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Community and ecosystem response to global change: the Old-field Community Climate and Atmospheric Manipulation (OCCAM) project

Changes in the concentration of carbon dioxide in the atmosphere ($[CO_2]$), coupled with concurrent changes in climate, including increases in tropospheric temperatures and changes in precipitation regimes, are likely to affect the structure and function of managed and natural communities and ecosystems. However, there have been relatively few investigations of how these various factors of global change may interact to affect in-situ communities in natural field settings. To meet this shortcoming, we describe an experiment designed to investigate the interactive effects of $[CO_2]$, temperature, and soil water availability on a constructed ecosystem with plants typical of an old-field system, including C3 and C4 grasses, forbs, and legumes near Oak Ridge, Tennessee. Experimental plots are constructed in field soil, and are contained within 4-m diameter open-top chambers used to control environmental factors. Soil moisture contents to depths of 35 cm were greater under elevated than ambient $[CO_2]$, particularly in dry plots. Aboveground biomass and leaf area index (LAI) were greater under elevated $[CO_2]$ than ambient $[CO_2]$, but differed little between wet and dry plots. These results, coupled with preliminary data on leaf-level stomatal conductance for two plant species, suggest that soil water budgets are affected more by CO_2-induced reductions in stomatal conductance than by changes in canopy production or architecture. Increases in temperature tended to reduce biomass production, LAI, and soil moisture, although these effects were attenuated with additions of $[CO_2]$ or water. Moreover, temperature effects on biomass production depended on species. In sum, results indicate that $[CO_2]$, soil moisture, and temperature, factors likely to both change and covary over the next several decades, will have interactive, direct and indirect effects on production and composition of typical old-field plant communities and ecosystems.