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Modelling hydrological processes in mountainous permafrost basin in North-East of Russia

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The studies of hydrological processes in continuous permafrost and the projections of their changes in future have been receiving a lot of attention in the recent years. They are limited by the availability of long-term joint observational data on permafrost dynamic and river runoff which would allow revealing the mechanisms of interaction, tracking the dynamic in historical period and projecting changes in future.
The Kolyma Water-Balance Station (KWBS), the Kontaktovy Creek watershed with an area of 22 km2, is situated in the zone of continuous permafrost in the upper reaches of the Kolyma River (Magadan district of Russia). The topography at KWBS is mountainous with the elevations up to 1700 m. Permafrost thickness ranges from 100 to 400 m with temperature -4...-6 °C. Detailed observations of river runoff, active layer dynamics and water balance were carried out at the KWBS from 1948 to 1997. After that permafrost studies were ceased but runoff gauges have been in use and have continuous time series of observations up to 68 years. The hydrological processes at KWBS are representative for the vast NE region of Russia where standard observational network is very scarce.
We aim to study and model the mechanisms of interactions between permafrost and runoff, including water flow paths in different landscapes of mountainous permafrost based on detailed historical data of KWBS and the analysis of stable isotopes composition from water samples collected at KWBS in 2016.
Mathematical modelling of soil temperature, active layer properties and dynamics, flow formation and interactions between ground and surface water is performed by the means of Hydrograph model (Vinogradov et al. 2011, Semenova et al. 2013). The model algorithms combine process-based and conceptual approaches, which allows for maintaining a balance between the complexity of model design and the use of limited input information. The method for modeling heat dynamics in soil was integrated into Hydrograph model (Semenova et al., 2015; Lebedeva et al., 2015).
Small watersheds of KWBS with areas less than 0.5 km2 presenting rocky talus, mountainous tundra and moist larch-forest landscapes were modelled with satisfactory results. The dependence of surface and subsurface flow formation on thawing depth and landscape characteristics is parametrically described.
Process analysis and modelling in permafrost regions, including ungauged basins, is suggested, with observable properties of landscapes being used as model parameters, combined with an appropriate level of physically-based conceptualization.
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