

Interactive comment on “Sediment loading in Fennoscandia during the last glacial cycle” by Wouter van der Wal and Thijs Ijpelaar

Anonymous Referee #5

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The main purpose of this study is to quantify sea-level responses to sediment redistribution caused by ice sheets in Fennoscandia over the last glacial cycle. To do so, the authors apply a recent sea-level model (Dalca et al., 2013), which computes sea-level responses to sediment erosion and deposition. The main finding is contained in Figure 7, which shows that sea-level responses to sediment redistribution are small in this region, such that accounting for sediment redistribution does not significantly help resolve differences between observed and modeled relative sea-level histories. This is a useful finding and the main strength of this study.

The manuscript has several weaknesses that I suggest the authors address before publication, most of which have to do with the presentation of the material. As I describe below, a number of items in the text are unclear, and most of the figures require major modification before they can be understood, particularly Figures 3-5. I do not

C1

have major scientific concerns about the study, but two minor concerns are that the study did not conserve sediment mass, and it's not clear how eroded material was spatially distributed, which would make it difficult to reproduce the results of this study. I suggest the authors expand on these points in the text. Overall, I suggest that this study will be of interest to a number of readers in Solid Earth after major revision.

Additional comments

Page 1, line 17: I suggest specifying the timescale over which changes in relative sea level can be as large as several meters. Is this the integrated sea-level change from the Last Interglacial to the present?

Page 1, line 25: I suggest rephrasing this sentence, since glacial erosion is not always faster than non-glacial erosion. Glaciers frozen to their beds, for example, can inhibit erosion, rather than accelerating erosion.

Page 2, line 1: Does “that amount” in this sentence refer to subsidence rates due to sediment deposition? If so, then I suggest rephrasing this sentence, since it makes it sound like subsidence rates can be no faster on 0.5 mm/yr, but subsidence rates depend on deposition rates, and thus could be faster in places with faster deposition.

Page 2, lines 17-19: It's not clear what is meant by the 40% in this sentence. I suggest clarifying this.

Page 2, line 25: I suggest changing “potential field” to “gravitational potential field”, to be clear.

Equations 1 and 2: Technical point: The sea-level model computes changes in sea level due to changes in load, rather than the magnitude of sea level itself (see Equations 10 and 17 in Dalca et al., 2013). That is, in that notation, it computes Delta SL rather than SL, and it does so from Delta L rather than L. I suggest modifying Equations 1 and 2 in the the Methods section to clarify this.

Page 6, Figure 2: I suggest increasing the font size. The labels are too small to read

C2

easily in this map.

Page 7, lines 12-14: I suggest specifying how the eroded material was spatially distributed in the model. If it were proportional to ice sliding speed, then the eroded thickness would depend on spatial variations in ice sliding speed, which would require an ice flow model. Was that done? If so, how? Was it assumed that erosion under the ice sheet was spatially constant? If so, I suggest specifying that.

Page 7, Line 12: Contrary to this statement, recent evidence suggests that basal erosion scales with glacier sliding velocity squared, not sliding velocity to the first power (Herman et al., 2015, Science, v. 350, p. 193-195).

Page 7, Figure 3: Please add latitude and longitudes and a colorbar that defines what the colors mean.

Page 8, Figure 4: It's hard to tell where this is and what the scale is. Please modify this figure to include latitude and longitude.

Page 8, Figure 5: It's unclear what the colors and numbers represent. I suggest adding latitude and longitude grids and a colorbar, and expanding the text in the figure caption to explain what the colors and numbers mean.

Page 9, line 17: What is the time at which there are measurements? Is it the maximum at any time over the last ~10 kyr? Or the average over that time? Or the present? I suggest clarifying this in the caption.

Page 9, line 18: I suggest changing "gravity rate" to "rate of change of gravitational acceleration" for clarity.

Page 9, lines 18-21: It would be useful to show these boxes in a map in one of the figures to help show where these sites are.

Page 10, Figure 6 caption: I suggest specifying exactly what time LGM is taken to be here, since the timing of LGM is not universally agreed upon elsewhere in the literature.

C3

For clarity, I also suggest changing "locations of Relative Sea Level data used in Fig. 7" to "Numbered black dots show locations of Relative Sea Level data in Figure 7."

Page 10, Figure 7: In most panels it's impossible to see a blue line. I assume that's because the red line and blue line are so close to one another that they overlap almost perfectly. If that's true, I suggest stating that in the figure caption.

Page 12, line 12: This states that the effects of sediment redistribution on sea level are comparable to those produced by water loading. This requires a citation, since changes due to water loading weren't shown in this study.

Page 12, line 20: I suggest noting that several tenths of a mm/yr is not negligible relative to modern globally averaged rates of sea-level change.

Interactive comment on Solid Earth Discuss., doi:10.5194/se-2017-18, 2017.

C4