

Reply to A. Heinemeyer, bdg-8-C1911-2011

Abstract: You might want to expand/change that last section: 'This is where new research approaches should be aimed at'; to make clear this thorough review provides a neat summary revealing some knowledge gaps in relation to interpreting SI signals correctly, to be addressed by future research.

→ **Changed to: “This review tries to identify present knowledge gaps in interpreting carbon stable isotope signals in the plant–soil–atmosphere system correctly and how future research approaches could contribute to closing these gaps.”**

Page 3623 Line 13: Better to use 'primary' as also animal detritus etc. is a source of SOM.

→ **Changed.**

P3627 L8: Is 'online' the right word or do you mean in situ?

→ **We have now specified “online”.**

P3627 L12: better to switch words around: agree well

→ **Done.**

P3636 L6: This (or the following) paragraph might want to consider latest insights into C allocation based on analyses of SR vs GPP. Recent time series analyses of SR and forest C fluxes suggests that there is a root internal C pool, mixing GPP-derived belowground C over time (days to weeks) and then allocating it to root or mycorrhizal fungal activity. The authors might want to consider some related recent literature (e.g. Vargas et al. On the multi-temporal correlation between photosynthesis and soil CO₂ efflux: reconciling lags and observations. *New Phytologist*. DOI: 10.1111/j.1469-8137.2011.03771.x; and another discussion paper: Heinemeyer et al. 2011 Exploring the “overflow tap” theory: linking forest soil CO₂ fluxes and individual mycorrhizosphere components to photosynthesis. *Biogeosciences Discuss.*, 8, 3155–3201, 2011 www.biogeosciences-discuss.net/8/3155/2011/ doi:10.5194/bgd-8-3155-2011).

→ **We have now included this point and the references in section 3.1. The new paragraph reads as follows:**

“Recently Vargas et al. (2011) observed multi-temporal correlation between photosynthesis and soil respiration across different ecosystems with time periods between 1 and 16 days. Based on a comprehensive time series analysis of flux data they concluded that multiple biophysical drivers are likely to coexist for the regulation of allocation and transport speed of carbon. Strong correlations both at the 1 day period and at periods >1d for forests suggest that the link between assimilation and soil respiration might potentially involve both the propagation of pressure-concentration waves in the phloem and the actual transport of new assimilates from the leaves to

belowground tissues. In addition, the correlations with longer time periods might be a result of transient storage and remobilisation of carbon in the plant tissues. Moreover, Heinemeyer et al. (2011) reported differences for particular components of soil respiration (root and mycorrhizal respiration) in their temporal relation and response to gross primary production. The authors assume that carbon storage in roots and/or fungi over days to weeks and later allocation to mycorrhizae might explain the correlation between photosynthesis and mycorrhizal respiration at longer temporal scales.

As a consequence, not only phloem transport but also short-term storage/remobilisation and transfer to rhizosphere biota (see 3.2) have to be considered for the interpretation of the speed of link or degree of coupling (cf. Kayler et al. 2010) between above and below-ground processes.”

P3637 L4: Some recent data show this in situ and reveal the dynamics in this C allocation over several years at fine temporal scale; Heinemeyer et al. BGD 2011.

→ Reference was made to this paper in the following sentence, which was modified to: “It has been shown that plant-derived C flux into (Vandenkoornhuysen et al., 2007) and through arbuscular mycorrhizal hyphae (Staddon et al., 2003; Godbold et al., 2006) is rapid, i.e. in the range of only a few days. Also for ectomycorrhizal hyphae a fast turnover of freshly assimilated C was found (Godbold et al., 2006), which has been confirmed recently also on the basis of several years of respiration data at high temporal resolution from a deciduous oak forest in southeastern England (Heinemeyer et al., 2011).”

P3637 L6: that (plant-derived) C turnover...

→ Plant-derived added (see also previous point).

P3637 L7: Maybe check/make clear if this only refers to AMF studies (i.e. Staddon et al.)! To my knowledge, the other studies quoted here only analysed C incorporation (vandenkoornhuysen) and transport (Godbold ref is missing!) not turnover or do they? Moreover, in ECM forests this linkage seems to vary considerably during seasons and years but there are not many high temporal resolution flux data to generalise this (again, see maybe Heinemeyer et al BGD 2011).

→ We confirmed that Staddon et al. and Vandenkoornhuysen et al. refer to AMF only, whereas Godbold et al. refer to both AMF and EMF. We added Godbold et al. to the reference list, and we added a sentence on the temporal variation of the linkage between C assimilation and C turnover in ectomycorrhizal fungi: “However, in forests dominated by ectomycorrhiza this linkage seems to vary considerably during seasons and years, suggesting alternative C sources for ectomycorrhizal metabolism such as litter decomposition (Heinemeyer et al., 2011), but there are too few high temporal resolution flux data available to allow a generalization.”

P3639 L9: This is true and it is interesting that some studies do not find such a clear reduction in Ra. However, some of these differences might well be explained by artefacts such as collar insertion for SR measurements, cutting of root C supplies as shown in a recent

study (Heinemeyer et al., EJSS, 2011) but one would need to check those references on such issues.

→ In principle, this comment is justified. However, these measurement artefacts would apply to both clipped and unclipped, shaded and unshaded, girdled and ungirdled plots. Therefore, if there is no significant difference found between treated and untreated plots, this really points to respiration of “old” C stored in the roots.

P3639 L26: It is a bit confusing maybe to quote the hysteresis when before you refer to rather general seasonal differences in the magnitude of R_a (if I understood this right). Surely the hysteresis effect is at hourly/daily time steps?

→ We talk about seasonal hysteresis here (see Högberg et al., 2009).

P3640 L12: Or different amounts/contribution of the individual SR component fluxes?

→ Right. Sentence changed to: “These different results might be explained by interacting effects of soil moisture and temperature on C supply for respiration (Davidson et al., 2006), different contributions of the individual component fluxes to total soil respiration, or changes in CO₂ transport rates in the soil (Phillips et al. 2011).”

P3643 L14: better use 'seems of young age' as it is only based on one references.

→ Done.

P3643 L20: Sorry, I don't know these 'early spring allocation' studies, but is it allocation of new or mobilisation of old stored root starch reserves?

→ We have specified that it is recent C that is allocated.

Section 3.5: A general question: Does this short section need to be included with the previous relevant sections (3.1 etc.), or does it justify/need to incorporate some of that material in here? As it is, I feel it is somewhat repetitive and could be either incorporated elsewhere or expanded by cutting other sections.

→ We followed this good suggestion and integrated section 3.5 into section 3.1, omitting repetitions with respect to phloem transport.

P3662 L15: Therefore, until a robust...

→ Changed.

P3663 L1: I don't quite like the term 'meshwork' is there a better (English) word? Is it physical and biochemical interactions or levels...? Or simply 'network' or interlinked processes.

→ Replaced with “**complex network of interlinked carbon transformation and transport processes**”.

Conclusions P4: This is a good summary of the 'open questions' and this is where I think the main text in the actual manuscript should be more critical/pointy, i.e. when stating things 'are like this' based on only one reference, this is maybe misleading (unless it is a review etc.) and should acknowledge that actually this is only based on a very limited number of studies, and quite often on seedlings - thus maybe this warrants further research.

→ We have tried to modify the main text according to the suggestion of A. Heinemeyer and tried to point out more future research needs where experimental data were scarce or not unambiguous.

Fig. 4: Add maybe the re-mobilisation aspect to this nice Fig., internal plant (root) C storage pool etc. but I might have overlooked it.

→ We have now added two new boxes for starch pools in the leaves and in the roots.