Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-221-AC1, 2016
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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Does the GPM mission improve the systematic error component in satellite rainfall estimates over TRMM, an evaluation at a pan-India scale?" *by* Harsh Beria et al.

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Received and published: 15 September 2016

Dear Ashish,

Thank you for taking time to give your comments. We tried to address them in a point-by-point answer format:

Q: Personally, I am not very much convinced with the assumption that, the IMD gridded observed rainfall data is reliable for evaluation in entire Indian river basin. Since Rain gauges are not available in several grids during study period 2000-2014. If you see your cited reference (Pai et al., 2014), there were about 2000-2500 gauges for all India

during 2006-2010, which indicate an average rain gauge density of 0.4-0.5 gauge per 0.25 grid pixel. Hence, a misleading conclusion can arrive due to the errors in C1 observed datasets especially in terms of POD and FAR. Please justify otherwise, I would suggest you please take those grids wherever, at least one rain gauges station is available.

A: In our study, we averaged precipitation to the basin scale (91 basins over India) and carried out all the statistical analysis over basin scale, rather than grid scale. The basin scale ensures the availability of one or more rain gauges on each basin. I would like to emphasize that not only is the IMD gridded precipitation product the best estimate of large scale precipitation, but also the only one available which uses such an extensive network of rain gauges.

IMD gridded observed rainfall (0.25° x 0.25°) (referred to as IMD-R) has been quality controlled by India Meteorological Department (IMD) and a number of publications have appeared in the recent past which use this product for statistical evaluation over Indian basins (Prakash et al., 2016a, 2016b, 2016c, Shah and Mishra, 2016a, 2016b). Pai et al. (2014) mentioned that the spatial distribution of rainfall, in particular the sharp rainfall gradient from the windward to the leeward side of the Western Ghats, was very well captured in IMD-R due to the high number of rain gauge stations used in development of the gridded product. Also, the high rainfall in the North-east was well represented. In the North-most basins, the quality of rainfall data was poor due to limited number of gauging stations, thus the corresponding basins were left out from the analysis. By far, IMD-R is the best known gridded precipitation product over India.

Recent study on the statistical utility of GPM (Prakash et al., 2016a, 2016c) over India used IMD-R to evaluate the performance of GPM over TMPA. Shah and Mishra (2016b) used IMD-R to assess the utility of multiple satellite precipitation estimates in real-time streamflow monitoring over Indian sub-continental river basins. Prakash et al. (2016b) used IMD-R to compare the performance of TMPA and GSMaP for the south-west monsoon. There has been a plethora of studies using IMD-R as the reference to

evaluate the performance of multiple satellite/reanalysis precipitation products, which establishes IMD-R as a benchmark product for evaluation of satellite based rainfall estimates.

Q: My second concern is about interpolation of IMERG (0.1 degree by 0.1 degree) data to 0.25 degree by 0.25 degree (as IMD resolution). How you interpolated the cases such as "if a grid is showing hit event and another adjacent grid is showing false event"/ "if a grid is showing miss event and another adjacent grid is showing false event"/ "if a grid is showing miss event and another adjacent grid is showing hit event"? Please explain

A: We did not interpolate daily IMERG precipitation estimates from a spatial resolution of (0.1° x 0.1°) to (0.25° x 0.25°). In order to compute basin-wise precipitation, we used Thiessen Polygon method, which doesn't explicitly take care of the hit/miss statistics during interpolation. By avoiding interpolation from 0.1° to 0.25°, we ensured that high resolution rainfall information was used to compute basin precipitation. To the best knowledge of the authors, there are no commonly used interpolation methods which explicitly account for hit/miss statistics. In the climate community, people use thresholding to account for drizzle effect (Teutschbein and Seibert, 2012) which is closest to conserving threshold statistics, but that is beyond the scope of our study. For your concern about the changing frequency of hit/miss event on interpolation, this was beyond the scope of this study and maybe an interesting study for the future. Publications in the past have used simple interpolation methods to compare hit/miss statistics of GPM vs TMPA, the focus was on threshold statistics rather than the interpolation method used (Guo et al., 2016; Prakash et al., 2016c; Sahlu et al., 2016).

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