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Model-based approach to seasonal ensemble forecast of snowmelt water inflow into a reservoir

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An approach to seasonal ensemble forecast of snowmelt runoff has been developed and applied for forecasting lateral water inflow into the Cheboksary Reservoir (the watershed area is 374,000 km2) located in the middle Volga River basin. The approach combines a physically-based semi-distributed hydrological ECOMAG model with ensembles of future weather scenarios for a specified lead-time of the forecast, which are then used as inputs for a hydrological model. The ECOMAG model describes processes of snow accumulation and melt, soil freezing and thawing, water infiltration into unfrozen and frozen soil, evapotranspiration, thermal and water regime of soil, overland, subsurface and channel flow. The hydrological model is forced using daily meteorological variables (precipitation, air temperature, and air humidity) taken from the available observation data prior to the forecast date. Using these datasets, the initial watershed state (primarily, areal distribution of snow water equivalent, soil moisture content and soil freezing depth) as well as the initial river channel state are simulated by the model. Results from these spin-up simulations are routinely controlled by comparing them with observations from snow and agricultural surveys and streamflow observations. To assign ensemble of weather scenarios for the specified lead-time of the forecast (3 months ahead in this study), two approaches are applied: (1) the historical, observed daily weather patterns are utilized which assumed to be representative of possible future weather conditions; and (2) the artificial daily weather patterns Monte-Carlo are simulated by a stochastic weather generator. Being forced by the assigned ensembles of weather patterns for the forecast lead time, the ECOMAG model produces ensembles of hydrographs of inflow into the Cheboksary Reservoir.

Using the developed approach, hindcasts have been produced for 30 spring seasons beginning from the filling of the reservoir in 1982 and the statistical properties of the obtained ensembles of runoff characteristics (volume and peak discharge) have been evaluated. The median forecast traces have been analyzed using the traditional Nash-and-Sutcliffe criterion as well as the distribution-oriented verification measures have been utilized to assess the probabilistic information contained in both forecast ensembles.