Trees using water more efficiently as atmospheric carbon dioxide rises

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A sonic aenomometer and air inlet tube on an eddy-covariance tower at University of Michigan Biological Station, Michigan, USA. The instruments allow for the continuous monitoring of gas exchange between the forest and the atmosphere. Credit: Chris Vogel

A study by scientists with the U.S. Forest Service, Harvard University and partners suggests that trees are responding to higher atmospheric

carbon dioxide levels by becoming more efficient at using water.

The study, "Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise," was published on-line today in the journal *Nature*. Dave Hollinger, a plant physiologist with the U.S. Forest Service's Northern Research Station, is a co-author with lead author Trevor Keenan of Harvard University and colleagues from The Ohio State University, Indiana University, and the Institute of Meteorology and Climate in Germany.

"Working with others, the Forest Service is developing knowledge that is essential to maintaining healthy, sustainable forests in a changing climate ," said Michael T. Rains, Director of the Northern Research Station. "We are striving to be at the forefront of delivering sound climate science to the public."

Terrestrial plants remove carbon dioxide from the atmosphere through photosynthesis, a process that is accompanied by the loss of water vapor from leaves. The ratio of water loss to carbon gain, or water-use efficiency, is a key characteristic of ecosystem function that is central to the global cycles of water, energy and carbon.

Scientists analyzed direct, long-term measurements of whole-ecosystem carbon and water exchange and found a substantial increase in water-use efficiency in temperate and boreal forests of the Northern Hemisphere over the past two decades.

"Our analysis suggests that rising atmospheric carbon dioxide is having a direct and unexpectedly strong influence on ecosystem processes and biosphere-atmosphere interactions in temperate and boreal forests," Hollinger said.

How efficient trees are in using water has implications for ecosystem

function, services and feedbacks to the climate system. These include enhanced timber yields and improved water availability, which could partially offset the effects of future droughts. However, reduced evapotranspiration, or the combination of evaporation and plant transpiration from the land to the atmosphere, resulting from higher water-use efficiency could lead to higher air temperatures, decreased humidity, and decreased recycling of continental precipitation. This could cause increased continental freshwater runoff, along with drought in parts of the world that rely on water transpired in other regions.

Scientists analyzed data from seven sites in the Midwest and Northeastern United States that are part of the AmeriFlux network including the Forest Service's Bartlett Experimental Forest in New Hampshire and the Howland Cooperating Experimental Forest in Maine and expanded the analysis to 14 additional forested sites in temperate and boreal regions. Flux towers at these sites measure fluctuations in carbon dioxide uptake and water loss. The Northern Research Station operates flux towers at five experimental forests; in addition to the Bartlett and Howland Forests this work is continuing at the Silas Little Experimental Forest in New Jersey, the Marcell Experimental Forest in Grand Rapids, Minn., and the Baltimore Long-term Ecological Research Site.

The mission of the U.S. Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. The agency has either a direct or indirect role in stewardship of about 80 percent of our nation's forests; 850 million acres including 100 million acres of urban forests where most Americans live. The mission of the Forest Service's Northern Research Station is to improve people's lives and help sustain the natural resources in the Northeast and Midwest through leading-edge science and effective information delivery.

More information: Paper: dx.doi.org/10.1038/nature12291

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