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Hydrological processes at the Suntar-Hayata ridge (Eastern Siberia) in past, current and future climate

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The detailed studies of permafrost, hydrological and glaciological processes at the Suntar-Hayata Ridge started within the Program of International Geophysical Year (1957-1958). The Suntar-Hayta Ridge (with highest mountain reaching 2959 m) is situated in Eastern Siberia and divides the Lena, Indigirka and the Okhotsk sea rivers basins. It is characterized by original combination of climate, geological and glaciological conditions.
In 2015 our research group got the access to the reports of High-Mountain Glaciological and Geocriological Suntar-Hayata station which were stored in the archives of Melnikov Permafrost Institute in Yakutsk (Russia). We used revealed data for assessment of runoff formation processes and the factors affecting them in remote high-elevation permafrost area, and estimated the parameters of hydrological model based on those findings.
Two watersheds of different scale were selected as the objects of our studies – the Suntar river (7680 km2) and the Sakharyniya River (84.4 km2).
The Hydrograph model (Vinogradov et al., 2011; Semenova et al., 2013) was used in the study as it explicitly describes hydrological processes in different permafrost environments including the dynamics of ground thaw/freeze (ex., Lebedeva et al., 2014). In the Hydrograph model the processes have a physical basis and certain strategic conceptual simplifications. The level of model complexity is suitable for a remote, sparsely gauged region such as Eastern Siberia as it allows for a priori assessment of the model parameters.
Based on the observations (meteorological data, ground temperature at different depth, soil profile physical properties, characteristics of vegetation, snow measurements, etc.) the model parameters were estimated for four main landscapes of the studied watersheds (bare ground, mountain tundra, sparse larch forest and riparian forest at swamped soils).
At the first stage we conducted the simulation of individual processes and compared the results with the observations. Such, the modelling of the formation and melting snow, soil thaw/freeze and evaporation for the Suntar-Hayata site were conducted. The results of this stage were considered satisfactory. For example, calculated daily values of temperature of the soil at various depths closely matched observed data with the largest discrepancies not exceeding 5°C.
At the second stage we conducted runoff modelling with initially assessed parameters for the period of maximum available meteorological information (1957-1964) for both studied watersheds. Lastly, the simulation of runoff processes were conducted for the period 1957-2013 (poor meteorological data) and for future climates based on conceptual scenarios. Detailed results of runoff simulations for past, current and future climates are explored.
For vast mountainous regions of the world with sparse monitoring networks like much of Russia, detailed catchment data only exists in small-scale research basins. Process based model parameterizations that are confirmed and refined in this basins can be applied in hydrologically similar regions for assessment of climate changes impacts on water cycle. This approach has been demonstrated here.

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