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Biogeosciences Discussions

Interactive comment on "Alaskan soil carbon stocks: spatial variability and dependence on environmental factors" *by* U. Mishra and W. J. Riley

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1. Interactive comment on "Alaskan soil carbon stocks: spatial variability and dependence on environmental factors" by U. Mishra and W. J. Riley

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It is great to see someone knowledgeable about geostatistics offering feedback about this fine paper- thank you Gustaf. Because the application of a spatially-resolved upscaling method is one of this paper's strongest aspects, it would be appropriate if the results of this method were discussed at greater length in the context of other methods. For instance, in the Results and Discussion (page 12), where the authors discuss how

their estimated SOC stocks differ from other published estimates- is there any way to compare prediction accuracy or spatial variation of stratified upscaling vs. spatially resolved upscaling within ecoregions (or at the statewide scale)? The current discussion only compares the estimates of SOC stocks across the methods, but would be stronger if it included some assessment of variability.

Response: Our thanks to the referee for his thoughtful comments regarding comparing prediction accuracy of our approach and previous studies in Alaska. The previous studies mentioned in our manuscript did not validate their SOC stock estimates, so we are unable to compare our prediction errors with these previous studies. However, as per referee's suggestion we quantified the coefficient of variability within each ecoregion of Alaska. We found large spatial variability within the ecoregions. For arctic tundra, intermontane boreal, Alaska range transition, and coastal rainforests, the predicted coefficient of variability in whole profile SOC stock was 49%, 38%, 43%, and 34% respectively. In the active layer SOC stock, the CV was 51%, 33%, 82%, and 221%. In permafrost SOC stock, the observed CV was 78%, 145%, 111%, and 140% respectively. Our data suggest large spatial variability exists within each ecoregion that these former studies used to stratify the study area. We will add these comparisons to the final manuscript to highlight the importance of testing SOC upscaling methods in heterogeneous landscapes.

2. Interactive comment on "Alaskan soil carbon stocks: spatial variability and dependence on environmental factors" by U. Mishra and W. J. Riley

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This study constitutes the first application of regression (or similar kriging) approaches to estimating soil C storage in permafrost terrain. While previous authors have successfully used large pedon databases to assess soil C storage in the Alaskan geographical region, the method of upscaling has been to use stratified thematic mean upscaling. See Hugelius (2012, Global Biogeochem. Cycl., doi: 10.1029/2011GB004154) for a

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comprehensive discussion of using stratified upscaling in remote geographic regions. This study by Mishra and Riley provides a first indication that more data-intensive methods utilizing multiple, spatially explicit, environmental variables (e.g. geographic regression or kriging) to predict soil C storage are applicable also to permafrost soils. This points to a potential way forward for developing scientific knowledge concerning poorly constrained estimates of the vast permafrost C pool.

Response- We thank Gustaf for his thoughtful comments regarding the use of geospatial approaches to quantify the SOC stocks of permafrost affected soils. As he also discussed, previous studies have estimated SOC stock by stratifying the study area, averaging point observations of SOC stocks within each stratum, and multiplying by the aerial extent of that stratum (Ping et al., 2008a; Tarnocai et al., 2009; Johnson et al., 2011). Outside of permafrost areas, this approach has been reported to be associated with high estimation errors because it does not represent soil and environmental variable heterogeneity within each strata (Thompson and Kolka, 2005; Meersmans et al., 2008; Sanchez et al., 2009).

We also agree that geospatial modeling approaches, such as those adopted in this study, can be used to better estimate SOC stocks in permafrost affected regions.

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