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Validation of satellite based precipitation over diverse topography of Pakistan

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ABSTRACT

This study evaluates the Tropical Rainfall Measuring Mission (TRMM) Multi-Satellite Precipitation Analysis (TMPA) product data with $0.25^\circ \times 0.25^\circ$ spatial and post-real-time 3 hours temporal resolution using point-based Surface Precipitation Gauge (SPG) data from 40 stations, for the period 1998–2013, and using gridded Asian Precipitation - Highly Resolved Observational Data Integration Towards Evaluation of Water Resources (APHRODITE) data abbreviated as APH data with $0.25^\circ \times 0.25^\circ$ spatial and daily temporal resolution for the period 1998–2007, over vulnerable and data sparse regions of Pakistan ($24\text{--}37^\circ$ N and $62\text{--}75^\circ$ E). To evaluate the performance of TMPA relative to SPG and APH, four commonly used statistical indicator metrics including Mean Error (ME), Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Correlation Coefficient (CC) are employed on daily, monthly, seasonal as well as on annual timescales. The TMPA slightly overestimated both SPG and APH at daily, monthly, and annual timescales, however close results were obtained between TMPA and SPG as compared to those between TMPA and APH, on the same timescale. The TMPA overestimated both SPG and APH during the Pre-Monsoon and Monsoon seasons, whereas it underestimated during the Post-Monsoon and Winter seasons, with different magnitudes. Agreement between TMPA and SPG was good in plain and medium elevation regions, whereas TMPA overestimated APH in 31 stations. The magnitudes of MAE and RMSE were high at daily timescale as compared to monthly and annual timescales. Relatively large MAE was observed in stations located over high elevation regions, whereas minor MAE was recorded in plain area stations at daily, monthly, and annual timescales. A strong positive linear relationship between TMPA and SPG was established at monthly (0.98), seasonal (0.93 to 0.98) and annual (0.97) timescales. Precipitation increased with the increase of elevation, and not only elevation but latitude also affected the intensity and amount of precipitation in Pakistan. It is evident that TMPA overestimates SPG in some regions and seasons and underestimates in other regions and seasons. It is thus determined from the current study that TMPA gives better results on annual, seasonal, and monthly timescales as compared to daily timescale. The TMPA might be used in all the four seasons including Winter, Pre-Monsoon, Monsoon, and Post-Monsoon. The TMPA mostly underestimates both SPG and APH in high elevation regions, whereas in plain and medium elevation regions it gives better results. This study concludes that TMPA can be a good substitute of SPG for water resource management in plain and medium elevation regions in central and northern parts of Pakistan, during all four seasons.

Keywords: TRMM: TMPA: Surface Precipitation Gauge: APHRODITE: Validation: Pakistan.

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