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Biogeosciences Discussions

Interactive comment on "Mechanisms of soil carbon storage in experimental grasslands" *by* S. Steinbeiss et al.

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We like to thank the referee for the comments on our manuscript but we think it is necessary to clarify some crucial misunderstandings that seemed to have occurred.
We are sorry that we did not sufficiently point out the aim of the natural labelling experiment that we presented in the manuscript. We mainly wanted to identify changes in the carbon source of DOC and soil organic carbon in relation to depth and different litter input amounts rather than focussing on changes in the total amounts of exported carbon in the dissolved carbon pool or stored carbon in the soil pools. The natural isotope label of the C4 plant material can easily be detected in all compartments receiving plant derived carbon and enabled a quantification of the respective carbon sources of DOC or soil organic carbon (Balesdent et al., 1998, Derrien et al., 2006, Kramer et al., 2006, Krull et al., 2007, Rubino et al., 2007).

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We never stated that an increased DOC flux to larger depth was responsible for priming, as the referee pointed out. The DOC export decreased with depth in both litter treatments. Between 10 and 20 cm depth the decrease was even stronger in the double litter treatment than in the no litter treatment (fig. 6 and page 3842 lines 22-28).

With all due respect to the reviewer we want to comment on the mentioned points.

(1) “In the surface horizons, more DOC is produced in the 2x litter than in the 0x litter."

In the surface horizon, DOC contains a **larger proportion of plant derived carbon** in the double litter treatment compared to the no litter treatment without changing the absolute amount of DOC (fig. 6, 7b and c and page 3843 lines 17-29).

(2) “This increased litter DOC production leads to more soil C loss in the surface horizons due to priming. Their data show no real differences in surface soil C content. It may be that C added from transport of DOC in the 2x experiment prompted loss and replacement of soil C leading to the same net change in both the 2x and 0x plots. This assumption is not well-supported by their data."

Again, there is no increased DOC production that leads to more soil carbon loss in the surface horizon. Carbon is stored in both treatments but significantly less carbon storage was observed in the double litter treatment in the top 5 cm of the soil (page 3839 lines 12-16). The **increased proportion of plant derived carbon in the DOC accelerated soil carbon turnover** and led to **a stronger replacement of inherited soil carbon by newly plant derived carbon** (page 3841 lines 21-24 and fig. 4).

(3) “In the next horizons (10-20cm), DOC must increase (as their data show - the only increase in DOC), without leading to priming, or prompting priming equivalent to soil C loss in that horizon."

Our data showed no increase of DOC in 10 to 20 cm depth (fig. 6). Also, we do not see a soil carbon loss in that horizon (fig. 1).

(4) “There must be more DOC flux into the 30cm horizon - though this was not observed

in their measurements."

When comparing the double litter treatment and the no litter treatment in 30 cm depth, the DOC export is bigger with double litter input (page 3842 lines 26-28 and fig. 6). At the same time we stated that most of the **soil organic carbon lost in this depth segment is respired** but not exported by soil solution (page 3846 lines 3-8).

(5) “That DOC prompts priming of soil C at that depth. This loss of soil C was observed."

The **plant derived proportion of DOC**, which was larger in the double litter treatment (page 3844 lines 3-9 and fig.7 b, c), that leached into the 20 to 30 cm depth segment was **proposed to cause priming** and consequently lead to larger soil carbon losses.

We have indeed only one C4 plot in our experiment, but each treatment is represented by an area of 10 x 10 m, where the measurements have been performed. On these areas independent soil samples and time series of DOC were analyzed. Although the results represented in the manuscript mostly derived from the C4 plot, all soil carbon data were ratified against 90 plots and soil solution data were ratified against 22 plots in the main experiment. Soil sampling and soil solution analyses were done in the same way on all plots. The data derived from the C4 treatments completely agreed with the average data of all other plots. Neither the carbon storage amounts nor the DOC concentrations in one of the treatments or any depth were identified as outliers tested within the whole plot community. It is common technique in source labelling experiments, e.g. C3-C4 vegetation change, to compare one field that received labelling (C4 vegetation) with one field that has not been labelled (continued C3 vegetation) (Balesdent et al., 1996, Ludwig et al., 2005, Kramer et al., 2006, Vanhala et al., 2007).

For a detailed description of the soil sampling procedure and mixing of samples before analysis we would like to refer to the method’s section (page 3834 lines 12-22). As we were interested in the differences between the treatments rather than the differences between sampling spots we analyzed pooled samples per depth and treatment in 2004 as suggested elsewhere (Webster, 2007).

The root data were derived from the same pooled soil samples that were used for carbon analyses (page 3837 lines 11-13 or 16-18) and thus already include possible differences between the treatments. The measured isotope values of the root material clearly show that they were exclusively roots of the C4 plants (page 3840 lines 5-7).

The identification and quantification of the sources of DOC in different soil depths by isotope measurements and the consequences of changes in this composition for carbon sequestration are still not well understood and are the major outcome of this short experiment. We demonstrated clear differences in the sources of the dissolved organic carbon with depth and treatment. Our data do probably contradict previous ideas on carbon transport by soil solution. To reveal a more detailed mechanistic picture, further experiments are necessary that focus directly on this topic.

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