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Interactive comment on "Self-similar growth of a bimodal laboratory fan" *by* Pauline Delorme et al.

Anonymous Referee #1

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I think this is a good paper and would recommend it for publication with minor revisions. The manuscript could really use more background on field observations of alluvial fans, particularly the threshold versus transport theories of fan slope, and a discussion on how well the experiment results reflect and can be applied to real-world observations. There were a number of errors in grammar and general sentence structure. I note a few of these in the technical corrections, but the paper could use a read-through and edit by one of the native English-speaking authors.

Alluvial fans often have a single main channel, rather than many radiating from the apex. The experiments of Reitz and Jerolmack (2012) behaved similarly to real fans, with multiple channels occurring only briefly during avulsions. The experiments for this study never had fewer than 4 channels. Why is this, and how are the results applicable to real alluvial fans if they differ in this regard?

Stock et al (2008) report a similar distance between the proximal and distal fan, but

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that median grain size of gravel deposits remained constant for the upper 70% of the fan. Some discussion of this would be useful.

How does the 32% length for slope transition compare with real-world fans? A couple possible sources are a databases of alluvial fans: Saito and Oguchi (2005) for humid fans, and perhaps reviews by Blissenbach (1954), Anstey (1965), or Hooke (1968) for arid fans.

You make a few references to “run 2”, and it gave me the impression that you only did your analyses for that single run. Assuming you mean to say that you are using run 2 for your figures as an example, I suggest adjusting the text to make this clear (if you did only do analyses for run 2, please explain why).

Was all of the material transported as bedload, or was some portion able to transport as suspended load? Did material deposit outside of the main channel? In the distal sections (the coal only section) of the fan was flow channelized? A shift from dominantly channelized flow to dominantly overbank flow downstream might affect your assessment of fan slope being controlled by the sediment grain size. Reitz and Jerolmack (2012) report extensive overbank flow during avulsions on their experimental fans, and similar behavior has been noted for fans based on field observations (e.g. Field 2001- “Channel avulsion on alluvial fans in southern Arizona”), did your fans feature similar behavior?

In the conclusion you note that you can estimate the sediment flux that fed the fan. While this may be true for your experimental fans, the grain size distribution and flux of sediment feeding alluvial fans is essentially never constant, so when examining alluvial fan surfaces we are only really understanding the depositional processes responsible for constructing the upper few meters of the fan. In addition, fan surfaces can be reworked, masking the formative process (de Haas et al, 2014). Some discussion of this and a description of how well your results can be applied to alluvial fans in the field would be very helpful.

The many sections of the paper seem a bit convoluted. The flow of the paper would be better sections 3-6 were merged into something like “experimental setup”, “model runs”, and “math analyses (or something)”. As it is now the division of sections 3 and 4 (as well as 5 and 6), seem a bit arbitrary, and the lines at the end of each section offering a preview of the next section are awkward. I would also suggest adding a “Notation” section as a reference for the different variables used in your equations.

Line by line comments and some technical corrections (page.line):

1.14: I think the reference here is supposed to be “Blair and McPherson (1994)-Alluvial Fan Processes and Forms”. There is a new version of this book chapter from 2009 (in book “Geomorphology of Desert Environments”) (the ref list has another Blair/McPherson paper from 1994)

2.5: “Perfect cone” is only the case for purely debris flow fed fans. See Williams et al (2006) “Aspects of alluvial fan shape. . .” (Williams et al also report that fluvially-fed alluvial fan slope-distance profiles (e.g. your figure 6b) follow an exponential fit, rather than two distinct slopes with a transition zone)

2.6: “Possible explanations for this curvature. . .” adding into this sentence that you are talking about the “transport” and “threshold” theories fan slope would clarify other parts of the paper where you refer to threshold theory.

2.21: “. . .no clear consensus. . .” some more detail/background on this would be helpful

3.14-26: this paragraph was hard to follow. See a few examples below:

3.16: rephrase sentence to “When unmixed, we find that for the same shear stress τ, the flux of coal grains is larger than that of silica grains (Fig. 2)”

3.19: rephrase sentence to: “The shear stress required to move large grains in the mixture is lower than it would be in a system of only large grains, because they protrude more into the fluid.”

3.21 “larges grains” change to “large grains”

3.22: “. . .different densities. . .” what about different diameter grains? Does this have an effect?

4.4: Is the “impervious wall” vertical?

4.13: See comment above. Alluvial fans typically have a single channel emanating from the apex which splits further downstream. The avulsion process appears different than the experiments of Reitz and Jerolmack (2012).

4.19: “Coal is deposited on the banks”: is coal ever deposited overbank?

4.26: “during run 2”. Did you only examine the boundary on run 2? Or do you mean to say that Fig 3a is of run 2? If the former, why not for other runs?

4.31: Same comment as for line 26

5.19: When describing similarities between profiles, do you mean all radii for a single fan, or across fans for all experiments?

5.25: See commend above (comparing the apparent match of sediment distribution change and slope transition with observations by Stock et al (2008))

7.3: the font for the variables in equations 7 and 8 is different

7.20: The sentence phrasing and grammar in this paragraph could use some editing.

7.24: Some background on the “threshold” vs “transport” theories for alluvial fan morphology would be useful.

8.33: Do you mean to say with “sediment discharge relative to water discharge” (i.e. sediment flux)?

9.20: The Conclusions section could also use some edits to grammar and sentence structure.

9.32: References here ("...in our experiments")

9.32-33: "As a consequence, we expect that the geometry of the final deposit (location and slope of the transition and proximal and distal slopes) allows us to estimate the relative flux that built the fan." This sentence seems like a big jump. The sediment supply to alluvial fans is not constant as it was in the experiments. Perhaps you mean to say the relative flux for the most recent fan deposits?

Figures:

Table 2: replace g/min-1 for sediment discharge with Lmin-1 (___is silica fraction volume or mass___...in eqn 3 it is volume) so that it uses the same units as Qw (and is easier to visualize V/V)

Fig. 3: Would it be possible to adjust contrast on photos of the fan (e.g. fig 3) so that it is easier to discern the silica against the coal?

Fig 6/7: I suggest using the same horizontal scale for these two figs.

Fig 7: Specify which run this is from (presumably run 2?)

Figure 10: this figure could probably be merged with Fig 3.

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