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Climatic and basin factors affecting the extreme snowmelt floods: an analysis on the basis of a dynamic-stochastic model

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Climatic and basin factors affecting the extreme snowmelt floods have been investigated on the basis of a dynamic-stochastic model, which combines a physically based model of snowmelt runoff generation with a stochastic weather generator. The investigations have been carried out for the Seim River basin (catchment area is 7460 km2) in the European Russia. The physically based model describes snow accumulation and melt, soil freezing and thawing, vertical soil moisture transfer and infiltration, detention of melt water by the basin storage, overland and channel flow. Calibration and validation of the model have been carried out on the basis of available stream-flow records for long-term period of observations. The weather generator includes the stochastic models of daily precipitation, air temperature, and air humidity time series. Multi-year weather scenarios have been Monte Carlo generated and transposed to snowmelt flood hydrographs by the physically based model. A specific, computationally effective procedure has been developed to minimize a number of the model runs needed to calculate low probability flood events. Genesis of the simulated extreme snowmelt floods has been analysed and sensitivity of their characteristics to climatic and basin parameters of the dynamic-stochastic model has been assessed. Probability distributions of the climatic and basin factors of extreme flood generation have been derived and analysed. It has been shown that the extreme floods exceeding the maximum observed flood in the Seim River can be generated under a wide diversity of hydrometeorological and basin conditions, including combinations of meteorological factors and runoff generation mechanisms (peculiarities of spring melt, infiltration into frozen soil, etc.) which have never been recorded during the period of observations. At the same time but in rare instances, quite ordinary meteorological factors and basin conditions can lead to extreme flood events.