

Interactive comment on “Water limitation may restrict the positive effect of higher temperatures on weathering rates in forest soils” by Salim Belyazid et al.

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Anonymous Referee #1 Received and published: 28 March 2019 General comment: The present manuscript describes the use of a model to calculate weathering rates under two different climatic scenarios where temperature and precipitation are expected to greatly vary within some years. The purpose of the study is very interesting since normally the expected increase of temperature is linked to an increase of the weathering rates and therefore availability of base cations to soil, which can contribute to a myriad of pedological and biological processes. However, as it was correctly pointed out by the authors, the weathering rates are dependent of other factors than tempera-

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ture and soil moisture and in parallel these two parameters will be dependent on other complex occurring processes. However the study has two main problems. Firstly, no precise information is provided concerning the model used. Authors do not specify if soil moisture is simulated along the soil profile and if the soil is divided into different layers (this is relevant since the first layers are essentially organic). Also, there is no information on the input required for this simulation and how it was obtained such as the organic matter and nutrient concentrations, the different soil types, parent material and also the different occur minerals at different forest sites, the vegetation parameters required to correctly use a vegetation growth model since different trees will have different litter rates and constitution and water uptake dynamics. Finally, authors do not specify how they have calibrate the model for these forest sites and ultimately how did they validate it. Authors should demonstrate that the model is correctly simulating the effects induced by temperature and soil moisture in these places. The second problem of the manuscript is the range of results and discussion achieved. Once authors point out that climatic changes have complex effects on weathering and that several processes are affected by the changes that ultimately can interfere with weathering it would be very interesting to understand what is governing the weathering rates or by other words, which processes are mostly being influenced by these changes and what is causing the results. As it is now the manuscript describes only the correlations between temperature and soil moisture and the weathering rates but we have no clue of what is behind these trends. When using a model, we can focus on specific flows and understand how the different pools are being affected. The manuscript title is a good example of the manuscript fail to provide more effective answers. When stating in the title that “Water limitation may restrict. . .” when that was already the hypothesis do not show much improvement. As a conclusion, while the study has a valid and significant goal, it fails along the day to deliver the important messages.

Response to Reviewer 1’s general comments: The summary and shortcomings pointed out are precise and very relevant. We are thankful for the constructive criticism and based on that will modify the manuscript in two ways: 1- we will give a more compre-

hensive description of the model and the datasets used, and 2- we will expand the results and discussion to explain the processes and pathways through which climate is affecting weathering in the simulations. We would like to add a section where we present and discuss the responses of the four weathering pathways to the changes in soil temperature and moisture, and how these changes affect the dissolution rates (through action of the kinetics or through affecting solution saturation levels). We will also reformulate the title to better represent the core message of the paper.

Detailed comments: Line 18 – “decomposition” – Authors often use this term along the manuscript but it would be more accurate to say “organic decomposition”. We will make the use of the term “decomposition” more explicit to avoid any misrepresentation.

Line 28 – 32 – this conclusion is general and authors have only simulated what happens in forest sites in Sweden! It is possible that climatic scenarios for different soils, vegetation covers and land uses result in completely different results. Authors should stick to their study cases. Thank you for pointing this out. We will reformulate the sentences to relate to the study area.

Line 34-35 – This sentence is too radical. It was not the economic activity that caused environmental impacts, but instead the “bad management in that economic activity”. The reviewer’s view is correct, we will rephrase.

Line 45 – There is a typo here (Ref). A relevant reference will be included here.

Line 88 – Which nutrients and which elements? At least the most important. We will explicitly spell out the nutrients and other elements simulated in ForSAFE.

Line 91-92 – CO₂ and H⁺ are not correctly formatted. There are several typos like these along the manuscript. Thank you for pointing this out, we will review these throughout the document.

Line 94 – Dissolution rate of H⁺??? We meant to refer to the dissolution pathways controlled by H⁺. We will reformulate this sentence.

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Line 125 – What are the differences between the different forest sites: vegetation types? Soil types? Parent materials? Topography? The simulated forest stands are all productive, managed forests, with predominantly spruce and pine forests. The biggest majority are on podzols, but most often than not unrelated to the bedrock material (due to till movements during glaciation). All sites are on well drained soils, usually with very gentle slopes. This information will be included in the paper with relevant references.

Line 136 – 140 – “Forest stand history and future management” this was used as an input? How? Forest management (including history) tells us when a stand was planted, thinned or cut. The model uses this information to reproduce the same interventions as on the field (planting, thinning and final felling).

Line 170 – This is the first time authors are saying that the parent materials was different and that this affected the results. The clear indication of the different parent materials involved in this study should be in M&M and the effect of these inputs on the weathering rate should be in Discussion. Yes we agree with the reviewer, we will include a description of the parent material in the methods.

Line 181-182 – This is a trivial result, since soil temperature will not mimic air temperature due to thermic soil properties. The study should focus on the interaction of the different processes on the weathering rate instead. We agree with the reviewer. We will still keep this statement to stress the importance of properly assessing soil temperature, but will put more focus on the response of the different weathering control processes to increased temperature (this is also in line with critique from reviewer 2).

Line 187-189 – This is also expectable since in winter the air temperature increase impacts more the soil that can be frozen. This is the case of Sweden but it will be different for sure in other places. These type of reflections should be in Discussion. Yes this is possible, but in case of insulation by snow the impact in winter can be very small (which is what we show). We will point this out more clearly, and come back to it in the discussion.

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Line 215 – The sub-type is very short. Also results are focused too much on summer and winter changes and also too many figures are devoted to these cases. That information can be summarized. We wanted to stress the winter-summer difference, as weathering will react differently to higher temperatures under these two seasons. In summer, when soil temperature increases more in unison with air temperature, it will be soil moisture that limits the effect on weathering. While in winter, soil moisture is not limiting, but soil temperature does not increase as much. We will seriously try to summarise these into fewer maps as requested by the reviewer, while trying not to lose the message above.

Line 240 -241 – Strange sentence. Yes we understand the reviewer's reaction. We will change or remove this sentence. Figure 2, 3, 5 and 7 – The colour ramp should be drastic so that we can see better when the most important changes will occur, Variations between green and blue or between different yellows are not different enough. Thank you for pointing this out, it becomes a little difficult to see the maps objectively after making a few dozens of them. We will revise the colour scales to make the difference more visible on the maps.

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