Response to AE comments.

General comments

E: Referee 2 made a good comment about using D84 rather than D50. Your response to them indicated that using D84 did not change the results, and I think that it might be of interest to readers if you included this in the paper.

A: In the results, I have clarified this in two ways:

- Noting that changing D50 to D84 has no effect on the correlation between qb and excess shear stress, and
- rather, this change merely reduces the critical dimensionless shear stress values

Comments by line number (from the tracked changes pdf)

E: 9: When reading the abstract before I read the rest of the paper, I didn't follow the sentence starting 'Back-calculated critical…'. Maybe split into two, to start by explaining that you back-calculated tau_c, and then explaining how it varied between the two approaches.

A: We agree this could be clearer – here is a revised version: "Critical dimensionless shear stress values were back-calculated and were higher for the 2D approach compared to the 1D. This result suggests that 2D critical values account for the relatively greater influence of high shear stresses, whereas the 1D approach assumes that the mean shear stress is sufficient to mobilise the median grain size."

E: 27: Change to 'widely used'

A: Done.

32: Define tau_c50. Explain whether you are referring to spatial or temporal variance in shear stress.

A: This has been defined, and we have clarified it is the spatial distribution that is being mentioned.

80: Give the precision of the gauge readings here. The equation for h didn't follow on from the rest of the sentence, as I think that you are measuring h directly, not from the area and w (which was implied by the equation)?

A: I have provided measurement precision. We are in fact using the $h = A/w$ equation when pairing the gage readings with the topographic data. I believe the order in which we explained this led to confusion and so I have moved the discussion of random error until after the data processing has been explained.

E: 125: It would be useful to provide a description of how the model calculates shear stress. This would also help later on to explain why in the model the depth and shear stress are not correlated, as in Fig 5.

A: We agree and have added that in the numerical model local shear stress is calculated using the bed friction coefficient and depth-averaged flow velocity components.

E: Table 3: Clarify which variables are modelled and which are measured in the flume.

A: This has been clarified in the table caption: "Summary of reach-averaged hydraulics (from 2D flow model) and sediment transport (from measurements)."

E: 172: The different methods are a key point in this paper, and could still be more clearly explained. It's up to you, but I'd move the appendix material to here, as it isn't long, but is important. Two things weren't clear to me. First, are all the depths in the depth-slope approach also derived from the flow modelling? Or the gauge measurements? I assume that it's the former, but when you specify that your second shear stress measurements come from the flow modelling, it implies that the first approach might come from a different data set. Secondly, it wasn't clear to me at what spatial resolution you were calculating depth and shear stress in the 2D approach – at the 1 mm resolution of the DEM?

A: We have decided to keep the full equations in the appendix as the existing explanation in the methods is self-contained.

We agree this was ambiguous and have been more clear – "1) the depth-slope product ($\tau = \rho gdS$) based on numerically modelled flow depths, and 2) numerically modelled shear stresses"

In the methods we specified that the numerical models had a grid resolution of 5 mm. For clarity, I've added a second mention of this resolution when discussing the frequency distributions of shear stress in the results section.

E: Table 4: I think that this should be in results, rather than the methods.

A: It is now in the results section.

E: 197: This comment about the amount of the bed where tau is between tau_c50 and mean tau comes up a few times, but I didn't quite understand why it was so important. A reference to Fig 6 here would help. 37% of the area doesn't sound that insignificant. Would it also help to explain what proportion of the bed had tau greater than mean tau?

A: We have added the reference to Figure 5. We have altered some of the interpretation in the discussion to make our point clearer: that although the mean shear stress may particulate in bedload transport, it may be far less important than the higher shear stresses. This is intuitive, but it is important to note as an explanation for why the back-calculated critical dimensionless shear stress values may always be higher if they come from 2D transport functions.

E: 208: I assume that you mean modelled shear stress?

A: We have clarified this.

E: 210: I don't think that you have defined how you normalised depth and shear stress.

A: We have made sure to use the term "mean-normalised" rather than just "normalised".

E: Fig 6: Add the symbols q and tau to first sentence of the caption.

A: Done.

E: Fig 7: x axis label in panel a should be tau/mean tau or depth/mean depth.

A: I've made the correction.