Universität Basel

Research Project

Explore the ‘upper hidden half’ of trees: The influence of crown position on the seasonal dynamics of biological processes in the canopy of a temperate mixed forest

Third-party funded project

Project title Explore the ‘upper hidden half’ of trees: The influence of crown position on the seasonal dynamics of biological processes in the canopy of a temperate mixed forest
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Most biological processes in trees are driven by the environmental conditions within the canopy. While the canopy surface is climatically closely connected to the free atmosphere, the vertical structure of tree crowns causes steep gradients in all environmental factors (e.g., light, temperature, wind, humidity) from the upper to the lowest canopy layer. Forest canopies thus provide vertically stratified micro-climates that exert very different impacts on all physiological processes at different canopy layers. Although this effect is well recognized, the difficult access to mature tree crowns generally prevents extensive, direct investigations. Consequently, biological processes in forest canopies, like evapotranspiration and productivity, are normally assessed as integrated values across the entire canopy, either for the whole tree via stem measurements, or for an entire forest area via flux towers.

The new canopy crane at a species-rich temperate mixed forest in Hölstein, provides the ideal infrastructure to perform *in situ* measurements within the entire crown volume of a total of ca. 260 mature trees of ten different species. For the current project, it is proposed to conduct the first spatially and temporally highly-resolved investigations on growth, leaf gas exchange, carbon reserve dynamics and water relations along the environmental gradient in canopies of broad-leaved and conifer tree species. Throughout three consecutive years, the following biological processes and traits will be recorded on permanently marked branches at four different canopy layers: leaf phenology, shoot growth and secondary branch growth, net leaf CO_2-exchange, non-structural carbohydrate tissue concentrations, stomatal conductance and branch water potentials. The micro-climatic variability (radiation, temperature and humidity) within the canopy will be recorded at multiple sites along vertical crown profiles in different species, which will enable to correlate the observed processes and traits in branches to the local environmental conditions. By further accounting for the spatial tree distribution at the site, all processes dynamics measured for individual trees, can be extrapolated to the three-dimensional forest canopy. In addition, dendrometer measurements at the main stems will allow to compare measurements of processes at different canopy layers with the integrative signals recorded at the stem-level (e.g., stem radius increment vs. phenology and branch growth, tree water deficit vs. branch water potentials).

By simultaneously investigating growth, carbon- and water-relations directly within the canopy of different tree species, this project will reveal closer insights in the functional interrelations of these processes that are key to understanding tree responses to environmental stresses, like drought. The explicit consideration of differences along the environmental gradient in the canopies will deliver three-dimensional

information of the observed processes, which will be also necessary for the development of more realistic dynamic tree growth models.

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