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Towards an improved modeling of chemical weathering in the SoilGen soil evolution model

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Abstract

As the need for soil information particularly in the fields of agriculture, land evaluation, hydrology, biogeochemistry and climate change keeps increasing, models for soil evolution are increasingly becoming valuable tools to provide such soil information. Although still limited, such models are progressively being developed. The SoilGen model is one of such models with capabilities to provide soil information such as soil texture, pH, base saturation, organic carbon, CEC, etc over multi-millennia time scale. SoilGen is a mechanistic water flow driven pedogenetic model describing soil forming processes such as carbon cycling, clay migration, decalcification, bioturbation, physical weathering and chemical weathering. The model has been calibrated and confronted with field measurements in a number of case studies, giving plausible results. Discrepancies between measured and simulated soil properties as concluded from case studies have been mainly attributed to (i) the simple chemical weathering system (ii) poor estimates of initial data inputs such as bulk density and element fluxes, and (iii) incorrect values of variables that describe boundary conditions such as precipitation and potential evapotranspiration. This study focuses on extending the chemical weathering system, such that it can deal with a more heterogeneous composition of primary minerals and includes more elements such as Fe and Si. We propose and discuss here an extended description of chemical weathering in the model that is based on more primary minerals, taking into account the role of the specific area of these minerals, and the effect of physical weathering on these specific areas over time. In the initial stage, the proposed chemical weathering mechanism is also implemented in PHREEQC (a widely applied geochemical code with capabilities to simulate equilibrium reactions involving water and minerals, surface complexes and ion exchangers, etc.) to facilitate comparison with the model results. Results of both modeling approaches are comparable. There is however need to confront such test results with measurements.