

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 #1

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General Comments:

This is a very interesting paper that uses forest inventory and satellite data to evaluate the influence of mean annual moisture balance on forest productivity and biomass across the western US with a particular focus on California, Oregon, and Washington. While it is no surprise that productivity and biomass in this region are affected by water availability, this paper provides the most thorough quantification of this influence to date and represents a fantastic use of US Forest Service survey data. This thorough quantification leads to the conclusion that water balance has not just an important influence on forest carbon in the western US, but that it is instead THE dominant driver in this region, with a strong and reliable effect on both biomass and productivity, which

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translates to a strong and reliable effect on carbon residence time. This information has clear implications for future forest carbon dynamics in a warmer world with altered precipitation regimes, which is importance since dynamic vegetation models are still in need of substantial improvement before their representations of future shifts in forest demographics across regions as large and complex as the western US are taken seriously. I recommend publication after some minor points below are addressed.

Specific Comments:

L79: The Singh et al. study is a great one but the focus is not on the impact of recent warm temperatures on west coast drought, but rather on an observed increase in the frequency of east-west dipole years when the western US is anomalously warm and the eastern US is anomalously cool. There have been many papers that more compellingly evaluate the role of temperature in exacerbating recent drought conditions on the west coast, particularly CA, than either of the references provided here:

AghaKouchak, A., L. Cheng, O. Mazdiyasn, A. Farahmand (2014), Global warming and changes in risk of concurrent climate extremes: Insights from the 2014 California drought, *Geophysical Research Letters*, 41(24), 8847-8852, doi:10.1002/2014GL062308.

Griffin, D., K. J. Anchukaitis (2014), How unusual is the 2012–2014 California drought? *Geophysical Research Letters*, 41(24), 9017-9023, doi:10.1002/2014GL062433.

Mao, Y., B. Nijssen, D. P. Lettenmaier (2015), Is climate change implicated in the 2013-2014 California drought? A hydrologic perspective, *Geophysical Research Letters*, 42(8), 2805-2813, doi:10.1002/2015GL063456.

Mote, P. W., D. E. Rupp, S. Li, D. J. Sharp, F. Otto, P. F. Uhe, M. Xiao, D. P. Lettenmaier, H. Cullen, M. R. Allen (2016), Perspectives on the causes of exceptionally low 2015 snowpack in the western United States, *Geophysical Research Letters*, 10.1002/2016GL069965, In press, doi:10.1002/2016GL069965.

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Shukla, S., M. Safeeq, A. AghaKouchak, K. Guan, C. Funk (2015), Temperature impacts on the water year 2014 drought in California, *Geophysical Research Letters*, 42(11), 4384-4393, doi:10.1002/2015GL063666.

Williams, A. P., R. Seager, J. T. Abatzoglou, B. I. Cook, J. E. Smerdon, E. R. Cook (2015), Contribution of anthropogenic warming to California drought during 2012-2014, *Geophysical Research Letters*, 42(16), 6819-6828, doi:10.1002/2015GL064924.

L132-136: The allometric equations and LAI-vs-root relationship should be cited, particularly for the diverse (non-forestry) readership of this journal.

L140: I don't think it's necessary to specify that stands of >100 years of age are considered here since it was already stated that only stands of this age group were considered in the analysis.

L177-194: The circularity involved in using the MODIS NPP product, which incorporates climate data, to evaluate the relationship between NPP and climate needs to be acknowledged.

L341-344: Is this artifact due to saturation of satellite-derived NDVI/LAI in densely vegetated areas? It seems like the likely reason for the false plateauing in the satellite obs could be stated.

L459-460: The projected soil moisture trends in Dai (2013) are for just 0-10 cm. For model projections of the more important 1-2 m layer, Cook et al. (2015) is a good reference, at least for CA and the Southwest.

Cook, B. I., T. R. Ault, J. E. Smerdon (2015), Unprecedented 21st century drought risk in the American Southwest and Central Plains, *Science Advances*, 1(1), e1400082, doi:10.1126/sciadv.1400082.

L469-472: But isn't it under hotter/drier conditions where, all else held equal, vegetation stands to benefit the most from increased CO₂. The argument that recent drought-driven declines in productivity in the Southwest is evidence for a lack of a CO₂

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effect is an incomplete argument, as it could be counter-argued that the recent drought period has been particularly intense and that the consequences would have been more severe without CO₂ fertilization. There is still much that is unknown about CO₂ fertilization, the forests that will benefit from it, and how these benefits will manifest, but just as it is unwise to argue that CO₂ fertilization will definitely allow semi-arid forests to become more productive in a warmer world, it is also unwise to imply without a thorough evaluation of evidence that CO₂ fertilization will not have any effect on the future relationship between CMI and NPP, BIO, or CRT.

Technical Corrections:

L39 & 41: CMI should be defined on L39, therefore allowing the definition of CMI_{wy} on L41 to make more sense.

L94: Should “be” be “by”?

L112: The specification of the converse hypothesis is unnecessary.

L125: Should “using” be “used”?

L237: Should “extensive” be “extensively”?

L443: “elucidate underlying mechanism” may be missing a word or letter.

Fig 2 caption, L847: Should “annual” be “annually”?

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