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Elevated CO2 induces changes in the ecohydrological functions of forests - from mechanisms to models

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Forests are known to considerably influence ecosystem water balance as a result of the many dynamic interactions between the plant physiology, morphology, phenology and other biophysical properties and environmental conditions. A changing climate will exert a new environmental setting for the forests and the biological feedbacks will be considerable. With the mechanistic ecosystem model Biome-BGC the dense net of cause-response relationships among carbon, nitrogen, water and energy cycles at a free-air CO2 enrichment (FACE) site in a North American deciduous broadleaved forest can be represented. At the Oak Ridge National Laboratory (ORNL) closed canopy sweetgum plantation elevated CO2 caused a decrease in stomatal conductance, and concurrent changes in daily transpiration were observed. This is in agreement with data from other FACE experiments. At the ORNL FACE site average transpiration reduction in a growing season was 10-16%, with 7-16% during mid summer, depending on the year. After parameterization of the model for this ecosystem the observed transpiration patterns could be well represented. Most importantly, the complete water budget at the site could be described and increased outflow could be observed ($\sim$15%). This yields crucial information for broader scale future water budget simulations. Changes in the water balance of deciduous forests will affect a wide range of ecosystem functions, from decomposition, over carbon and nutrient cycling to plant-plant competition and species composition.