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# Climate Extremes Triggered State Shifting of US Great Plains Prairie under Experimental Warming

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Ecosystems can exist under multiple stable states. Transition from one stable state to another is usually triggered by perturbations such as climate extremes, which should be large enough to push the ecosystem over a threshold. Ecosystem state changes can alter ecosystem functions and services as dramatically as in Sahara with vegetation changes from tropical forests to grassland and deserts over 6000 years. Thus it is crucial to understand mechanisms underlying ecosystem state changes.

State changes of ecosystem vegetation have been well documented in paleo-records and predicted to occur under climate change by dynamic global vegetation models. Paleo-records usually offer broad-scale patterns of ecosystem state changes over time and rarely offer much insight into fundamental mechanisms underlying the state changes. Model predictions may be calibrated against contemporary and paleo vegetation distributions but have not been carefully tested against experimental evidence. The latter, however, is extremely rare largely because global chance experiments are mostly short term.

We have observed state shifting of a US Great Plains prairie under long-term experimental warming and clipping treatments. Our analysis of 11-year data from the experiment showed two-stage stimulations of above-ground net primary production (ANPP) with small increases in the first 7 followed by distinctly large increases under experimental warming in comparison with those under control. The two-stage ANPP simulations were corresponded with species reordering with the plant community over time but not related to warming-induced changes in temperature, soil moisture and nitrogen dynamics in the grassland. The state shifting of the grassland under the experimental warming was partly because our experimental site locates in an ecotone between the mixed and tall grass prairies. Under the experimental warming, the prairie was shifting from the mixed prairie as dominated by Schizachyrium scoparium (little blue stem) with a typical height of about 1 m to a typical tallgrass prairie dominated by Sorghastrum nutans (Indian grass) of about 2 m tall. Our results suggested that chronic experimental treatments differentially exerted impacts on individual species to certain thresholds, beyond which plant community structure and ecosystem functions were changing to a different state. , The threshold change was triggered by climate extremes with two consecutive drought years in 2005 and 2006 followed by a very wet year in 2007.