Earth Surf. Dynam. Discuss., 3, C231–C234, 2015
www.earth-surf-dynam-discuss.net/3/C231/2015/

Earth Surface Dynamics Discussions

Interactive comment on "Grain sorting in the morphological active layer of a braided river physical model" *by* P. Leduc et al.

Anonymous Referee #2

Received and published: 12 August 2015

This paper examines spatial grain size variability in the morphologically active layer of a braided river physical model. The morphologically active layer is defined as that volume of sediment bounded by the surfaces of deepest scour and highest fill at each plan position across the model domain. The model was run for 40 hours. A surrogate measure of bed surface grain size was derived once every hour from the grey-scale properties of bed texture in overhead imagery. Surface DEMs were created photogrammetrically from the same images. At each plan position, the thickness of the morphologically active layer was used to normalise the absolute elevations of each surface and the resulting relative thickness was divided into ten layers of dimensionless bed depth. For a given layer at each time point, a subset of plan positions had associated grain size estimates, so that forty spatially partial maps of grain size were constructed for each layer. Final maps of estimated grain size in each layer were derived by computing the

median value of the grain size estimates at each plan position. Averaging by layer across the whole model domain provided an indication of the grain size distribution at specific relative depths in the morphologically active layer. With the exception that the two deepest layers show a tendency to be coarser grained, the distribution of grain sizes was almost identical within each layer. The principal result is then that the morphologically active layer was essentially homogeneous, which leads to the conclusion that in braided rivers, despite locally complex sorting, there should be very little vertical sorting of bed materials at reach scale.

General comments: The paper addresses a knowledge gap – we know very little about the 3D variability of bed material grain size in braided river deposits. I agree with the authors that this is a significant gap, for example when seeking to parameterise numerical models of braided or wandering river processes or when applying the morphological method to derive transport rates from measurements of morphological change. The modelling approach is appropriate; indeed, physical modelling is almost certainly the only practicable means of studying this question. The idea of the morphologically active layer is very useful and normalisation of the cell-by-cell elevations by active layer thickness provides a sensible means of conceptualising and analysing the problem. In detail, the derivation of a median grain size surrogate using Carboneau's method is pragmatic and reasonably well constrained. The results are novel – I am not aware of any equivalent assessment of textural variability with depth for braided river deposits – and the conclusions will be of interest to the braided rivers community and those who work on related systems, including wandering gravel-bed rivers. Overall presentation is good. In sum, this is an interesting, well executed piece of work that can be published subject to consideration of some relatively minor points.

Specific comments: 1. The derivation of final grain size maps for each layer (Figure 7) is described in section 3.2. It is too succinct. It took a significant amount of time to understand the procedure (I hope the synopsis above is correct). A better explanation would improve the paper and a schematic diagram that illustrates how final maps were

derived from layers, time and cell position would be beneficial. Readers will not be convinced by the results without a clear appreciation of how the layer by layer data were obtained.

2. A niggling concern is that the reconstruction of the sediment volume is based on multiple maps of the surface bed material. Where grain sizes from multiple time steps are available for a particular point in a particular layer you use the median to represent the cell's grain size (page 587, line 5), but no other modification of the grain size is made to account for post depositional alterations unless the surface is completely replaced. You therefore assume that the surface textures are preserved at each time step without subsequent modification or alteration. I'm not convinced that this is straightforward or reasonable. Some discussion is needed to clarify your thinking about the relation between the surface measurements that you use and the sediment volume that you derive.

3. Figure 9 is not terribly convincing. The associated text is quite speculative, so it just about works, but a fuller analysis of the spatial coincidence of the confluence zones and coarsest patches would improve the argument.

4. Gravel-bed rivers are generally expected to exhibit armouring, albeit patchy and dependent on sediment supply and it is likely that many readers will be interested in what this data set reveals about relative surface coarsening. It would be good to see some explicit consideration of the degree or not of surface coarsening because armouring plays a key role in our understanding of transport processes and is always a consideration when sampling surface vs sub-surface bed materials.

5. Sticking with sampling, the results presumably have implications for how braided river deposits should be sampled in order to obtain representative grain size data? It would be useful to see some consideration of that as a justification for and outcome from the work done.

Technical corrections: 1. Page 579, lines 1-15. Many of the sorting patterns and

processes at work in braiding rivers may also produce similar sedimentary packages in wandering gravel-bed rivers. Is the literature on wandering river sediments of value here (and might the results be applicable in such rivers?)

2. Page 579, line 20 (and elsewhere, e.g. 578, line 24). It is not clear how you are using the word "aggregated" and whether you are using it consistently. Sometimes it seems to be used to just mean averaging, but in other cases I suspect you mean something else. Clarifying this may help with the need to improve explanation of the process by which the grain size layers were derived.

3. Page 581, lines 26 on. This sentence is too long and should be split in two.

4. Page 582, lines 7-9. The final sentence of the first paragraph is not needed and should be deleted.

5. Page 583, line 1. Is this discharge figure correct? It seems very small.

6. Page 583, line 9. Did you have a set of criteria that helped you decide when the flume bed became fully braided?

7. Page 583, lines 24-26 are unclear and incomplete. Please unpack Carbonneau's method a little so that readers who are unfamiliar with it gain some insight into what it does. For example, what is the "entropy value" here.

8. Figure 6 floats – there does not appear to be any reference to it in the text.

9. Figure 8 is the key analytical figure and is useful in showing that the equivalent GSDs vary little between layers. However, it is much harder to extract from this a straightforward evaluation of how estimated median size varies with depth, which is one of the points you try to make on page 588. A simple plot, perhaps inset in Figure 8, would make this claim easier to evaluate.

Interactive comment on Earth Surf. Dynam. Discuss., 3, 577, 2015.