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Faunal Drivers of Soil Flux Dynamics via Alterations in Crack Structure

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Organismal activity, in addition to its role in ecological feedbacks, has the potential to serve as instigators or enhancers of atmospheric and hydrologic processes via alterations in soil structural regimes. We investigated the biomechanical effect of faunal activity on soil carbon dynamics via changes in soil crack structure, focusing on three dryland soil systems: bioturbated, biocompacted and undisturbed soils. Carbon fluxes were characterized using a closed-system respiration chamber, with CO_2 concentration differences measured using an infrared gas analyzer (IRGA). Results show that faunal influences play a divergent biomechanics role in bulk soil cracking: bioturbation induced by belowground fauna creates "surficial" (shallow, large, well-connected) networks relative to the "systematic" (deep, moderate, poorly connected) networks created by aboveground fauna. The latter also shows a "memory" of past wetting/drying events in the consolidated soil through a crack layering effect. These morphologies further drive differences in soil carbon flux: under dry conditions, bioturbated and control soils show a persistently high and low mean carbon flux, respectively, while biocompacted soils show a large diurnal trend, with daytime lows and nighttime highs comparable to the control and bioturbated soils, respectively. Overall fluxes under wet conditions are considerably higher, but also more variable, though higher mean fluxes are observed in the biocompacted and bioturbated soils. Our results suggest that the increased surface area in the bioturbated soils create enhanced but constant diffusive processes, whereas the increased thermal gradient in the biocompacted soils create novel convective processes that create high fluxes that are diurnal in nature.