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Multi-decadal rainfall trends in western Uganda derived from satellite-based datasets

Jeremy Diem
Georgia State University, Geosciences, Atlanta, United States (jdiem@gsu.edu)

It has been recently reported that much of equatorial Africa has experienced a drying trend over the past several decades, but those results have not always been based on validated rainfall data. Multiple, satellite-based products now provide daily rainfall estimates from 1983 to the present at relatively fine spatial resolutions. The purpose of this research is twofold: (1) to assess the accuracy of four rainfall products covering the past several decades in western Uganda; and (3) to ascertain recent, multi-decadal trends in rainfall for the region. The four products are African Rainfall Climatology Version 2 (ARC2), Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS), Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks – Climate Data Record (PERSIANN-CDR), and TAMSAT African Rainfall Climatology And Time series (TARCAT). The bias and accuracy of ten-day, monthly, and seasonal rainfall totals of the four products were assessed using approximately ten years of data from ten rain gauges. The homogeneity of the products over multiple time periods was assessed using change-point analysis. CHIRPS was the only product that could be considered sufficiently accurate at estimating seasonal rainfall totals throughout most of the region. TARCAT tended to underestimate totals, and ARC2 and PERSIANN were in general the least accurate products. Only annual rainfall estimates from CHIRPS and TARCAT were significantly correlated with ground-measured rainfall totals. TARCAT was the most homogeneous product, while ARC2, CHIRPS, and PERSIANN had significant negative change points that caused a drying bias over the 1983-2016 period. After adjusting the satellite-based rainfall estimates based on the timing and magnitude of the change points, annual rainfall totals derived from all four products indicated that western Uganda experienced significantly increasing rainfall from 1983-2016. There are two rainy seasons in western Uganda, from March to May and from August to November, except the northernmost region which shows a unimodal rainy season from late March to mid-November. The temporal analysis of each rainy season revealed that the rainy seasons have started earlier– and thus increased in duration – over the past 35 years. The earlier season onset has been caused by significantly increased rainfall in the weeks just prior to the typical start of the rainy seasons.