IWRM2018-83
8th International Water Resources Management Conference of ICWRS

Coupled hydrometeorological modeling of snowmelt runoff formation in the Northern Ural region using the WRF and Hydrograph models

Andrey Shikhov (1) and Olga Makarieva (2,3,4)

(1) Perm State University, Geography, Cartography and GIS, Russian Federation (shikhovan@gmail.com), (2) Gidrotehproekt Ltd., St-Petersburg, Russian Federation , (3) Melnikov Permafrost Institute, Yakutsk, Russian Federation , (4) St. Petersburg State University, St. Petersburg, Russian Federation (omakarieva@gmail.com)

Snowmelt runoff is more than 60% of the annual streamflow in most of Northern Eurasia, including Northern Ural region. Northern Ural is characterized by high snow accumulation, especially its western slopes which are exposed to moist westerly winds. Snow accumulation period continues from October to April and maximum snow water equivalent (SWE) reaches 300-500 mm.
A major challenge of snowmelt runoff forecasting in the Northern Ural is the lack of precipitation gauges and snow survey data. Therefore, the estimation of precipitation and SWE spatial distribution causes the uncertainty of snowmelt [U+FB02]oods forecast, which were regularly observed in recent years. The coupling atmospheric models with hydrological models can be used for improvement the flood forecast reliability in the conditions of lack of ground-based observations and also extend substantially the forecast period (Zhao et al., 2009).
The aim of this study is to assess the bene[U+FB01]ts of a high-resolution atmospheric forcing to the distributed hydrological modeling system "Hydrograph" snowmelt flood events simulations in the Northern Ural river basins. The studied basins of Vishera and Yayva rivers (S = 31083 km2 and 5400 km2 respectively) are characterized by mountainous terrain with elevation ranges from 100 to 1469 m, and sparse ground-based observations (three weather station and four hydrological gauges).
We used to simulate the snowmelt runoff the distributed hydrological modeling system "Hydrograph" (Vinogradov et al., 2011) driven by the 39 h numerical forecasts of Weather Research and Forecasting (WRF) atmospheric model. The WRF model version 3 (Skamarock et al., 2008) was run with 10 km grid spacing, on the GFS/NCEP initial and boundary conditions.
The Hydrograph model requires the following atmospheric variables: 2 m temperature and dewpoint temperature, solid and liquid precipitations, incoming short-wave and long-wave radiations (optional). Hydrograph model was successfully used to simulate the river runoff in cold regions with a lack of ground-based observations data (Vinogradov et al., 2011). Therefore, the model previously was not driven by high-resolution meteorological forecasts.
WRF model tend to overestimate the precipitation at the end of cold period, so the snow water equivalent may be also overestimate. The RMSE of snow water equivalent not exceeded 25% of measured SWE (Kalinin et al., 2015). Besides, we also assess other precipitation data sources, such as global atmospheric models GFS/NCEP, GEM/CMC ICON/DWD. On the one hand, these models have a lower spatial resolution, but on the other hand, the ICON model did not overestimate the precipitation during the cold season of 2017.
We performed a comparative analysis of snowmelt runoff simulation results using the WRF-simulated and ground-based meteorological input by the example of two case studies of snowmelt floods: spring flood in April 2016 and rain-on-snow event in November 2013.

References
Kalinin N.A., Shikhov A.N., Sviyazov E.M. (2015) Simulation of snow accumulation and melt in the Votkinsk Reservoir catchment using the WRF-ARW model. Russian Meteorology and Hydrology 40(11). PP. 749–757.
Skamarock W, Klemp J, Dudhia J, Gill D, Barker D. 2008. A description of the Advanced Research WRF version 3. NCAR Tech., Note NCAR/TN-475+STR.
Vinogradov Y.B., Semenova O.M. & Vinogradova T.A. (2011). An approach to the scaling problem in hydrological modelling: the deterministic modelling hydrological system. Hydrological Processes 25. PP. 1055–1073.
Zhao Q., Liu Z., Ye B., Qin Y., Wei Z. & Fang S. (2009) A snowmelt runoff forecasting model coupling WRF and DHSVM // Hydrology and Earth Systems sciences 13. PP. 925–940.