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Moss cover limiting carbon and methane fluxes of a Siberian tundra under warming climates

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In the Arctic terrestrial regions, mosses strongly affect water and heat fluxes due their high water holding capacity and insulation. A land surface model, CHANGE, is used to quantitatively assess the influences of moss cover on soil temperature (TSOIL), active layer thickness (ALT), and carbon and methane flux feedbacks. The CHANGE model was coupled with a moss process module, explicitly representing heat, water, and carbon exchanges in the atmosphere–vascular plants–moss–soil system. A ground excess ice process is newly added to CHANGE. The model was applied to a tundra site in northeastern Siberia over the period of 1980–2100, using the forcing data of RCP8.5 warming scenario. The simulated results indicated that the moss resulted in lower ALT even in the future warming climate, which was validated by model experiments that controlled the thickness and fractional surface coverage of the moss layer. The moss-induced cooler TSOIL under the present climate limited ecosystem carbon assimilation and methane production by reducing water availability to plant roots due to the presence of ice. In contrast, the moss-induced cooling reduced soil dryness at the future warming, deriving higher methane production. This feature was further enhanced at the condition with ground excess ice. Our modeling study suggests that moss has a significant impact on TSOIL, ALT, and carbon and methane fluxes in Arctic tundra of future warming.