GC31B-1179: The Permafrost Condition from 1960 to 2300 Based on Simulations of the GIPL2 Permafrost Dynamics Model across Eurasia: Implications for Soil Carbon Vulnerability, Infrastructure and Socio-economic Impacts

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The impact of climate warming on permafrost and the potential of climate feedbacks resulting from permafrost thawing have recently received a great deal of attention. Most of the permafrost observatories in the Northern Eurasia show substantial warming of permafrost since the 1980s. The magnitude of warming has varied with location, but was typically from 0.5 to 3°C. The close proximity of the exceptionally ice-rich soil horizons to the ground surface, which is typical for the arctic tundra biome, makes tundra surfaces extremely sensitive to the natural and human-made changes that resulted in development of processes such as thermokarst, thermal erosion, and retrogressive thaw slumps that strongly affect the stability of ecosystems and infrastructure.

The main aim of this study is to evaluate the vulnerability of permafrost under climate warming across the Permafrost Region of the Northern and High-altitude Eurasia in respect to ecosystems stability, infrastructure, socioeconomic impact, and to estimate the volume of newly thawed soils, which could be potential source or sink of additional amount of carbon in the Earth System. We applied the process-based permafrost dynamics model GIPL2 (Geophysical Institute Permafrost Lab), using a historical climate forcing CRU3.1 data set for retrospective (1960-2009) and CCSM4 RCP4.5 and RCP8.5 (2009-2300) for analysis of permafrost dynamics in the future. Our projections according to the CCSM4 RCP4.5 and RCP8.5 climate scenario indicate that the maximum unfrozen volume of soil within three upper meters could change between 12.8 and 20.8K cubic km during 2009-2300. If we assume a similar response (as modeled) of soil temperature and near-surface permafrost area shrinkage to warming in Eurasia, an additional 25% of the total volume of thawed soils could become biogeochemically active by the end of the current century and 60% by 2300.