C13E-1386 - Coupling of Snow and Freeze-Thaw Processes to Model Permafrost State in a Timberline Ecotone

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Abstract

Warmer climate of the past several decades has affected permafrost thermal state in the Arctic and also caused encroachment of tall woody vegetation into tundra areas. It remains to be explored whether the impact of tall vegetation on thermal state of the permafrost has a dampening effect on the climate trend warming the permafrost, or the opposite effect. Specifically, vegetation expansion can affect snow distribution and accumulation and therefore change heat exchange processes in an area with encroached woody species. In this study, we present an empirical analysis based on datasets collected from 11 energy budget stations located in the Polar Urals area (Western Siberia). We analyzed characteristic differences in terms of radiative fluxes, surface and subsurface temperatures, soil moisture, ground heat fluxes, and snow depth. Results demonstrate differences between areas with encroached vegetation and tundra areas. A physically-based ecohydrological model tRIBS-VEGGIE is used in this study. This model includes coupling of a distributed snow model and a 1-D subsurface thermal model based on energy and mass balance formulations. Calibration and validation are conducted using in-situ measurements from our monitoring stations. This model demonstrates simulation of temperature and moisture regimes during subsurface freeze and thaw process as dependent on surface budgets of vegetated snow covered and snow free areas. This study provides insights into mass-energy transfer between surface and subsurface of vegetated areas, the state of the permafrost and its impact on the Arctic hydrologic fluxes.

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