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## Validation of Satellite Rainfall Estimates over Equatorial East Africa

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The sparsity of rain gauge (RG) data over Africa is a known impediment to the assessments of hydro-meteorological risks and of the skill of numerical weather prediction (NWP) models. Satellite rainfall estimates (SREs) have been used as surrogate fields for a long time and are continuously replaced by more advanced algorithms. Using a unique daily rainfall dataset from 36 stations across equatorial East Africa for the period 2001–2018, this study performs a multi-scale evaluation of gauge-calibrated SREs, namely, Integrated Multi-satellite Retrieval for Global Precipitation Measurement (GPM) (IMERG), Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA), Climate Hazards group Infrared Precipitation with Stations (CHIRPS) and Multi-Source Weighted-Ensemble Precipitation (MSWEP). Skills were assessed from daily to annual timescales, for extreme daily precipitation, and for the TMPA and IMERG near real-time (NRT) products. Results show that: 1) the satellite products reproduce the annual rainfall pattern and seasonal rainfall cycle well, despite exhibiting biases of up to 9%; 2) IMERG is the best overall for shorter temporal scales (daily, pentadal and dekadal) while MSWEP and CHIRPS perform best at the monthly and annual timesteps, respectively; 3) the SREs' performance, especially in MSWEP, shows high spatial variability likely due to the variation of weights assigned during gauge calibration; 4) all the SREs miss between 57% (IMERG NRT) and 83 (CHIRPS) of daily extreme rainfall events recorded in the RGs; 5) IMERG NRT outperforms all the other products regarding extreme event detection and accuracy; and 6) for assessing return values of daily extreme values, IMERG and MSWEP are satisfactory while the use of CHIRPS cannot be recommended. The study highlights some improvements of IMERG over its predecessor TMPA and the potential of Multi-Source Weighted-Ensembles products such as MSWEP for flood risk assessment and validation of NWP rainfall forecasts over East Africa.