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Dynamic-stochastic modelling of snow cover characteristics over the European Russia

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A dynamic-stochastic model, which combines a deterministic model of snow cover formation with a stochastic weather generator, has been developed. The deterministic snow model describes temporal change of the snow depth, content of ice and liquid water, snow density, snowmelt, sublimation, re-freezing of melt water, and snow metamorphism. The model has been calibrated and validated against the long-term data of snow measurements over the territory of the European Russia. The model showed good performance in simulating time series of the snow water equivalent and snow depth. The developed weather generator (NEsted Weather Generator, NewGen) includes nested generators of annual, monthly and daily time series of weather variables (namely, precipitation, air temperature, and air humidity). The parameters of the NewGen have been adjusted through calibration against the long-term meteorological data in the European Russia. A disaggregation procedure has been proposed for transforming parameters of the annual weather generator into the parameters of the monthly one and, subsequently, into the parameters of the daily generator. Multi-year time series of the simulated daily weather variables have been used as an input to the snow model. Probability properties of the snow cover, such as snow water equivalent and snow depth for return periods of 25 and 100 years, have been estimated against the observed data, showing good correlation coefficients (>0.80). The described model has been applied to different landscapes of European Russia, from steppe to taiga regions, to show the robustness of the proposed technique.