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Interactive comment on "Dynamic modelling of weathering rates – Is there any benefit over steady-state modelling?" *by* Veronika Kronnäs et al.

Anonymous Referee #1

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A neat and generally well written and structured paper, the subject of which (weathering) falls within the scope of SOIL and is of broad international interest. However, several related and somewhat similar applications of the models have already been published, as indicated by the strong Sweden related references. And - as stated by the authors - as both models are based on the same weathering equations, it is hardly surprising that the results (long-term) from both models are similar and suggests little benefit is gained in using the more complex model when looking at long-term climate change and forest management impacts. Furthermore, the dynamic ForSAFE model, by definition is bound to provide more detailed and seasonal results and information, making the answers to the question posed by the title and to the hypotheses some-

what self-evident. I think the paper could be substantially improved if there were more focus on and calibration of the ForSAFE model with empirical field data; for example, with measured soil temperature, soil moisture, forest growth (base cation uptake) and leaching data.

Specific comments relating to validity of analyses and assumptions, relevance of discussion and conclusions.

p. 1, l. 20 (and p. 4, l. 31). Annual precipitation may remain similar but what about the seasonal distribution? How will temperature change affect snowfall and snowmelt, surely a very important feature of climate change in such latitudes, the water cycle and weathering?

p. 3, l. 19 (and p. 8, l.11). Why/how are base cations, Al3+ and organic acids inhibitors of weathering? Do you mean that if the concentrations of weathering products in the soil solution increase, the weathering reaction slows down as equilibrium concentrations are reached? But then aren't the weathering products being continually take away through up take, leaching or adsorption by the soil allowing weathering to proceed?

p. 4, l.16. There is little description of the soil type at the two sites. From the horizon abbreviations listed in Table 2, it would appear the soil are not Podzols?

p. 5, l.16. Furthermore, thickness of the mineral soil horizons at Hissmossa is 55 cm (and not 50 cm; Table 2) and how/why is the organic layer included where surely it is a question of organic matter decomposition rather than mineral weathering? It is not stated how stoniness was derived and if the hydraulic parameter values (Table 3) have been corrected for stone content. Given the concluded importance of soil moisture, the fixed value used in PROFILE and same value for all layers (0.2) seems rather crude. The field capacity values in Table 3 also seem somewhat low – is this because of stone content correction? How have any time related changes in organic layer thickness (and therefore soil moisture content) been taken into account? P. 4, l. 31: by "rainfall" you mean annual precipitation?

p. 5, l. 6-11. The description of the scenarios is unclear, at least to me. For example, does the base scenario mean there are two thinnings and a clear cut every 70 years (and starting from the year of planting – Table 1), deposition loads constant from "todays" (which year?) levels into the future plus climate change temperature (but no change in precipitation)? What is the whole tree harvesting treatment: stems + branches or stems + branches + stumps? Is it carried out every 70 years during the 1900-2100 period? It would be useful to number or letter the scenarios and refer to them in the text and, tables and figures. Which scenario is used for Figure 1? Doesn't the 70 year rotation period cover a different set of years between the two sites (2011-2080 vs. 2041-2100), when the climate change has changed the climate. Doesn't this explain the differences in weathering between the two sites rather than differences in soil texture (p. 5, l. 21), which anyway would also affect the soil hydraulic properties besides surface area? Why is only Mg weathering presented in Figure 2 and in Figure 4 to represent silicate mineral weathering? Wouldn't the sum of base cations be a more appropriate measure of overall silicate weathering? As weathering largely takes place by acid (proton) attack, why is silicate weathering decreased by acidified conditions (p. 6, l. 17) and why would apatite weathering be increased? Doesn't the base scenario include harvesting effects besides climate change effects (p. 6, l. 29)? See also p. 8, l. 21-24.

p. 7. l. 19: by "more detailed forestry plans" do you mean timing of thinning and timing and intensity of harvesting?

p. 8, l. 13- Isn't a matter of litter decomposition and not weathering? And I think you need to give a reference that supports the statement about harvesting intensity effects of soil solution base cation concentrations. Concentrations and leaching loads may increase with whole-tree harvesting as a result of increased drainage (percolation) and disturbance of the site.

p. 8. L. 25-. The contribution of your C-horizon is small (Table 2). And if the material is less weathered, then there would be more weatherable minerals and therefore potential

for weathering? Is the explanation for taking silica concentrations into account the same as mentioned above, i.e. equilibrium concentrations reached?

p. 9. l. 6. A paper by Starr & Lindroos (Geoderma (2006) 133: 269–280) shows this.

Conclusions: I appreciate the recognition of the importance of soil moisture to weathering (and decomposition) and for the reasons stated (time step). However, wouldn't a model with a daily time step be more suited to forest stand nutrient/biogeochemical cycling studies rather than modelling long-term climate change effects.

Units: Wouldn't it be more correct to present weathering in units of moles charge rather than equivalents? And why sometimes meq m-2 yr-1 and sometimes meq m-3 y-1 (Fig. 2, 3, 4, 5). Is it somehow because the latter refer to a specific layer (of differing thicknesses) rather than to the fixed organic layer + 50 cm layer or simply a typo?

Table 1. Coordinates are decimal degree latitude (N) and longitude (E). Figure 1. Title: Using which scenario and for which period of time? Figures 2 & 6. Is it necessary to include the ForSAFE monthly values? See Fig.3. Fig. 3. Use a circle around the years of clear cutting on the whole tree harvesting scenario and base scenario lines rather than the vertical line that intersects all scenarios. Are the years 1941,2010 and 2080 for Västra Torup and 1973 and 2043 for Hissmossa? Fig. 4. Is each dot is a year of the 70 year rotation period? Why only layer 4 (B-horizon)? Fig. 5. The base scenario includes the climate change temperature scenario and does the "constant climate change scenario" refer to the last one in the list on p. 5?

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