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Coupling soil inorganic-organic carbon dynamics for verifiable carbon dioxide removal by enhanced weathering

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Scientifically verifiable, durable, and scalable carbon dioxide removal (CDR) technologies are essential to reducing atmospheric CO2 concentrations and avoiding the most dangerous impacts of climate change this century. Within the nature-based solution portfolios, the soil system provides promising CDR and sequestration potential, including in both organic and inorganic forms at time scales that reflect durable removals that exceed 100 years or longer. By applying crushed basic rock (e.g. basalt) dust to cropland with appropriate irrigations, enhanced weathering makes managing soil inorganic carbon (SIC) possible to sequester billions of tons of CO2 over a short period. Meanwhile, the dissolution of cations from rock dust also contributes to a more stabilized soil organic carbon (SOC). Here, we will present a model that couples soil inorganic and organic carbon cycles under applications of rock dust. Our modeling results will assess (1) how the CDR provided by enhanced weathering varies with local environmental and management conditions, (2) synergies between SIC formation and SOC stabilization, (3) the role of cation exchange capacity in regulating CDR by enhanced weathering, and (4) potential CO2 limitation and chemical inhibition in large scale enhanced weathering application. A sophisticated process-based model considering both SIC and SOC dynamics will contribute to a better quantification of carbon sequestration by enhanced weathering at large scales and guide appropriate soil management.