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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

Anonymous Referee #3

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Review of "Fluvial response to changes in the magnitude and frequency of sediment supply in a 1D model" by Müller and Hassan

The authors asses the effects of sediment pulses or episodic sediment supply on channel geometry (slope and bed surface grain size) under conditions with a given channel width. They address the effects of the magnitude and the order of sediment pulses. The topic is interesting to the ESurf reader but the reviewer feels that (a) there are a number of content-related issues that need to be addressed (see below) and (b) the manuscript structure needs to be improved in order to communicate the paper message to the reader in an effective way.

Main comments:

1. Structure and readability of the manuscript require improvement. Reviewer 2 provides a list of suggestions. I was especially troubled by the later part of the manuscript.

The authors have provided animations of some of the numerical runs, which tell us that there may be some issues with the numerical model:

2. the model result (BESMo_SupplementVid_OF.mp4) seems to be nonuniform (concave) at times at which, the reviewer thinks, the result should be uniform or spatially invariant;

3. there seems to be a problem with the modelling of the substrate grain size (it is varying during the run); is sediment mass properly conserved?

4. in run BESMo_SupplementVid_OF.mp4 the water surface elevation shows unphysical wiggles;

5. the numerical model consists of only 13 cells: this seems to be a small value given the focus of the manuscript on the spatial propagation of disturbances induced by sediment pulses. I suspect that the simulations would crash for a smaller grid size given the boundary condition of the sediment supply?

6. the model is applied to transcritical conditions, which implies that bed level change and the flow need to be solved in a mathematically coupled manner (Lyn and Altinakar, 2002);

The calibration of the model parameters is yet unclear:

7. The strategy used for parameter calibration needs to be clarified. What parameters are considered to be calibration parameters? Why? How is the calibration conducted?

8. Now slope at the end of the experimental and model runs seem to be equal. Is this the result of the current method of calibration?

9. Friction parameter(s) can be calibrated separately from parameters in the sediment transport relation. This simplifies the calibration procedure and improves its result.

10. It would be good to use part of the laboratory experiments for model calibration and the remaining part for model validation. It may be a good idea to use the 'simpler' experimental runs (equilibrium runs?) for parameter calibration.

Other main comments:

11. P5 Eq. 2b. It is unclear to the reviewer whether and why the equation for the normal flow depth would hold under transcritical and supercritical conditions. Please explain.

12. P5 Fig 1. Unnecessarily complex figure. Also, why is slope included in the 'hydraulic part'? Should it not be part of the 'sediment part', right after 'elevation change'?

13. P3 ln 20. What is a "quasi-grey box system"?

14. Definitions of 'equilibrium', 'quasi-equilibrium', and 'dynamic equilibrium' would be more suited in the introduction section.

15. After providing these definitions I think the authors need to describe the controls of the equilibrium state of a channel. Also, please explain which parameters are governed by these controls. Also, Blom et al (2017) describe how it is the mean sediment supply (and its grain size distribution) that sets the mean channel slope and bed surface texture in the normal flow zone. It may be nice to test this finding in the current manuscript. Problem here would be that it is not straightforward to create a normal flow zone in a laboratory flume (see next comment). In any case I think it would be useful to relate the current findings to the Blom et al (2017) findings. P2 ln 19-21 "in contrast to". This statement may be fine-tuned by addressing the findings of Blom et al (2017).

16. Authors' laboratory experiments are, over their entire length, governed by a "hydrograph boundary layer" (e.g. Parker, 2004; Wong and Parker, 2006) and, at the same time, a backwater segment (e.g. Nittrouer et al., 2012; Lamb et al., 2012). The reviewer

thinks that this fact, as well as the associated implications, need to be well explained to the reader.

17. Please note that a dynamic equilibrium will only be reached if the sedigraph is repeated for a sufficiently long time.

18. P2 ln 33-35. I think a connection should be made to the above-mentioned hydrograph boundary layer. P3 ln 3 "temporal sensitivity". It seems that here the authors are actually talking about the hydrograph boundary layer? P3 ln 1. "may never achieve equilibrium". The fluctuations of bed elevation and surface texture in the hydrograph boundary later do not imply that equilibrium is not achieved.

19. P3 ln 8. "This reaction is not instantaneous, but delayed by a reaction time in which no adjustment takes place." Why would there be a phase of NO adjustment? I do not understand the physics underlying the "reaction time".

20. P4 ln 5-9. The current research questions can be improved. The first question is a yes/no question, which should be avoided. The 2nd one needs to be subdivided into two questions.

21. P2 ln 2 "substantial body of research". Please specify references. I am not certain that, regarding the impact of sediment pulses, lowland have received more attention than mountain streams.

22. P5 Eq 10. I would call this equation the Hirano (1971) equation (describing conservation of the mass of sediment of the ith class within the active layer) and not the modified Exner equation.

23. P7 ln 9-10. "fixed bed elevation at the outlet". Does this mean a hydrodynamic downstream boundary condition in which the normal flow depth is imposed at the downstream end? If so, please explain this to the reader.

24. P7 ln 13-17. These lines do not fit in this section on model setup.

25. Section 2.1. How are the model equations solved? What numerical schemes have been used for the time and space discretization?

26. Given the fact that the laboratory experiments, over the entire length, are governed by a hydrograph boundary layer, the results of the numerical model are expected to depend on the spatial grid size. Please address this issue.

27. P7 ln 31 “Photos were used..” what method was applied here? What parameters were measured using this method?

28. I do not well understand Tables 1 and 2. I see codes R1-R7 and OF-cFtM. How do these codes relate to each other? Are you certain you want to use the complex codes OF-cFtM? Table 2 lists the total mass fed, but what is the duration of each experiment? In other words, what is the mean sediment supply rate? In table 2 why are the values either 1500 kg or 2100 kg and not all 1500 kg? What about the grain size distribution of the supplied sediment? I do not well understand the feed rate, duration, and pulse period values of Table 1. Please explain or reconsider the presentation of the values.

29. P12 ln 2-3 “For example a transport rate equilibrium might be reached before an equilibrium in slope.” I am not certain I agree with this statement.

30. P12 ln 14 “In the flume Dg and D90 were measured in a 2 m wide middle section, while slope, Dg, and D90 in the simulation are averaged 15 over the full 12 m length.” This mismatch seems unnecessary. For the simulation data the modeller can chose any averaging length, so also the one that matches with the laboratory experiment.

31. P12 ln 16. “. We achieved the best match (shown in Fig. 3) with a grain size distribution of width σ = 1.6”. This I do not understand. The grain size distribution of the sediment does not need to be calibrated, right? The sediment specifications seem to be known from the laboratory tests?

32. P13 ln 3. “which shows that the main factor determining the long-term slope is the total volume of sediment fed”. This seems to confirm the findings by Blom et al (2017)?

What is the role of the GSD of the supplied sediment?

33. The conclusion section seems to be a summary rather than a conclusion section. I would reconsider and shorten this section.

Specific or detailed comments:

34. P1 ln 5-6. “was configured using flume experiments with a similar scope.” I’d suggest to rephrase and be more explicit here.

35. P2 ln 7. I’d suggest to rephrase “evacuate a grain size”

36. P2 ln 8 “Patterns of quasi-cyclic behavior”. Please explain.

37. P4 ln 11 “We developed”. Should it be “We applied”?

38. P5 Eq. 2a. Has S0 been explained?

39. P5 ln 3-4. Meaning of sentence is unclear. Also, Eq 2 should be Eq 2a?

40. P5 Eq 8. Exner eq is needed ony if N-1 Hirano equations are used (N is number of grain size fractions). Alternative is to use N Hirano equations and not the Exner equation.

41. P5 ln 24 “the exchange of material between the layers”. I’d replace this by “The grain size distribution of the sediment flux between the active layer and the substrate..”

42. P6 ln 19 “to parameterize the model”. Not sure you are saying what you intend to say. Do you not mean “to find values for model parameters”? Multiple locations in text.

43. Slope in mentioned twice (P6 ln 17 and ln 28).

44. P8 ln 18. I do not think the reference Shields stress of Wilcock and Crowe is a “critical” stress.

45. P8. Here you describe several flume runs without listing the run code. This leads to unnecessary confusion.

46. P8 ln 1. “number of stones”?

47. P20 ln 22. “grain size distribution” of what?

48. P20 ln 27 “GSD of the system”. I guess this should be “GSD of the bed surface”?

49. P22 ln 14. “The Tobias”?

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