Geophysical Research Abstracts
Vol. 21, EGU2019-5983-1, 2019
EGU General Assembly 2019

Thermal conductivity of charcoal-rich soils – preliminary results from a study on relict charcoal hearth (RCH) sites from Germany and the USA

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Historic charcoal production, which involved harvesting and pyrolyzing timber in hearth sites, introduced lasting anthropogenic disturbances (e.g., disproportionate chemical constituents, altered soil physical properties) to forest ecosystems. The full effects of charcoal production are still not well understood, particularly changes to soil thermal properties. Previous studies found charcoal additions alter soil heat capacity and thermal conductivity; however, further research is required to constrain the mechanisms governing the effects of charcoal fragments on soil thermal properties.

This study examines thermal conductivity in charcoal-rich soils to examine how charred material, such as aged charcoal and biochar, affect soil temperature regime. 425 mL PVC cylinders were filled with charcoal-sand mixtures representative of field conditions at relict charcoal hearths (RCH) (% w charcoal: 0%, 2%, 4%, 8%, 16%, 24%, 32%), and field samples were collected at RCH sites in Brandenburg, Germany and Connecticut, USA. Thermal conductivity was measured for all samples using heat pulse and hot wire technique (Hukseflux TPSYS02 / TP08 thermal needle) at volumetric water contents ranging from 0 to 50%.

Initial results indicate charcoal additions have a lowering effect on soil thermal conductivity. Compared to low-charcoal samples, repacked charcoal-rich samples had higher water contents at saturation and lower thermal conductivity, which dropped slightly with decreasing water content. Thermal conductivity for repacked low-charcoal samples dropped more rapidly with decreasing water content. Field data showed similar trends: RCH samples had lower thermal conductivity as compared to adjacent non-RCH reference samples. This study will further constrain the effects of charred material on soil thermal properties, both within a single RCH site and across RCH regions in the USA and Germany.