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Comment on soil-2021-78

Anonymous Referee #3

Referee comment on "Modelling the effect of catena position and hydrology on soil chemical weathering" by Vanesa García-Gamero et al., SOIL Discuss., https://doi.org/10.5194/soil-2021-78-RC3, 2021

Review of the manuscript "Modelling the effect of catena position and hydrology on soil chemical weathering" by García-Gamero et al.

This research work presents application of a 1dimentional pedogenetic (soil profile evolution) model SoilGen on various points on a catena sale landform and comparing the model results to the measured soil properties in the catena. Through this the authors attempt to identify links between topographic position and hydrological attributes with the chemical weathering of soil profiles in said landform. In addition, a sensitivity analysis of the model has been done using a range of annual average precipitation.

From this work the authors have found that the chemical weathering (represented by chemical depletion fraction (CDF)) seems to have no or very weak correlation with catena position or the slope gradient but seems to have some correlation with hydrological factors such as soil moisture and infiltration. The sensitivity analysis of the model has shown some interesting relationship between the annual average precipitation and chemical weathering. Increasing annual average precipitation seems to increase chemical weathering up to a threshold value after which chemical weathering rate seems to decrease.

The manuscript is well written and easy to follow. The results are well presented and the results interpretation and the physical underpinnings of the results are well described. However I have some concerns with the manuscript (described below) that will probably amount to minor revisions. I believe that the manuscript is acceptable for publication after these concerns have been addressed.

1. I believe the readers would benefit form an additional section to the manuscript describing the SoilGen model and its physical underpinnings. The mathematical formulations of such a model maybe too complex to be describe in detail in manuscript

like this. However a brief description on how the model works (maybe with a flow diagram) would complete the manuscript.

2. In this work, authors have used slope gradient as the only topographical variable in their analysis. Slope does indeed influence the hydrological state of different areas of the catchment. It is well known that both slope and upstream contributing area (cumulative area of the catchment which drain through a particular point) determine the hydrological state of a node in a catchment. In fact all the landform/soilscape evolution models (SIBERIA, mARM3D, SSSPAM) in 3 dimension use area and slope as primary variables for erosion calculations. As I understand the sample points does not particularly lie on a transect or on the same drainage line. So the upstream contributing area could be very different sample point to point. I believe that an analysis on the relationship of contributing area (or the combination of slope and area) and the CDF could be beneficial to this manuscript.

3. As I understand the slope gradient is kept constant for the entire soil profile simulation time of 20000 years? In 20000 years the geomorphology of the catchment would most definitely change and the slope gradient and (for a lesser extent) contributing area of the sample points would also change. The authors have noted this issue and have attributed the difference in the observed and simulated CDF values for this changes. Were any geomorphological evolution (landform evolution) simulations of the catena done using available landform evolution model such as MILESD, LORICA, or SIBERIA to characterise the change of geomorphological attributes (slope gradient and/or contributing area) of the sample points over the simulation time of 20000years? If the authors have done such simulation work they could use a time series of slope gradients extracted from the landform evolution simulation results at each sample point and input that into their soil profile simulation model which may give better results.

4. Page 9: Figure 2: This figure shows the time series input variables used for the SoilGen model over 20000years of simulations. According to the figure 2 form 12000years to 20000years the input variables seems to be constant. Is this an effect of data not being available beyond 12000years in to the history and average values were used from 12000 to 20000 years or the variables are found to be constant using any other means? This was not clear from the text describing the figure2.

5. Page 18: Figure 8: In this figure the authors have provided the results of the sensitivity analysis of the model with respect to different annual average precipitations. The CDF of the upper soil layers (<40cm) increase with precipitation until 800mm/year and then decrease. The general pattern of the CDF-soil depth variation is consistent for all the CDF-depth curves where the CDF is high in shallow soil compared to deeper soil, except for the 900mm curve where the CDF of the upper soil layers are lower than the deep soil layers. The 1000mm curve seems to show the same trend as well. It would be beneficial to the readers if the authors could elaborate on this “inversion” of depth vs chemical withering curve at 900mm and the physical underpinnings they suspect leading to this anomaly.