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Interactive comment on "Fluvial response to changes in the magnitude and frequency of sediment supply in a 1D model" *by* Tobias Müller and Marwan Hassan

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We thank the referee for the helpful comments provided. Following the comments, we intend to change the manuscript in the following way:

Shorter comments

1,2,3,8,9,15,16,18,20) We will follow the advice and edit the manuscript accordingly. We will also include a list of symbols and be more explicit in the shortened grain size characterizations.

Longer comments

4) Why did the author choose a value of alpha equal to 0.45 when laboratory experiments with sand and pea gravel show that is varies between 0.2 and 0.3 (Toro Escobar et al., 1996; Viparelli et al., 2010)?

- We chose alpha as 0.45 as it produced the best match in slope, D_g, D_{90} and transport rate to the flume experiments. How changing this parameter affected the model performance is shown in the sensitivity analysis in supplement figures S1-S4. We will clarify this in the manuscript.

5) Why did the authors implement a procedure to store and access the vertical stratigraphy and then do not use the numerical results to characterize the grain size distribution of the substrate (page 14, line 7)?

- We implemented subsurface stratigraphy to allow for surface/subsurface interactions. As the videos in the supplement show, the subsurface is mostly unaffected by the sediment feed regime. We did not want to restrict the model in case subsurface/surface exchange of grains would become important, for example with very large pulses in the equilibrium simulations.

6) How did the authors specify the downstream boundary condition of the flow equation in the case of subcritical flow?

- In case of subcritical flow, we calculated water depth using normal flow conditions + 0.01 m. We will clarify this in the manuscript.

7) Was the laboratory flume a water recirculating and sediment feed flume? If it was, how did the authors accounted for the constant volume of water in the system in the calculations? (Parker and Wilcock, 2003; Parker, 2004 – Chapter 22)

- A sediment feed flume was used for the experiments, not a recirculating one. In the flume experiments a constant flow volume was maintained within an error of 2%, which is why we did not see the need to adjust the flow in the calculations.

10) Pages 10 and 11, lines 16-17 and 1-20, this is a very long paragraph and it is very difficult to follow

- We will rewrite this paragraph to make it clearer.

11) Page 11 line 24, Gfluv is this surface?

- Yes, we will add a note to specify this.

12) Page 12 line 2, What do the authors mean with 'transport rate at equilibrium might be reached before an equilibrium in slope'? If the time rate of change of bed elevation is computed with equation (8), when the bedload transport rate summed over all the grain sizes does not change in the streamwise direction (equilibrium), the bed elevation does not change in time and the slope does not change in time. I do not understand how mass can be conserved if the sediment transport is in equilibrium and the slope is not.

- We meant that under constant feed conditions the transport rate might approximate the feed rate while the slope still adjusts. We agree that this statement is unsubstantiated and will be removed.

13) Page 12 line 16, why didn't the authors validate the model with the grain size distribution of the sediment used in the experimental run? This information should be given in the model validation section with the discussion on how they determine the values of the model parameters, i.e. reference Shields number of the Wilcock and Crowe relation and alpha

- In the simulations we used a normally distributed approximation of the flume grain size distribution (GSD) with a sigma of 1.6 to allow for systematic alteration of this distribution in the equilibrium experiments. This distribution and the original flume GSD are statistically the same in D_g and D_{90} is within the error of measurement of the flume experiments.

14) It is not clear to me why the comparison between experimental and numerical results presented in Figure 3 is not done in the central 2 m long section of the flume. In other words, why did the authors average the numerical results over the entire flume length?

- In the simulation we averaged over the full length of the flume as we assume the average condition is the best representation of the state of the system. In the flume experiment the central 2m section of the flume was assumed to best represent the state of the experiment to avoid a bias of bed surface measurements due to the outflow and inflow conditions. Note that both transport rate measurements and the slope measurements represented the state of the full length of the flume.

17) Page 15 lines 4-8, the authors write 'In simulations with a narrow GSD (sigma < 0.4), we observe a decrease in Smlp when the pulse period is long'. In Figure 6c there seems to be a decrease in Smlp when the ratio between the pulse period and the fluvial evacuation time is slightly larger than 1 in all the runs but two, i.e. sigma = 0.4 and 0.7. As the ratio between the pulse period and the fluvial evacuation time increases, Smpl is larger the Sconst in the runs with sigma > 1. What am I missing? Any explanation for the behavior when the ratio is close to 1?

- With a 'long' pulse period we do refer to cases where the time between pulses is longer than the fluvial evacuation time (T_{pp}>T_{fe}). With this sentence we explicitly refer to sigma < 0.4 as these simulations show a gradual decrease in S_{mlp}/S_{const}.

It is correct that the response of the simulations with other sigma values is mixed, with some showing a drop in S_{mlp} right at $T_{pp}/T_{fe} = 1$. As we explain later in the manuscript, we attribute this increase in S_{mlp} to the armouring of the bed. The simulations showing an intermittent decrease of S_{mlp} are in a state in which material can be efficiently exported from the system without having intense armouring limiting the slope adjustment yet. Note that these large pulses increase the slope quite rapidly, leading to high shear velocities which allows high transport rates. In conclusion, we see the states of lower S_{mlp} as conditions where armouring did not become the dominant control yet, which happens when $T_{pp}/T_{ar} = 1$ as shown in Figure 6d. We will add this interpretation to the discussion.

19) Page 19 lines 8-10, the authors write 'Yet, the flume might be too complex of a system to ever reach an equilibrium in the same way as the numerical model, and the response of slope in the flume experiments might be transient, meaning that the adjustment of the channel cannot directly be attributed solely to the most recent forcing event'. It seems that the authors are questioning the usefulness of the numerical simulations presented in this manuscript and the validity of their model verification. Consider rewriting in a more positive way.

- We will rewrite this part and additionally consider comments of referee 3 regarding applicability of the model results.

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