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A spatially explicit and multi-class model to simulate sediment and SOC redistribution

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Erosion, deposition and export of soil organic carbon is strongly related to runoff and sediment transport but the implementation of spatial and temporal dynamics of SOC erosion are not well represented in current models. In most cases, long-term erosion models or erosion modules in soil simulation models use an average annual soil and SOC erosion rate, which is constant over time, the basic assumption therefore being uniformitarism. Information on space-time distributions of soil/SOC loss, export and sediment quality is important to optimize management practices and to simulate the effects of erosion on soil biogeochemical cycling. For example, quantifying the relative importance of low intensity-high frequency and high intensity-low frequency erosion events in long-term erosion studies is challenging given the lack of long-term observations, especially at larger spatial scales.

The objective of this paper is to develop and test a continuous simulation model that represents the natural variability in climate, soil conditions, land use and other dynamic factors that cause sediment/SOC erosion variability at the landscape scale. We confront model results with observed distributions of sediment and carbon transport. The results indicate that catchment efflux is enriched in clay and carbon (enrichment rations (ER) between 1.5and 6) for smaller events where the total sediment delivery is below 20%. The model simulates much lower ER, close to unity, for more extreme events. The larger events (return period > 5 years) dominate the total sediment export while, due to the selective transport of the fines during smaller events, smaller events (return period > 1 year) dominate carbon export. Finally, we present numerical experiments and discuss these in relation to the role of event size and spatial/temporal scales. These results strongly suggest that the erosion induced sequestration of SOC is strongly influenced by the spatial concentration and tempo of deposition.