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Interactive comment on "A coupled soilscape-landform evolution model: Model formulation and initial results" *by* W. D. Dimuth P. Welivitiya et al.

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General The authors describe a quantitative model suitable to estimate evolution of some soil physical properties over the landscape. The model description and the presented mathematical formulations look OK. The manuscript is well-written. My major comments relate to the over-selling of the model as a pedogenesis model (see comment 1), to the linkage to the real world (2, 3) and to the clarity of model assumptions (4).

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Discussion paper

1. One major comment, even an objection, that I have is that the paper states at many locations that it concerns a soil genesis model. This illustrates a narrow vision on soil genesis, and comes entirely from a geomorphological perspective. In fact, only soil physical processes are considered, and not even all of these (e.g. heat flow and clay migration are no part of the model, the effect of SOC on erodibility is unaccounted for). It ignores that soil genesis involves many other processes, of mineralogical, chemical and biological kinds. See Bockheim and Gennadiyev (2000) for a list of soil formation processes and Minasny et al. (2015; Fig.5) for a check if these processes are covered by the soil models of to date. I therefore advise the authors to be clear in the ambition level of this model, which is the mechanistic simulation of 3D-redistribution of soil particles of various size over the landscape. Mention perhaps “soil texture evolution model”, but not soil evolution model s.l.

2. The evolution of the soilscape is only to a limited degree connected to physical boundary conditions such as rain, evaporation, heat/temperature. As I understand it, water plays a role to redistribute topsoil material, but does not influence the subsoil (linkages to weathering of minerals, clay migration). The weathering mechanism entirely concerns physical weathering, and the process is driven by 2 parameters n and alpha, which are empirical (section 2.4). True drivers of physical weathering are related to temperature fluctuations, and specifically the occurrence of frost. For these reasons the model is not fully mechanistic, i.e. does not represent the actual processes, but rather “functional”, it describes what happens and uses empirical factors to achieve this. This means that the model cannot be used for studies on effects of global change on soilscapes, where differences in P, PE and T should drive the processes. I would invite the authors to discuss this item in the paper.

3. To allow model testing beyond plausibility testing (“face validity”), which is attempted in the paper, additionally, confrontation to field data would be needed. This is clearly beyond the scope of this paper and, unfortunately, of most soilscape modelling studies. Some sensitivity experiments are done in this paper, which is commendable. I would

expect a strong sensitivity of projected landscapes to the initial landscape as well, but this was not studied. This again touches the ambition level of this model: is it meant for synthetic studies or for real world cases?

4. In general, some assumptions are not so clear. For instance: how does mass redistribution relate to the elevation of the soil-atmosphere interface, in other words, how are mass and volume connected. OK, via the bulk density (for erosion in eq.4; for deposition in eq. 7), but is bulk density then assumed a constant and not affected by bioturbation, strain by weathering? Is this valid over 60.000 years? Are there other assumptions that should be known?

A few specifics:

- l.83: “scorpan” not introduced; this is in fact clorpt+soil point data+position (see McBratney et al. 2003), thus not so different.

- l.573: erosion and d50 correlate: is this a model artefact? For instance, if the organic matter content would be simulated as well, would it not become part of the correlative complex?

- l.689: soil formation and its evolution? =repetition.

Refs:

Bockheim, J.G., Gennadiyev, A.N., 2000. The role of soil-forming processes in the definition of taxa in Soil Taxonomy and the World Soil Reference Base. Geoderma 95, 53–72.

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