Poster #61

Measuring and Modeling the Size and Temporal Dynamics of Nonstructural Carbohydrate Reserves in Temperate Forest Trees

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Like all woody plants, trees store nonstructural carbohydrates (NSCs), such as sugars and starch, to use as carbon and energy sources for daily maintenance and growth needs, as well as during times of stress. Allocation of NSCs to storage is an important strategy associated with future growth and survival, and thus understanding NSC dynamics is important for predicting how woody plants, from individuals to whole forest ecosystems, may respond to global change. Yet, large knowledge gaps exist regarding the size and turnover of NSC pools as well as the representation of allocation and storage processes in models, both contributing to uncertainty in forecasts of future atmospheric CO_2 inputs by forest ecosystems.

The primary goal of our work is to provide a detailed picture of NSC storage in temperate forest trees in New England by quantifying the seasonal patterns of NSCs in various organs throughout the tree and constructing whole-tree NSC budgets. Monthly field sampling at Harvard Forest in 2014 along with subsequent laboratory analyses have allowed for the quantification of NSCs in foliage, branch, stemwood, and root tissues, which are currently being scaled up to determine whole-tree NSC budgets. In all species (red oak, red maple, paper birch, white ash, and white pine), sugar concentrations in branch tissue (3-5y) were lower in the growing season than in the dormant season, with sugar generally increasing from August to December. Starch concentrations peaked in October and then sharply declined to December, with the exception of white pine, which exhibited a maximum starch concentration in June, followed by a steady decline onward. Additionally measurements of sugars and starch in foliage, stemwood, and root tissues collected monthly in 2014 are currently being compiled to further resolve organ-specific seasonal patterns and contribute to estimates of NSC storage at the whole-tree level.

In 2015, we collected additional samples 1) to estimate turnover time (i.e. mean age) of NSCs stored in different tissues using radiocarbon analysis, and to better understand mixing between new and old NSCs, and 2) to explore the relationship between growth and NSC storage. These data will be used to constrain the representation of NSC storage in the transport resistance model. A parsimonious version of the transport resistance framework is being used to test the influence of varying representations of NSCs (i.e. single pool vs. continuously simulated concentration gradients), and thus improve on the simplistic and untested representations of NSC storage in most existing forest C models. Improving model representation of NSC storage is instrumental in predicting the capacity of trees to tolerate abiotic and biotic stressors and, more generally, it is fundamental to our ability to predict forest responses to global change.