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Statistical Assessment of Precipitation Products: Case studies over Africa, Australia, and the Himalayas

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Accurate and reliable spatial and temporal representation of precipitation variability is essential for water resource management as well as for understanding of various global (and regional) hydrological responses. The growing number of high-resolution precipitation products in the past decade requires a more rigorous evaluation process to understand their skills and limitations over different parts of the world. Using advanced statistical techniques of (complex) empirical orthogonal functions (EOF) and three-cornered-hat (TCH) methods, various monthly precipitation products derived from satellite-based measurements and global reanalyses over different climatic and topographic regimes such as Africa (2003-2010), Australia (1981-2014), the Himalayan region of Bhutan (1998-2012) were evaluated. The products were also assessed for their possible biases in terms of probability distribution and also in the spectral domain. The results indicated that while the precipitation products generally agreed reasonably well with gauge-based rainfall observations, their accuracies were widely different over the three regions. All the satellite-based products (CMORPH, CHIRP, TRMM) underestimated monsoon rain over the Himalayas, while some of them (CMORPH, GSMaP_MVK) systematically overestimated convective rainfall over central regions of the African rain-belt. Satellite-based CHIRP and the MERRA reanalysis product provided consistent long-term rainfall variability and change over Australia for the period 1981-2014 while the gauge-adjusted TRMM product (3B43 v7) was found to be more consistent with gauge observations over the Himalayas (e.g., Bhutan). Over the African continent, both conventional statistical measures (biases and root-mean-square-errors) and TCH method revealed PERSIANN to be more accurate than TRMM and other regional precipitation products such as ARC (version 2) and TAMSAT. Seasonal biases were still apparent in satellite-based/reanalysis precipitation estimates over Australia even after applying a gamma-distribution bias correction. The biases were pronounced during major ENSO (El Nino Southern Oscillation) and IOD (Indian Ocean Dipole) events. Therefore, a frequency-based bias correction was applied to account for the major periodic precipitation biases over Australia.