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Modelling hydrological consequences of climate change in the permafrost region and assessment of their uncertainty

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Abstract A physically-based, distributed model of runoff generation in the permafrost regions is presented. The model describes processes of snow cover formation, taking into account blowing snow sublimation, snowmelt, freezing and thawing of the ground, water detention by a basin storage, infiltration, evaporation, overland, subsurface and channel flow. An important feature of the model is the detailed description of water and heat transfer within the active layer of soil during its seasonal thawing and freezing. A case study has been carried out for the Pravaya Hetta River basin (the catchment area is 1200 km^2) of Western Siberia within the Lower Ob River basin. The basin is located in tundra and forest-tundra vegetation zones. It has been shown that after precipitation, melt of ground ice is the second largest input to the basin water balance and accounts for about 70% of annual precipitation. Seasonal snow losses due to sublimation during blowing snow transport can reach almost 30% of the maximum snow accumulation. The model has been applied to assess the impact of climate change on hydrological processes in the permafrost basin. Uncertainty of the simulated hydrological consequences of climate change has been assessed by the multi-scenario approach. Simulated runoff response to the projected climate change varies significantly as a result of the uncertainty of the climate change scenario.

Key words permafrost hydrology; cold region modelling; climate change; uncertainty