

Earth Surf. Dynam. Discuss., referee comment RC2
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Comment on esurf-2021-22

Anonymous Referee #2

Referee 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-RC2>, 2021

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.

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.

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?

- 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.

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.

Line 20: right parenthesis missing at end of sentence

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?

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)?

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

Line 83: delete comma

Line 88: delete comma

Line 90: exist existed

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

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

Line 152: length lengths

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

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)

Line 232: missing right parenthesis after first "yr"

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?

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

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

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.

Lines 279-280: move citations to end of sentence

Line 280: "relationship in" "relationship between"

Line 289: weekly weakly

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

Line 291: missing oxford comma

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"?

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

Line 299: where by whereby, SPR SPRs

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"?

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

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...")

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

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)

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

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

Line 370: "over" □ "to"

Line 371: "as, for instance, in..."

Line 375: add comma after "happens"

Line 378: "orth" □ "north"

Line 379: "neither" □ "not", "nor" □ "nor by"

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

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

Line 403: "As with" □ "With"

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..."

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

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

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

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

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

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.

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

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

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

Line 443: delete "setting with"

Line 450: missing right parenthesis at end of sentence

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

Line 459: "vegetation" □ "vegetation cover"

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

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

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

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

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

Line 640: "bin slopes" □ "slope bins"

Line 641: "two-polynomial" □ "binomial"

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?

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

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)

SUPPLEMENT LINE COMMENTS:

Line 57: delete extra right parenthesis

Eq. S4: EMT □ EEMT

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

Figure S3: What are the dashed lines in A?