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Biogeosciences Discussions

Interactive comment on "Rapid transfer of photosynthetic carbon through the plant-soil system in differently managed grasslands" *by* G. B. De Deyn et al.

Anonymous Referee #2

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De Deyn et al. present a study on the short-term transfer of C between plants and soil micro-organisms in grasslands with contrasted vegetation compositions. They used an in situ 13CO2 pulse labelling to measure differential C uptake among different plant species and the transfer of 13C fixed by the plant to key microbial groups characterized by their PLFA. This work reveals the strong temporal tightness of relationship between plants and micro-organisms. The transfer of C assimilated by the plant to soil microbial communities occurred within 24h after the pulse labelling. Interestingly, this rapid transfer not only concerned arbuscular mycorrhizal fungi, but also bacteria and saprophytic fungi. Thus, the dynamic and activity of microbial populations in soil and its impact on soil organic matter dynamics is finely driven by the plant and its photosynthetic activity.

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Interactive Discussion
Discussion Paper

The study also shows contrasted C uptake and retention rates between plant species. These findings are timely and important. The manuscript is carefully written with a nice style. I have some comments that might be considered to better valorise results and improve the manuscript. 1. The way you sampled the soil deserves to be clarified. You indicate that soil samples were collected by a single and relatively small core (3,4 cm diameter). Given the size of this core, there was likely only one plant species above the soil sample. How did you determine the location for the sampling and, for this sampling, how did you take into account the abundance of different plant species. This question is important because the rate of 13C assimilation by the plant and the rate of transfer of plant-derived 13C to microorganisms may change with plant species. 2. The study uses changes in delta 13C of plant biomass and PLFA in order to estimate the rate of C fixation plants and its transfer to microbial communities. However, this delta 13C represents only a part of the reality. Changes in delta 13C reflect mean residence times (MRT) of C in the studied compartments. MRT is defined as the ratio between the size of compartment and the flux of C that goes through. Thus, a plant with high standing biomass and fixation rate of CO2 and a plant with low standing biomass and fixation rate of CO2 may present the same MRT of C in their tissue although these two plants have contrasted roles in term of CO2 fixation and C incorporation in soil. This means that the biomass of plants and microbial communities should also be taken into account in order to estimate the role of these biota on ecosystem fixation and storage of carbon. This could moderate and change some conclusions of the present study. For example, based on the long retention of C in moss tissue, the study suggests that this functional group of plant could promote sequestration of C in grasslands. However, biomass of moss is typically low as their abundance in grasslands (i.e. Fig 1). Thus, the capacity of this functional group to fix and accumulate C in their biomass is limited. The lack of effects of fertilizer application on the C uptake suggested by the present study could also be explained by this focus on delta 13C. 3. A conclusion of the study is that using a priori defined functional groups of grasses, forbs and legumes may not the best way of aggregating plants in relation to C cycling. Although

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I am convinced by the conclusion, what do you propose as alternative approach? Do you think that the approach based on plant and microbial traits currently developed by many researchers is more relevant? 4. Another conclusion of the study is that the cessation of fertilizer could promote C sequestration of C in grassland by favouring moss over grass and fungi over bacteria. The rationale is that moss and fungi have greater C retention than grass and fungi. I find this conclusion rather simplistic. The carbon stored in plant and fungi represent only few % of total carbon stock present in grasslands. Most of grassland carbon is stored in soil organic matters particularly in the recalcitrant part of these SOM. Moreover, the cessation of fertilizer, probably combined with the maintenance of plant cutting (this information is lacking in the Material & Methods section), will induce a penury of available (soluble) nutrients in soils. In response to this penury, micro-organisms intensify their enzymatic activities and mine nutrients in SOM releasing large amount of C from the soil. In this scenario, and in the absence of legumes that compensate for the lack of nitrogen, the cessation of fertilizer decreases the sequestration of carbon in grasslands. Thus, the conclusion of the study should be moderate and include some processes that are not studied in this work but could reverse the prediction made by this study. 5. Finally, I find that the main result of the study, which is the temporal tightness of C transfer between plants and micro-organisms in grasslands, and its consequences for our understanding of plant-soil interactions deserves more discussions. For example, this result indicates that the activity of micro-organisms, which contributes to the release of N from recalcitrant SOM, follows the photosynthetic activity of plants in grasslands. This synchronisation of plant and microbe activities could explain to the synchronisation of soil nutrient availability to plant requirement of nutrients (defined by the photosynthetic activity and the stoichiometric contrains of the plant) as demonstrated the very low amount of N leached below this ecsosytem (Fontaine et al. 2011 and Drake et al, 2011). This high retention of nutrients in grasslands promotes SOM accumulation and C sequestration over long term.

Some specific points Abstract L20-25 This sentence is long and deserves to rewritten.

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You could recycle the sentence L7-10 of the conclusion section. Discussion P929 L23 P930 L1-2 This sentence should be clarified since T.repens belong to the particular group of legumes.

Interactive comment on Biogeosciences Discuss., 8, 921, 2011.