

Author response: Interactive comment on “Scaling impacts on environmental controls and spatial heterogeneity of soil organic carbon stocks” by U. Mishra and W. J. Riley

Anonymous Referee #1

This work builds on a previous study published by the authors in 2012 by investigating spatial scaling controls on soil carbon stock estimates. The authors use a suite of databases with spatial resolutions ranging from approximately 100m to 10km, including National Land Cover Database, USGS databases, and DEMs (convolved to 100m). The authors successively increased the spatial scale of environmental variables, using both observational data and geospatial approaches, to predict soil carbon stocks at different spatial scales. Their principal finding was that the strength of controls of environmental factors on soil carbon stocks generally decreased as spatial scale increased (which makes sense), with the effects of temperature exerting the strongest controls across scales. At finer scales, the controls of topographic attributes were more prominent while at larger scales temperature and elevation were more significant. While these findings are perhaps not surprising, and are consistent with other reports, the implications are of broad significance with respect to interpretation of earth system models. The main take home message of this important work is that current modelling efforts operating at coarse spatial scales (> 100 km) are likely unable to utilize certain environmental data in estimating soil organic carbon stocks. The manuscript is generally well written, well researched, and clearly presented. I feel this should be appropriate for the readership of Biogeosciences and offer minor comments by line number, below.

Response – We thank the reviewer for summarizing our study and indicating its implications. We have adopted all the changes recommended by the reviewer in the revised manuscript.

1724, L3: If citing Jenny, it would be appropriate to also mention the significance of time as a soil forming factor. The authors mention this on page 1734, line 7, but it’s worth mentioning here.

Response – We thank the reviewer for this suggestion. The text has been modified in the revised manuscript to include Time as a soil forming factor (P4L6).

1725, L9: I think it would be helpful to succinctly state what the authors mean by “model benchmarking”.

Response – Thanks for this suggestion. By the term “model benchmarking”, we mean using observation based scaling relationships to test the land biogeochemical representations in earth system models. The text has been modified to define the term “model benchmarking” (P5L18-20).

1727, L9: Would it be possible to provide a citation or reference for the UAF Northern Soils Research Program?

Response – Thanks for this suggestion. We provided a citation for the Northern latitudes soils program (P7-8L23-1).

1729, L14: Perhaps this is described in detail in Mishra and Riley, 2012, but there are no descriptions of soil depths in this study. Could it be clarified that pedons described here are to 1m?

Response – On page 1727 line 12, we provided the sampling depths of the pedon data we used in this study. The sampled depths ranged from 0.05 – 4.5 meters. We added a sentence in the modified manuscript to describe the depth distribution of sampled pedons (P8L6-8).

1732, L20-25: Could it be clarified how the relationship between scrub vegetation and SOC stocks changes (positive or negative relationship)?

Response – Thanks for this suggestion. The control (median geographically weighted regression coefficient across Alaska) of scrub vegetation on SOC stocks decreased linearly (from 0.3 to 0.13) with increasing scale. At finer scales, scrub vegetation showed higher control on SOC stocks, which decreased by about 57% as the scale increased up to 10 km. Despite the observed decrease in control of scrub vegetation on SOC stocks due to scaling, the relationship between scrub vegetation and SOC stocks remained positive (more positive to less positive). We modified the text in revised manuscript to describe the change in control of scrub vegetation on SOC stocks (P14L10-14).

1734, L20: Another good discussion of soil forming factors at multiple scales affecting SOC stocks: Torn MS, Swanston CW, Castanha C, Trumbore SE. 2009. Storage and Turnover of Organic Matter in Soil, in *Biophysico-Chemical Processes Involving Natural Nonliving Organic Matter in Environmental Systems*; edited by Senesi N, Xing B, Huang PM. John Wiley and Sons, Jew Jersey, USA. pp. 219-272.

Response – Thanks for this suggestion. We have cited appropriately the recommended reference (P4L19).