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Evaluation of high resolution global satellite precipitation products using daily raingauge data over the Upper Blue Nile Basin

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Water resources assessment, planning and management in Africa is often constrained by the lack of reliable spatio-temporal rainfall data. Satellite products are steadily growing and offering useful alternative datasets of rainfall globally. The aim of this paper is to examine the error characteristics of the main available global satellite precipitation products with the view of improving the reliability of wet season (June to September) and small rainy season rainfall datasets over the Upper Blue Nile Basin. The study utilized six satellite derived precipitation datasets at 0.25-deg spatial grid size and daily temporal resolution:1) the near real-time (3B42_RT) and gauge adjusted (3B42_V7) products of Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA), 2) gauge adjusted and unadjusted Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN) products and 3) the gauge adjusted and un-adjusted product of the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center Morphing technique (CMORPH) over the period of 2000 to 2013.The error analysis utilized statistical techniques using bias ratio (Bias), correlation coefficient (CC) and root-mean-square-error (RMSE). Mean relative error (MRE), CC and RMSE metrics are further examined for six categories of 10th, 25th, 50th, 75th, 90thand 95th percentile rainfall thresholds. The skill of the satellite estimates is evaluated using categorical error metrics of missed rainfall volume fraction (MRV), falsely detected rainfall volume fraction (FRV), probability of detection (POD) and False Alarm Ratio (FAR). Results showed that six satellite based rainfall products underestimated wet season (June to September) gauge precipitation, with the exception of non-adjusted PERSIANN that overestimated the initial part of the rainy season (March to May). During the wet season, adjusted CMORPH has relatively better bias ratio (89 %) followed by 3B42_V7 (88%), adjusted-PERSIANN (81%), and non-adjusted products have relatively lower bias ratio. The results from CC statistic range from 0.34 to 0.43 for the wet season with adjusted products having slightly higher values. The initial rainy season has relatively higher CC than the wet season. Results from the categorical error metrics showed that CMORPH products have higher POD (91%), which are better in avoiding detecting false rainfall events in the wet season. For the initial rainy season PERSIANN (<50%), TMPA and CMORPH products are nearly equivalent (63-67%). On the other hand, FAR is below 0.1% for all products while in the wet season is higher (10-25%). In terms of rainfall volume of missed and false detected rainfall, CMORPH exhibited lower MRV (∼4.5%) than the TMPA and PERSIANN products (11-19%.) in the wet season. MRV for the initial rainy season was ∼20% for TMPA and CMORPH products and above 30% for PERSIANN products. All products are nearly equivalent in the wet season in terms of FRV (< 0.2%). The magnitude of MRE increases with gauge rainfall threshold categories with 3B42-V7 and adjusted CMORPH having lower magnitude, showing that underestimation of rainfall increases with increasing rainfall magnitude. CC also decreases with gauge rainfall threshold categories with CMORPH products having slightly higher values. Overall, all satellite products underestimated (overestimated) lower (higher) quantiles quantiles. We have observed that among the six satellite rainfall products the adjusted CMORPH has relatively better potential to improve wet season rainfall estimate and 3B42-V7 that initial rainy season in the Upper Blue Nile Basin.