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Soil moisture impact on land carbon uptake: not a zero-sum game

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The terrestrial biosphere is estimated to absorb 25-30% of anthropogenic CO_2 emissions, yet is the least constrained terrestrial carbon flux, leading to large uncertainties in climate projections[1,2]. Using model runs from the Global Land-Atmosphere Coupling Experiment-Coupled Model Intercomparison Project phase 5 (GLACE-CMIP5)[3] experiments, we show that soil moisture variability and gradual moisture regime shifts are major limiting factors of land carbon uptake due to the nonlinear response of terrestrial vegetation to water stress, and through increased temperature though land-atmosphere interactions. We find that the effects of soil moisture on net biome productivity are of the same order or magnitude as the land sink itself, largely offsetting the positive effects of CO_2 fertilization throughout the 21^{st} century. Our results emphasize that the capacity of continents to act as a future carbon sink critically depends on soil moisture stress and land-atmosphere interactions, and that prediction of the carbon and water cycles need to be treated as an interacting system.

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