Biogeosciences Discuss., 8, C1696–C1702, 2011
www.biogeosciences-discuss.net/8/C1696/2011/

Biogeosciences Discussions

Interactive comment on "Plant communities as drivers of soil respiration: pathways, mechanisms, and significance for global change" *by* D. B. Metcalfe et al.

D. B. Metcalfe et al.

daniel.metcalfe@slu.se

Received and published: 28 June 2011

Reviewer 1)

Comment: The only main remark I have on this paper is that the focus is not really clear. I thought the focus would be on soil respiration, given the title, but after the introduction it appeared to me that most of the text was more about carbon cycling in soil or the C inïňĆux rather then about the ïňĆux of CO2 that is coming out of the soil (point 2 Plant traits and soil carbon cycling). It would be interesting to get more insight into rates of input/output and the source of the output, respired by roots, mycorrhiza, heterotrophs (of different types) associated with plants with different traits.

It may be there in the text already but scattered across the paper so not easy to get a picture of the ïňĆux components, a ïňĄgure, perhaps a reworked version of Fig. 1 could help. Response: Please see our detailed responses to each comment, with line numbers, below. We have revised the manuscript text and inserted a new figure, to link together different sections better and more clearly illustrate the relevance of the different discussion topics specifically for R. The titles of the sections have been altered to make it clear that our focus is on R, rather than soil C cycling in general. We have added text to give more information about the rates of C input/output, and how the R flux compares to other ecosystem C fluxes (Lines 177-179, 224-227, 242-245, 302-303). The new figure (Figure 2) clearly outlines the different components of R, and how they are related to each other and the key abiotic and biotic drivers. Generally, however, we have focused on plant community impacts on total R, rather than the components of R, partly because of the very limited amount of theoretical or experimental data for the latter, and partly because a number of comprehensive syntheses have already been published, which we cite, focusing on variation in the individual components of R (Lines 120-121, 641-642). We do however highlight the general deficit of knowledge about the components of R as a "critical gap" in our knowledge (Lines 638-644).

Comment: Abstract- The structure needs to be improved, I think one should ïňĄrst be brieïňĆy introduced to the different components of soil respiration and the drivers before the predictions are presented. Now we read about belowground carbon ïňĆux but not about the ïňĆux out of the soil so it is not immediately clear how the belowground ïňĆux links to the focus of the paper which according to the title is soil respiration so the ïňĆux from the soil to the atmosphere. Response: We have modified the structure of the Abstract and added some text to make its focus much more clearly targeted at R. We now specifically state why belowground carbon partitioning is important for understanding R (Lines 59-60) and mention the different components of R (Lines 51-54)

Comment: Line 11: 'Within vegetation types, belowground carbon ïňĆux will be mainly controlled by photoynthesis' and following sentence are unclear. What do you mean

with 'will'? Under which conditions? Response: We have revised this sentence to remove the sense of certainty conveyed by "will", and clarify the subsequent line (Lines 51-69)

Comment: Main text Page 2150 and following: Plant traits and soil carbon cycling It would be interesting to get more insight into rates of soil C input/output. Response: We have altered the title of this section to make our focus clearer. We have now also inserted more detailed information at several points in the text about the rates of soil C inputs and outputs (Lines 177-179, 224-227, 242-245, 302-303). We also cite other studies which have focused on a more extensive inter-comparison of R component fluxes (Lines 120-121, 641-642) which is beyond the scope of this review.

Comment: Page 2154 line 11 and 13: 'mycorrhizal hyphae turnover relatively quickly' and 'and contain more recalcitrant structural compounds that inhibit decomposition' please explain as this seems contradicting. Response: Our intended meaning is that mycorrhizae generally appear to have shorter life spans than roots in general, not that their turnover rate in the soil was necessarily faster. The sentence has been modified to clarify this (Line 312).

Comment: Page 2162 line 19: and what about acclimation by soil biota as they have a strong impact on soil respiration.? Response: We now explicitly address this point (Lines 542-546).

Comment: Conclusions Line 5-6: so there is a disproportional increase in respiration relative to primary production? Otherwise no surprise more respiration with more production and this does not need to imply a positive feedback if the increases are proportional and counterbalance each other. Response: Our intention with this sentence was to make the point that changes in R with climate change may be greater than anticipated when including plant community shifts in addition to abiotic effects on microbial activity, but we agree that it is debatable whether faster growing plants would necessarily drive an increase in whole ecosystem CO2 emissions (even if they

increased R) because photosynthetic uptake could also increase, so we have removed any reference to this. We have now modified the sentence to clarify (Lines 603-606)

Comment: As with the abstract the conclusion seems to deal more with C cycling in general rather than addressing the components of soil respiration (autotrophic, mycorrhiza, heterotrophic) and how they are impacted by plant communities, across space and time. I suggest to rewriting the ïňĄrst part of the conclusions also such that it better matches the (very interesting) part which lists the critical gaps. The list of gaps could help for some restructuring of the main text. Response: We have now tried to more explicitly tie summary statements in the conclusion back to their relevance for R. We mention R seventeen separate times in the conclusion. In addition, we now include a reference to some of the evidence for differences in plant C allocation to mycorrhizae, exudates and roots (Lines 623-626). Generally, however, both in the conclusion and main text we have focused on plant community impacts on total R, rather than the components of R, partly because of the very limited amount of theoretical or experimental data for the latter, and partly because a number of comprehensive syntheses have already been published, which we cite, focusing on variation in the individual components of R (Lines 120-121, 641-642). We do however highlight the general deficit of knowledge about the components of R as a "critical gap" in our knowledge (Lines 638-644).

Comment: Figure 1) Can soil respiration be included more explicitly? Range of the rate and contribution of the different components (plant roots, mycorrhizae, decomposer soil biota)? Response: At the bottom of Figure 1, in the "Soil Processes" box, we have explicitly mentioned potential differences amongst plant functional types in terms of the rates of respiration from different soil components (soil microbes, mycorrhizae, roots). Given the preliminary nature of this conclusion and the very large variation amongst ecosystems and methods, we are reluctant to provide more specific estimates of actual rates of respiration or proportional contributions to total R, as this could convey a misleading sense of certainty in general patterns across all ecosystems and climates.

However, we have now added another row to the bottom of this box specifically stating the likely overall consequences of the different interacting factors for the pattern of total R between plant functional types.

Comment: Figure 2) As the manuscript focuses on soil respiration I think a ïňĄgure showing how soil CO2 efïňĆux (ïňĄgure f) is related to each of the other factors (those in ïňĄgures b to e) would be more informative than the current ïňĄgure. Response: We now include a new figure (Figure 2) which is designed to clearly illustrate how (1) R is a composite signal from different soil components (roots, mycorrhizae, soil microbes) and (2) Each of these components are affected by the different factors in the old Figure 2 (now Figure 3). In addition, we now cite and discuss a number of previous syntheses which have focused specifically on partitioning components of R (Lines 120-121, 641-642) and relating R to several factors such as TBCF and production (Lines 133, 227, 245, 250, 252, 289, 302, 380, 619, 626). We strongly feel that the old Figure 2 (now Figure 3) should be retained because there is still substantial scientific value in providing a more descriptive overview of global patterns in R and its key drivers. We hope that the other figures and the text together provide a more detailed picture of the mechanisms and processes underlying these broad patterns.

Comment: Figure 3) Please include the soil respiration component (the topic of your paper) Additional or other ïňĄgures would be helpful to get better insight in what the paper is about. Especially a ïňĄgure which explicitly shows the pathways of soil respiration, what the underlying sources (with a range of their proportional contribution) are and how they are connect across space and time. Response: We have modified Figure 3 (now Figure 4) to make the link to R much clearer by specifying the respiratory components of the belowground flux, and showing how R should change along the x-axis along with the other ecosystem properties (environmental resources, plant resources, GPP limitation). We also include a new figure to outline the basic components of R, i.e., how they are linked together and what their main drivers are (Figure 2). We have refrained from specifying estimates in this figure of the proportional con-

tributions because there is either too little information available or the values vary so much depending on ecosystem type and methodology, meaning that any estimates that we could provide would be misleading. Instead, in the main text we now provide a more developed discussion of the proportional contributions (Lines 177-179, 224-227, 242-245, 302-310) and cite the several syntheses available which have considered this topic in greater detail (Lines 120-121, 641-642).

Comment: A ïňĄgure which illustrates the scales (time and space) and methodology (including the resolution and an indication of its variation) used to obtain data on the different components of soil respiration could also be insightful to see the discrepancy between the models and to demonstrate the need to include local processes in more detail for improving global scale models. Response: Following this suggestion, we experimented extensively with various graphical forms of representing spatial and temporal scales of the different components of R and their key drivers but found it very difficult to distil this complex, uncertain information into a figure without making potentially misleading generalizations. A full critical consideration of the methods used to quantify R components, and their spatiotemporal patterns in nature, is beyond the scope of this review, outside of its primary focus, and has already been very competently executed by several authors. Instead, we now refer to these issues in the text (Lines 77-79, 670-676) and cite these review papers (Lines 120-121, 641-642).

Comment: References) A very relevant reference I missed: Ostle et al. (2009) Integrating plant-soil interactions into global carbon cycle models Journal of Ecology Response: Thank you for pointing out this omission. We have now included this reference at several points in the text (Lines 145, 500, 580)

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/8/C1696/2011/bgd-8-C1696-2011-supplement.pdf