Supplementary information for

Inter-comparison of gauge-based gridded data, reanalysis and satellite precipitation product with an emphasis on hydrological modelling

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S.1. Detailed information on Precipitation products

We have selected four precipitation products of different resolutions and from different sources. Detailed description of each products is as follows:

Gridded Indian Meteorological Department (IMD) Data

The high-resolution (0.25° × 0.25°) daily gridded rainfall data (Pai et al., 2015) was developed by the Indian Meteorological Department (IMD) for a spatial domain of 66.5°E to 100°E and 6.5°N to 38.5°N covering the mainland region of India. The gridded data was generated from the observed data of 6995 gauging stations across India using spatial interpolation for the period 1901–2013. Several studies in the past using the same dataset have reported such as complex network (Agarwal et al., 2018), downscaling (Lakhanpal et al., 2017, Sehgal et al., 2016) and rainfall variability (Krishnamurthy and Shukla, 2000, Guntu et al., 2020). This shows that the data are highly accurate and capable of capturing the spatial distribution of rainfall over the country. For this study area, around 19 grid points were located within the river basin with continuous rainfall data without any missing values.

Tropical Rainfall Measurement Mission (TRMM) Data

The Tropical Rainfall Measurement Mission (TRMM) was a joint mission between the National Aeronautics and Space Administration (NASA) and the Japan Aerospace Exploration Agency (JAXA) to monitor tropical precipitation. The TRMM data products are archived as orbital products, gridded products, and other TRMM products like TRMM ancillary products, ground-based instruments products, and Field experiment products from GES DISC (Goddard Earth Sciences Data and Information Services Centre). TRMM 3B42V7 satellite product is one type of the TRMM Multi-Satellite Precipitation Analysis (TMPA) products, and daily precipitation was used in this model (Huffman et al., 2007). The TRMM 3B42 product provides daily rainfall at the spatial resolution of 0.25° for a latitude band from 50°N to 50°S over a period of 1998 to 2017. The TMPA algorithm combines precipitation estimates from microwave and infrared satellites, as well as the Global Precipitation Climatology Centre (GPCC) monthly gauge analysis. More details about TMPA algorithms can be found in Huffman et al. (2007). The TRMM 3B42 daily precipitation data were obtained from this website https://giovanni.gsfc.nasa.gov.

Bias corrected Tropical Rainfall Measurement Mission (TRMM) Data

Some of the errors associated with satellite precipitation data sets are consistent under predictions, missing seasonal variation (Worqlul et al., 2014), and a low or higher number of dry days (Piani et al., 2010). One of the most straightforward and robust methods in reducing the systematic error is Bias correction. Bias correction may vary from simple additive correction (Berg et al., 2012) to a more complex histogram matching that can correct multiple moments of the distribution of a variable at a time (Haerter et al., 2011; Teutschbein and Seibert, 2012a). Model parameter values obtained using biased TRMM as forcing might not yield a reliable estimate of watershed characteristics (Behrangi et al., 2011; Bitew et al., 2012). Therefore, understanding and correcting the bias associated with TRMM is a necessary step. In this study, the bias of TRMM rainfall was corrected by applying monthly multiplicative correction coefficients of IMD rainfall.

Climate Forecast System Reanalysis (CFSR) Data

The Climate Forecast System Reanalysis (CFSR) data was started in 1979 by the National Centres for Environmental Prediction (NCEP). This is designed and executed as a global, high resolution, coupled atmosphere-ocean-land surface-sea ice system to provide the best estimate of the meteorological data. Currently, it is available over the 36-years period with a spatial resolution of 0.31^0 x 0.31^0 (38 km). Daily precipitation data of the NCEP-CFSR was obtained from this website https://globalweather.tamu.edu/ in the SWAT format that comprises the five NCEP-CFSR climate variables such as precipitation, temperature, solar, wind, and humidity. The current CFSR will be extended as an operational, real-time product into the future.

S.2. Statistical Metrics

Probability of Detection (POD) represents the ratio of the number of rainfall events correctly detected by the precipitation dataset to the number of rainfall events occurrences observed by reference data. It ranges from 0 to 1 (1 is the best value).

False Alarm Ratio (FAR) represents the false detected rainfall events by given dataset when rain is not observed by reference data. It ranges from 0 to 1 (0 is perfect value).

Critical Success Index (CSI) represents the fraction of hit rainfall events by the precipitation product to total rainfall events by observed and precipitation product (Sakolnakhon (2013)). It ranges from 0 to 1 (1 is a perfect value).

In general, when the values of POD < 0.65, FAR > 0.35, and CSI < 0.45, it is assumed that the product performance is poor in terms of detecting rainfall. Calculation of these three metrics is well explained in AghaKouchak andMehran (2013).