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Interactive comment on "Comparing soil carbon loss through respiration and leaching under extreme precipitation events in arid and semi-arid grasslands" *by* Ting Liu et al.

Anonymous Referee #1

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General Comments

The manuscript of Liu et al presents very interesting information regarding the triggering of soil carbon losses via respiration and leaching by extreme precipitation events. The results of the soil column experiments illustrate that leaching losses of carbon from soils as consequence of extreme precipitation events may well exceed carbon losses due to enhanced respiration. However, the overall relevance of dissolved organic and dissolved inorganic carbon leaching losses will ultimately depend on the fate of the leached carbon on its way to groundwater and further through rivers into the ocean. If the dissolved organic carbon and inorganic carbon are retained in subsoils, then the

leached C might well be finally emitted from the soil to the atmosphere in the form of CO2, if the dissolved organic carbon (DOC) is mineralized or if the soil water is lost via evapotranspiration, thus releasing the dissolved inorganic carbon (DIC)...This aspect of the importance of the downstream fate of leached carbon for the overall relevance of the leaching pathway for the carbon balance is missing in the manuscript.

When judging the relevance of dissolved inorganic carbon leaching for the carbon balance, it is also crucial to differentiate between the biogenic fraction of DIC and its lithogenic (carbonate-rock derived) fraction. In my opinion, it is much more straight forward to compare the biogenic leaching losses of DIC with the NEP, than total DIC leaching losses. The authors might want to consider this in their discussion of their results in lines 25ff on page 9. In this context the application of the isotopic mass balance model is important. The results of this model depend strongly on the delta 13C values of the end-members carbonate and CO2 from soil respiration. The authors decided to use the delta 13C of the soil organic matter of -24 per-mille to calculate the biogenic fraction of dissolved inorganic carbon. Because isotopic fractionation occurs during the mineralization of soil organic matter, the authors might additionally use their delta 13C value of -23.1 per-mille as end member in order to assess the uncertainty that is associated with potential isotopic fractionation during mineralization and diffusive CO2 transport in soil (Cerling et al., 1991. On the isotopic composition of carbon in soil carbon dioxide. Geochim. Cosmochim. Acta 55, 3403-3405). Quantitatively more important than the isotopic fractionation during mineralization and diffusion of CO2 for the delta 13C value used as end member for the soil organic carbon derived fraction of DIC is the isotopic fractionation between CO2 in the gas phase and bicarbonate (Zhang et al., 1995. Carbon isotope fractionation during gas-water exchange and dissolution of CO2. Geochim. Cosmochim. Acta 59, 107-114). In the pH range of the investigated soils, the vast majority of the DIC will be present as bicarbonate (HCO3-). According to Zhang et al. (1995), isotope fractionation between the gas phase and the aqueous phase will shift the delta 13C of bicarbonate in equilibrium with gaseous CO2 by some 10-11 per-mille. Hence, the end member delta 13C of DIC in equilibrium with CO2, which has a delta 13C value of -24 per-mille, can be around -14 to -13 per-mille. Considering this isotopic fractionation between gaseous CO2 and bicarbonate will greatly increase the calculated fractions of biogenic (soil organic carbon-derived) DIC.

Specific comments On page 3, line 19, the soil is classified as “chestnut soil”. This classification is not in line with the international soil classification system of the World Reference Base for Soil Resources (WRB, 2015). Please classify your soils also according to the WRB system (http://www.fao.org/3/a-i3794e.pdf). On page 6, lines 20ff, the authors argue that the variation in SIC contents between sites are caused by the variation of pH values, suggesting a causality between pH (independent variable) and SIC content (dependent variable). The question is, whether the pH is really controlling SIC contents or vice versa…

On page 9, lines 29ff, the authors cite Kindler et al. (2011) for numbers of DIC leaching losses equaling 12% of NEP and DOC leaching losses equaling 2% of NEP. I do not understand how the authors extracted these numbers from the Kindler et al. (2011) publication.

Starting on page 9, line 31, the authors argue that the carbon loss due to extreme precipitation events was much greater than carbon losses through warming-enhances respiration. This comparison is perhaps misleading, because it implies that extreme precipitation events occur only as consequence of climate change. More correct would be the comparison of carbon losses due to warming-enhanced respiration with carbon losses due to “climate change-enhanced” extreme precipitation events.

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