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Biogeosciences Discussions

Interactive comment on "Water availability limits tree productivity, carbon stocks, and carbon residence time in mature forests across the western United States" *by* Logan T. Berner et al.

Anonymous Referee #2

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This is a nice study demonstrating the regional relationship between water availability and productivity, C stocks and residence time in forests of the western US. An impressive data set based on both forest inventory and satellite data were used to establish these relationships. I am not a specialist in estimating forest NPP or C dynamics, but the methods used and assumptions made seem reasonable and the authors are experts in these ecosystems.

Their results indicate that mature forests in the western US were strongly sensitive (across spatial gradients) to changes in water availability. This is not a surprising result, but the scale and scope of this analysis makes this a publishable study. Where I take issue is the inference drawn from this analysis. The authors conclude that their

analysis suggests that projected climatic change over the coming century could reduce productivity, biomass and carbon residence time in many parts of this region. Indeed, they justify their study by noting that "Changes in ecosystem structure and function along spatial climatic gradients can provide insight into long-term ecosystem response to climatic change". While this makes sense in the broadest terms, using spatial relationships (based on average values derived from long-term data) to make predictions about temporal changes in (or the differential sensitivity of) ecosystems to a climate change is risky at best.

We have long known that large scale spatial relationships between NPP and precipitation (or water availability) have a slope that is determined by combined changes in water availability, biogeochemistry and the plant community. But the temporal dynamics over which each of these factors will change in the future will vary dramatically. . .from decades to centuries to even millennia. Thus, spatial models of NPP vs. water are not good predictors of expected temporal dynamics in ecosystems. . ..particularly in forests that have long-lived trees and where communities may turnover very slowly (hundreds of years?). Please see the three references below. Combined, they do a nice job of covering many of the well-known problems inherent in substituting spatial models for temporal models when projecting a future with directional and chronic climate change.

Thus, while I am in favor of publishing this analysis, the conclusions drawn that "projected warming and drying over the coming century. . .could have important impacts on ecosystem structure, function, and services. . ." are really not that noteworthy. Nonetheless, a well-done confirmatory message is much better than much of the introduction and discussion which repeatedly references "sensitivities to changes in water availability" in the context of climate change. As presented, the implication that there is climate change relevance in this analysis is really quite misleading. . .given that spatial sensitivity does not equate to temporal sensitivity – except perhaps for sign. This is true under today's environment, and spatial relationships such as those derived here will likely be even poorer surrogates for predicting the future as the varying time scales of change

(climate vs forest community turnover vs. biogeochemistry) lead to novel functional relationships.

Thus, at the very least the authors should point out the limitations of their analysis and approach with regard to its relevance to future temporal C dynamics. Specifically, because the slopes (sensitivity) of temporal relationships between NPP and water are almost always less steep than slopes from spatial models, the authors need to recognize that the sensitivity implied by their analysis will likely not be manifest.

Estiarte et al. 2016. Few multiâĂŘyear precipitationâĂŘreduction experiments find a shift in the productivityâĂŘprecipitation relationship. Global Change Biology 22: 2570–2581.

Gaitan et al. 2014. Vegetation structure is as important as climate for explaining ecosystem function across Patagonian rangelands. Journal of Ecology 102: 1419-1428.

Wilcox 2016. Does ecosystem sensitivity to precipitation at the site-level conform to regional-scale predictions? Ecology 97: 561-568.

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