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Use of satellite-derived data for characterization of snow cover and simulation of snowmelt runoff through a distributed physically based model of runoff generation

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A technique of using satellite-derived data for constructing continuous snow characteristics fields for distributed snowmelt runoff simulation is presented. The satellite-derived data and the available ground-based meteorological measurements are incorporated in a physically based snowpack model. The snowpack model describes temporal changes of the snow depth, density and water equivalent (SWE), accounting for snow melt, sublimation, refreezing melt water and snow metamorphism processes with a special focus on forest cover effects. The remote sensing data used in the model consist of products include the daily maps of snow covered area (SCA) and SWE derived from observations of MODIS and AMSR-E instruments onboard Terra and Aqua satellites as well as available maps of land surface temperature, surface albedo, land cover classes and tree cover fraction. The model was first calibrated against available ground-based snow measurements and then applied to calculate the spatial distribution of snow characteristics using satellite data and interpolated ground-based meteorological data. The satellite-derived SWE data were used for assigning initial conditions and the SCA data were used for control of snow cover simulation. The simulated spatial distributions of snow characteristics were incorporated in a distributed physically based model of runoff generation to calculate snowmelt runoff hydrographs. The presented technique was applied for study areas including the Vyatka River basin with the catchment area of 124,000 km2 the Upper Don basin with the catchment area of 101800 km2. The correspondence of simulated and observed hydrographs in these basins are considered as an indicator of the accuracy of constructed fields of snow characteristics and as a measure of effectiveness of utilizing satellite-derived SWE data for runoff simulation. A technique for updating snowmelt runoff model with satellite-derived SCA maps was developed and application of this technique for improving flood simulation results was demonstrated.