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# Reservoir inflow forecast by combining meteorological ensemble forecast, physical hydrological simulation and machine learning

**Junjiang Liu** and Xing Yuan
School of Hydrology and Water Resources, Nanjing University of Information Science and Technology, Nanjing, Jiangsu, China(jjliu@nuist.edu.cn)

Accurate streamflow forecasts can provide guidance for reservoir managements, which can regulate river flows, manage water resources and mitigate flood damages. One popular way to forecast streamflow is to use bias-corrected meteorological forecasts to drive a calibrated hydrological model. But for cascade reservoirs, such approaches suffer significant deficiencies because of the difficulty to simulate reservoir operations by physical approach and the uncertainty of meteorological forecasts over small catchment. Another popular way is to forecast streamflow with machine learning method, which can fit a statistical model without inputs like reservoir operating rules. Thus, we integrate meteorological forecasts, land surface hydrological model and machine learning to forecast hourly streamflow over the Yantan catchment, which is one of the cascade reservoirs in the Hongshui River with streamflow influenced by both the upstream reservoir water release and the rainfall runoff process within the catchment.

Before evaluating the streamflow forecast system, it is necessary to investigate the skill by means of a series of specific hindcasts that isolate potential sources of predictability, like meteorological forcing and the initial condition (IC). Here, we use ensemble streamflow prediction (ESP)/reverse ESP (revESP) method to explore the impact of IC on hourly stream prediction. Results show that the effect of IC on runoff prediction is 16 hours. In the next step, we evaluate the hourly streamflow hindcasts during the rainy seasons of 2013-2017 performed by the forecast system. We use European Centre for Medium-Range Weather Forecasts perturbed forecast forcing from the THORPEX Interactive Grand Global Ensemble (TIGGE-ECMWF) as meteorological inputs to perform the hourly streamflow hindcasts. Compared with the ESP, the hydrometeorological ensemble forecast approach reduces probabilistic and deterministic forecast errors by 6% during the first 7 days. After integrated the long short-term memory (LSTM) deep learning method into the system, the deterministic forecast error can be further reduced by 6% in the first 72 hours. We also use historically observed streamflow to drive another LSTM model to perform an LSTM-only streamflow forecast. Results show that its skill sharply dropped after the first 24 hours, which indicates that the meteorology-hydrology modeling approach can improve the streamflow forecast.