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Sensitivity of hydrological response of a monsoon-dominated river basin to spatial resolution of precipitation and land surface data

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A physically-based distributed model of runoff generation with daily time step resolution based on the ECOMAG (ECOlogical Model for Applied Geophysics) hydrological modeling platform has been developed for the upper part of Ussuri River basin with its 24400 km2 watershed and 223 km-long river course. The model describes processes of interception of rainfall/snowfall by the canopy, snow accumulation and melt, soil freezing and thawing, water infiltration into unfrozen and frozen soil, evapotranspiration, thermal and water regime of soil, overland, subsurface, ground and river flow. The governing model's equations are derived from integration of the basic hydro- and thermodynamics equations of water and heat vertical transfer in snowpack, frozen/unfrozen soil, horizontal water flow under and over catchment slopes, etc. The model setup for Ussuri River basin included watershed and river network schematization by DEM analysis taking into account peculiarities of soils and landscapes space distribution, meteorological time-series preparation, model calibration and validation against historical observations. Most of the model parameters are physically meaningful and derived through the datasets of the soil and landscape basin characteristics.

Two versions of the hydrological model with spatial schematization of different resolution were investigated in terms of hydrological response: (1) rough version with spatial schematization of watershed area and river network on the basis 1x1 km DEM and use of soil and landscape maps of 1:2,500,000 scale, and (2) detailed version with 80x80 m DEM and use of the soil and landscape maps of 1:300,000 scale. In addition, each version of the model has been tested against two meteorological forcing: (1) using meteorological data (temperature, air humidity, precipitation) observed at 8 meteorological stations and (2) with additional involving precipitation data recorded at 15 hydrological stations on the basin. The daily discharge data for 15 streamflow gauges, which are located at the Ussuri River and its tributaries, were used for calibration and validation of the model for 40-year period (1972-2013). Sensitivity of the model hydrological response to resolution of the land surface characteristics and spatial representation of precipitation is discussed.

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