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Permafrost Dynamics Modeling in European Russian North using a High Spatial Resolution RCM

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A large number of borehole temperature measurements at different depths were obtained for the European Russian North permafrost regions starting in the 1960s. This data set is serving as a baseline against which to measure changes in near-surface permafrost temperatures and permafrost boundaries, to validate climate model scenarios, and can also be used for permafrost temperature reanalysis. Most of the observatories show a substantial warming during the last 30 to 35 years. The magnitude of warming varied with location, but was typically from 0.5 to 2 deg C at the depth of zero annual amplitude (e.g. Romanovsky et al., 2008). Warming in permafrost temperatures observed in the Russian North has already resulted in the thawing of natural, undisturbed permafrost in areas close to the southern boundary of the permafrost zone.

In order to assess possible changes in the permafrost thermal state and the active layer thickness, the equilibrium GIPL-1.3 was implemented for the entire Pechora River basin. The climate forcing derived from the output of high resolution Regional Climate Model HIRHAM driven by ECHAM5/MPI-OM that corresponds to the IPCC SRES emission scenario A1B. We used the 25 km horizontal resolution datasets of mean monthly air temperature and snow water equivalent, prescribed vegetation, soil thermal properties, and water content, which are specific for each vegetation and soil class and geographical location.

Projections of future changes in permafrost suggest that by the end of the 21st century, late-Holocene permafrost in Russian North may be actively thawing at all locations and some Late Pleistocene permafrost could start to thaw as well. At the same time, the modeling results show how different types of ecosystems affect the stability and thermal state of permafrost.

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