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Numerical Modeling of Permafrost Dynamics Using Modified CoLM with Optimal Parameterization for Snow Density

Xinling Dong (1), Zhihua Zhang (1), John Moore (1,2,3)

(1) College of Global Change and Earth Systerm Science, Beijing Normal University, Beijing, P.R.China, (2) Arctic Centre, University of Lapland, PL122, 96100 Rovaniemi, Finland, (3) Department of Earth Sciences, Uppsala University, Villavägen 16, Uppsala, SE-75236, Sweden

Most land surface models (LSMs) do not perform well in representing permafrost dynamics and snow properties. Due to the complex permafrost distribution characteristics and the differenncesbetween vegetation coverage types and snow-covered land, the LSMs simulations are even worse. In this study, we modified the permafrost scheme in the Common Land Model (CoLM) to improve its capability of simulating permafrost processes and snow density process. We adopted a new frozen soil parameterization scheme, the present version of CoLM includes permafrost layers down to 3.4 meters in ten different thicknesses. Based on literature and temperature gradient measurements, we extended the soil column to 25 soil layers and bottom depth to 15.4 m. Moreover, we revise the original snow cover fraction parameterization of CoLM according to specific snow cover characteristics including the effects of wind compaction on snow density in treeless regions. We have compared and validated the modified model against in situ soil temperatures from 431 Russian observation stations between 1973 and 2006. The modified model produces more accurate surface temperature simulation results. The modified CoLM provides a useful tool for understanding and predicting the fate of permafrost under a warming climate.