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Pore to Core: Linking Soil Organic Carbon Protection Mechanisms to Ecosystem CO_2 Fluxes in Response to Varying Antecedent Soil Moisture Conditions

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Soil carbon (C) persistence in soils is unpredictable in the face of extreme wetting and drying as its protection mechanisms are not understood well enough to incorporate into process-rich simulation models. While much research has focused on the size of the soil organic C (SOC) pool and its gross fluxes, new approaches in SOC characterization and modeling can now address the very nature of SOC persistence, specifically the contributions of physical occlusion and chemical composition to C longevity.

Despite the importance of soil structure and hydrology for SOC protection and destabilization, Earth system models remain grounded in structures in which first-order transfers among SOC pools are proportional to the size of the donor pool. Such models are based on C "quality," an ill- defined term that cannot be measured directly and cannot represent rewetting dynamics such as the respiration response to water movement through pores and the role of water as a solvent within pores. Finally, scale point measurements of decomposition and greenhouse fluxes to tower or landscape/watershed scales, a critical requirement for effective use of such data in ESMs, remains highly uncertain.

Our objective is to develop the process-rich understanding of how SOC is decomposed as a result of pore-scale changes in SOC physical protection under varying antecedent moisture conditions, and use this knowledge to improve the predictive power of models at a variety of scales.