Validation of Satellite-Based Precipitation Products Over Sparsely-Gauged African River Basins

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Abstract

Six satellite-based rainfall estimates (SRFE)-namely, Climate Prediction Center (CPC) morphing technique (CMORPH), the Rainfall Estimation Algorithm, version 2 (RFE2.0), Tropical Rainfall Measuring Mission (TRMM) 3B42, Goddard profiling algorithm, version 6 (GPROF 6.0), Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN), Global Satellite Mapping of Precipitation moving vector with Kalman filter (GSMapMVK), and one reanalysis product [the interim ECMWF Re-Analysis (ERA-Interim)]-were validated against 205 rain gauge stations over four African river basins (Zambezi, Volta, Juba–Shabelle, and Baro–Akobo). Validation focused on rainfall characteristics relevant to hydrological applications, such as annual catchment totals, spatial distribution patterns, seasonality, number of rainy days per year, and timing and volume of heavy rainfall events. Validation was done at three spatially aggregated levels: point-to-pixel, subcatchment, and river basin for the period 2003–06. Performance of satellite-based rainfall estimation (SRFE) was assessed using standard statistical methods and visual inspection. SRFE showed 1) accuracy in reproducing precipitation on a monthly basis during the dry season, 2) an ability to replicate bimodal precipitation patterns, 3) superior performance over the tropical wet and dry zone than over semiarid or mountainous regions, 4) increasing uncertainty in the estimation of higher-end percentiles of daily precipitation, 5) low accuracy in detecting heavy rainfall events over semiarid areas, 6) general underestimation of heavy rainfall events, and 7) overestimation of number of rainy days in the tropics. In respect to SRFE performance, GPROF 6.0 and GSMaP-MKV were the least accurate, and RFE 2.0 andTRMM3B42were the most accurate. These results allow discrimination between the available products and the reduction of potential errors caused by selecting a product that is not suitable for particular morphoclimatic conditions. For hydrometeorological applications, results support the use of a performance-based merged product that combines the strength of multiple SRFEs.

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