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Validation of satellite-based precipitation estimates over different African River Basins

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Satellite-based precipitation products have become increasingly available and accessible in near real-time, encouraging the scientific community increasingly to use these data to replace or supplement sparse ground observations. Six satellite-based rainfall estimates (SRFE), namely, CMORPH, RFE 2.0, TRMM 3B42, GPROF 6.0, PERSIANN, GSMaP-MKV, and one reanalysis product (ERA-interim) are validated against rain gauge data over four partly sparsely-gauged African river basins (Zambezi, Volta, Juba-Shabelle and Baro-Akobo). The objective is to provide the scientific community using SRFE as input data for hydro-meteorological applications an intercomparable validation study of these products over different hydro-climatological conditions in Africa. The validation focuses on the general ability of the SRFE products to reproduce daily and monthly rainfall and, particularly, on rainfall characteristics that are relevant to hydro-meteorological applications, such as, annual catchment totals, spatial distribution pattern within the river basin, seasonality of precipitation, number of rainy days per year, and timing and amount of heavy rainfall events. The accuracy of those products is assessed using a ground observation network, comprising of 203 stations with daily records between 2003 and 2006 (data coverage: <25, 25- 50, 50-75 and >75 % of data for 38, 13, 18 and 31 % of stations, respectively). Considering the time and space variability of the different rainfall characteristics as well as the conventional hydrological working units, the validation is done on three spatially-aggregated levels: point, subcatchment, and river basin. For the latter two the ground observations are interpolated using Kriging with External Drift, where the drift is defined as the terrain elevation. The performance is measured using standard statistical measures (MAE, RMSE, pBIAS, r, and NSeff) as well as visual inspection. The examined products showed depending on the spatially-aggregated level they have been analyzed: a) a good reproduction of dry periods, b) skills in reproducing precipitation over arid areas on a monthly basis, c) good representation of the spatial distribution pattern across the basins, d) difficulties in capturing the amount of precipitation on an event basis, and e) low detectability of heavy rainfall events over mountainous areas. Product-wise, GPROF 6.0 and GSMaP-MKV exhibited the poorest performance, which might be linked to the interpolation that was required due to the not complete daily coverage of the target areas and shortcomings in the algorithm selecting the correct rain profile, respectively. On the contrary, RFE 2.0 and TRMM 3B42 showed the highest potential in reproducing the inter-annual variability, the spatial and quantitative distribution, and the timing of rainfall events and, thus, may be recommendable as input for hydro-meteorological applications on a pan-African scale, such as monitoring and forecasting of floods and droughts.