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Impact of drought and heat events on carbon exchanges in temperate pine forests of different ages in Eastern Canada

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North American forests play an important role in the global carbon cycle because they offset a large portion of global fossil fuel carbon dioxide (CO_2) emissions. A substantial fraction of these carbon sequestering forests are located in the north-eastern temperate climate zones, where spring through early summer is the most productive period of the growing season. Therefore, variations in carbon sequestration rates due to environmental constraints during this period may have a profound impact on seasonal and annual net ecosystem productivity (NEP) of forest ecosystems in the region. Recent studies suggest that, in the future, summer warming and drought events may be shifted to both spring and autumn shoulder seasons and concurrent heat and drought events may exacerbate the negative effects of drought on carbon cycling in these forests. In this study the impact of seasonal and annual climate variability as well as extreme climatic events on gross primary productivity (GEP), ecosystem respiration (RE), net ecosystem productivity (NEP) and evapotranspiration (Ec) in an age-sequence (72, 37 and 9 years old) of planted temperate pine (white pine, Pinus strobus L.) forests, north of Lake Erie in southern Ontario, Canada will be examined using eight years (2003-2010) of eddy covariance flux and meteorological data. These sites are known as the Turkey Point Flux Station and had been part of the Canadian Carbon Program (CCP) or the Fluxnet-Canada Research Network (FCRN. The response of canopy transpiration (Et) and forest growth rates to experimentally reduced precipitation during the early growing season will also be evaluated in the 72-year old forest. A 20 m x 20 m throughfall exclusion setup was established and throughfall was excluded from April 1 to July 3, 2009. During this period 270 mm precipitation (27% of annual total) fell, of which 90% was excluded excluded. Sapflow measurements suggested that Et was 14% less in the drought plot compared to the reference plot when evaluated at the end of growing season in November. Tree growth estimates at the end of growing season indicated 17% decrease in growth in the drought plot. Climate predictions foresee changes in precipitation patterns, more than total precipitation amounts. The short-term deficit in water supply during peak growing season may have important implications for forest ecosystems. The findings of this throughfall manipulation will help to quantify the impacts of spring and early summer water deficit on forest ecosystems and evaluate their potential responses to future climate regimes. Our study also suggests that the simultaneous occurrence of early growing season drought and extreme summer heat events may play a large role in reducing the annual net carbon uptake in mature and young forests in eastern North America.