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Effects of soil thermal dynamics on the carbon balance in high-latitude permafrost regions: a modeling study with Jsbach

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Permafrost carbon dynamics are one of the important unknowns of our current earth system knowledge. During the glacial cycles, high latitude regions have accumulated vast amounts of carbon, deep in the soil. The possibility of releasing this carbon back to the atmosphere would have immense outcomes for the whole earth system. The projected increase in global temperatures, thus deepening the active-layer thickness or even permafrost thawing require a valid representation of physical and biogeochemical processes and their interactions in the earth system models. For this reason we have been extending the Jsbach land surface scheme to better suit the physical forcing of soil organic matter dynamics in permafrost regions. Jsbach is a land surface scheme, which can be coupled to the ECHAM atmospheric model. Through modifying Jsbach by increasing soil depth to 10 meters and by including the soil freezing and thawing processes, the model will represent soil thermal properties, the soil temperature profile and the soil water status in high latitude regions more realistically. Dependency of soil heat capacity on the amount of liquid-solid water content, and the availability of super-cooled water together with ice have been added to the Jsbach model as well. This new version of the model is tested for site levels and the performance is evaluated against the observational data. Our results show that considering the phase change process has important outcomes with regard to the available soil water content and soil temperature profile, thus effecting the soil carbon processes such as the decomposition rate. Improving the land surface schemes with respect to high latitude processes will support more valid carbon cycle and climate simulations.