29 (and in other parts of the manuscript)

Line: 56 and 59

Referee’s comment.

56: ‘4.000 Mt CO₂e’ has a remarkably precise number of significant digits. See also Line 59.
‘560 M t CO₂e’ is more believable.

Authors response.

This was not intended as a precise number, this was an error, the point was used as “separator” to represent “four thousand.”

Action taken.

Corected

Text added or removed

Changed to “4 000”

Line: 63

Referees comment.

Please note that ‘C sequestration of managed forests to a large extent depends on the balance between forest growth and removals’ refers only to the site scale because the full

carbon accounting will depend on the ultimate use of the wood in relatively long-lived stocks or short-lived ones like bioenergy

Authors response.

We agree with the referee. However, this study was limited to living biomass carbon stock changes in the forest ecosystems. The methods for carbon accounting calculations the carbon in long lived harvested wood products are still debated. Even more uncertain are calculations of substitution effects. We mention this in the discussion section.

Action taken.

Clarified.

Text added or removed

Text modified: "The sentence starting on line 62 was changed to: "In general, forests that are actively managed sequester C in the forest ecosystem carbon stocks at higher rates than non-managed forests (Nabuurs et al., 2008)."

Line: 68

Referees comment.

'that has been found to cause substantial losses to' -> 'causes losses' because the word substantial is subjective and there is causality in this case.

Authors response.

OK, we agree.

Action taken.

Corrected

Text added or removed

The word "substantial" was removed.

Line: 121

Referees comment.

This is incorrect. The atmospheric surface layer i.e. planetary boundary layer during most daytime conditions will be on the order of hundreds of meters to kilometers

Authors response.

The surface layer (SL, also known as the constant flux layer) and planetary boundary layer (PBL) are quite different entities, and we think we have used the term surface layer in its normal meteorological meaning. For example, the American Meteorological Society (https://glossary.ametsoc.org/wiki/Surface_boundary_layer) defines the SL as follows: A layer of air of order tens of meters thick adjacent to the ground where mechanical (shear) generation of turbulence exceeds buoyant generation or consumption. In this layer Monin–Obukhov similarity theory can be used to describe the logarithmic wind profile. The friction velocity u^* is nearly constant with height in the surface layer. The exact height of the SL is difficult to define, but is typically thought to be about 4–10% of the PBL height (Stull, 1988, Pielke, 2002).

Pielke, R. A., Avissar, R., Raupach, M., Dolman, A. J., Zeng, X. B., and Denning, A. S.: Interactions between the atmosphere and terrestrial ecosystems: influence on weather and climate, *Global Change Biology*, 4, 461–475, 1998.

Stull, R. B.: *An introduction to Atmospheric Boundary Layer Meteorology*, Kluwer Academic Publishers, Dordrecht, 1988.

Action taken.

We have clarified L121 with a few extra words

Text added or removed

from: assumed to be the top of the atmospheric surface layer

to: assumed to be the top of the atmospheric surface, or constant flux, layer. cf Stull, 1988:

Line: 252

Referees comment.

I feel that fig. 2 can be smaller / more efficient (unnecessary white space and italicization)

Authors response.

OK, we changed figure 2, making it smaller and removing italicization

Action taken.

We changed figure 2, making it smaller and removing italicization

Text added or removed

Figure 2 was revised according to the suggestions made by the referee.

Line: 279

Referees comment.

Please don't use the * symbol in place of multiplication in formal equations. Also, this equation should be labeled.

Authors response.

OK

Action taken.

Corrected.

Text added or removed

Changed to the symbol “.”. Equation was labeled.

Line: 296, Fig. 3

Referees comment.

Not sure if a map like this will pass colorblindness criteria

Authors response.

The map was checked versus colorblindness criteria

Action taken.

Figure 3 will be checked against colorblindness criteria and modified accordingly.

Line: 314

Referees comment.

Still not sure what 'limited to the north' means because there is a gradient and forests begin to dwindle of course once one gets too far north

Authors response.

In figure 3a and c, mean values for PODySPEC are represented in maps over Europe. Starting line 314 we try to in words describe the geographical distribution of high values of POD over Europe. We think that this description should not be too detailed, since the reader can see the maps by themselves, but we try to describe this large scale pattern for the high values. In that context, the authors think that there is a relatively clear limitation of high values of POD towards northern latitudes, “limited to the north by mid-Sweden and south

Norway and Finland". We do not think that we can clarify this further, without adding quite a lot of additional text. Again, the reader can see the distribution by themselves.

Action taken.

No action.

Line: 314, figure 3.

Referees comment.

The small font and poor quality of text in the colorbars needs to be improved for visibility (applies to a few figures)

Authors response.

OK.

Action taken.

The maps in the figures were corrected with respect to small font and poor quality of text in the colorbars.

Text added or removed

Revised maps added, also other maps were revised regarding small font and colorbars..

Line: 396, Fig. 6

Referees comment.

Fig. 6 would benefit from uncertainty bars

Authors response.

Figure 6 shows the rates of total, annual gross stem volume increment growth for forests in Europe as mean annual values for the time period 2008-2012. We assume that the referee suggest that we add uncertainty bars representing the variability between the five different years 2008 – 2012. Unfortunately this is not possible since forest statistics are only provided as the mean values for the five year period. In fact, this is generally the tradition for forestry statistics, to be provided as running 5-year mean values.

Action taken.

No action

Line: 410

Referees comment.

It would be good to point out here and elsewhere that these are the results that follow from the assumptions of the models

Authors response.

OK.

Action taken.

We tried to clarify this by adding text.

Text added or removed

Text added to Line 410 to replace the word "This": "The results from this study, with modelling of negative ozone impacts on forest growth in combination with the application of forest statistics,"