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Interactive comment on "Coupling slope-area analysis, integral approach and statistic tests to steady state bedrock river profile analysis" *by* Yizhou Wang et al.

Anonymous Referee #1

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Wang et al. combine elements of the well-known slope-area and integral approaches to solve the stream power model assuming steady state. First, they estimate a value for concavity index (m/n) using an integral approach. They then determine steepness index. They argue, based on previous work, that slope-area analysis can be used to identify substrate along a river (e.g. bedrock, alluvium). They discuss problems with slope-area analysis including differentiation of discrete and noisy data, which produces unstable results. Solving the integral problem avoids such issues. Statistical tests are performed to 'examine if residuals are independent and homoscedastic'.

I have three comments. My first comment concerns the assumption of steady state. The authors do not provide evidence that rivers analyzed are at steady state. They

refer to Snyder et al. (2000), who used Merritts and Bull's (1989) eustatic correlations to determine uplift rates. Merritts and Bull's calculated uplift rates are very variable in space and time (0-4 mm/yr). Snyder et al. outline their reasons for assuming steady state (e.g. low and constant uplift rates for >100 ka south of the Jackass catchment, stable climate, profile shape; see their pg. 1254). They state that disequilibrium conditions are more likely in regions of high uplift-rate (e.g. the rivers north of ∼40oN in this study). Snyder et al. are circumspect in their assumption of steady state. River shape is not diagnostic of equilibrium conditions. In other places, recent work on inversion of drainage patterns for uplift rate histories indicates that river profile shapes are controlled by spatio-temporal variations in uplift rate moderated by erosional processes (e.g. Pritchard et al., 2009; Roberts & White, 2010; Roberts et al., 2012). The inverse integral approach first described in these papers does not require a priori assumption of steady state.

The assumption of steady state makes it difficult to interpret changes in concavity index reported by the authors. Perhaps the shapes of these rivers are a function of smoothly varying uplift rates and a simpler erosional history? It would be straightforward to test this idea by inverting for uplift rate histories and comparison of results to independent observations of uplift along the Californian coastline.

Secondly, there are a number of relevant papers that are not cited. For example, the integral methodology was developed in a number of papers not discussed (e.g. Pritchard et al., 2009; Roberts & White, 2010; Roberts et al., 2012; Czarnota et al., 2014; Paul et al., 2014; Wilson et al., 2014). Their results suggest that uplift can be inserted along rivers, which makes values of chi difficult to interpret. Erosional parameter values in the stream power model (e.g. m and n) can be determined from joint inversion of drainage patterns (e.g. Rudge et al., 2015). In Roberts et al. (2012, doi:10.1029/2012TC003107) the slope-area methodology was shown to produce unstable results for small amounts of randomly distributed noise.

Finally, the methodology (e.g. lines 26-30 on page 4 and lines 1-4 on page 5) is difficult to follow. I think the authors suggest that concavity indices vary along rivers with different substrates (e.g. alluvium, bedrock)? And the point of doing the slope-area analysis is to identify where substrate changes? Their approach needs to be explained more clearly. For example, I think caption to Figure 4c could be clearer (e.g. 'The correlation coefficients of chi-z plots as a function of theta for the bedrock portion of the river'). A comparison between predictions of substrate from slope-area analysis and observations would give the reader more confidence in results (e.g. page 4, lines 14 and 26-30). Can substrate be verified using, for example, satellite imagery/the Snyder paper? Some terminology used is confusing. For example, what does 'proper bedrock channel concavity' mean?

Typographical errors. Page 3, line 7: '. . .a better way to [perform] stream profile analysis'. Page 3, line 15: define zb. Page 4, lines 15, 27, 28: add spaces between numbers and units. Caption to Figure 4: labels for panels e and f are incorrect. Figure 4, panel (f): 'aluvial'.

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