Climatology-focused Evaluation of CMORPH and TMPA Satellite Rainfall Products over the Nile Basin

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Abstract

With many operational satellite-rainfall products being increasingly available for long periods, it is now possible to examine whether these products can reproduce climatologically-known rainfall characteristics over large river basins that suffer from poor surface monitoring resources. Such assessment is a pre-requisite for fine-scale hydrologic applications that rely on these products. This study performs evaluates two high-resolution rainfall satellite-rainfall products, TMPA-3B42 and CMORPH, over the full spatial domain of the Nile River Basin in Eastern Africa. The large latitudinal extent of the basin, its complex topography and diverse land-use result in widely contrasting regimes and distributions of annual and seasonal rainfall. The results suggest that the two products are fairly successful in reproducing some of the regionally-specific rainfall patterns across climatologically different parts of the basin. However, significant overestimation and underestimation by CMORPH and TMPA-3B42, respectively, are clearly evident over the majority of the basin and can reach or exceed 100% of mean annual rainfall. The biases are also evident in the seasonal rainfall cycle. The bias shows a complex dependency, in terms of magnitude and sign, on topography and latitude, especially in the central parts of the basin and over the Ethiopian Highlands region. The performance of both products is much better over the Equatorial region of the basin. The significant underestimation by the gauge-adjusted TMPA-3B42 product compared to CMORPH is attributed to the sparsity in operational gauges, which can adversely affect bias adjustment procedures. Current and future algorithmic developments are expected to bring much-needed improvements for satellite-rainfall products to see full operational utility in these regions of the world.

See Sample results in the following figures

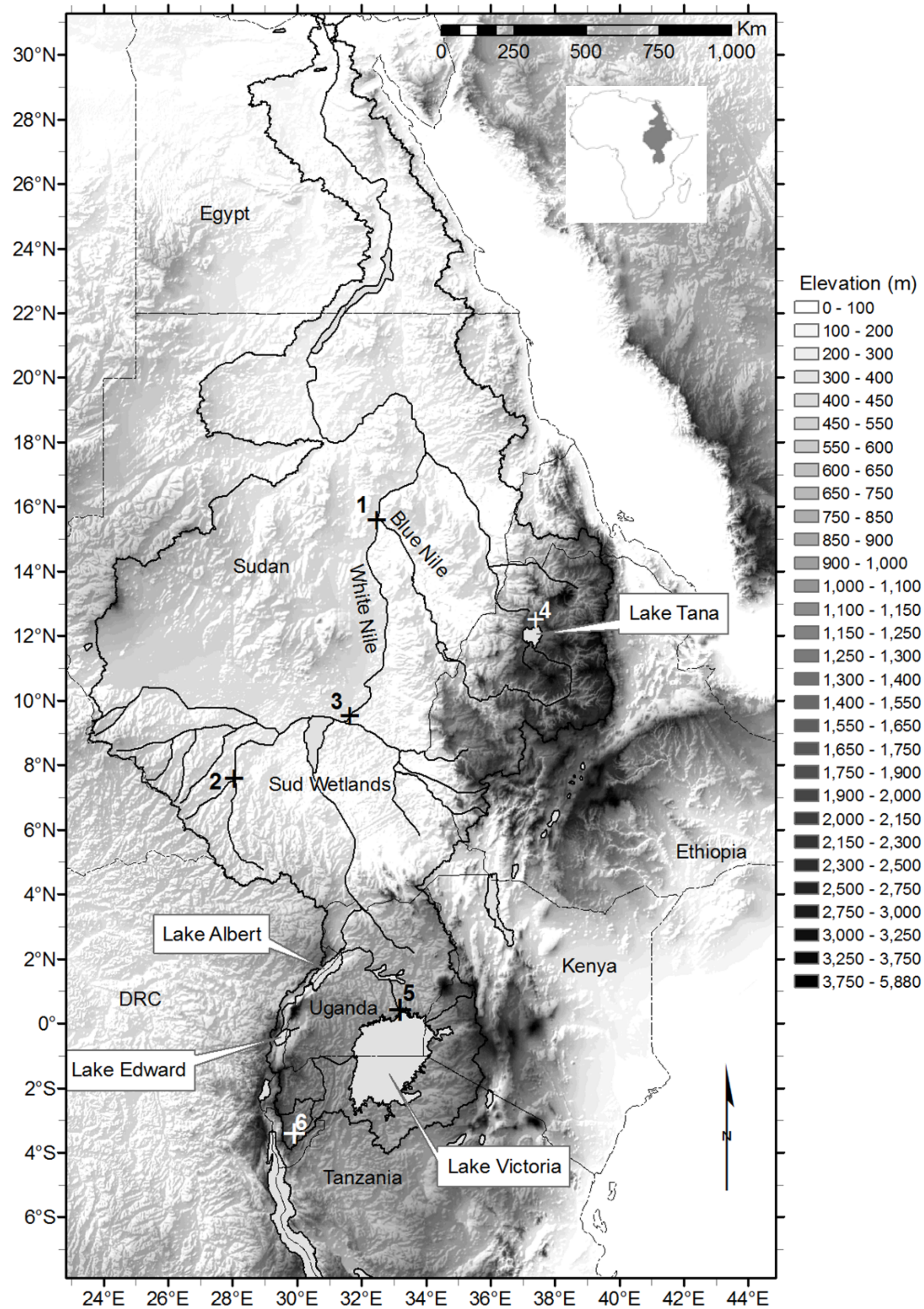

Figure 1: Topographic map of the Nile Basin. The inset shows the geographic location of the Nile basin. The (+) signs indicate the locations of six rain gauges stations, numbered 1-6 from North to South: (1) Khartoum, (2) Malakal and (3) Wau, Sudan; (4) Gondar, Ethiopia; (5) Jinja, Uganda; and (6) Kitega, Burundi.

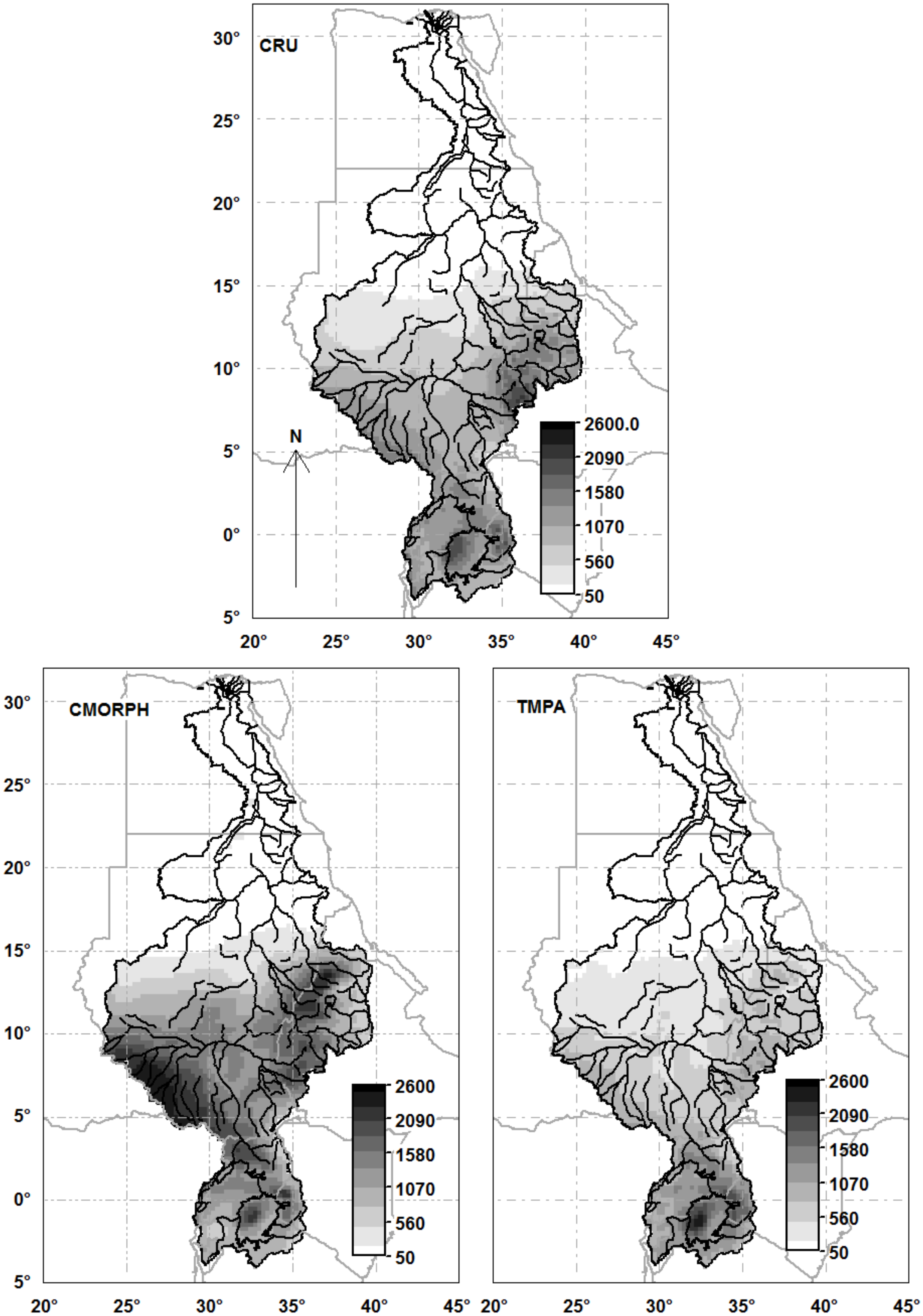

Figure 2: Mean annual rainfall distribution (mm) over the Nile Basin based on the CRU 2.0 climatology, and the CMORPH and TPMA-3B42 products.

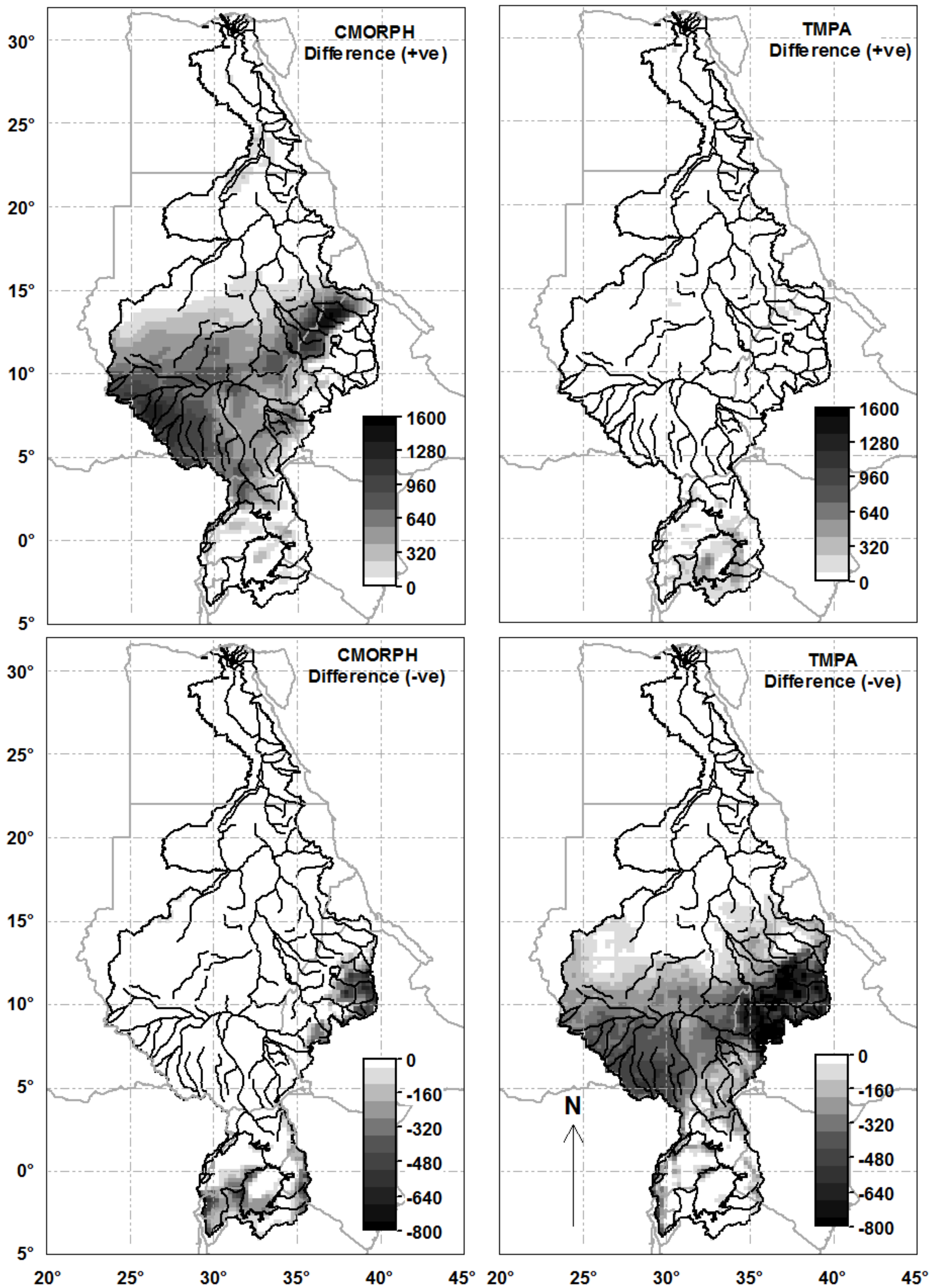

Figure 3: Biases in annual rainfall distribution over the Nile Basin decomposed into two parts: positive (overestimation) and negative (underestimation) differences.

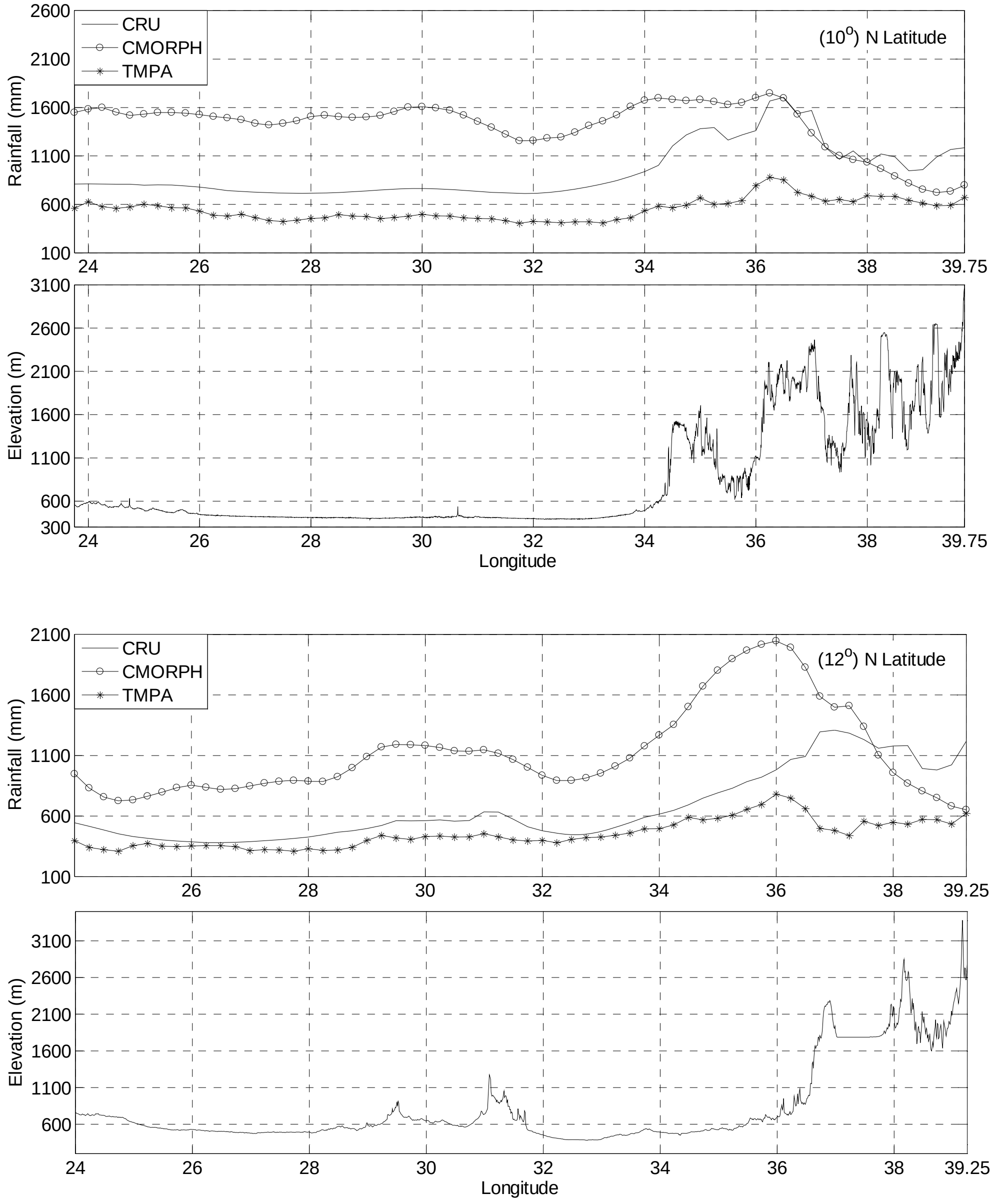

Figure 4: Cross sectional plots of mean annual rainfall (mm) and elevation along two constant latitudes: 10º N, upper two plots, and 12º N, lower two plots.