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Permafrost and Active Layer Modeling in the Northern Eurasia using MODIS Land Surface Temperature as an input data.

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High latitude environments such as those of northern Eurasia are particularly vulnerable to climate change, which is expected to be pronounced in these areas. Climate warming is likely to cause permafrost thawing with subsequent effects on surface albedo, soil organic matter degradation, hydrology, and greenhouse gas emissions.

Recently, there have been a number of experiments to simulate soil temperature and permafrost dynamics on regional and global scales. In these simulations, that employ some stand-alone equilibrium or transient permafrost models, the upper boundary conditions are usually the air temperature from observations or climate forcing from available Global or Regional Climate Models. In this research we used the GIPL-1.1 model, which is a spatially distributed model of permafrost based on an approximate analytical solution of soil freezing and thawing, and which includes an estimation of thermal offset due to the difference in frozen and thawed soil thermal properties. The GIPL-1.1 model also accounts effectively for the effects of snow cover, vegetation, soil moisture, and soil thermal properties.

The key source of surface temperature data is the MODIS Land Surface Temperature (LST) product which provides per-pixel temperature values as input data in the GIPL-1.1 model. LST is one of the key parameters in the physics of land surface processes, combining surface-atmosphere interactions and the energy fluxes between the atmosphere and the ground. The RMS error of the derived surface temperatures when compared with in situ data ranges from 0.5 to 1.5 K over the 5-yr period within the Northern Eurasia region.

The results of permafrost modeling using the GIPL-1.1 model show a very good agreement between calculated distribution of permafrost temperatures, active layer thickness, observed data, and the distribution of permafrost derived from the International Permafrost Association (IPA) permafrost distribution and ground ice map.