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Interactive comment on “A method to detect soil carbon degradation during soil erosion” by C. Alewell et al.

Anonymous Referee #1

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Referee comment on Alewell et al. (2009) : a method to detect soil carbon degradation during soil erosion.

General comments

This paper reports the results of coupled C-stable isotope and ^{137}Cs activity measurements performed on upslope eroded soils and downslope wetland soils that are thought to represent soil organic carbon erosion and deposition stages within a mountain grassland environment of the Swiss Alps. Making the assumption that no degradation of eroded organic matter took place during removal, transport and deposition, the authors use a simple mixing equation to derive the theoretical C-isotope composition of wetland organic matter impacted by upland erosion or alternatively the time required to match the observed composition. Reference ^{137}Cs activities required for

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the calculation are provided by undisturbed wetland soils sampled nearby. The paper by Alewell et al. is well written and contains a very interesting approach to the study of soil organic carbon erosion and redistribution in the landscape.

Specific comments

The idea is not new and tentative comparisons between soil ¹³⁷Cs activity and total organic carbon concentration levels have been reported for different settings (i.e., Mabit and Bernard, CRAS. Paris 327, 1998 ; Ritchie and McCarty, Soil and Tillage Res. 69, 2003 ; Huon et al., in : Advances in Soil Science CRC Press, Boca Raton, 2006). The total organic carbon contents of eroded soils is correlated with the redistribution of soil particles along slopes, possibly providing some time constrain on soil organic carbon erosion rate estimates using ¹³⁷Cs inventories. Alewell et al. provide a more advanced picture of the process by involving the C-stable isotope composition of soil-derived organic carbon. The major result of the study is that the calculated composition is intermediate between that of upland (erosive site) and wetland (accumulation site) soils. The difference is interpreted as the effect of degradation of eroded organic matter prior to deposition and accumulation. This issue is of great interest because the evaluation of soil erosion as a significant source or sink of carbon to the atmosphere is still debated (i.e., Lal and Pimentel, Science 319, 2008) mainly because the extent of carbon renewal in soils and of carbon degradation during transport is not well constrained.

Two important weaknesses of the study should be pointed out.

1) The direct comparison between eroded upland soils and impacted wetland soils is based on the assumption that the mass transfer of soil organic carbon is a conservative process. The breakdown of soil aggregates during detachment and the suspended transport are known to be selective processes that are accompanied by particle size sorting even on a short distance (i.e., Bellanger et al., Catena 58, 2004). Because the total organic content and C-stable isotope composition of soil organic matter are

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significantly different for each size fraction and have contrasted residence times (i.e., Balesdent, European J. Soil Sci. 47, 1996), the difference observed in the calculation may also reflect the selective accumulation (in the impacted wetland soils) of soil organic particles of a given size with respect to those of the upland soils. An equivalent conclusion may be drawn for the preferential adsorption of fallout ^{137}Cs on fine-sized minerals in topsoil horizons. Models usually used to report soil erosion rates with ^{137}Cs -activities also involve grain size fractionation factors, in particular for fallout inventories (i.e., Walling and He, IAEA report, 2001). I think that the authors should better involve soil particle size distribution and re-distribution arguments in their study to reject this possibility. Other difficulties may also arise for direct application of mixing equations because of heterogeneous ^{137}Cs distribution patterns in eroded soils.

2) The calculation used requires ^{137}Cs activity measurements for the eroded and accumulation sites as well as for the reference fallout value. It is a pity that the ^{137}Cs activity measurements are not reported in the paper and that the inventory corresponding to the Chernobyl accident used as a reference (?) is not displayed.

I suggest that the authors provide additional arguments and data with respect to soil particle sizes and ^{137}Cs activity measurements to strengthen their discussion section.

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