Morgan Furze

Quantifying nonstructural carbon pools in temperate forest trees

Project Summary:

Like all woody plants, trees store nonstructural carbon (NSC), primarily consisting of sugars and starch, as reserves to support growth and metabolism. The importance of this storage lies in the fact that immobile, long-lived trees can draw on these reserves in order to cope with times of stress, including exposure to drought, pests and disease, disturbance, and climate extremes. Thus, NSC is remarkably relevant when predicting forest responses and resiliency to global climate change, and has an influence at multiple scales from individual tree survival to carbon cycling in whole forest ecosystems. However, important questions about the size, turnover, and availability of NSC remain unanswered. These knowledge gaps lead to large uncertainty about how to represent carbon allocation and storage processes, and have implications for model forecasts of terrestrial ecosystem feedbacks to atmospheric CO_2 under future climate scenarios.

The primary objective of this work is to construct detailed budgets of the size, turnover, and availability of the mobile C pool in temperate forest trees in New England. Field sampling at Harvard Forest along with laboratory analyses will allow for the quantification of NSC at the individual tissue level, which will then be scaled up to determine whole-tree and whole-ecosystem NSC budgets. In 2015, we will be collecting samples for radiocarbon analysis to estimate turnover time (i.e. mean age) of NSC stored in different tissues, and to better understand mixing between new (recent photosynthate) and old NSC. These data will be used to test a multi-pool model representation of storage in forest trees. Using this data to improve models of tree carbon dynamics will enhance our understanding of the capacity for trees to tolerate abiotic and biotic stressors as well as our ability to predict forest responses to global climate change.

Personal Contribution:

I am currently a second year Ph.D. student in Andrew Richardson's laboratory at Harvard University. This project compromises a major portion of my thesis work, which more generally focuses on the storage of nonstructural carbon reserves in woody plants. After joining the laboratory in the fall of 2013, I began leading this work at Harvard Forest. As project lead, I direct field sample collection, sample processing, and data analysis.

Throughout 2014, I collected root cores, stem cores, and branch samples monthly from 24 trees of 5 dominant New England species at Harvard Forest (Petersham, MA), yielding nearly 2,000 samples. My role was to organize, prepare for, and lead each sample collection. Generating this dataset which includes multiple tree species, high temporal resolution, and a broad range of tissue types is essential to support the improvement and development of models that represent carbon allocation and storage processes.

With the completion of sample collection in December 2014, I have shifted my focus to processing these samples. I am supervising a female Harvard University undergraduate student, and we will conduct all of the laboratory analyses for this project. I have already obtained NSC concentrations from 2014 branch samples, and this data will be presented on my poster at ESS. I will use tissue level concentrations of NSC and allometric equations to scale-up to whole-tree budgets and then extrapolate to whole-ecosystem budgets using forest inventories. These data will be used to test existing ecosystem model predictions (e.g. PnET, FÖBAAR) of seasonal dynamics of NSC, as well as hypotheses related to differences between evergreen and deciduous, and ring porous and diffuse porous hardwood species. I will take the lead on publishing these results and sharing them at the annual conference of the American Geophysical Union.