

Title: Increasing Impacts of Extreme Droughts on Vegetation Productivity under Climate Change

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Project Abstract: Terrestrial gross primary production (GPP) is the basis of food production and vegetation growth globally¹, and plays a critical role in regulating atmospheric CO₂ through its impact on ecosystem carbon balance. Even though higher CO₂ concentrations in future decades can increase GPP², low soil water availability, heat stress, and disturbances associated with droughts could reduce the benefits of such CO₂ fertilization. Here we analyzed outputs of 13 Earth System Models (ESMs) to show an increasingly stronger impact on GPP by extreme droughts than mild and moderate droughts over the 21st century. Due to a dramatic increase in the frequency of extreme droughts, the magnitude of globally-averaged reductions in GPP associated with extreme droughts was projected to be nearly tripled by the last quarter of this century (2075–2099) relative to that of the historical period (1850–1999) under both high and intermediate greenhouse gas emission scenarios. In contrast, the magnitude of GPP reduction associated with mild and moderate droughts was not projected to increase substantially. Our analysis indicates a high risk of extreme droughts to the global carbon cycle with atmospheric warming; however, this risk can be potentially mitigated by positive anomalies of GPP associated with favorable environmental conditions.