

Response to Reviewer 1, “The impact of earthquake cycle variability on neotectonic and paleoseismic slip rate estimates”

Richard Styron

Reviewer comments denoted as [Ax] where x is the comment number. Comments referenced as [Ox] or [Bx] refer to those from Reviewer 2 and 3, respectively.

Review by Anonymous Reviewer #1

[A1] P1L1: I suggest to use “aleatoric variability” and “epistemic uncertainty”. That way there is only one “variability” and one “uncertainty”, which makes the language more clear. Please modify throughout the manuscript.

This is a fine suggestion.

Changes: modified terminology.

[A2] P1L9: I believe the mathematicians call it just CV and not COV. Maybe a good idea to stick to the prior naming convention.

Also a good suggestion.

Changes: modified acronym.

[A3] P1L10: This statement “... is quite high” ... is a bit too vague. Better add numbers (COV values) here as well.

I modified the sentence in question to state that the rates may vary by a factor of 3 or on short (<5,000 year) timescales.

Changes: Numbers added.

[A4] P1L23: Putting the “e.g.” at the end of a list of references seems unusual. Is this an accepted format for this journal? Please check and modify in necessary.

It was a LaTeX error on my part, and has been fixed.

Changes: LaTeX fix.

[A5] P1L1: The connection to locking depth should be explained a bit more.

Good to also provide a reference here.

I added a phrase stating that the width of the zone affected by earthquake-cycle strains is a function of the fault's locking depth, and added refs to Savage and Burford (1973), the classic locked-fault-above-creeping-fault reference, and Hetland and Hager (2006), which demonstrates that this process can instead be the result of post-seismic relaxation.

Changes: explanation and references added.

[A6] P3L29: I find it troublesome to talk about periodic/regular occurrence just because CV is smaller than 1. That would be correct for $CV = 0$, as you also pointed out. Depending on CV value between 0 and 1, it might be better to talk about quasi-periodic, or quasi-random behavior.

The referenced sentence states that in this paper, I'm not using the word 'periodic' to mean perfectly periodic behavior. In any case I added a wiggle phrase stating that I mean 'quasi-periodic' but I won't change the word through the whole paper because it would decrease readability a bit.

Changes: terminology explained.

[A7] P4L26: Using this distribution seems plausible. It would however be really interesting to see other distributions explored –if possible, that would be a great addition to make the manuscript more complete.

I have added another numerical experiment using an empirical slip distribution; see the response to [06a].

Changes: numerical experiment w/ alternate slip distribution added.

[A8] P5L17: Here you describe qualitatively how more or less closely the different distributions align with the mean slip rate. While doing this qualitatively is ok to first order, I suggest that you go one step further and compute some form of misfit function i.e., residual (simplest a L1 or L2 norm).

An L-norm of any sort isn't appropriate because the numbers here aren't pairwise (observation, model) data. Instead, there is a single 'true' value at any time t , which is invariably 1, and then hundreds to thousands of simulated values at each time t .

Instead, because the true value is 1, all of the results shown in Figure 5 are quantified percentiles of misfit. While I could calculate the CV as suggested in comment [A3], this is pretty reductive and the numbers at any time t can be retrieved from Figure 5.

Changes: None.

[A9] P6L2: stress drop doesn't need to be "complete" –just has to be "the same" each time to get to the outcome you describe here. Maybe better rephrase accordingly.

No, this isn't true. The outcome that I describe is a *correlation* between loading time and displacement, not an *invariance* of either loading time or displacement. Having 'the same' stress drop doesn't predict correlated loading time/recurrence intervals and displacement.

It's possible that this paragraph was too confusingly written for it to be easily interpretable. I have made some minor changes to the sentence structure for clarification
Changes: Paragraph edits.