Topographic Controls on Soil Respiration and Fine Root Distribution at the Shale Hills Critical Zone Observatory

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In the following abstract, Thomas Adams assisted myself, Alexandra Orr, in the collection of the all of the data analyzed. Additionally, Jason Kaye and David Eissenstat provided guidance in the research design, analytical methods, data analysis, and presentation materials.

Fluctuations in soil moisture caused by climate change could profoundly impact belowground carbon dynamics. However, most studies investigating the impact of soil moisture fluctuations on belowground carbon processes are plot-level experiments, with minimal topographic variation. Scaling these experiments to the landscape level is challenging because complex topographic variation drives spatial and temporal patterns of soil water content. We examined how variation in soil moisture along with other factors such as temperature, soil thickness and aboveground net primary production, influenced root distribution and soil respiration across a first-order catchment of diverse topography (Shale Hills CZO).

During the 2014 field season, 250 soil cores were taken to a maximum depth of 165cm. Soil cores were divided into depth increments of 20 to 40 cm, homogenized then split so that each half contained roughly equal soil and root constituents. One half of the sample was analyzed for root distribution, and the other half was analyzed for soil properties. Root samples were separated into absorptive roots (1st to 3rd order roots) and transport roots (>3rd order roots) and then length and average diameter determined. Soil samples were analyzed for NO_3^-, NH_4^+, soil organic matter, rock content, exchangeable acidity, C:N and CEC. Other measures including LAI, leaf litter mass and tree diameter were also determined within each plot to compare aboveground patterns with root distribution. Initial results show complex variations in root distribution that may be most influenced by the interaction of rock and water content in the soil.

During the 2015 field season, weekly measurements of soil respiration, water content and temperature (both at a 5cm depth) were taken at 200 locations throughout the catchment. Within a transect across a hill slope, an additional eight respiration chambers recorded measurements every 15 minutes. Initial results show that hillslope swales exhibited higher seasonal respiration rates than the planar slopes, ridge tops and valley floor. Soil moisture tended to be highest in the valley but did not differ between other slope positions. Soil moisture limited soil respiration at levels of saturation but enhanced soil respiration during rewetting events.

Collectively, these preliminary results suggest that there is high spatial and temporal variation in root length density and soil respiration that are not easily predicted by simple metrics such as slope position or soil moisture.