



Carbon-Water Interactions during Warm Spring and Summer Drought

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Warmer temperatures during spring and a higher prevalence of drought during summer are projected in a changing climate. In 2012, the US experienced the warmest spring on record and the most severe drought since the Dust Bowl period. It is crucial to understand the impact of such events on carbon-water interactions in terrestrial ecosystems to better predict their response in a future climate. We combined an extensive network of direct ecosystem flux measurements with satellite remote sensing and atmospheric inverse modelling to quantify the impact of the warmer spring and summer drought on biosphere-atmosphere carbon and water exchange in 2012 across the US. We found that earlier vegetation activity increased spring carbon uptake and compensated for the reduced uptake during the summer drought, which mitigated the impact on net annual carbon uptake. The early phenological development in the Northeast played a major role for the continental-scale carbon balance in 2012. The warm spring also depleted soil water resources earlier, and thus exacerbated water limitations during summer. Our results show that the detrimental effects of severe summer drought on ecosystem carbon storage can be mitigated by warming-induced increases in spring carbon uptake. However, the positive carbon cycle effect of warm spring enhances water limitations and can increase summer heating through biosphere-atmosphere feedbacks.