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Post-fire spatial and temporal complexity in Yellowstone: what does it mean for climate change
forecasts?

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Climate change is expected to result in more severe fire seasons in mid-elevation Rocky Mountain forests. Here, we explore the challenges and opportunities of modeling the response of the post-1988 fire landscape to such climate changes. The 1988 Yellowstone fires resulted in increased heterogeneity in stand structure, and recent evidence suggests this variation in stand structure also resulted in initial variation in ecosystem function including aboveground net primary productivity and nitrogen availability. Using the Century ecosystem model, we demonstrated that following the 1988 fires, the ability of the Yellowstone landscape to store carbon to year 2100 depended on the specific global climate model used as well as the rate of post-fire vegetative recovery. However, in the absence of fire, lodgepole pine forests were projected to be a large C sink due to positive responses of lodgepole to increased warming. This suggests the importance of incorporating post-1988 fire recovery patterns into future carbon projections. In addition, N availability is known to limit forest productivity in Yellowstone National Park, which may have important feedbacks to carbon cycling. The model results indicated that N availability increased following the 1988 fires, and differed based on the ratio of grasses and trees in the post-fire stand. Overall, these model results compliment earlier synthesis efforts that suggest resilience of the Yellowstone landscape to fire over long time periods. For shorter term projections (to year 2100), the model results show that projected changes in climate and the multiple trajectories of recovery representing the heterogeneous post-1988 fire landscape may be important. Ongoing work using FIRE-BGC suggests that projections in climate change must include effects of multiple disturbances, such as bark beetles and fire, to forecast realistic C change scenarios. We conclude that there are at least 3 important factors that must be considered in short-term (<100yr) projections of climate change in Yellowstone: (1) multiple trajectories of response from single, fire events, (2) spatial and temporal heterogeneity in N-C feedback responses, and (3) multiple disturbance interactions.