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Forest Ecosystem-scale Responses and Resilience to Drought

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The observation and modeling of ecosystem responses to stress are major challenges in carbon (C) cycle science. We examined ecosystem response and resilience during the exceptional 2012 US drought in an oak-hickory forest, synthesizing flux tower, ecophysiological and satellite observations with an ensemble of GPP models. During drought, gross primary productivity (GPP) was suppressed and the ecosystem was a net C source for ~50 days during July and August. Ecosystem function recovered rapidly after soaking rains, such that the forest was a net C sink through the end of the growing season. Data-driven models (MODIS, MPI) and the Community Land Model (CLM) bracketed observations—significantly over- or underestimating drought response and resilience, and in the case of CLM, failing to simulate the early season GPP peak during well-watered conditions. In contrast, solar-induced fluorescence showed excellent coherence with observed GPP, despite a large scale-mismatch between the satellite and ground-based observations, demonstrating site-level skill at tracking GPP and associated dynamics due to plant water stress. Taken together, there is a pressing need for integrated observational and modeling investigations to better characterize and represent ecosystem stress responses in models, with particular emphasis on improving the representation of stomatal conductance.