VALIDATION OF SATELLITE RAINFALL PRODUCTS OVER DIFFERENT PARTS OF AFRICA

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Abstract

Rainfall is a crucial resource in many socio-economic activities. This is particularly so for those African countries relying predominantly on rain-fed agriculture. Many countries have been affected by rainfall variability and long-term changes in both rainfall amount and distribution over recent decades. However, the number of rain-gauges throughout Africa is small, unevenly distributed, and the gauge network is deteriorating. Satellite rainfall estimates are being used widely in place of gauge observations or to supplement gauge observations. Rigorous validation is required in order to have some level of confidence in using the satellite products for different applications. Some global and regional validations have been done for different satellite rain products. In many parts of Africa, where these products are arguably needed most, there has been very little validation work. The few validations works over have mainly been limited to few products, particularly to monthly estimates at a spatial resolution of 2.5^o x 2.5^o lat/long.

Here different satellite rainfall products are evaluated over there locations in Africa at different spatial and temporal scales. The first validation site is a complex topography over Ethiopia, the second is located over the Sahel, and the third over Zimbabwe. The validation over Ethiopia is done for three groups of products. The first group has low spatial (2.5^o) and temporal (monthly) resolutions. These include Global Precipitation Climatology (GPCP) Multi-satellites (GPCP-MS), GPCP Satellite and Gauge (GPCP-SG), National Oceanographic and Atmospheric Administration-Climate Prediction Centre (NOAA-CPC) Merged Analysis (CMAP), and the Tropical Rainfall Measuring Mission (TRMM) combined ‘TRMM and Other Sources’ (3B43) products. TRMM-3B43 has higher spatial resolution (0.25^o), but has been remapped to 2.5^o in order to compare it with the other products. The second group consists of products with high spatial (0.1^o to 1^o) and temporal (three-hourly to 10-daily) resolutions. These products include NOAA-CPC African Rainfall Estimation Algorithm (RFE), NOAA-CPC African Rainfall Climatology (ARC), GPCP one-degree daily (1DD), the ‘TRMM and Other Satellites’ product (3B42), TAMSAT (Tropical Applications of Meteorology using Satellite data), and a relatively new product from NOAA-CPC named the CPC morphing technique (CMORPH). These products are evaluated at 10-daily temporal and 1^o spatial scales. The third group, consisting of RFE, TRMM-3B42, CMORPH, PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Network), and the Naval Research Laboratory’s blended product (NRL), are evaluates at daily time scale and spatial resolution of 0.25^o.

The validation over the Sahel and Zimbabwe is done at daily time scale and spatial resolution of 0.25°. The products evaluated over the Sahel are RFE, ARC, TRMM-3B42, and CMORPH. Products evaluated over Zimbabwe are RFE, TRMM-3B42, CMORPH, PERSIANN and NRL. The following table give summary of the different satellite rainfall products evaluated.

Product	Time Res	Space Res	Period	PM	Gauge
CMORPH	30-min	0.07 deg	2002-Pres	Y	N
NRL	3-hourly	0.25 deg	2003-2006	Y	N
PERSIANN	3-hourly	0.25 deg	2000-2006	Y	N
TRMM-3B42	3-hourly	0.25 deg	1998-Pres	Y	Y
TRMM-3B42RT	3-hourly	0.25 deg	2002-Pres	Y	N
CPC-RFE	Daily	0.1 deg	2001-Pres	Y	Y
CPC-ARC	Daily	0.1 deg	1995-Pres	N	Y
GPCP-1DD	Daily	1.0 deg	1996-Pres	nd	nd
TAMSAT	10-daily	~0.05 deg	1996-Pres	N	N
GPCP	Monthly	2.5 deg	1979-pres	Y	Y
CMAP	Monthly	2.5 deg	1979-pres	Y	Y
TRMM-3B43	Monthly	2.5 deg	1998-Pres	Y	Y

Summary of the different satellite products evaluated here. The PM and Gauge columns indicate whether the satellite product includes passive microwave (PM) and gauge observations

The validation over Ethiopia shows that the performance of the first and second group of is reasonably good. The results are not so good for comparisons at daily accumulations. Though the products performed reasonably well in detecting the occurrence of rainfall, they performed poorly in estimating the amount of rainfall in each pixel. The performance of the daily rainfall is better over Zimbabwe as compared to Ethiopia. This is attributed to the effect of the complex topography over Ethiopia. The performance of the satellite products is very poor over the dry parts of the Sahel with false alarm ratio as high as 96%. This is mainly attributed to the evaporation of raindrops in the hot and dry atmosphere under the cloud.