Identifying Critical Thresholds for Acute Responses of Plants to Water Stress (TARP)

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Sponsor: DOE Office of Science, BER (KP 12 03 01 0)

- **The TARP study strives to evaluate growth and physiological responses of large trees to severe soil water deficits.**
- **Critical data quantifying growth reductions and mortality leading to forest failure are needed to test extant ecosystem models.**
- **Driver: Global environmental change prediction.**
- **Unique contribution: Replicated study of acute water stress on large trees that will provide key data for testing the validity of model outputs.**

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Biogeography models and dynamic ecosystem simulation models used in the assessment of climatic change routinely predict species displacement and population migration following mortality. Although such predictions are based on reasonable hypotheses regarding plant response to warming and associated inter-specific competition, predicted mortality rates driving current models and mechanisms remain largely untested. We propose a manipulative field study to provide data on the impact of acute drought on mechanisms responsible for growth and mortality of deciduous forest canopy trees representative of common plant functional types (*Liriodendron* and *Quercus*). We propose to deploy replicated understory canopies for the removal of 100 percent throughfall and stem flow around mature trees to allow the artificial introduction of a spring drought. Such droughts overlap the period of optimum stem growth and have a greater potential to disrupt plant function. Key measurements include weekly dendrometer band observations, periodic evaluation of plant nonstructural carbohydrates status, automated measurements of sapflow, periodic observations of foliar photosynthesis and conductance, and observations of soil moisture status by depth and horizontal extent of the tree root zone. A primary goal of this research will be to translate such data into mechanistic expressions of the threshold levels of moisture stress responsible for limiting plant function and growth and the inclusion of mechanistic expressions in biogeochemical and biogeography models to enhance their usefulness for assessments of climatic change. While the proposed field experiments and observations will be limited to acute precipitation manipulations, interactions between acute drought, future warming, elevated CO_2 and increasing tropospheric ozone will be addressed with stand-level ecosystem models to evaluate the potential for mitigating (CO_2) or exacerbating (temperature, ozone) impacts.