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Satellite rainfall for food security on the African continent: performance and accuracy of seven products between 2001 and 2016

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Food security is the most emerging issue for most countries on the African continent. The major share of the agricultural production in Africa is rain fed whereas many of the irrigated zones are in water scarce and/or transboundary river basins. Accurate and detailed information on rainfall distribution is essential to support food security and water accounting applications. However, the network of meteorological stations that may provide such information is sparse.
Gridded precipitation products developed from satellite imagery sources have become increasingly available as an alternative or an addition to observed rainfall. The goal of this study was to evaluate and compare seven existing rainfall products for the Africa continent for the purpose of food security monitoring and water resources applications. We made a point-to-grid comparison for daily, dekadly, monthly and annual time steps of approximately 1,100 WMO stations that reported rainfall between 2001 and 2016. The rainfall products that were included are ARC, CHIRPS, PERSIANN, RFE, TAMSAT, TRMM 3B42 and MSWEP. A set of 5 continuous statistical indicators (Pearson correlation coefficient, Mean Erorr, Bias, Root Mean Square Error and Nash–Sutcliffe Efficiency coefficient) and two categorical indicators (Probability of Detection and False Alarm Ratio) were used.
WMO stations are unevenly distributed across Africa; though the total number of daily precipitation observations in Africa has increased by 50% from around 400 in 2001 to 600 in 2016. In West-Africa the coverage has improved significantly with the exception of Guinea-Conakry, Liberia and Sierra Leone. In Eastern and Southern Africa less stations are reporting with the exception of Tanzania. “White areas” are the horn of Africa, the sparsely populated Sahel desert stretching from Mauritania to Sudan and a belt in central Africa from Sudan down south to Angola. Important high intensity rainfall zones in West Africa (Fouta Djallon highlands, Nigeria) and Central Africa (Congo Basin) as well as Ethiopia in East-Africa have poor observation records.
Our analysis confirmed earlier findings that daily rainfall estimations of all products are weakly related with daily observation. We therefore focused on the cumulative values for dekads and months that we averaged for all stations in Africa. These values show that the most reliable products are MSWEP, CHIRPS, ARC and RFE, although the last two have the lowest ME equaling -0.80 and 1.22 respectively. TRMM has the highest ME value (0.11) but depicts poor scores for the other six indictors. Weakest products are TAMSAT and PERSIANN that were ranked lowest for almost all statistical indicators. Preliminary spatial results show that the performance of the products for coastal stations is lower than inland stations. The Bias of most products is high in north Africa compared to similar areas in Sub-Saharan Africa.