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Snowmelt flood frequency estimation by a physically-based hydrological model combined with a weather generator and assessment of the estimation's uncertainty

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A dynamic-stochastic model, which combines a physically based model of snowmelt runoff formation with a stochastic weather generator, has been proposed to estimate frequencies of extreme snowmelt floods. The model provides an alternative to the standard flood frequency analysis in the cases of scarce series of recorded flood events and non-stationary of these series caused by the man-induced changes of river basins. Opportunities of the dynamic-stochastic model have been illustrated through a case study based on 7460 km^2 Seim river catchment in European Russia. The physically based model is based on the finite-element discretisation of catchment area and describes snow accumulation and melt, soil freezing and thawing, vertical soil moisture transfer and infiltration, detention of melt water by the depressions at the catchment surface, overland and channel flow. Calibration and validation of the model have been carried out on the basis of available peak flow records for 20 snowmelt floods. The weather generator includes stochastic models that produce daily values of precipitation, air temperature, and air humidity during a whole year. Daily meteorological records, accumulated at the Seim catchment for 101 years, have been used to estimate parameters of the stochastic models. Daily weather variables during a whole year have been generated by Monte Carlo procedure and transposed to snowmelt flood discharges by the physically based model. The suitability of the dynamic-stochastic model has been demonstrated through its ability to reproduce distribution of the observed snowmelt flood peak discharges. Sampling variance of the estimated frequencies has been analyzed. Special procedure has been developed to minimize a number of the model runs

needed to calculate the flood peak discharge of the low probability. Uncertainty of the calculated peak discharge of low probability caused by uncertainty of the assigned model parameters has been assessed on the basis of Latin hypercube sampling-based technique.