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Interactive comment on “Carbon flux to woody tissues in a beech/spruce forest during summer and in response to chronic elevated O₃ exposure” by W. Ritter et al.

W. Ritter et al.

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Author reply to comments of Reviewer #1

We thank Professor Howard S. Neufeld (Reviewer #1) for his constructive review that helped to improve our paper and present our findings more clearly. We considered the individual comments as follows (please find the revised version of our ms as a supplement):

Reviewer #1: Given the current discussion in the literature about technical limitations for determining the fate of recently assimilated carbon, I might ask if the conclusions expressed by Mencuccini and Hölttä regarding the suitability of pulse labeling for studying

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soil respiration are of any concern here? Certainly the conclusions reached by Ritter et al. in this paper concerning CO₂ efflux from trees and the fraction of newly assimilated ¹³C in respired CO₂ are bolstered by the detailed and thorough description of the ISOFACE system provided in Grams et al. (2011) as well as the discussion of the potential sources of error in this paper, and the data are consistent with that reported in other papers coming from this research group (i.e. Kuptz et al. 2011a, 2011b, Nikolova et al. 2009).

Author reply: Mencuccini and Hölttä (2010) call the suitability of isotopic approaches into question for relating sudden changes in canopy photosynthesis of (particularly tall) trees to the substrate availability and thus rate of soil respiration. In general, we agree with the referee that this criticism could be extended to the link between canopy photosynthesis and stem and coarse root CO₂ efflux. The authors distinguish between the transfer time of individual isotopically labeled molecules and the faster propagation time of waves of turgor and osmotic pressure (i.e. sucrose concentration wave propagation time). However, they clearly pointed out that labeling studies are well suitable to track individually labeled molecules and to study mean residence time or half-life of C in systems such as tall trees. This is exactly what we were aiming at in our manuscript as our isotopic labeling focused on the carbon turn-over and translocation of recent photosynthates (i.e. isotopically labeled sugar molecules) at various positions along the canopy-stem-root-soil continuum during summer and in response to 2xO₃. This is why we talk about “the flux of recent photosynthates” and “labeled C” throughout the manuscript. Therefore, we do not see our manuscript to be affected by the criticisms of Mencuccini and Hölttä (2010). Nevertheless, we adjusted the conclusive section of our manuscript to stress once more the fact that our approach is focused on tracking of labeled sugar molecules and should not be confused with the faster propagation of phloem pressure-concentration waves.

Reviewer #1: In the methods section of previous papers from this group, where repeated measures analyses of variance were used, those authors made mention of

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that fact, but it is omitted here. I would suggest that a sentence or two be inserted in the Statistical Methods section (2.11) regarding these analyses (see Figures 2 and 3). Also, according to Table 3, paired t-tests were used to detect differences among stem positions and coarse roots. However, it is not clear what was paired. Was upper stem compared to coarse roots, and then also to lower stem? Such comparisons run the risk of elevating the experimental wide error rate. Of course, the differences are so large that this will not change the conclusions, but I thought the authors might justify their statistical approach here perhaps. A similar mention of paired t-tests in Figure 4 leaves the reader confused as to which two items are being compared, so maybe the authors could clear that up.

Author reply: As suggested by the reviewer we now mention where repeated measure analyses of variance were used. Please note the corresponding improvements in section 2.11 Statistical Analyses. We are sorry about the apparent confusion on the use of the t-test and improved the clarity in this point: In Table 3, the CO₂ efflux from the lower stem was compared to the upper stem and then to the coarse roots. In woody plants, CO₂ efflux is known to vary between different stem heights/positions (Bowman et al., 2005; Hölttä and Kolari, 2009). For each species, we wanted to show whether the CO₂ efflux differs between the stem tissue at the crown base and at breast height. Due to its proximity, CO₂ efflux assessed from the lower stem position was compared to coarse-root CO₂ efflux. In Figure 4, the t-test for paired comparisons was used to detect differences in delta¹³C shift between O₃ regimes within gaseous samples regarding CO₂ and solid samples of labeled beech and spruce trees. Please note our corresponding amendments in the legends of Table 3 and Figure 4.

Reviewer #1: There is no mention made of the potential impacts (or lack thereof) on photosynthesis from elevating the CO₂ concentration during the stable isotope labeling period. The elevation amounts to almost a 30% increase in concentration over ambient levels prior to labeling, which should certainly affect instantaneous rates, even if briefly. The authors do note that stomatal conductance was most likely not affected, and that

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Ci to Ca ratios were altered only slightly, but rates of net photosynthesis must have increased somewhat. Perhaps a sentence or two regarding this could be made in the Discussion section. High CO₂ can ameliorate O₃ effects in some species, so would the conclusions drawn from this study be affected if the actual O₃ effect was slightly attenuated during the labeling period?

Author reply: The referee is correct that we may expect some increases of the CO₂-uptake rate during the labelling period as CO₂ concentrations were increased in the photosynthetically most active sun crowns by 18 and 27 % (i.e. 71 and 103 $\mu\text{l L}^{-1}$) in spruce and beech, respectively. The methodological aspects of the isoFACE labelling infrastructure are dealt with in great detail in Grams et al. (2011). Therefore, we decided to be brief on these aspects in this present ms but nevertheless now mention the potential increase in CO₂ uptake rate in the M&M section. The observed O₃ effects are likely to result from long-term exposure (7 years) to 2x O₃. Such long-term effects are unlikely to be counteracted by short-term increases of CO₂-concentration. In addition, and most importantly, in most cases amelioration of O₃ effects by elevated CO₂ concentrations are typically observed at much higher CO₂ concentrations and are related to reductions in stomatal conductance (for e.g. beech see Grams et al. 1999). Since stomatal aperture was not affected during the operation of the isoFACE infrastructure (Grams et al. 2011), amelioration effects are unlikely. This aspect has now been added to the discussion of the revised paper.

Reviewer #1: One item that has not been addressed is the fact that the high O₃ treatment was 2x ambient, which is fairly high relative to current O₃ levels. Perhaps some statement could be made about the relevance of the treatment effects found at 2x ambient, given the known current and projected ambient O₃ conditions for that region.

Author reply: C allocation was assessed in response to long-term, 7-year long exposure of adult beech and spruce trees to a twice-ambient O₃ (2x O₃) treatment. During the exposure to 2x O₃ maximum concentrations were restricted to < 150 nL L⁻¹ to prevent risk of acute O₃ injury (cf. Matyssek and Sandermann, 2003). This exposure

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strategy resulted in a chronically enhanced O₃ regime simulating the widely observed trend of currently increasing O₃ background concentrations within a range, in which O₃ levels that sporadically occur at the site were provided at higher frequency (Fowler et al. 2008; Sitch et al. 2007; Vingarzan 2004). In this way, the experimentally enhanced 2x O₃ regime was realistic in view of projected scenarios as also applying to Central Europe. This argumentation has now been added to the M&M section of the revised version of the ms.

Reviewer #1: Finally, I think the paper would benefit from some brief speculation on why beech and spruce differ in their carbon allocation responses after O₃ exposure, perhaps by using the model proposed by Kuptz et al. (2011a) in their paper on seasonal respiratory carbon allocation patterns in these trees.

Author reply: As suggested by the reviewer we added a brief speculation on the differences in O₃ sensitivity of beech and spruce to the Discussion section.

Reviewer #1: I have made a few minor suggestions to correct or improve the English and they are given after the references cited below.

Author reply: All suggestions have been incorporated accordingly. Please see our improvements in the revised paper.

References

Bowman, W. P., Barbour, M. M., Turnbull, M. H., Tissue, D. T., Whitehead, D., and Griffin, K. L.: Sap flow rates and sapwood density are critical factors in within- and between tree variation in CO₂ efflux from stems of mature *Dacrydium cupressinum* trees, *New Phytol.*, 167, 815–828, 2005.

Fowler D., Amann M., Anderson R., Ashmore M., Cox P., Depledge M., Derwent D., Grennfelt P., Hewitt N., Hov O., Jenkin M., Kelly F., Liss P., Pilling M., Pyle J., Slingo J., Stefenson D.: Ground-level ozone in the 21st century: future trends, impacts and policy implications, *The Royal Society Policy Document*, pp. 132., 2008.

Grams, T.E.E., Anegg, S., Häberle, K.H., Langebartels, C., and Matyssek, R.: Interactions of chronic exposure to elevated CO₂ and O₃ levels in the photosynthetic light and dark reactions of European beech (*Fagus sylvatica*), *New Phytologist*, 144, 95-107, 1999.

Grams, T. E. E., Werner, H., Kuptz, D., Ritter, W., Fleischmann, F., Andersen, C. P., and Matyssek, R.: A free-air system for long-term stable carbon isotope labeling of adult forest trees, *Trees*, 25, 187-198, 2011.

Hölttä, T. and Kolari, P.: Interpretation of stem CO₂ efflux measurements, *Tree Physiol.*, 29, 1447-1456, 2009.

Kuptz, D., Fleischmann, F., Matyssek, R., Grams, T. E. E.: Seasonal patterns of carbon allocation to respiratory pools in 60-year-old deciduous (*Fagus sylvatica*) and evergreen (*Picea abies*) trees assessed via whole-tree stable carbon isotope labeling, *New Phytol.*, 191(1), 160-172, 2011a.

Kuptz, D., Matyssek, R., and Grams, T. E. E.: Seasonal dynamics in the stable carbon isotope composition ($\delta^{13}\text{C}$) from non-leafy branch, trunk and coarse root CO₂ efflux of adult deciduous (*Fagus sylvatica*) and evergreen (*Picea abies*) trees, *Plant Cell Environ.*, 34(3), 363–373, 2011b.

Matyssek, R. and Sandermann, H.: Impact of ozone on trees: an ecophysiological perspective, *Prog. Bot.*, 64, 349-404, 2003. Mencuccini, M. and Hölttä, T.: The significance of phloem transport for the speed with which canopy photosynthesis and belowground respiration are linked, *New Phytol.*, 185, 189-203, 2010.

Nikolova, P. S., Raspe, S., Andersen, C. P. Mainiero, R. Blaschke, H. Matyssek, R., and Häberle, K. H.: Effects of the extreme drought in 2003 on soil respiration in a mixed forest, *Eur. J. For. Res.*, 128, 87-98, 2009.

Sitch, S., Cox, P. M., Collins, W. J., and Huntingford, C.: Indirect radiative forcing of climate change through ozone effects on the land-carbon sink, *Nature*, 448, 791-794,

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2007.

Vingarzan R: A review of surface O3 background levels and trends. Atmospheric Environment, 38, 3431-3442, 2004.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/8/C2862/2011/bgd-8-C2862-2011-supplement.pdf>

Interactive comment on Biogeosciences Discuss., 8, 4131, 2011.

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8, C2862–C2872, 2011

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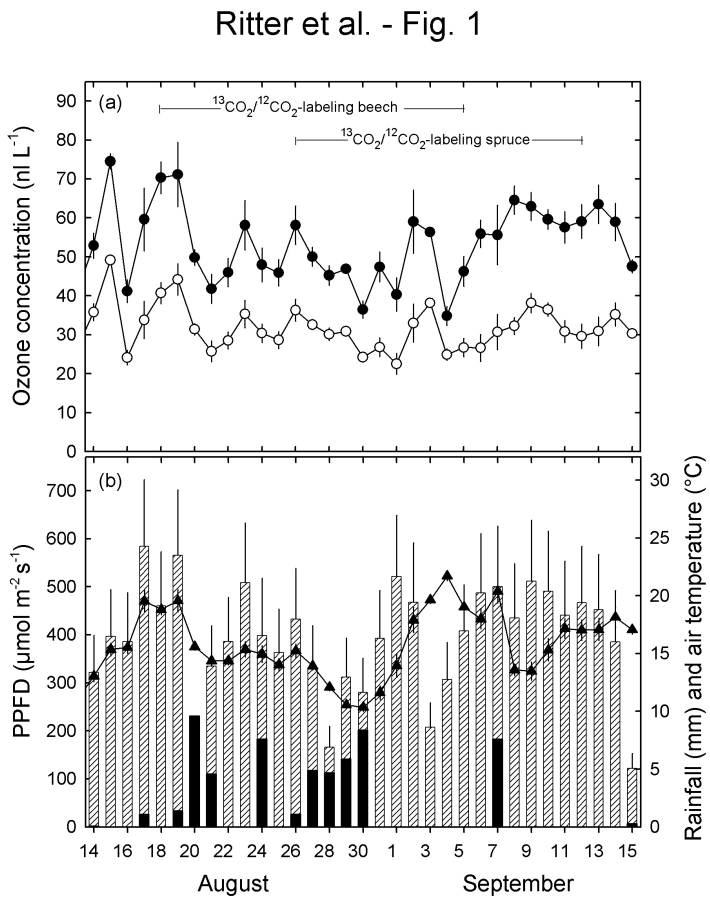


Fig. 1.

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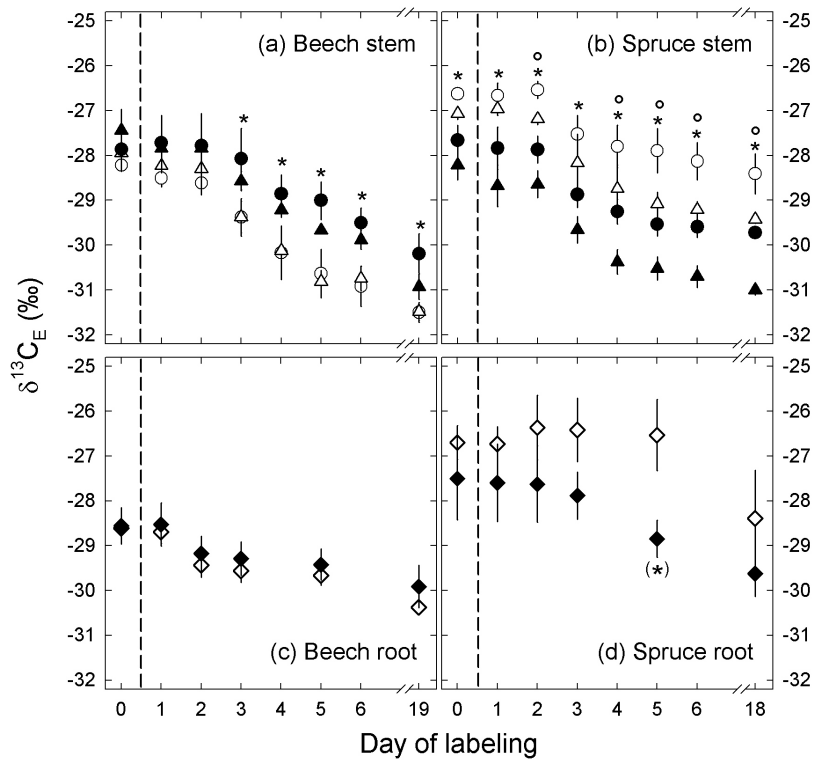


Fig. 2.

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Ritter et al. - Fig. 3

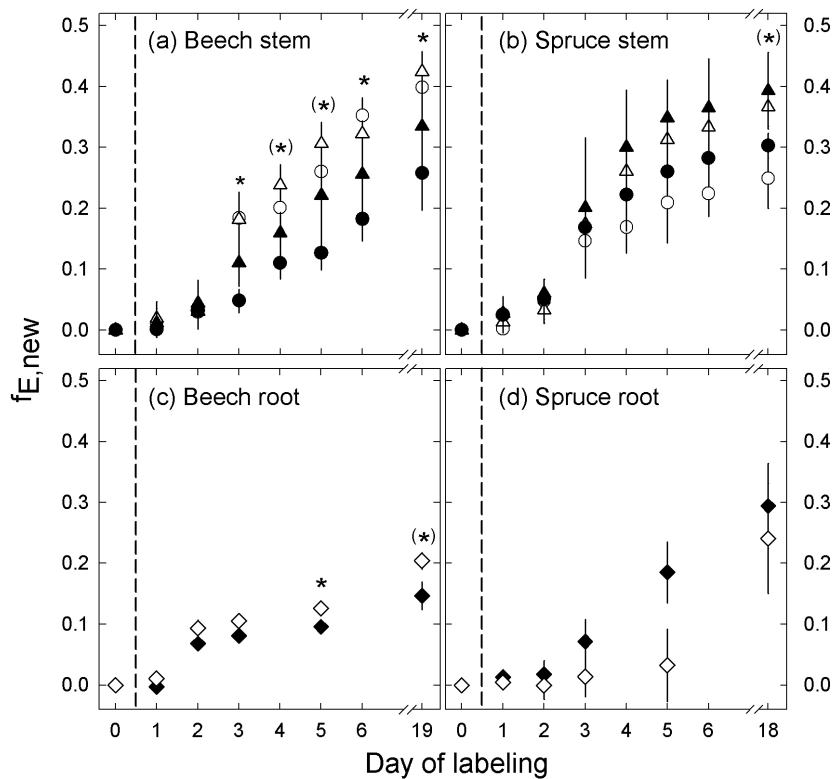


Fig. 3.

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Ritter et al. - Fig. 4

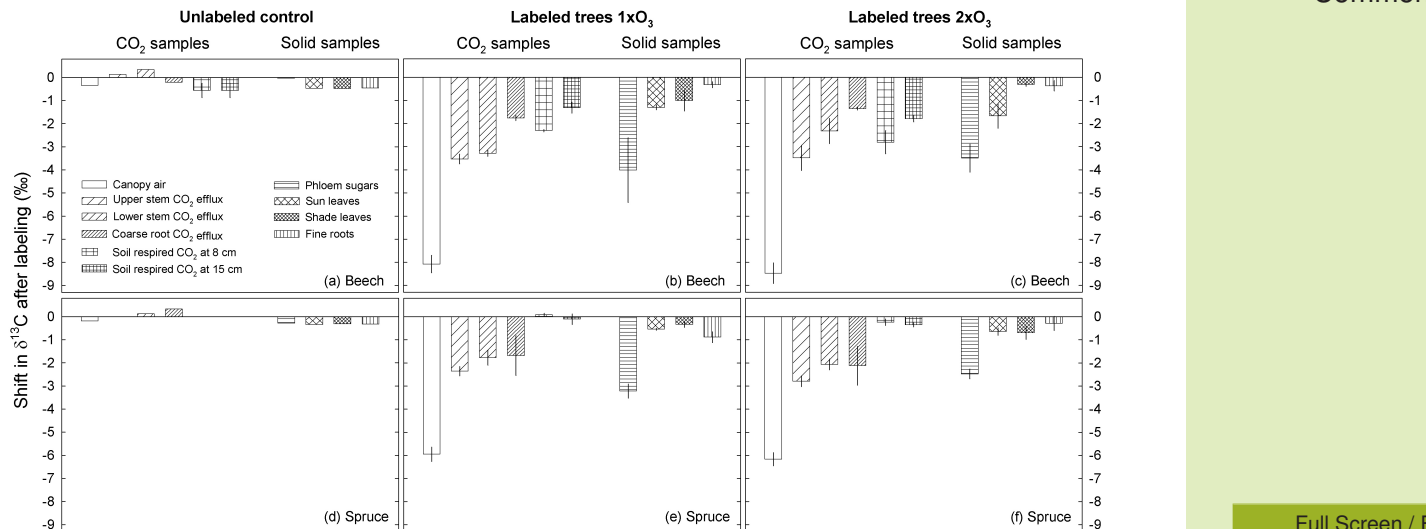


Fig. 4.

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