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Soil moisture controls of future global soil carbon changes - an unconsidered source of uncertainty

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It is now well established that future climate change, and mitigation policies required to avoid dangerous climate change, depends critically on interactions between the climate and the carbon cycle. Many models have shown the potential for positive feedbacks to accelerate the rate of CO2 increase in the atmosphere as natural carbon sinks (especially terrestrial sinks) are weakened in response to climate change. The nature of the climate-carbon cycle feedback depends critically on the response of soil carbon to climate. Much attention has been paid to the role of temperature in determining soil carbon decomposition but the role of soil moisture is much less studied and potentially important too. Uncertainty in the response of soil carbon to soil moisture changes could arise from uncertainty in the relationship between soil moisture and heterotrophic respiration.

Here we attempt to quantify the potential importance of the uncertainty in the response of organic matter decomposition to soil moisture. We used twelve soil moisture-respiration functions with a soil carbon model (RothC), and data from a coupled-climate carbon cycle GCM to investigate the impact of heterotrophic respiration dependence on soil moisture on the climate-carbon cycle feedback. Global changes in soil moisture acted to oppose temperature-driven decreases in soil carbon, and hence tended to increase soil carbon storage. Ignoring climate-change driven soil moisture changes could therefore lead to an overestimation of the positive climate-carbon cycle feedback. We found considerable uncertainty in soil carbon changes due to the response of soil respiration to soil moisture, warranting further research into this relationship. There may also be considerable uncertainty in the regional responses of soil carbon to soil moisture changes since climate model predictions of regional soil moisture changes are less coherent than temperature changes.