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A Comprehensive Evaluation of SM2RAIN-GPM Precipitation Product over India

Deen Dayal[1], Ashish Pandey[1], and Praveen Gupta[2]
[1]Department of Water Resources Development & Management, Indian Institute of Technology Roorkee, Roorkee, India
[2]Space Applications Centre, Indian Space Research Organization (ISRO), Ahmedabad, India

Precipitation is an essential climatic variable for any hydrological study; however, obtaining continuous data of observed precipitation at a desirable resolution has been quite challenging. In this regard, satellite-based precipitation estimates play an important role in enhancing the present hydrologic prediction capability as they are mostly available at a high spatiotemporal resolution with global coverage. Without referring to ground measurements, satellite-based estimates can be biased and, although some gauge-adjusted satellite-precipitation products have already been developed, those need to be evaluated before any hydrological applications. In the present study, SM2RAIN-GPM rainfall product is evaluated for its performance with respect to the gauge-based India Meteorological Department (IMD) gridded dataset over the entire Indian region. The SM2RAIN-GPM dataset is the integration of SM2RAIN (bottom-up approach) based rainfall estimates derived from satellite soil moisture and Global Precipitation Measurement (GPM) based Integrated Multi-satellitE Retrievals for GPM (IMERG) early run product. The evaluation of the satellite-based daily rainfall estimates is carried out for 12 years (2007-2018) on the basis of qualitative and quantitative indicators. In general, the SM2RAIN-GPM rainfall product is excellent in detecting the daily rainfall events over India (mean and median probability of detection are 0.81 and 0.89, respectively), although some of the events are falsely detected (mean and median false alarm ratio are 0.47 and 0.46, respectively). Overall, a good agreement has been observed between satellite rainfall against IMD rainfall product with the mean and median Agreement Index as 0.7 and 0.74, respectively, whereas the median Kling-Gupta efficiency (KGE) is found to be 0.46. The mean absolute error in satellite rainfall is found to be in the range of 0.44 to 16.98 mm/day with a mean of 2.78 mm/day and a median of 2.43 mm/day. Further, the error has been decomposed into random and systematic components and it is found that the systematic error component is more dominant. Moreover, the percent bias (PBIAS) in satellite rainfall was found to be in the range of –97.25 to 201.91, while the RMSE to standard deviation ratio (RSR) ranged from 0.53 to 1.6. The mean and median values of PBIAS (RSR) are found to be 4.51 (0.79) and 7.91 (0.77), respectively. The precipitation product has higher under-hit and false biases than over-hit and miss biases. The performance of the product over the Himalayan region, North-eastern India, and the Western Ghats is relatively poor compared to other regions. The present study indicates that the SM2RAIN-GPM rainfall product is useful in hydrological studies of ungauged regions of India.