# 1 Comments by Associate editor, Rebecca Hodge

Thanks for your careful response to the reviews. I have read through the reviews and the revised paper, and identified some points where some additional explanation would help to explain some of the underlying rational behind the model. Thanks also for incorporating more literature into the paper. There is another recent paper that would be worth considering: Gabel V, Tucker GE, Campforts B. 2024. A mathematical model for bedrock incision in near-threshold gravel-bed rivers. Earth Surface Processes and Landforms 49 : 4168–4186. DOI: 10.1002/esp.5957

**Reply**: Good point. I also added a comment to highlight the differences between our simulations and the stream-power incision model (line 285-288).

Comments by line number in the tracked changes version:
78: The justification for the value of A* was raised by one of the reviewers; please add the explanation in your response to the main text.

**Reply**: Done. This was explained in the previous rebuttal letter, but the text has not been amended. It's done now.

80: Delete 'The exponent…' as this is now repeated earlier.

**Reply**: Done

96: Like the reviewers, I don't understand why transport length is a more relevant parameter than hop length. To me, hop length makes more sense as it is describing the trajectory of the grains and hence the distance between grain impacts with the bed. I think that you need to clarify what you mean by deposition. To me, deposition is the point at which the grain stops moving for a period of time, and between entrainment and deposition there might be several saltation hops, i.e. the grain impacts the bed multiple times over this distance. In this situation, the transport length would be several times the hop length, and using the transport length in place of the hop length would underestimate the number of grain impacts. If you are considering deposition as any time when the grain contacts the bed, even if it is immediately entrained again, then the hop length and transport length are comparable. Please make it clear which scenario applies to your model. This is further confused in Table 1 where $\xi$ is referred to as a sediment hop length.

**Reply:** I think there is a misunderstanding of what the transport length, $\xi$, is. This parameter does not describe the deposition process with a rest period of varying duration as you describe it; it simply established a linear relationship between the deposition rate $\dot{d}$ (i.e., the flux of particles that are about to settle) and the sediment flux $q_s$ carried by the river. The ratio of $q_s$ to $\dot{d}$ has the dimension of a length, and simply states that, for given hydraulic conditions, $\dot{d}$ is proportional to $q_s$. An example of what transport length might look like is a sediment-laden river flowing over an initially sediment-free, non-erodible bed. The transport length is the distance from the inlet where deposition occurs before the sediment is re-entrained. In the SD2004 model, the important factor is the deposition rate $\dot{d}$, and that the transport length defines this flux from $q_s$.

I have removed all remaining references to 'hop length' and replace them with 'transport length'

104: In SD2004, the cover term is the areal exposure, not the sediment thickness. Are you assuming that the area and depth of sediment cover are proportional?

**Reply:** In line 104, I use "cover" to indicate that the sediment covers the bedrock. The absence of "cover" therefore means that 100% of the surface is exposed. Note that, to avoid any ambiguity, I have added a sentence to equation (11b) specifying that $h_s$ is an average thickness, i.e. a volume of sediment per unit area, that takes into account both spatial coverage and variations in thickness.

140: Is es the actual sediment erosion rate, or the potential erosion rate in the case of unlimited sediment supply? If it's the actual erosion rate, wouldn't it be possible to have a scenario of a bedrock channel where there is no sediment cover and any sediment that is deposited is immediately entrained, such that deposition is equal to erosion? Fig 1 implies that this only occurs in alluvial channels.

**Reply:** Yes, $\dot{e}_s$ is the potential erosion rate and $x_s\dot{e}_s$ is the actual erosion rate. For the actual erosion rate to equal the potential erosion rate, there would need to be sufficient sediment on the surface, i.e. $x_s = 1$. While the model does not calculate actual sediment thickness, the partitioning implies that there is no bedrock erosion when $x_s = 1$, as all the sediment is reentrained before it can impact the bedrock.

164: Correct equation reference.

**Reply:** Done.

360: What are the units of topography and the sediment map?

**Reply:** The units for topography and sediments are in meters.

380: Units needed for the colour bars.

**Reply:** ok. I added a comment about the time units. The simulation time is the total duration of these high-flow events, expressed in years. In reality, these events occur sporadically, so the actual time should be longer.