Enhancing the Operational Hydrologic Forecast by Simultaneous Assimilation of Satellite-based Soil Moisture and In-situ Streamflow

Fangni Lei[1], Huanfeng Shen[2], Chunlin Huang[3]

[1]*School of Resource and Environmental Science,*
Wuhan University, Wuhan 430079, China, leifangni@whu.edu.cn
[2]*School of Resource and Environmental Science,*
Wuhan University, Wuhan 430079, China, shenhf@whu.edu.cn
[3]*Cold and Arid Regions Environmental and Engineering Research Institute,*
Chinese Academy of Sciences, Lanzhou 730000, China, huangcl@lzb.ac.cn

Abstract: With the SMOS (Soil Moisture and Ocean Salinity) satellite launched and the upcoming SMAP (Soil Moisture Active and Passive) mission carried out, satellite-based surface soil moisture observations have received enormous attention from scientists and engineers, especially among hydrologists. This measurement can not only be used to validate the model simulation, but also can improve the hydrologic predictions through data assimilation method which could be a compensation for imperfect model physics, noisy forcing data and inaccurate parameters. In this paper, the satellite-based surface soil moisture and in-situ streamflow observations are simultaneously assimilated into a physical-based hydrological model, the Soil and Water Assessment Tool (SWAT), to evaluate its impact on substantial hydrologic states such as profile soil moisture, evapotranspiration, and surface runoff. This approach, the simultaneous assimilation with diverse observations (SADO), uses the downscaling method and ensemble Kalman filter (EnKF) to handle the operational hydrologic forecast in the Heihe Basin, Northwest China. The results show that the sole assimilation of surface soil moisture can moderately improve estimations of root-zone soil moisture and other related hydrologic variables, especially for evapotranspiration and lateral flow. What is more, the dual assimilation of surface soil moisture and streamflow observations indeed enhance the hydrologic forecast with reduced error for watershed outlet runoff. Comparison between the sole and dual assimilation scenarios reveals the importance of SADO in operational hydrologic forecasting. Meanwhile, the downscaling technique demonstrates its capability in assimilation of remotely-sensed surface soil moisture.

Keyword: Data assimilation, Soil moisture, Sreamflow, Operational hydrologic forecasting