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Uncertainties in Global Soil Erosion Modelling

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It is widely recognized that accelerated soil erosion has been a major threat to sustainable agriculture across the globe for many decades. Human activities induce land-use changes that can trigger soil erosion on large scales and lead to irreversible changes in the landscape. By altering the landscape however, soil erosion also influences the global carbon cycle, which plays an important role for the current climate change. How the carbon cycle is affected through all stages of soil erosion (soil detachment, sediment transport and deposition) is not well known yet. It is therefore important to investigate soil erosion and its controlling factors including global climate dynamics.
The current study aims to provide accurate soil erosion estimates on global scale for different climate and land-use scenarios and analyze the effects on the carbon dynamics.
Three main research questions are:
1. How to model soil erosion processes, which naturally occur on local scales, in an accurate way on global scale?
2. How do land-use and climatic changes influence the soil erosion fluxes?
3. How much carbon is mineralized and sequestered due to soil erosion on global scale and what are the uncertainties?
To answer the above questions, the Revised Universal Soil Loss Equation (RUSLE) model will be improved and applied to simulate the soil erosion fluxes on global scale for different climate scenarios. The RUSLE model combines properties of topography, precipitation, soil and land-use to estimate soil erosion fluxes. To assess the importance of soil erosion for the past and future global carbon dynamics, the RUSLE model will be coupled to the JSBACH dynamic global vegetation model and the effect of land-use changes will be studied.

There exist several uncertainties in the modelling of global soil erosion fluxes. The main uncertainties are due to coarse global datasets on elevation, precipitation, soil characteristics and land-use, and due to limitations in the use of the RUSLE model on global scale. The RUSLE model is an empirical model to be used on high spatial and temporal resolutions. To be able to use this model accurately on a half degree global scale, both the model parameters as the spatial and temporal resolution of the input global datasets have to be scaled. Here I show how the scaling issues are tackled in this study in order to improve the accuracy of the soil erosion fluxes and what the challenges are.
Furthermore, RUSLE has two main limitations:
1. Absence of a limit to the amount of soil erosion generated by the model
2. Absence of a parameterization for deposition and transport of eroded sediments
The first mentioned limitation can be addressed by including the gravel content, as it prevents too high soil erosion fluxes to be generated. The second issue will be addressed by including the transport capacity in the RUSLE model. However, scaling will impose additional complication.