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Interactive comment on "Bumps in river profiles: the good, the bad, and the ugly" *by* Wolfgang Schwanghart and Dirk Scherler

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General comments

This manuscript presents a new method for smoothing river long profiles based on a quantile-carving approach, which the authors then use to examine errors in elevation values extracted from different globally available DEMs. The paper is interesting and well-written, and provides useful insight into the applicability of different global DEMs for fluvial profile analysis as well as presenting a novel algorithm which has potential to be used in many studies. I think that the paper is suitable for publication in *Earth Surface Dynamics* following some minor corrections, which I have detailed below. Some general points:

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Discussion paper

- In many studies analysing river profiles, other metrics, such as channel gradient and drainage area, are used along with elevation to examine channel response to changes to external forcings such as climate or tectonics. It would be useful to include some analysis of how these metrics vary between the different DEM datasets, or with and without the CRS smoothing algorithm, as these are key datasets that will be needed in channel profile analysis by any users of the code. I suggest expanding the analysis (either by including a figure or another table) to include statistics of the channel gradients.

- The calibration of the parameters K and τ clearly has a large impact on the elevation values extracted from the profiles (e.g. Fig 3). Although the authors discuss the fact that these parameters can affect the elevation values, it would be useful to include some more guidance on how these parameters can be set by the user to avoid over- or under-smoothing their channel profiles. This has been done for the K parameter in Section 6.2, but it would be useful to also include information on the sensitivity of the method to τ.

- I wonder if there is potential to include a spatially variable K parameter along the profile based on the distribution of local relief (e.g. where the K parameter is calculated directly from the relief of the surrounding landscape, rather than having to be set by the user)? This could be useful in areas like the Nepal site where the topography varies dramatically along profile. I'm not suggesting doing this for the paper, but it may be useful to include as a potential avenue of development for the method.

Specific comments

Page 1, Line 23: river profiles may also reflect signals of base level and sediment transport processes.

Page 2, Line 3: clarify here that bumps in river profiles may also be from real signals of climatic/tectonic perturbations in the profile.

Introduction: traditional methods of analysing river profiles to extract climatic/tectonic signals generally use slope and area as well as the elevation of the river profiles. It would be useful to mention these metrics in the introduction and how they relate to the extraction of the elevation values.

I think the introduction could be expanded to review some of the advantages of fluvial profile analysis and to include some more literature on how these methods have been applied in the past. At the moment I think this is slightly glossed over, and it would be good to emphasise this to show the value of the authors' new method for the geomorphology community.

Page 3, Line 32: I think it would be useful to expand upon these methods here and provide references for these approaches, since these are the benchmark algorithms which the authors are trying to improve upon with their method.

Page 4, Lines 2-5: Is this the running average approach demonstrated in Figure 1?

Page 4, Line 9: It would be helpful for the authors to restate the aims and approach of the study here to emphasise to the reader how the method that they outline improves upon previous methods given the research needs stated in this paragraph.

Figure 1: It would be good to highlight particular sections on the different profiles where the elevation increases downstream to make this clearer to the reader.

Page 4, Line 30: The authors state that the CRS method assumes local smoothness of the profile and spatial autocorrelation. I agree that a non-parameteric approach is very useful, as we don't have to assume that the channel is incision based on a specific model (e.g. stream power), but what is the justification for assuming that these should be local smoothness/spatial autocorrelation? We might expect this to be the case if the profile is in steady state and is nicely concave, but what about if the profile is transient? This will create local patches within the profile which are 'bumpy' or perhaps not spatially correlated. How easy is it for the method to differentiate between these and DEM artefacts?

Page 6, Eq 4: How does the sensitivity of the method vary with grid resolution ($\triangle x$)? From equation 4 it seems that the smoothing should increase as the resolution becomes coarser.

Fig 3: It looks like the smoothing parameter K and τ have a big effect on the final shape of the profile. How should the user choose appropriate values of these parameters? This is maybe explained later in the paper.

Table 1: It would be useful to include the vertical errors on each of the datasets used in the study.

Page 7, Line 4 and throughout: Although the lidar DEMs are much higher resolution than the global datasets, it would still be useful to acknowledge/quantify the errors associated with these datasets. How were they gridded/filtered? What is the vertical error on the resulting DEMs? When was the lidar data flown compared to the global datasets (any temporal differences that could account for some of the error)?

Page 7, Lines 15-17: Would it be possible to vary the K parameter spatially, for example, correlated with relief/gradient? This could be useful for sites such as the

Nepal one where there is a large difference in relief along the profile. May be beyond the scope of the paper for the moment, but it would be interesting to see if there was a correlation between the required smoothing parameter and the surrounding relief, so you could preferentially smooth the profile in areas more prone to errors.

Page 7, Lines 24-28 and Appendix B: I downloaded TopoToolbox and implemented the CRS smoothing method (which was easy to do!). It may be useful in the Appendix to include a link to a tutorial for using the CRS method, which I saw exists on the TopoToolbox wordpress. The authors have provided the tool *crsapp* for visual checking of the parameters, which is great, but it would be useful to provide a tutorial for use of this tool as well.

Figure 5: Could you expand upon this caption to show what is being represented here? Is this the offset for every pixel in the river profile?

Figure 7: It would be useful to see these data for the other two field sites as well as for the Nepal site, to show visually how the distribution of the residuals varies with relief.

Page 9, Section 6.2: I think including analysis of channel slope and curvature may be needed in order to compare the ability of the different DEM datasets to analyse topographic information. Although elevation may not vary much with grid resolution, parameters such as local slope and curvature have been shown to be very sensitive to grid resolution (e.g. Vaze et al., 2010 (Env. Modelling and Software); Grieve et al., 2016 (ESurf)), with the range of slope and curvature values decreasing with resolution. Analysis of elevation values alone may suggest that the TanDEM-X dataset is not an improvement on the 30m datasets, but the higher resolution dataset may actually be more useful for extraction of these other metrics which are also important for channel profile analysis.

Page 10, Section 6.3: In general I like the title, and I get the idea of the good, bad, and ugly errors, but I think it could be expanded on a bit more - the authors should clarify here why random errors are good, and systematic errors are bad (can state more clearly that random errors are easier to smooth from the profile, whereas systematic errors are more difficult to distinguish from real signals).

Page 10, Section 6.4: I think some of this section makes more sense to have in the introduction to set the context of why developing the CRS algorithm is important.

Technical corrections

Page 2, Lines 19-20: I'd suggest rewording this sentence - it's unclear at the moment. Do you mean that random errors may or may not be clustered spatially?

Page 6, Line 15: rephrase sentence 'Thus derived profiles are monotonously decreasing downstream while filtering the wiggles'

Page 9, Line 16-18: Split this into two sentences.

Appendix A3: Equation wrongly labelled, should be A12.

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