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Discussions

Interactive comment on "No tropospheric ozone impact on the carbon uptake by a Belgian pine forest" *by* L. Verryckt et al.

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Dear referee

We thank you for your constructive criticism, and the time invested in the analysis of this manuscript. Our responses and explanations related to your comments are listed below.

The referee's comment: 1. The basis of the authors' reasoning is that the effects of ozone on the functioning of trees are fleeting, and last only a few days. It is unfortunate that the authors do not give references confirming this statement, because I think that it is not obvious. The literature suggests that the effects of ozone may extend over the long term, particularly by activation of defense gene or induction of senescence, especially when ozone levels are relatively high. It seems to be the case in this study,

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since the authors indicate that the usual critical levels (AOT40 and PODy) are exceeded each year. Therefore, if the trees have already experienced "high ozone fluxes days" before the days of "low ozone fluxes" selected for calibrating the model, it becomes difficult to argue that the behavior of the trees in "low ozone fluxes days" is the same as if they had never been exposed to the pollutant. On the contrary, it makes sense that there is little difference between the two situations. I wish that the authors give more convincing arguments on this point, and justify the assumption that the trees behave in the "low ozone flux" days in the same way as if they had never been exposed to ozone.

The authors' response: The reasoning behind our analysis is indeed that O3 effects on gross C uptake only last on the short term. (We assume that they occur through e.g. damage to the photosynthetic apparatus after O3 uptake peaks, when the detoxification capacity of the tree is exceeded, and that this damage is repaired after the peak, when O3 loads have fallen back to low levels.) Nevertheless, we agree with you that a carry-over effect cannot be ruled out and that we need to somehow demonstrate that the trees exposed to low O3 fluxes late in the growing season behave in the same way as when exposed to similar low O3 fluxes early in the growing season. To demonstrate this, we compiled a dataset that contained per growing season only the days after the first major O3 flux peak in the growing season. From these days, we further selected only the ones with low O3 fluxes (we excluded the O3 flux peaks) and no short-term effect expected (we excluded also the first six days after the O3 flux peaks). We trained the GPP model with these data and then predicted GPP for the days occurring before the first major O3 peak in each growing season. If a carry-over effect would be present, it would be somehow included in the trained model. This would then underestimate GPP for the days before each first major O3 peak, where a carry-over effect is assumed not yet to have occurred. We evaluated and compared the linear regressions of measured versus modelled GPP (GPPmea and GPPmod) of both datasets (Figure 1). For both regressions, intercept and slope were not significantly different from 0 and 1 respectively (training: pslope = 1, pintercept = 1, testing: pslope = 0.83, pintercept = 0.44). The slopes were also not significantly different from each other (p = 0.86) and neither were the intercepts (p = 0.53). From these results, we infer the model did not underestimated GPP for the days before each first major O3 peak in the season. Based on this analysis, we conclude that carry-over effects of O3 were unlikely to have occurred, since not detectable with this approach at a statistically significant level, and that our assumption on the absence of (detectable) carry-over effects is valid. We will add this information to the revised manuscript.

Note: Testing for a carry-over effect by training the model with the days before each first major O3 flux peak and then evaluating GPP predictions for low O3 days after each first major O3 peak was not possible, because there were too few data for good model training.

An additional note: Exceedance of the critical levels for AOT40 and POD1 does not necessarily imply long term O3 damage in the Scots pine forest in our study. These critical levels are determined based on experiments on seedlings (Karlsson et al., 2004) and the critical level of POD1 for Scots pine was adopted from the critical level for Norway spruce since no data on Scots pine is available (Mills 2011). The critical levels are, in general, based on the best available knowledge, so they are not definitive or absolute (Skärby et al., 1998).

The referee's comment: 3. The question of the validity of the use of a model calibrated for low-radiation conditions to calculate fluxes in high radiation conditions should also be more justified.

The authors' response: Here, we would like to refer to our response letter to referee #1, who raised the same comment. We show with histograms that the parameterisation dataset includes equally well days with high radiation (Rg) and days with low Rg. Moreover, the Rg range of the parameterization set fully contains the Rg range in the high O3 uptake data. We are confident that (1) our model does not include a bias due to underrepresentation of days with high Rg in the dataset used for calibration and (2) that this dataset and the high O3 update dataset overlay sufficiently in the multi-parameter space, including Rg. Therefore our GPP model is not only calibrated for low radiation conditions, and as the other histograms included in the response letter demonstrate, neither for only low temperature or VPD. We will add this information to the revised manuscript.

The referee's comment: 4. I have still some remarks, which are just details:

- The 0.61 conversion factor between the conductance values for water and ozone is questionable, many authors use 0.663 instead (see eg Grünhage et al, 2013). However, this did not have much impact on the results presented.

The authors' response: The value we used in this paper is based on the Graham's law of diffusion (Mason and Kronstadt 1967). We agree that sometimes a slightly higher conversion factor is applied. But as you suggest, using a value of 0.663 instead of 0.61 will not have a significant impact on our results. Therefore we decide not to change this value in our analyses.

- The specificity of this cover (sparse canopy), and the validity of fluxes measurements on these types of vegetation could be discussed further.

The authors' response: We do not fully understand what the referee is pointing to with this comment. We do not think additional information about the specificity of the cover and the validity of fluxes measurements on pine forests will be relevant to this manuscript.

- Many cited references are quite old (half are over 10 years). Are there not more recent references?

The authors' response: We will take this into account when revising the manuscript. Where deemed useful, we will add more recent references or replace older with more recent references.

Caption of Fig. 1: GPPmea as function of GPPmod for two datasets: (a) only the days before the first major O3 peak in every year, (b) the training dataset with the days after the first major O3 peak in every year, excluding those with high O3 fluxes + six following days. The black line is the 1:1 line. The blue line is the regression fit including 95% confidence intervals (in grey).

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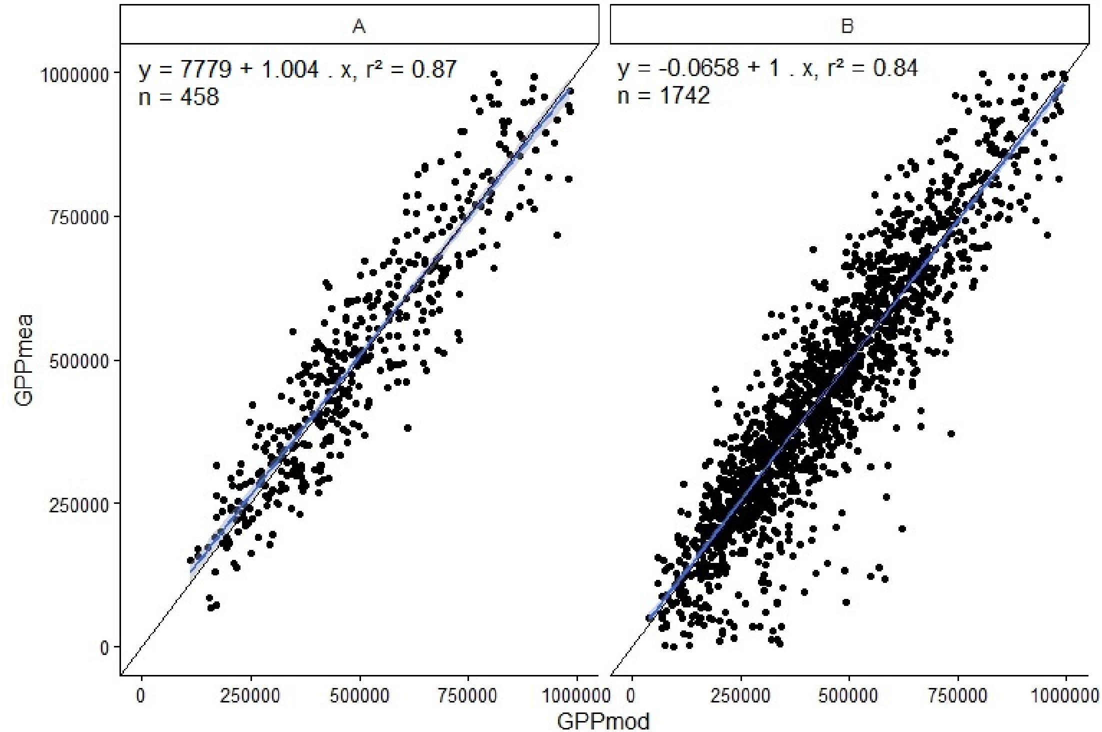

Fig. 1. GPPmea as function of GPPmod for two datasets: (a) only the days before the first major O3 peak in every year, (b) the training dataset with the days after the first major O3 peak in every year.

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