The role of lateral transport on storage and fate of soil carbon in permafrost dominated hillslopes and hollows.

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A large fraction of high latitude, permafrost-dominated, landscapes are characterized by hillslopes. In these landscapes, soil carbon both accumulates and is lost through processes that laterally transport carbon. At present, these processes are not included in regional or global landsurface models. We present preliminary model results of a numerical model of soil transport and storage on an idealized cross section of a permafrost dominated hillslope. In this model soil carbon is transported within a thawed layer. The model tracks the erosion of soil carbon along the hillslope and it subsequent storage in an unchannelized hollow at the base of the hillslope. In a simple scenario, where the landscape is blanketed by a carbon-rich layer (such as Yedoma) overlying carbon-poor materials, the progressive transport of material from the hillslopes to hollows results in the net sequestration of carbon in the landscape. This sequestration occurs because carbon-rich soil is transferred from the near-surface layer of the hillslopes into thicker, frozen deposits that accumulate in the hollows. We also investigate potential hillslope transport-driven feedbacks on the storage and distribution of soil carbon by incorporating basic representations of carbon production by an upper vegetation layer and carbon loss through decay within the mobile soil layer. These results are a first step in using models of lateral sediment transport by geomorphic processes to better characterize landscape-scale distributions of carbon. The model results may be used to help guide soil sampling efforts and provides a process-based framework for the interpretation of the sampling data. If confirmed by field data, the model results suggest that the uneven spatial distribution of soil carbon reservoirs in the landscape have significant implications for coupled carbon and landsurface responses to warming. For example, currently unchannelized hollows and valley bottoms are thought to be highly susceptible to erosion and channel expansion in response to climate change driven active layer deepening and increased runoff. If these areas are rapidly incised and eroded, stored carbon will be released and redistributed more rapidly than would be anticipated by thaw processes strictly driven by ground surface warming.