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Global component analysis of errors in three satellite-only global precipitation estimates

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The approach to deal with the inconsistency of benchmark

To alleviate the effects of reference inconsistency on the analysis, the SPP error metrics over mainland China and the rest of the world were calculated using the following steps:

(1) Global maps of biases and systematic error

a. The spatial maps of biases and systematic error computed over the global land areas use CPCU data as the benchmark. Maps of biases and systematic error over mainland China use CGDPA data as the reference.

b. The spatial maps of biases and systematic error over mainland China replace the Chinese mainland part of the global land areas.

(2) Error components of SPPs under different precipitation intensities

The satellite and ground reference precipitation values over the globe (except for mainland China) were stored in vector S1 and vector G1, respectively. Then the satellite and ground reference precipitation values over mainland China were stored in vector S2 and vector G2, respectively. Third, S1 and S2 form a new vector S ($S = [S1, S2]^T$), while G1 and G2 form a new vector G ($G = [G1, G2]^T$). Finally, the SPP error components under different precipitation intensities were computed by using equations (1)-(9).

The inconsistency of reference data has little impact on the evaluation results.

Table S1 Summary of the total bias and its three independent components for five evaluated satellite-only global precipitation estimates in main areas of the global land areas.[a]

Products	Season	COUNS	Mexico	Brazil	Europe	India	China	Australia
IMERG-Late	MAM	T: >100% in most areas of humid; MC: H	T: > 100% in most regions; MC: H and F	The mutual cancellations between M and F	T: >100% in most regions; MC: H	T: > 100% in most regions; MC: H and F	T: >100% in most areas of semi-humid; MC: H and F	The mutual cancellations between M and F
	JJA	T: >100% in areas other than humid areas; MC: H	T: >100% in northwest; MC: H	Similar to MAM season, except for the magnitude of T and H is higher than MAM season	MC: H; the mutual cancellations between M and F	The mutual cancellations between M and F	T: between ±20%	The mutual cancellations between M and F
	SON	T: between ±60%; MC: H	The mutual cancellations between M and F	The mutual cancellations between M and F	The mutual cancellations between M and F	The mutual cancellations between M and F	T: between ±40%	The mutual cancellations between M and F
	DJF	T: > 100% in humid areas and less than -60% in arid and semi-arid areas; MC: H,	T: >100% in south; MC: F and H	the mutual cancellations between M and F	T: >80% in most areas; MC: H	T: >100% in most areas; MC: H and F	T: >-60% in most semihumid; MC: M	The mutual cancellations between M and F

		F and M, respectively						
GSMaP-MVK	MAM	T: >100% in most areas of humid; MC: H	T: > 100% in most regions; MC: H and F	The mutual cancellations between M and F	T: >80% in most regions; MC: H	T: >100% in most regions; MC: H and F	T: > 100% in most areas of semi-humid; MC: H and F	The mutual cancellations between M and F
	JJA	T: >100% in most areas; MC: H and F	T: > 100% in northwest; MC: H	Similar to MAM season, except for the magnitude of T and H is higher than MAM season	MC: H; the mutual cancellations between M and F	The mutual cancellations between M and F	T: between ±20%	The mutual cancellations between M and F
	SON	T: >60% in most areas; MC: H	The mutual cancellations between M and F	The mutual cancellations between M and F	T: >60% in most areas; MC: H	The mutual cancellations between M and F	T: >100% in semihumid; MC: H and F	The mutual cancellations between M and F
	DJF	T: > 80% in southeast; MC: H	T: > 100% in most areas; MC: H	The mutual cancellations between M and F	T: between -40% and -60% in most areas; MC: M	The mutual cancellations between M and F	T: > 100% in the centre of mainland China; MC: F	The mutual cancellations between M and F
PERSIANN-CCS	MAM	T: >100% in most areas other than humid; MC: F and H	T: >100%; MC: F	T: >80% in most regions; MC: H and F	T: <40% in most areas; the mutual cancellations between M	T: >100% in south; MC: H and F	T: >-40% in most areas; MC: H	The mutual cancellations between M and F

					and F			
	JJA	T: >100% in parts of midlands to west; MC: H and F	T: > 100% in northwest; MC: H and F	T: >60% in most inland areas; MC: F	The mutual cancellations between M and F	The mutual cancellations between M and F	The mutual cancellations between H and F	The mutual cancellations between M and F
	SON	T: >100% in most areas of northeast and between -40 and -60 in southeast; MC: F and H, respectively	The mutual cancellations between M and F	T: >80% in most inland areas; MC: F and H	The mutual cancellations between M and F	The mutual cancellations between M and F	T: < -60% in humid; MC: M	The mutual cancellations between M and F
	DJF	T: >100% in areas other than humid; MC: F and H	T: >100%; MC: F	T: >80% in inland and east; MC: F and H	T: >60% in most areas; MC: F	T: > 80% in most areas; MC: F	T: < -40% (>100%) in most areas of humid (other areas); MC: M (H and F)	The mutual cancellations between M and F

[a] Noation: T, H, M, and F represents the total bias, hit bias, miss bias, and false bias, respectively; MC indicates the major component of total bias.