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# Size matters - very high resolution permafrost simulations on the 4 km scale in Northeast European Russia

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Recent observations indicate warming of frozen ground in many northern regions and degradation of ice- and carbon-rich permafrost. In northern Eurasia, permafrost temperature has increased by 1 to 2 K during the last 30 years, and thawing of Little Ice Age permafrost is now being observed at many locations. Older late-Holocene permafrost has apparently also begun to thaw at locations in northeastern Europe and northwest Siberia. Model studies indicate that the area of the Northern Hemisphere underlain by permafrost could be further reduced substantially in a warming climate, with potentially far-reaching consequences on infrastructure and possible release of large amounts of greenhouse gases. However, thawing of permafrost, in particular if it is ice-rich, is subject to a time lag due to the large latent heat of fusion, which, together with lack of spatial resolution, makes state-of-the-art global climate models unsuitable to adequately model soil thawing and freezing processes. We address these problems by using a very high resolution (4 km) version of the HIRHAM5 regional climate model, which has been downscaled from a 25 km HIRHAM simulation of the entire northern circumpolar domain. Instead of the traditional approach via a degree-day based frost index from observations or model data, we use the regional model to create boundary conditions for an advanced permafrost model, the University of Alaska GIPL2 parallel transient model, for time slices covering present-day climate and two possible future evolutions. This approach offers the advantage that the permafrost model can be run on the grid of the regional model, i.e. in a considerably higher resolution than in previous approaches. We present results from a time-slice integration for the Pechora River basin in northeast European Russia. According to the climate scenario used here, late-Holocene permafrost in the Pechora River watershed is projected to thaw actively at all locations and carbon-rich Late Pleistocene permafrost also could start to thaw at some locations.