Numerical Modeling of Permafrost Dynamics in Alaska Using a High Spatial Resolution Dataset

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ABSTRACT. Climate projections for the 21st century indicate that there could be a pronounced warming and degradation of permafrost in the Arctic and sub-Arctic regions. Climate warming is likely to cause permafrost thawing with subsequent effects on surface albedo, soil organic matter degradation, hydrology and greenhouse gas emissions.

In order to assess possible changes in the permafrost thermal state and the active layer thickness, the GIPL2-MPI parallel transient model was implemented for the entire Alaskan permafrost domain. For this study we used an input data set with grid boxes size 2 km by 2 km. Input parameters to the model are spatial datasets of mean monthly air temperature and precipitation, prescribed vegetation and thermal properties of the multilayered soil column, and water content, which are specific for each vegetation and soil classes and geographical location. As a climate forcing we used Scenarios Network for Alaska Planning (SNAP) data set (http://www.snap.uaf.edu/). The five IPCC Global Circulation Models that performed the best in Alaska: ECHAM5, GFDL21, MIROC, HAD and CCCMA were assessed according to how closely model outputs for the recent past matched climate station data for temperature, precipitation, and sea level pressure. The outputs from these five models have been scaled down to 2 kilometer resolution using the PRISM model (http://www.prism.oregonstate.edu/), which takes into account elevation, slope, and aspect. All derived values are representing a single month within a given year for the five models composite, A1B emission scenario.

We compared ground temperatures at the depths of 2 m, 5 m, and 20 m for twelve decades from 1980-2100. Initial results of simulation show that by the end of the current century, the widespread permafrost degradation in Alaska could begin within the vast area southward from the Brooks Range except for the high altitudes of the Alaska Range and Wrangell Mountains.

Keywords: Active Layer Thickness; Ground Temperature; Numerical Modeling; Thawing Permafrost.

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