EGU2020-3550
https://doi.org/10.5194/egusphere-egu2020-3550
EGU General Assembly 2020

Negative asymmetry response of ecosystem productivity to annual rainfall anomalies over the conterminous U.S during the 2010 -2018 period

Amen Al-Yaari[1], Jean-Pierre Wigneron[2], Philippe Ciais[3], Alan Knapp[4], Markus Reichstein[5], Jerome Ogee[2], Lisa Wingate[2], Nuno Carvalhais[5], Fan Lei[6], Koen Hufkens[2], Jerome Chave[7], Frédéric Frappart[2,8], Jennifer Swenson[9], and Ducharne Ducharne[1]

[1]Sorbonne, METIS, Paris, France (amen.al-yaari@inra.fr)
[2]INRAE, UMR1391 ISPA, F-33140, Villenave d'Ornon, France
[3]Laboratoire des Sciences du Climat et de l'Environnement, IPSL, Gif-sur-Yvette, France
[4]Department of Biology and Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO, USA
[5]Department of Biogeochemical Integration, Max Planck Institute for Biogeochemistry, Jena, Germany
[6]School of Geographical Sciences, Nanjing University of Information Science and Technology, Nanjing, 210044, China
[7]Laboratoire Evolution et Diversité Biologique, UMR5174, CNRS, Université Paul Sabatier, IRD, Toulouse Cedex 9, France
[8]Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), 31400, Toulouse, France
[9]Nicholas School of the Environment, Duke University, Durham, NC, 27708, USA

Terrestrial ecosystems play a major role in the interannual variability of the global carbon budget representing a substantial sink equivalent to about one-third of current anthropogenic CO_2 emissions (Le Quéré et al., 2018). Therefore, it is vital to understand how plants and vegetation respond to the impacts of climate extremes as this impacts the productivity terrestrial ecosystems. The conterminous United States (CONUS) represent a diverse range of climate conditions and ecosystems where productivity and its interannual variability are controlled regionally by rainfall and/or temperature. The responses of ecosystem productivity to wet and dry years have been previously investigated over the CONUS using annual aboveground net primary productivity (ANPP) data from multi-site observations (Knapp and Smith, 2001). From this previous study, a positive asymmetry of ANPP in response to rainfall anomalies was found at individual sites (i.e. an increase of ANPP in wet years was greater than a decline in dry years). Here, we evaluate the asymmetry of ecosystem productivity to rainfall over the entire CONUS from 2010 to 2018 using multiple data streams including: the Global Unified Gauge-Based precipitation data, the GRIDMET surface meteorological data (maximum temperature, minimum temperature, precipitation accumulation, and Palmer Drought Severity Index), the SMOS satellite L-Vegetation optical depth product, CO_2 fluxes (net ecosystem exchange (NEE) & gross primary productivity (GPP)) derived from eddy covariance measurements, MODIS ANPP product, Fluxnet GPP at site scale, and three different GPP products from observation-driven models. We address the following two questions: (1) How does ecosystem productivity across the CONUS respond to rainfall anomalies during the period 2010-2018? (2) Does the evidence for positive asymmetry previously observed using site studies hold true across the entire CONUS? For this, we define an asymmetry index (AI) where

positive AI indicate a greater increase of productivity in wet years compared to the decline in dry years, and negative AI indicate a greater decline of productivity in dry years compared to the increases in wet years. We find that the spatial patterns of AI across the CONUS are similar amongst the different products and exhibit more pronounced negative asymmetries over the Great Plains and the west north central region whilst positive asymmetries are observed over the southwestern USA during the 2010-2018 period. While the “shrubland” biome shows a persistent positive asymmetry during the period, the “grasslands” biome appears to have switched from positive (observed by Knapp and Smith, 2001) to negative anomalies during the last decade. The observed asymmetry of the different GPP products is reflected by the negative asymmetry of the precipitation anomalies (skewness of precipitation annual anomalies), which we conclude is the primary driver of negative asymmetry across the US continental surface.

References

Knapp, A.K., Smith, M.D., 2001. Variation Among Biomes in Temporal Dynamics of Aboveground Primary Production. Science (80-.). 291, 481. https://doi.org/10.1126/science.291.5503.481

Le Quéré, C., Andrew, R.M., Friedlingstein, P., Sitch, S., et al., 2018. Global Carbon Budget 2018. Earth Syst. Sci. Data 10, 2141–2194. https://doi.org/10.5194/essd-10-2141-2018