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Biogeosciences Discussions

Interactive comment on "Summer drought reduces total and litter-derived soil CO_2 effluxes in temperate grassland – clues from a ^{13}C litter addition experiment" *by* O. Joos et al.

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Response to Anonymous Referee #2

General comments

C3966

1. "...However, whereas the first aim is clearly achieved, it is common knowledge and ecosystem models do generally include moisture sensitivity as it is one of the main drivers of environmental processes. The results and discussion of the second aim are weak. It does not become clear to me, if Flitter and FBG are more sensitive under

drought conditions than in the control plot. Of course do they both decrease under drought compared to the control plot and Flitter responds stronger than FBG in the drought plot due to higher moisture limitations than the bulk soil, but, are Flitter and FBG under drought differently sensitive to environmental drivers than in the control plot?"

–> We agree with the reviewer that it would be desirable to estimate if the different partitions of soil CO2 efflux (FSoil) have become more sensitive under drought. However, we think that our set-up does not allow an in-depth analysis, because (1) the litter addition superimposed the relationship to environmental drivers; (2) drought delayed the peak in litter decomposition and thus, environmental conditions for FSoil under ambient and drought conditions were not identical. Therefore, we have been very careful in formulating our aims and have not included 'a changing sensitivity under drought', neither in the first nor in the revised version of the manuscript. However, we tried to improve the discussion of a changing impact of environmental drivers in the results by including Q10 values in Table 2, and by highlighting them in chapter 4.2: 'Our results show that the two components of soil CO2 efflux were affected differently by climatic factors under ambient precipitation'. The comments of the reviewer have indicated us that the reader expects a discussion on a changing temperature dependency. Therefore, we added a section where we discussed why we did not observe change in the temperature dependency (chapter 4.3): "The experimental drought did not decrease the temperature sensitivity of soil CO2 effluxes (Tab. 2) which contrasts with the compilation of soil respiration data from different ecosystems by Reichstein et al. (2003). One reason for the apparently lacking change in the temperature sensitivity is the overarching effect of the litter addition on FSoil. Moreover, the increase in soil CO2 effluxes occurred delayed which hampered a direct comparison to ambient conditions."

2. C3967 "Points that need clarification": 1. Labelled litter is placed directly onto the soil surface. Was the remaining grass from the previous growing season cut before that?"

–> Yes, we did cut the remaining grass just before the litter addition to be able to place the litter directly onto the soil surface. We added this information in chapter 2.4 of the revised manuscript.

3. "For CO_2 flux measurements, standing plant biomass was cut down to 3 cm height. How was it possible to separate the standing grass biomass from the added litter?"

–> For the estimates of the contribution of litter to soil CO_2 efflux soil respiration, we did not have to separate the litter from the standing biomass, because we traced the litter-derived 13C signal in respired CO_2. We removed the standing biomass because of its dark respiration, which would affect total CO_2 efflux. The 'green' biomass was clipped away the day before the measurement, which was facilitated by covering the 'brownish' litter with a coarse net (mesh size = 4 mm); see chapter 2.4.

4. "...I am doubtful about the gap filling of the soil moisture values for the 5 cm layer in the drought plot. Were the 97 days a continuous gap or on and off days? It is not visually distinguishable in Fig. 1c. In either case it needs to be explained, how representative the values available for the regression are of the drought period. The relatively low R^2 already indicates that the regression does not hold especially since the soil moisture values of 5 cm depth are one of the main parameters in the sensitivity analysis. Measurements of 15 and 30 cm depth need to be shown and interpreted since the status of the soil in these layers greatly contributes to the observed FBG fluxes. It needs to be explained, why only the measurements of the 5 cm layer were taken into account for the interpretation of the results."

–> Unfortunately, the soil moisture sensor at 5 cm depth failed, very likely because it was too dry and soil shrinkage led to an insufficient contact with the soil matrix. In the revised manuscript, we replaced the 5 cm data by those at 15 and 30 cm depth in Figure 1. We also used all the soil moisture data sets at 15 and 30 cm depth to estimate potential relationships of the different components of Fsoil to environmental drivers. In the analysis of potential drivers in the revised manuscript, we only show and

concentrate on one soil depth again (30 cm), because overall this dataset gave the best correlations between measured and modelled CO_2 efflux values modelled with the different environmental variables.

C3967 5. "Discussion – Soil CO_2 efflux: Please explain, why a peak shortly after the addition of litter is observed and state, that it is derived from litter decomposition. Please explain here, why soil moisture has no significant effect. It is explained later on but misses the arguments, that a) total CO_2 efflux is determined also from lower layers, not only from the first 5 cm and b) that the soil moisture status is probably within an optimum range for respiration processes so that little variations are not significant."

–> We added this point to the discussion in chapter 4.1: "The seasonal pattern of soil CO_2 effluxes under control conditions showed a clear peak in mid May, which can be attributed to the high rates of litter decomposition at the first rainfalls after adding the litter (Figure 1). Thereafter, FSoil decreased throughout the rest of the year because of a declining availability of easily degradable litter components (Figure 3) and decreasing temperatures in fall. Soil moisture had a small effect on FSoil under ambient conditions. Amount and timing of rainfall were evenly distributed across the seasons and hence, soil moisture varied little and was in the optimal range for soil respiration (20 to 40%; Mielnick & Dugas, 2000)."

C3968 6. "In general, the discussion would benefit from further interpretation of the results like on pg. 11019, lines 22-26, and stating and explaining differences compared to other works, rather than only listing similarities."

–> As shown above and in the response to reviewer 2 we revised the discussion in several sections to interpret the data more in-depth.

References

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Reichstein, M., Rey, A., Freibauer, A., Tenhunen, J., Valentini, R., Banza, J., Casals, P., Cheng, Y., Grünzweig, J.M., Irvine, J., Joffre, R., Law, B.E., Loustau, D., Miglietta, F., Oechel, W., Ourcival, J.-M., Pereira, J. S., Peressotti, A., Ponti, F., Qi, Y., Rambal, S., Rayment, M., Romanya, J. Rossi, F., Tedeschi, V., Tirone, G.Xu, M., Yakir, D.: Modeling temporal and large-scale spatial variability of soil respiration from soil water availability, temperature and vegetation productivity indices, Glob. Biogeochem. Cycl., 17, 15.1-15.15, 2003.

Interactive comment on Biogeosciences Discuss., 6, 11005, 2009.