Geophysical Research Abstracts
Vol. 18, EGU2016-10763, 2016
EGU General Assembly 2016

High sensitivity of broadleaf trees to water availability in northeastern United States

Mathieu Levesque (1), Laia Andreu-Hayles (1), and Neil Pederson (2)

(1) Columbia University, Lamont-Doherty Earth Observatory, Palisades, United States (mathieul@ldeo.columbia.edu), (2) Harvard Forest, Harvard University, Petersham, United States (neilpederson@fas.harvard.edu)

Broadleaf dominated forests of eastern US cover more than one million km2 and provide ecosystem services to millions of people. High species diversity and a varied sensitivity to drought make it uncertain whether these forests will be carbon sinks or sources under climate change. Ongoing climate change, increased in atmospheric CO_2 concentration (ca) and strong reductions in acidic depositions are expected to alter growth and gas exchange of trees, and ultimately forest productivity. Still, the magnitude of these effects is unclear. A better comprehension of the species-specific responses to environmental changes will better inform models and managers on the vulnerability and resiliency of these forests. Here, we combined tree-ring width data with δ13C and δ18O measurements to investigate growth and physiological responses of red oak (Quercus rubra L.) and tulip poplar (Liriodendron tulipifera L.) in northeastern US to changes in water availability, ca and acidic depositions for the period 1950–2014. Based on structural equation modeling approaches, we found that summer water availability (June-August) is the main environmental variable driving growth, water-use efficiency and δ18O of broadleaf trees whereas ca and acidic depositions have little effects. This high sensitivity to moisture availability was also supported by the very strong correlations found between summer vapor pressure deficit (VPD) and tree-ring δ13C (r = 0.67 and 0.71), and δ18O series (r = 0.62 and 0.72), for red oak and tulip poplar, respectively. In contrast, tree-ring width was less sensitive to summer VPD (r = -0.44 and -0.31). Since the mid 1980s, pluvial conditions occurring in northeastern US have increased stomatal conductance, carbon uptake, and growth of both species. Further, the strong spatial field correlations found between the tree-ring δ13C and δ18O and summer VPD indicate a greater sensitivity of eastern US broadleaf forests to moisture availability than previously known. This appears especially true since much of the calibration period looks wet in a multi-centennial perspective. Overall, our findings indicate a great potential for the use of tree-ring stable isotopes in large-scale hydroclimatic reconstructions studies in eastern US.