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Importance of soil thermal dynamics on land carbon sequestration in Northern Eurasia during the 21st century

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Recent modeling studies have suggested that carbon sinks in pan-arctic ecosystems may be weakening partially as a result of warming-induced increases in soil organic matter (SOM) decomposition and the exposure of previously frozen SOM to decomposition. This weakening of carbon sinks is likely to continue in the future as vast amount of carbon in permafrost soils is vulnerable to thaw. Here, we examine the importance of considering soil thermal dynamics when determining the effects of climate change and land-use change on carbon dynamics in Northern Eurasia during the 21st century. This importance is assessed by comparing results for a "business as usual" scenario between a version of the Terrestrial Ecosystem Model that does not consider soil thermal dynamics (TEM 4.4) and a version that does consider these dynamics (TEM 6.0). In this scenario, which is similar to the IPCC Representative Concentration Pathways (RCP) 8.5 scenario, the net area covered by food crops and pastures in Northern Eurasia is assumed to remain relatively constant over the 21st century, but the area covered by secondary forests is projected to double as a result of timber harvest and the abandonment of land associated with displacement of agricultural land. Enhanced decomposition from the newly exposed SOM from permafrost thaw also increases nitrogen availability for plant production so that the loss of carbon from the enhanced decomposition is partially compensated by enhanced uptake and storage of atmospheric carbon dioxide in vegetation. Our results indicate that consideration of soil thermal dynamics have a large influence on how simulated terrestrial carbon dynamics in Northern Eurasia respond to changes in climate, atmospheric chemistry (e.g., carbon dioxide fertilization, ozone pollution, nitrogen deposition) and disturbances.