General comments:

The authors present results from a new macroevolution model coupled with a land- scape evolution model, examining how variation in geomorphological parameters drive drainage reorganization and, through drainage reorganization, speciation and extinc- tion. Overall, the manuscript is clearly written and I was able to follow the authors' logic section to section. The problem of coevolution of drainage networks and the aquatic species that populate them is interesting and important and the authors' work on the SpeciesEvolver component is a strong contribution. If this manuscript is intended to introduce to the SpeciesEvolver model to geomorphologists and demonstrate an application alongside other Landlab tools, then it works pretty well. However, if the modeling results presented here are intended to say something substantive about the relation- ships between geomorphological parameters, drainage basin reorganization, and the evolution of species that inhabit them, I think there are some significant problems. First off, I think it needs to be more clearly stated whether the authors' goal is the former or the latter. If the goal is to say something meaningful about speciation and topography and not just "check out the cool experiments you can do with the tool we made", then there should either be some sort of field data incorporated (which would be really diffi- cult) or some of the unrealistic conditions associated with these model runs need to be changed or at least convincingly addressed in the text.

We thank you for your review. We find it much improves the paper. Immediately below, we provide an overview of the primary changes in the revision in very large part motivated by your review.

In the introduction we improved the overview of past work, including multiple recent modeling studies on drainage reorganization. Parametrization of many of these studies, and maybe future ones, is done with limited exploration of the parameter space, i.e., 1 to a few values for each parameter. Formally exploring the space is a substantial effort. We put forth that our motivation in the drainage reorganization sensitivity analyses is to (1) provide guidance to future studies given that we do explore such a wide parameter space and (2) describe key relationships among inputs and outputs given the processes we modeled.

Also in the introduction, we expand on the outline that the intent is two-fold: (1) present an approach to study the evolution of life alongside landscape evolution which we do by demonstrating SpeciesEvolver, and (2) explore the parameter space of commonly used process models used to simulate drainage reorganization and identify key patterns on inputs and outputs.

In methods, we more fully describe that a large parameter space is explored to avoid us selecting arbitrary bounds on parameter limits and to not invalidate the sensitivity analysis sampling (and use the discussion more fully for limitations to our approach). Discussed below in specific comments as well, the trial with the greatest relief is not necessarily the outcome of an unreasonable combination of parameters, but instead is the outcome of processes not included (e.g., mass wasting). Processes not included is discussed separately. Further, limiting parameter values given predefined combinations with other parameters as a precondition to run that combination invalidates the unbiased nature of sampling the parameter space.

A new section of the discussion is devoted to the primary model limitations and future adaptions. Absence of mass wasting and lithologic heterogeneity, stream power incision, and broad species dispersal ability are among the limitations emphasized here. Conclusions stated throughout the paper on the relative relief and perturbation impact on drainage reorganization is emphasized as this relationship is controlled by the processes included in the model. We envision that the heavy lifting of the thousands of modeling runs, all data made available, will provide a starting point for additional complexities in future work.

More specific comments:

Page 3 Line 7: I don't think a landscape evolution model that neglects mass wasting will realistically represent divide migration where total relief is as high as it is in many of the simulations. I think it would be more meaningful to stick to relief ranges where diffusion could reasonably be assumed to be the dominant hillslope process if landslides aren't to be included.

In the revision we describe more in the paper introduction and more fully in discussion-limitations how our approach is focused on the contribution of the fluvial component of drainage reorganization with minimally consideration (i.e., diffusion) of hillslope processes. Also in the discussion we indicate that our model likely underpredicts divide migration as relief increases. Additionally, more critical to the species modeling is stream capturing than divide migration.

Page 3 Line 21-Page 4 Line 6: The description of the SpeciesEvolver component needs more depth. The ESurf readership is going to be mainly geomorphologists. Speaking for myself, I hardly know anything about speciation and extinction and even less about the considerations involved in modeling these processes. It's an interesting tool and it deserves a lot more than two paragraphs included here. I don't understand very well how it works or why I can trust that it describes natural processes accurately.

We agree and find it generally challenging to provide a deeper description without making the paper unreasonably long. For this reason we cite a short paper that strictly describes the SpeciesEvolver software where users can go for further details of the tool made for species on continents in general, whereas this paper under review provides the first use of the tool, which is for riverine species and drainage reorganization.

Page 7 Line 5: Is it realistic for a species to occupy all parts of a stream network? The relief of some of the modeled landscapes described here definitely would give you different climate zones.

In the paper revision this good point is included in the discussion on model limitations/considerations. Given that most networks span the total relief (from boundary to divide) and including species distribution by climate zones, the outcome would be a greater number of speciations for the higher elevation species, less for the lower elevation species. Most importantly to the study at hand and given we are familiar with model functionality in different setups, we can predict our interpretations would be quite similar, in terms of which inputs had a greater impact on which outputs, even if we do make incorporate this modification. Richness would be increased even more, given the greater number of initial species – the absolute increase of richness is not central to this study.

Page 7 Line 19: How is a perturbation of 0.1 m going to do anything to really modify the landscape, if we're interested in the divides? Along the same lines, why include scenarios with a modeled fault displacement of 100 m when that's so much larger than anything observed in nature? If we're just trying to shake things up and see what happens, why keep other parameter values within empirically observed ranges?

We are not only interested in divide migration, but total stream and divide percent change as these metrics are readily comparable across the two scenarios. Even the 0.1 m perturbation affected these responses, under some combinations with other parameters, although minimally. It is useful in sensitivity analyses to include extremes of parameter value ranges that may matter less to help make clear which parameters matter most relative to other parameters.

The 100 m perturbation magnitude of base level and fault throw is over 1000 years given that this is our time step. Even over this time span this is large (about 5 1999 Jiji earthquakes given throw measured from that event). We emphasize in the revision that this magnitude is motivated by knickzones of this magnitude (100 m) which is key to propagation of the erosional wave that drives drainage reorganization.

Page 7 Line 22: Shouldn't knickpoints matter to the modeled species? Since knickpoint migration is what's transmitting the perturbation to the divides, I would think you'd need to account for the knickpoints' influence on aquatic life in order to accurately model what happens when the knickpoint makes it all the way upstream.

I am aware of studies that consider knickpoint/waterfall influence on individuals within the same species. I am not aware of studies of knickpoints/waterfalls as they relate to creation of species. There is potential for unidirectional geneflow (fish flowing down waterfalls), having less of an impact on divergence of populations above and below falls. Including impacts on dispersal by knickpoints would be a reasonable avenue for future research.

Page 8 Lines 6-7: Maybe I'm missing something, but why would D go extinct just because its river has been captured by C?

This is addressed in the text in the caption of Figure 3, which is, "While N3 did extend into the watershed of N4, it did not overlap the stream nodes of the prior time step, therefore N3 did not capture N4 following the strict definition of capture in this study." D becomes extinct because it does not overlap/been captured by another stream in T1. N3 and N4 are off by 1 cell across the time steps. Side note: SpeciesEvolver can be adapted to be less precise, eg species can disperse if streams are close, and not precisely from a time step to the next, although in this study, stream overlap across time steps had to be precise.

Page 8 Line 18: Does this mean that the divide percent change response only records whether a divide moved, and not how much it moved?

This is correct regarding the divide percent change response. In the revision, main divide migration distance was also calculated to provide a quantified sense of migration.

Page 9 Line 7: Will species in the north-draining rivers be more likely to go extinct due to loss of drainage/habitat area, or do they only go extinct when all drainage area is lost?

Species in north-draining rivers are more likely to become extinct in the base level fall scenario as the main divide approaches the northern boundary. They will go extinct once the outlet at the northern boundary has a drainage area below the critical drainage area, if the species does not exist in a stream network elsewhere in the grid. If it does exist elsewhere, only the species population in that shrunken drainage disappears.

Page 9 Line 25: Why allow parameter combinations that lead to relief structures that are impossible to produce under Earth conditions? I just think it undermines the results a bit.

This would involve selecting a maximum uplift rate and/or minimum erodibility that produces some relief put forth as reasonable relief (Mt Everest?, or one selected for a landscape without landsliding?). In this contribution we preferred the inverse approach of using the near gamut of observed parameters because these are the model inputs, rather than preconditioning results. This is not to argue that selecting a narrower range is not reasonable to produce landscapes more appropriate to the processes, rather we took an approach to provide the full gamut, and now, describe its limitations in the discussion.

Page 10 Line 10-11: Does changed here just mean that they moved or that they were incorporated into a different drainage network?

Rephrased to clarify that we are referring to the stream percent change response. Also in the revision, we restate the meaning of this response earlier in this section.

Page 11 Line 5: Does 3% seem like a reasonable value compared to real landscapes? There seems to be evidence for stream capture all over the place. I think it would help me to understand better what's going on in the model landscapes if I had a better idea what the distribution of relief was. Maybe they're mostly very low.

> We agree the distribution of relief should be better described. We do so in the revision. The 3 % should not be translated as anything like 3 % of landscapes on Earth have captures. If one did make that argument, one would be implying that these parameters are exponentially distributed in space for the parameters that were exponentially sampled.

Page 12 Line 1: Is this the formation of endorheic basins?

> Yes. We added mention of "endorheic" in this sentence.

Page 13 Line 5: It doesn't seem like there are all that many landscapes that commonly experience perturbations resulting from fault slip or base level fall where the perturbation magnitude approaches the relief magnitude. Again, I just wonder whether these model scenarios are realistic enough to provide meaningful insights in a lot of the iterations.

> More important to relating the model to the real world is not the total landscape relief, but the relief upslope of the perturbation. Perturbations can be propagated up landscapes as local base level drops. A base level fall/fault slip may have little effect across the total landscape beyond a steepened "erosional wave" moving upslope over time, upslope drainages may become more susceptible to reorganization if the erosional wave decays slower than the upslope relief decreases.

Minor nit-picks:

Page 8 Line 16: Should say species diversification?

> Yes. We inserted 'species lineage' prior to 'diversification'.

Page 12 Line 25: Reads better if the sentence doesn't begin with "Although"

> Removed "Although".

Page 12 Line 29: This is the first time I've seen "lineage response" in this paper.

> Removed "lineage response" by rewriting sentence with only introduced terms.

Page 13 Line 8: Should say "Cross-divide difference in relief"?

> Yes. Corrected.

Page 13 Line 9: relief, thus

> Inserted missing comma after 'relief'.

Page 13 Line 13: landscapes, although topographic relief

> Combined two sentences at "landscapes" and "although".