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Streamflow hindcasting in European river basins via multi-parametric ensemble of the mesoscale hydrologic model (mHM)

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There have been tremendous improvements in distributed hydrologic modeling (DHM) which made a process-based simulation with a high spatiotemporal resolution applicable on a large spatial scale. Despite of increasing information on heterogeneous property of a catchment, DHM is still subject to uncertainties inherently coming from model structure, parameters and input forcing. Sequential data assimilation (DA) may facilitate improved streamflow prediction via DHM using real-time observations to correct internal model states. In conventional DA methods such as state updating, parametric uncertainty is, however, often ignored mainly due to practical limitations of methodology to specify modeling uncertainty with limited ensemble members. If parametric uncertainty related with routing and runoff components is not incorporated properly, predictive uncertainty by DHM may be insufficient to capture dynamics of observations, which may deteriorate predictability. Recently, a multi-scale parameter regionalization (MPR) method was proposed to make hydrologic predictions at different scales using a same set of model parameters without losing much of the model performance. The MPR method incorporated within the mesoscale hydrologic model (mHM, http://www.ufz.de/mhm) could effectively represent and control uncertainty of high-dimensional parameters in a distributed model using global parameters. In this study, we present a global multi-parametric ensemble approach to incorporate parametric uncertainty of DHM in DA to improve streamflow predictions. To effectively represent and control uncertainty of high-dimensional parameters with limited number of ensemble, MPR method is incorporated with DA. Lagged particle filtering is utilized to consider the response times and non-Gaussian characteristics of internal hydrologic processes. The hindcasting experiments are implemented to evaluate impacts of the proposed DA method on streamflow predictions in multiple European river basins having different climate and catchment characteristics. Because augmentation of parameters is not required within an assimilation window, the approach could be stable with limited ensemble members and viable for practical uses.