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Interactive comment on "Icelandic grasslands as long-term C sinks under elevated N inputs" *by* Niki I. W. Leblans et al.

Anonymous Referee #2

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This study has addressed how increased N inputs associated with seabird nesting colonies have influenced total ecosystem C stocks and net C accumulation rates in unmanaged Icelandic grassland soils. Results from this study demonstrate that increased N inputs from bird droppings (i.e. guano) are related to higher rates of soil C accumulation. I agree that greater N inputs from guano might be partly responsible for greater soil C accumulation; this is evident from absolute measurements within the high-N input sites and from the comparison between ENH and MNL sites. However, I think that the authors have chosen a rather convoluted way to show and explain their results. I think both the main emphasis of this study and the explanation of the potential underlying mechanisms responsible for higher net SOC storage rates need a major revision and key data might need to be added and analysed in order to support the main findings of this study.

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1) The main emphasis of this study should simply be on the potential effects of bird droppings (guano) on net changes in soil C storage across different Iceland grasslands. The current emphasis on the "necessity for a better understanding of the N-induced stimulation of long-term C storage in northern ecosystems" is honestly outside the limits and possibilities of this study. The authors have not addressed the potential C sink ability of northern ecosystems under increasing anthropogenic N emissions but the long-term effects of guano deposition on net changes in SOC. The same authors state this in the discussion: "the N status was clearly more closely related to the annual seabird-derived N input than to ecosystem maturation", thus I would change the 'global change' emphasis from anthropogenic N inputs and ecosystem C sinks to how long term organic N inputs might influence changes in soil C accumulation rates. The introduction should set the stage of how long-term organic C and N inputs were found to be influencing C accumulation rates from previous literature studies.

I find strange that 'organic N inputs' or "N inputs from guano' are expressions never used in the manuscript.

2) If the authors aim to compare total ecosystem C and N stocks they need to clearly set a soil depth range, 0-20 or 0-30 cm for example, where total ecosystem stocks are compared across the different sites. Currently there are too many differences in ecosystem age, soil depths, and successional development stages to be able to compare main C and N stocks in a meaningful way. I think authors have to clarify what 'topsoil' means in terms of soil depth range (could this be 0-30 cm for all sites?).

3) In terms of mechanisms, a key missing factor here, which could be mainly responsible for changes in soil C accumulation rates across sites is actually the rate of C addition to soils through guano deposition. Bird droppings return both C and N to the soil with significant consequences for the formation of SOM. If the authors do not have information on rates of C additions per hectare per year, they might be missing a critical factor, which could explain as much variability as N inputs in long-term changes of soil SOC.

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4) There is some confusion in relation to the species composition of the plant communities studied here. For example, on Page 6, lines 1-2: The authors state that Cerastium fontanum was the only plant species found in all experimental plots but on page 4, lines 29-30 they also state that “The MNL site hosts a species-rich grassland community, typical for low nutrient conditions (Magnússon et al., 2014)”, which is contradictory and create confusion later when interpreting the results.

Other: Page 5, lines 12-15: I don’t understand why sampling was done ‘outside’ the main long-term experimental plots (10x10 m) in “Adjacent to each permanent plot, three 0.2x0.5 m subplots were placed for destructive measurements”. What is then the meaning of the permanent plots to this particular study?

Conclusion Lines 21-23, Page 12. The study does not show in any way that “ the decadal net SOC storage rate of mature Icelandic grasslands was greatly stimulated by chronically elevated N inputs, which supported the theory that the increasing northern terrestrial C sink during the past decades could be (partly) caused by increasing anthropogenic N inputs”. The SOC storage effect is likely due by long-term deposition of bird droppings.

Remove Fig. 6 because the positive relationship between soil C and soil N (either net changes or content %) is already well known and does not add any new insight into the main findings of this study.

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