ELS2014 –The Earth Living Skin: Soil, Life and Climate Changes
EGU – SSS Conference
Bari | Italy | 22 – 25 September 2014
ELS2014-13-1

From Local to Global Scale Soil Erosion Modelling

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Human activities like deforestation and agricultural practices induce land-use changes that can trigger soil erosion on large scales. Soil erosion also influences the global carbon cycle, which may play an important role for climate change. The current Dynamic Global Vegetation Models (DGVMs) are designed to simulate land carbon dynamics of vegetation and soils as a result of changing climate and land-use. However, they lack the capability to account for soil erosion. This limits their usage for investigating soil carbon dynamics and the global carbon cycle. In this study a stand-alone soil erosion module for the MPI Earth system model (MPI-ESM) is developed. The particular scientific aim is to create a basic structure for the representation of erosion by water on global scale. The erosion module is based on the Revised Universal Soil Loss Equation model, RUSLE, and contains topography, soil, climate and land-use parameters. The RUSLE model, which is originally developed for the local spatial scale, is based on a large set of empirical data on soil erosion gathered under different conditions in the United States. The implementation of RUSLE on the global scale using global datasets is still relatively new. At the same time scaling methods are needed to gap the bridge between local and global scale soil erosion.
Therefore, the current study presents a validation and sensitivity analysis of the different parameters of the erosion module to spatial and temporal resolutions of the input datasets, and to different methods of scaling up. Validation with existing data shows that soil erosion is in general overestimated by the erosion module. With the sensitivity analysis it is shown that the coarse resolution input data cannot resolve small scale features in the landscape, while at the same time the original RUSLE parameterizations are not adapted to the global scale.
Furthermore, the current study also presents some preliminary steps to expand the soil erosion module with a simple representation for deposition and net sediment export to streams. Modelling these local scale dynamic processes is a challenge, therefore a simple representation is proposed where net sediment export is estimated and deposition is the net result of erosion and net sediment export. The advantage of this approach is that the net sediment export can later be validated with long term sediment budgets from river systems. While local scale erosion measurements are scarce, river sediment budgets are more abundant and thus pose a better framework for validation of the erosion module.
Finally, by combining the deposition and sediment export processes with soil erosion a better and more complete picture of the soil carbon dynamics can be obtained.