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Using Satellite Precipitation to Improve Flood Modeling Applications of Global Reanalysis Precipitation Datasets

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Deriving flood vulnerability maps at basin scale typically requires simulating a long record of annual maximum discharges. To improve this approach, long precipitation records from global reanalysis systems must be downscaled to a spatio-temporal resolution applicable for flood modeling. This study evaluates a combined spatial downscaling and error correction technique based on high-resolution satellite precipitation products applied on NASA's Global Land Data Assimilation System (GLDAS) reanalysis precipitation dataset. The TRMM 3B42 25-km and 3-hourly blended satellite precipitation product is used for driving the GLDAS reanalysis downscaling. The study focuses on 437 flood-inducing storm events that occurred over a period of ten years (2002-2011) in the Susquehanna River basin located in the northeast United States. A validation strategy was devised for assessing error metrics in rainfall and simulated runoff as function of basin area, storm severity and season. The WSR-88D gauge-adjusted radar-rainfall (stage IV) product was used as the reference rainfall dataset, while runoff simulations forced with the stage IV precipitation dataset were considered as the runoff reference. Results show that the generated rainfall ensembles from the downscaled reanalysis products encapsulate the reference rainfall. Frequency analysis of rainfall and runoff and mean relative error and root mean square error statistics exhibited improvements in the precipitation and runoff simulation error statistics of the 3B42-driven downscaled GLDAS reanalysis dataset compared to the original reanalysis precipitation product. Results vary by season and less by basin scale. The proposed downscaling scheme is modular in design and can be applied on different satellite and reanalysis dataset over different regions.