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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 #1

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This is an interesting study on the effect of seabird-derived N inputs on SOC storage in N-limited grassland systems of Iceland. There are not too many studies on the long-term effect of N on ecosystem C stocks, particularly in northern environments, and this is an innovative approach to gain insight into this issue. However, there are several problematic points which have to be addressed before the paper can become acceptable. There are three main problems in this study. First of all, the study is based on the assumption that there are only N inputs introduced by the guano of seabirds (authors stated that other nutrients are not so important as the grasslands are N-limited). However, guano also contains organic and inorganic C and so the study design is biased as there is a high additional C input at seabird-sites (up to 30% of guano is organic matter!). The only way to save this study would be to measure the C content of the guano and substract it from the SOC stocks, but it is questionable if a single value for guano

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C can be used for correction of total SOC stocks of the whole soil profile (probably you could estimate the guano-C-input per year, but if this can be used to correct SOC accumulation of the last 1600 years in mature soils is questionable). A further main problem is that no information on soil texture is given. Soil texture largely controls the stabilization of SOC via mineral sorption. For grassland soils Hassink (1997, Plant and Soil 191, 77-87) found are strong worldwide relationship of the maximum C storage capacity of soils with the fine mineral fraction content (medium+fine silt and clay <20 μm). Therefore, a precondition would be that the study sites are comparable in terms of soil texture. If there are differences in terms of soil texture, differences of SOC stocks could also (partly) be attributed to that. Besides, the authors stated that "subplots Mnl and Mnh were protected against possible human and livestock influence prior to the measurements. . .by enclosure cages". However, if there is livestock on Heimaey, the study sites cannot be viewed as unmanaged grasslands as on Surtsey and therefore not directly compared. Livestock grazing would not only be associated with additional manure (C and N) inputs but also with potentially enhanced decomposition of soil organic matter depending on the grazing intensity (due to animal trampling, aggregate disruption etc.). There are several minor points which have to be clarified. In terms of plant analysis, characteristics of Cerastium fontanum were investigated, as it was the only species that was present in all plots. However, it is questionable if the differences in terms of aboveground biomass etc. can solely be related to different N regimes as there were different plant communities/successional stages at the study sites. Probably, the performance of Cerastium fontanum was confounded by other more dominant species? Regarding the soil analyses and calculation of C and N stocks, it seems that the bulk density of the soils (which is necessary to calculate C and N stocks) was determined correctly, even when the authors did not use this term, but the values should be given (in g cm-3). In terms of the calculation of SOC storage rates, the millennial rates were calculated for consecutive cumulative soil ages with 200 years intervals assuming a constant soil accumulation rate in the subsoil. This assumption is too speculative: on the one hand, this is rarely the case over longer periods of time, on the other hand,

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translocation of C from top- to subsoils in form of DOC may be a relevant process in this environment given high precipitation. Therefore, a calculation of SOC storage rates over the 1600 years is highly speculative and thus also the conclusions regarding the long-lasting positive effect of N inputs on C sequestration. In view of the discussion, particularly in sections 4.2.2 and 4.3, it would certainly be a benefit to include literature on the C storage capacity/C saturation of soils that could also be calculated for these soils (see e.g. Hassink 1997, Wiesmeier et al. 2014, Global Change Biology 20, 653-665). After a revision in terms of these points, the manuscript can be evaluated again.

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