

Earth Surf. Dynam. Discuss., author comment AC2  
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## Reply on RC2

Mirjam Schaller and Todd Alan Ehlers

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Author comment on "Comparison of soil production, chemical weathering, and physical erosion rates along a climate and ecological gradient (Chile) to global observations" by Mirjam Schaller and Todd Alan Ehlers, Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2021-22-AC2>, 2021

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### General comment to the handling editor(s) and both reviewers.

We thank the two anonymous reviewers for their constructive and insightful comments. We appreciate the time they have spent on evaluating this work. Nearly all of the suggested changes are reasonable and we implemented the changes as described in this response to reviews.

General comments were addressed in rewriting chapter 1 Introduction in order to present a coherent text to the reader. In addition, chapter 3 Methodology was adjusted to the suggestion made. Last but not least a chapter 5.3 Study caveats and challenges was added to the discussion. The specific comments are addressed below. The reviewer's comments are in bold, the replies in italics, and changed text in normal font.

Response to reviewer comments 2 for preprint esurf-2021-22

**Schaller and Ehlers combine new and existing measurements and calculations of soil production, chemical weathering, and physical erosion rates to examine trends between climate, vegetation, weathering, and erosion at four sites along a transect of the Andes spanning diverse precipitation, temperature, and vegetation zones. They analyze trends at these four well-characterized sites and extend their analyses to a global compilation of similar measurements in granitic catchments worldwide to demonstrate the nonlinear and non-monotonic relationships between climate, vegetation, weathering, and erosion. I found the manuscript to be well organized and written, with high quality figures clearly conveying the results. More importantly, I also found the analyses and discussion to be interesting and well conceived – not only to address the hypotheses of the study, but also to examine the complexities within the large and diverse datasets it aggregates.**

*Response: Thank you for your time in reviewing the manuscript and your enthusiasm for it.*

**That said, my most substantive comment is that, in a few places (noted below), I felt that greater explanations of how the hypotheses and results presented here relate to previous work are needed to properly put the results in context. For instance, the hypotheses follow a summary of past research in the region that largely contradicts the hypotheses, yet no explanations or references substantiating the hypothesized relationships between soil production, erosion, climate, and vegetation are provided. Of course, these are largely explained (and even demonstrated in the figures later) by comparing the data to various empirical predictions in the results section, but I believe proper context and referencing is needed in the introduction. Moreover, many references in the discussion seemed to point readers to past studies rather than identify and explain the relevant connections between the presented results and this past work.**

*Response: We are a little bit confused on what exactly the reviewer is referring to without an example or two. Nevertheless, we've tried to clarify things by modifying the last paragraph of the introduction where hypotheses are presented to reference other literature, and also allude to the results we present. We have also modified different parts of the discussion section, as suggested, to mention when our results agree or disagree with previous studies.*

#### **GENERAL COMMENTS:**

**- I appreciate that paleoclimate considerations are discussed in lines 86-94 and I wonder if other paleo-environmental conditions (and potential changes) that may affect your results and interpretations are worth considering. For instance, I presume measurement of the various factors that may explain the low contribution of chemical weathering to total denudation in the southernmost study site (e.g. solute fluxes, organic acid concentrations, soil thickness, microbial abundance) are based on modern observations, but have these also remained constant (or at least similar in pattern amongst the study sites) over the integration timescales of cosmogenic erosion rates?**

*Response: Well... Very interesting point! Unfortunately – this a large problem facing these types of studies because, with the exception of paleoclimate predictions (which are also often quite sparse) there simply are not data sets available for the other items mentioned like paleo solute fluxes, paleo microbial abundances, etc. However, the point raised is a good one. In the new discussion section 5.3 (Study caveats and challenges), that was added in response to the other reviewer, we have added text addressing this comment and that future studies could also address this as it adds an unknown to our (and every other paper on this topic) analysis.*

**- It seems worth addressing how slopes have been calculated in the studies utilized in the global compilation (e.g. if they have been calculated from similar resolution DEMs and over similar length scales and differencing or averaging schemes e.g. topographic slopes vs steepest-descent slopes)...unless standardized slope measurements from GTOPO30 have been used (column 15 in table S8)? I don't suspect that differences in calculation would dramatically affect the binning into (rather generously sized) 10 deg slope bins, but given the significance of this binning on your analyses and known e.g. scale-dependence of slope measurements, I do think this warrants some discussion.**

*Response: We have now clarified how slopes were computed in the supplemental material where we already discuss this, and also in the figure captions. For brevity – figures NOT involving a correlation analysis use the original reported slope by the study (when available). If the original study did not report a slope the symbols were not color coded to*

*indicate this. For the correlation analysis we wanted to avoid differences between how individual studies calculated slopes and treated all data the same – so for the correlation analysis we extracted the slopes from GTOPO30.*

#### **MAIN TEXT LINE COMMENTS:**

**Throughout: numerous places where north and south are unnecessarily capitalized (e.g. in “North- and South-facing” and e.g. line 256). Clauses beginning with “which” should be preceded by a comma.**

*Response: Thanks. Fixed. The document was scanned for North and South and changed to north and south where necessary. In addition, commas were added to clauses beginning with which.*

#### **Line 20: right parenthesis missing at end of sentence**

*Missing parenthesis was added.*

**Line 42: I am a bit confused here if denudation rate refers to chemical denudation rate specifically or to total denudation rates (guessing the latter)...particularly since “total denudation rates” are referenced in lines 55-56. Perhaps add “total” before denudation rate or “(physical plus chemical denudation)” after?**

*Response: Yes, we meant total denudation rates and corrected the section in question.*

**Lines 62-64: I’m a bit confused about the hypotheses since they seem to partly disagree with the previous observations just discussed...? Perhaps this should be explained briefly (or appropriate citations added supporting these ideas)?**

*Response: Thank you for highlighting this. We’ve done a massive rewrite of the introduction to make it clearer and have specifically set up more clearly the contradictions in previous work and how our hypotheses stem from them.*

**Lines 80-81: Minor point, but I’d suggest rephrasing “where the neighbouring...” since I think “due to subduction of the Nazca Plate” does not fully explain the along-strike similarity to which you are referring (the Nazca Plate also subducts below the Northern Andes, where you have flat slab subduction) and it’s worth noting that the tectonic regime within the study regions is similar beyond just Nazca Plate subduction**

*Response: Rephrased to state similar geometry and orientation of the subducting Nazca plate near the coast.*

#### **Line 83: delete comma**

*Response: Comma was removed*

#### **Line 88: delete comma**

*Response: Comma was removed*

**Line 90: exist  existed**

*Response: Error was corrected*

**Line 109-110: add comma after 43 and delete comma after citation**

*Response: Comma was added respectively removed*

**Line 151: missing right parenthesis after units of soil production rate. Add "are" before "the mean..."**

*Response: Missing parenthesis was added and the "are" inserted.*

**Line 152: length  lengths**

*Response: S was added*

**Line 157: Is there some new meaning to the square brackets used to enclose variable units? If not (as I presume), I'd suggest standardizing throughout**

*Response: In physics / geophysics literature units are typically (not always) reported in square brackets. We changed it to be consistent throughout the manuscript.*

**Lines 178-180: Seems like this sentence should only state that the leaf area index LAI and SPRs at sample locations were compared to model predictions (if I understand correctly)**

*Response: The sentence was corrected as suggested.*

**Line 232: missing right parenthesis after first "yr"**

*Response: Parenthesis was added*

**Line 240: Why do you only point out the similarity in rates between La Campana and Nahuelbuta for physical erosion rates? The majority of the rates also appear to agree between the two sites for soil production and chemical weathering, no?**

*Response: Thanks for catching this. We've modified the other relevant parts of the text to address this.*

**Line 247: you've been using an oxford comma up to here...add comma after "weathering" for consistency**

*Response: Comma was added*

**Lines 273-275: Optional, but it would be helpful to briefly summarize e.g. Heimsath and Whipple's finding about the influence of lithology and rock strength variations on SPRs here and move the citation to the end of the sentence, instead of simply directing readers to that paper**

*Response: The reference has been added to the end of the sentence.)*

**Line 277-278: Couldn't it alternately suggest that MAP simply influences SPR non-monotonically, even in the absence of other processes/environmental differences? I'd at very least suggest rephrasing "this observation could suggest that..." Perhaps "processes" should also be changed to e.g. "factors" since MAP**

**is not a process.**

*Response: Sentence changed as suggested.*

**Lines 279-280: move citations to end of sentence**

*Response: Citations were moved to the end of sentence*

**Line 280: "relationship in"  "relationship between"**

*Response: Suggested change was made*

**Line 289: weekly  weakly**

*Response: Correction was made. Thank you.*

**Line 290: "suggest an even weaker correlation"  "correlate even more weakly"**

*Response: Sentence was changed as suggested*

**Line 291: missing oxford comma**

*Response: Missing comma was added*

**Line 295-296: "hillslopes with slopes >30 deg...decrease with decreasing slope"?? I'm very confused about what this refers to since Figure S4 appears to show increasing trends with slope. Perhaps this should be a citation to Figure 4 and say "SPRs within the highest slope bins decrease with slope"?**

*Response: Latter half of sentence reworded to clarify meaning.*

**Line 298: I'm not sure it's necessary to say "qualitatively" since you are showing a quantitative trend here. Suggest deleting.**

*Response: "Qualitatively" was deleted*

**Line 299: where by  whereby, SPR  SPRs**

*Response: Both errors were corrected*

**Line 308-309: I find "SPR is a process of chemical weathering and physical erosion" to be a bit awkwardly worded. Perhaps change "SPR" to "soil production" or "SPR depends on both chemical weathering and physical erosion"?**

*Response: Sentence corrected as suggested.*

**Line 317: Should Figure 5B be referenced here too?**

*Response: Text was rearranged and reference is not needed anymore.*

**Lines 322-323: These two sentences confused me, since the black bold line in 5A shows the empirical prediction, no? I suggest rephrasing to clarify this (perhaps "...are predicted to increase rapidly with...")**

*Response: Corrected as suggested by the reviewer.*

**Lines 349-350: suggest changing “a combination of increasing...vegetation” to “variations in MAP, soil depth, and vegetation worldwide” since your data and the model-data comparisons show that non-monotonic relationships and co-variation of these factors can perhaps explain the global variations**

*Response: The sentence was changed as suggested and reads now as: “In summary, based on the previous considerations, we find that global variations in observed SPRs can be explained by variations in MAP, soil depth, and vegetation worldwide (Fig. 5).”*

**Line 354: occurs  occur, “for different slope areas observed”  “across different hillslope gradients” or simply “across the different slopes observed” perhaps (in any case, I find “slope areas” to be confusing since it could be confused for some metric of drainage area, too)**

*Response: Sentence was adjusted and reads now as: “We note that although high-slope settings produce the highest SPRs, the trends in MAP and vegetation causing an increase and then decrease in SPRs as MAP or LAI increase occur across different hillslope gradients (Fig. 4).”*

**Lines 366-367: I think this statement should be qualified a bit (“may still be meaningful”) since the extent to which the measured Zr concentrations of bedrock truly reflect the Zr concentration of the parent rock from which soil and saprolite derived is still uncertain, even if the sign of change is correct**

*Response: Section has been reworded to address this comment.*

**Lines 368-369: suggest combining these sentences “...is negative because the ZR concentration in the saprolite is lower than...”**

*Response: Sentence was corrected as suggested and reads now as: “In contrast, the calculated fraction of weathering in saprolite for sample NAPED20 in Nahuelbuta is negative because the Zr concentration in the saprolite is lower than the concentration in the bedrock.”*

**Line 370: “over”  “to”**

*Response: Corrected as suggested.*

**Line 371: “as, for instance, in...”**

*Response: Corrected as suggested.*

**Line 375: add comma after “happens”**

*Response: Corrected as suggested.*

**Line 378: “orth”  “north”**

*Response: Corrected as suggested.*

**Line 379: “neither”  “not”, “nor”  “nor by”**

*Response: Corrected as suggested.*

**Line 389-390: by effectively diluting it? Perhaps change "diminish" to "dilute" if so...?**

*Response: "diminish" was replaced by "dilute" as suggested.*

**Line 398: "leading to an" □ "which may underestimate  $W_{total}$  and overestimate  $E_{soil}$ "**

*Response: Sentence corrected as suggested and reads now as: "Due to this possible Zr loss in regolith, the calculated  $W_{soil}$  is a minimum value which may underestimate  $W_{total}$  and overestimate  $E_{soil}$ ."*

**Line 403: "As with" □ "With"**

*Response: Corrected as suggested.*

**Line 406: the passive voice here makes it unclear if the attribution of the stabilizing effect of plants on the decrease in physical erosion rates has been proposed previously in other studies (guessing not?). "We attribute the..." or perhaps "The decrease in physical erosion rate may result from..."**

*Response: Sentence corrected and reads now as: "The decrease in physical erosion rate may result from stabilizing effects of plants."*

**Lines 407-408: "increases" □ "increase", "is lower again" □ "decrease again"**

*Response: Sentence was adjusted as suggested.*

**Line 410: suggest flipping sentence "Precipitation, temperature, and pH all affect microbial abundance"**

*Response: Sentence corrected and reads now as: "Precipitation, temperature, and pH all affect microbial abundance (e.g., Fierer and Jackson, 2006; Bahram et al., 2018; Tan et al., 2020)."*

**Line 412: "in" □ "along", "increase" □ "increases", "decrease" □ "decreases"**

*Response: Sentence was corrected.*

**Line 414: perhaps this statement should be qualified "which may explain the decreasing pH values from north to south and the lower bacterial abundance..."**

*Response: The corrected sentence reads now as: "A comparable increase in MAP and decrease in MAT is observed in the Chilean Coastal Cordillera, which may explain the decreasing pH values from north to south and the lower bacterial abundance in Nahuelbuta than La Campana (Bernhard et al., 2018; Oeser et al., 2018)."*

**Line 415: "made observations are unique" □ "hypotheses are valid"**

*Response: Sentence was changed to address the comment.*

**Line 420-421: I think this sentence should be split to clarify that the observed correlations between denudation rates and chemical weathering do not derive from this same global compilation.**

*Response: Sentence fixed/clarified.*

**Line 425: "is absent or reduced" □ "is not operative or occurs only at low rates"**

*Response: Sentence was adjusted.*

**Line 430: "increasing" □ "to increase", "diminishing" □ "diminish"**

*Response: Adjusted as requested.*

**Line 431: "not only do climate and vegetation..., but so does topography"**

*Response: Sentence was corrected.*

**Line 443: delete "setting with"**

*Response: Deleted.*

**Line 450: missing right parenthesis at end of sentence**

*Response: Missing parenthesis added.*

**Line 458: add "monotonically" since they do increase with MAP at lower MAP values**

*Response: Suggested correction made.*

**Line 459: "vegetation" □ "vegetation cover"**

*Response: Missing word added.*

**Line 459-460: I think this citation needs to be explained more clearly/thoroughly - particularly as it related to trends between chemical weathering rates (and SPRs) and MAP and/or vegetation**

*Response: Section in question was reworded.*

**Line 471: I'm not sure "stabilize" sufficiently/properly describes the trend. "increase and then stabilize"**

*Response: Sentence corrected as suggested.*

**Line 474: "the low contribution of chemical weathering to total denudation"**

*Response: Corrected as suggested.*

**Line 475: "where solute fluxes are high and soils and saprolites are rich in organic acids"**

*Response: Corrected as suggested.*

**Line 478: I'd suggest also adding "and non-monotonically"**

*Response: Suggestion was incorporated.*

**Line 640: "bin slopes" □ "slope bins"**

*Response: Corrected as suggested.*



**Line 641: “two-polynomial” □ “binomial”**

*Response: Changes was integrated.*

**Line 647: “for different mean annual precipitations and zero soil depth and blue lines are for different MAP and soil depths, assumed to covary (Supplemental Text 2)” Is that correct or is one MAP assumed for the blue lines?**

*Response: Fixed. Panel B was adjusted to panel A and figure captions adjusted.*

**Line 652: Pluralize all (or none) of the y-axis variables**

*Response: Corrected as suggested.*

**Figure 2 - Optional, but it seems like with both different marker colors and symbols you could also display slope aspect and relative elevation information cited in the text (which might help illustrate the trends you discuss)**

*Response: Yes – we color coded the symbols by slope.*

#### **SUPPLEMENT LINE COMMENTS:**

**Line 57: delete extra right parenthesis**

*Response: Deleted.*

**Eq. S4: EMT □ EEMT**

*Response: Corrected.*

**Lines 60-61: I’m guessing the S5s and S6s here should be changed to S3 and S4?**

*Response: Corrected.*

**Figure S3: What are the dashed lines in A?**

*Response: these dashed lines are the 95% confidence level. We added this to the figure caption.*