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Pr. V. Vanacker
Editor
Earth Surface Dynamics

Dear Pr. Vanacker,

Please find below our response to your comments on the manuscript entitled *Hillslope denudation and morphologic response to a rock uplift gradient* (esurf-2019-50), on behalf of myself and co-authors.

Best regards,

Vincent Godard

Dear authors,

I have gone through the revised version of your paper, and appreciate the changes that were made in the text. Particularly, the changes made to the methods are useful, and improved the logical flow of the manuscript.

Before acceptation, there are several minor issues that need your attention.

(1) The methods now include the basics of the morphometric analyses, and the geomorphic transport laws that were used to derive the sediment fluxes (here, E*). You have added two equations at the beginning of the section (3.1.1.). I feel that a few sentences need to be inserted, so that the readers can easily grasp the logic flow of the section and the sequence of the equations. For example the link between the first two equations (Eq 1 and 2) and the remaining part of the section (Eq. 4) is not entirely clear to me. Also, note that you express in Eq. 2 Qs as a nonlinear function of the hillslope gradient, then argue for a linear relationship (L181), and then again use the Sc (critical hillslope gradient) in the remaining equations suggesting that you have non-linear behaviour. The text would be easier to follow if you insert a few lines of text between the equations. Also, check that you use systematically the same annotations. The combination of continuity equations (dQs/dx, expressed as a function of E) and z(x) is confusing.
Done. We have reworded the transition from equations 1&2 and equation 3. We have also added further clarification for a better understanding of the evolution from equation 1 to 4.

(2) The relationship between the denudation rates that were measured on the hilltops and the curvature is not straightforward. Figure 12A illustrates this issue, with a large scatter in the denudation rates for the range of hilltop curvatures. Even if you exclude the "P" sample, do you

have a significant relationship between the two variables? Which variable (beyond curvature) is explaining the increase in denudation rates that you observe along the transect? Can you elaborate on the variability of the denudation rates in the text of the discussion? Is there possibly a sampling bias (1 clast or amalgamation of clasts? shielding?)?

Indeed, one single value of D can not account for all the measured C_{HT} and E at hilltop sites, with values spread from 0.003 to 0.006 m^2/a. As discussed in the text, geological and climatic parameters are homogeneous over these sites, and we did not identify any systematic variations for a particular parameter that we could associate with these changes in D. We have added a sentence concerning the eventuality of sampling bias. As discussed in the text, our favored interpretation for this range of values is the existence of authogenic transience for hillslopes leading to local acceleration or deceleration of erosion due to short-wavelength and short-lived changes in surface conditions. Such effects are usually averaged out when using catchment-wide denudation rates but are more visible in this study where we use direct measurements of denudation at hilltop locations.

Beyond these two comments, I have minor editorial comments

L134: What do you mean with “passive” benchmark.
Done. Changed to *passively deformed marker*

L134: tilting
Done

L135: I would delete “recent”
Done

L155-161: The argumentation on the transport-limited system is a bit confusing.
Done. The corresponding sentences have been reworded to better indicate that the first one was relevant to the hillslope dynamics, whereas the second one was dealing with the river network.

L208: hillslope
Done

L185: Can you clarify the definition of LH? Is LH, the maximum hillslope length?
Done. Horizontal distance from hilltop to channel

L191: In Eq. 7, isn’t there a Er value missing in the right term?
No, E* is obtained by dividing equation 3 by equation 5. This is now explicitly indicated in the text

L225: Can you write the full equation? In the short version, you have written only dz in the left term, and dx in the right term.
Done

L228: In Eq. 12, you write z(x) and z(xb), while in previous equations, you have used the abbreviated form and have written “z”. Please check for consistency.
Done

L288 and following: Can you include the units of the measures of hillslope gradients?
Done

L292: Why do you refer to “highly mobile conglomerate-derived class”? What is the size of the clasts? And what is the diffusive process responsible for mobilisation of the clasts along slope?

What we want to underline is the low cohesion of the regolith as an explanation for the low value of S_c. The information on clast size has been added to the settings. The main processes for downslope transport are creep and dry ravel. This is now indicated in the text, as well as a reference to field photograph 3B.

L306: The reference value of 0.25 is lower than what is commonly observed in literature for steady-state profiles? Typically, values are closer to 0.40 - 0.50. Why do you observe values of 0.25?
In the global compilation of Harel et al. m/n ranges from 0.16 to 0.63. One interesting features of their dataset is that high *K* values (corresponding to highly erodible lithology such as the one we consider here) are often associated with low m/n values (below 0.3). So we do not consider the observed value to be particularly problematic. This information has been added to the text.

L329: Please rephrase "CHT undergoing a 2-fold increase from 7 to 10 km". Can you state from W to E?
Done

L367: Can you add the units here for Sc (m/m)?
Done

L368: What do you mean with "indicating possible decaying dynamics of the landscape"?
Done. "Toward lower relief added"

L369: appear
Done

L367-373: This section - where the authors argue that the R* vs. E* relationship could point to change in climatic boundary conditions along the transect - seems to be contradiction with the statements made on L328-338 of "homogeneity of geological, climatic and biological properties over the transect". Can you clarify your statement (L367-373)?
Done. An eventual change in climate would act at a regional scale and would still result in spatially homogeneous conditions at the scale of our transect.

L508-510: Here, you link the different denudation rates of the hilltop positions with the rock uplift rate patterns. How do you calculate the "implied slope rate of 20 mm/ka" from the differences in the denudation rates measured at the hilltop positions? What is the uncertainty on the derivation of the slip rates? Which assumptions are you using to derive slip rates based on surface denudation rates?
As indicated in the text the key assumption is that of topographic steady state, allowing to consider that denudation and uplift rates are equals. The text has been modified to include the various uncertainties.

L527: delete "globally"
Done

L529: Can you rephrase "between the two ends of the profile"?
Done. Changed to "along the profile"

Figure 2: In Figure 2, the authors map the travel times to the top of the Oxfordian marls. The link between the text (introduction to the study area) and the figure caption is not entirely clear. Can you introduce this information in the description of the study area? Can you explicitly mention why and how you use this information on the top of the basement in you study (for example L360 and following)?

Done. Presentation of the Mées Structure added to the settings section. In the discussion and the caption of figure 2 it has also been clarified that this information on basement geometry was derived from seismic surveys.