Poster #9-12

The Role of Soil Moisture on Soil Carbon Decomposition

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Soil microbes exert complex feedbacks on soil organic carbon dynamics, which can be affected differently by changes in soil moisture and temperature. For example, soil respiration may be increased under increased temperature, but concomitant changes to microbial physiology may result in feedbacks to microbial populations that alter the carbon fluxes. However, studies of the role of soil moisture are lacking. Soils of three distinct textures (sandy, loamy and clayey) were collected from mixed forests of Georgia, Missouri and Texas, respectively, and incubated for 90 days under different moisture regimes: air dried, 25% water holding capacity (WHC), 50% WHC, 100% WHC and 100% saturation. Soil respiration was measured weekly, and destructive sampling was conducted at 1, 15, 60 and 90 days to determine microbial biomass carbon and nitrogen, dissolved organic carbon, and hydrolytic enzyme activities. Results showed that CO_2 production is higher in clayey soil followed by loamy and sandy soils. Sandy soils have the highest CO_2 efflux at 50% WHC, loamy soils at 100% WHC, and clayey soils at 100% saturation. In general, microbial respiration exhibits a bell-shaped response to moisture variation regardless of soil texture, while hydrolytic enzyme activities increase with increasing moisture content. We extended the experimental results by conducting a theoretical analysis of the response of microbially-mediated SOC decomposition to intensified soil moisture extremes by the end of the 21st century at the Missouri Ozarks AmeriFlux (MOFLUX) site, using our Microbial-ENzyme Decomposition (MEND) model. The magnitude of microbial respiration reduced by drought is greater than that of increased microbial respiration by wetting. Under extreme drought, all active microbial biomass, enzyme activity and turnover rates of SOC pools decreased more compared to wetting, resulting in lower cumulative soil C loss under intensified moisture extremes. These findings remain true even when the effect of changing inputs, i.e., changes in substrate supply, are considered. Both the experimental and modeling studies emphasize the nonlinear response of soil microbial response to moisture variations. Currently, most soil carbon studies are focused on temperature responses, while this work points to the importance of the sensitivity of SOC dynamics to soil moisture.