3rd International Conference on Earth System Modelling
Vol. , 3ICESM-287, 2012
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Sensitivity of soil carbon release to simultaneous changes in temperature and moisture

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Three times more carbon is stored in world soils than in the atmosphere, therefore small changes in this reservoir can have important implications for carbon emissions from land and subsequent changes in climate. However, the response of soil organic matter to changes in climate is still very uncertain. Most of the discussion in this topic have focused on the sensitivity of soil respiration to changes in temperature, ignoring important interactions with soil moisture. Here, we present a synthesis of mechanistic responses of soil organic matter decomposition to changes in both temperature and moisture. We compiled mechanistic and empirical functions relating temperature and moisture with decomposition or respiration rates. Then we calculated the gradient (vector of partial derivatives), the gradient norm, and directional derivatives representing hypothetical changes in temperature and moisture occurring simultaneously. Our simulations showed a wide variety of responses with higher uncertainties at the high end of the temperature range. Moisture however, can amplify or dampen the temperature response at both extremes of the moisture range. Geographically, most models agree that the larger sensitivities to simultaneous changes in both climatic variables occur in the tropics and some temperate regions with hydromorphic soils. Boreal and arctic soils on the contrary, showed the lowest sensitivity. This analysis suggests that given their large sensitivity to climatic change, tropical regions should have priority for the study of soil carbon dynamics and the interactions with climate so the large uncertainties also predicted for these regions can be reduced.