Earth Surf. Dynam. Discuss.,
doi:10.5194/esurf-2016-37-RC4, 2016

Earth Surface Dynamics
Discussions

Interactive comment on "Quantifying the roles of bed rock damage and microclimate on potential soil production rates, erosion rates, and topographic steepness: A case study of the San Gabriel Mountains, California" *by* Jon D. Pelletier

S. M. Mudd (Referee)

simon.m.mudd@ed.ac.uk

Received and published: 12 October 2016

In this paper Jon Pelletier has used the dataset from Heimsath et al 2012 to explore controls on soil production. In the original paper, Heimsath and colleagues argued that rapid erosion rates could affect the P_0 term in the soil production function. The obvious follow on question is: by what mechanisms does erosion rate modulate P_0? As stated by Heimsath and Whipple's comment (doi:10.5194/esurf-2016-37), the original 2012 paper did not mechanistically explain observed trends. So, does Pelletier's paper give insight into the mechanisms? Firstly we can look at the damage indicator. I found this

Printer-friendly version

Discussion paper

interesting since many authors have speculated on the role of fracturing in controlling weathering rates, and the implementation of equation (3) is a novel attempt to translate mapped faults into a metric for fracture density using results from detailed field studies. To compare this metric with soil production, Pelletier calculates P_0 from every data point by regressing the soil production function, using a slope of h_0 previously regressed in the Heimsath et al paper, to its $h = 0$ intercept. To do this, one must assume that the individual P_0 results are meaningful and not simply the results of scatter in the data due to local heterogeneities in shielding and erosion history; Heimsath and Whipple feel this unwise, a point I will revisit later in this comment. However once Pelletier follows this thread he finds a weak correlation between the D metric and $P_{0,regressed}$ data (I'm not sure if I'd be so bold as to call it measured). One can explain 10What about aspect? There are a few rather high $P_{0,regressed}$ values for south facing slopes. Of the 11 points with $P_{0,regressed}$ values greater than 300 m/Myr, 8 of them are on south facing slopes. But there are also a large number of points on south facing slopes that don't have P_0 values that are higher than the mean P_0 value. The model combining topographic gradient and aspect again shows a correlation between it and the P_0 values, this time explaining 30I am somewhat confused by section 2.2. It seems strange to generate a map of steepness and from that calculate the spatial distribution of h and E. Global topographic maps are readily available so why calculate S from equation (8), which contains many assumptions, rather than just use topographic data? It also seems quite odd to use equation (7) since theory suggests that for a given erosion rate and P_0, hillslope-scale gradient will vary as a function of hillslope length. More explanation of these choices is warranted. It is worth commenting on the use of scatter in soil production data to regress P_0 values for individual samples. Because these numbers were collected at specific points in the landscape (i.e., they are not basin-averaged data), one must consider if the local sources of scatter. Suppose one measured 10 P values in close proximity (e.g., in a 15 m radius): how variable would those P values be? We don't actually know how representative the P values are on a local scale, but we know soil thickness can have quite a bit of local variability, chemical weathering can have substantial local variability, and you can have substantial local variability in the production of 10Be (from where snow falls, any transience in erosion history, etc.). So I do not think Heimsath and Whipple's concern about interpreting the P_0 values is unwarranted: I share this concern. So, in summary, I am worried that the potential uncertainties in P values makes it difficult to come to strong conclusions about influences of other factors on P_0, that even if you believe the P_0 values are representative the correlation with D is rather weak, and that I do not feel the effects of aspect have been sufficiently separated from gradient effects.

Interactive comment on Earth Surf. Dynam. Discuss., doi:10.5194/esurf-2016-37, 2016.