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Global assessment of how averaging over spatial heterogeneity in precipitation and potential evapotranspiration affects modeled evapotranspiration rates

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Table S1. Statistical significance of the differences in heterogeneity bias (%) in evapotranspiration estimates at 1° by 1° grid cell in individual climate zones across the contiguous US corresponding to Figure 5a,b in the manuscript.). These analysis show that for example, while the difference between heterogeneity biases estimated at Cs and Ds climate zones (highlighted in yellow) are not statistically significant across all four combinations of datasets, the difference between estimated heterogeneity bias in Cs versus Cf, Ds versus Cf, as well as Cs versus Bs climate zones (highlighted in grey, blue, and green, respectively) are significant across all four data combinations (highlighted in Table S1 of the supplementary material).

Heterogeneity Bias per Dataset* and Climate Zone**	**Heterogeneity Bias per Dataset* and Climate Zone****	**p-Value**	**Hodges-Lehmann*****	**Lower Confidence Level** for the Hodges-Lehmann statistics	**Upper Confidence Level** for the Hodges-Lehmann statistics
Dataset1.BW	**Dataset1.BS**	0.1407	-0.12012	-0.44881	0.02
Dataset1.Cf	**Dataset1.BS**	<.0001	-0.45556	-0.57755	-0.28807
Dataset1.Cf	**Dataset1.BW**	<.0001	-0.20579	-0.32164	-0.11896
Dataset1.Cs	**Dataset1.BS**	<.0001	3.0654	2.44269	3.91066
Dataset1.Cs	**Dataset1.BW**	<.0001	3.62997	2.48213	4.43869
Dataset1.Cs	**Dataset1.Cf**	<.0001	4.04859	3.10156	4.40548
Dataset1.Df	**Dataset1.BS**	<.0001	-0.10735	-0.30208	-0.04524
Dataset1.Df	**Dataset1.BW**	0.0019	-0.11438	-0.21242	-0.02926
Dataset1.Df	**Dataset1.Cf**	0.0426	0.00849	0.00029	0.01866
Dataset1.Df	**Dataset1.Cs**	<.0001	-3.09103	-4.06841	-2.53851
Dataset1.Ds	**Dataset1.BS**	<.0001	3.24898	2.23717	3.99479
Dataset1.Ds	**Dataset1.BW**	<.0001	3.53964	2.36851	4.18713
Dataset1.Ds	**Dataset1.Cf**	<.0001	4.00665	3.35766	4.29738
Dataset1.Ds	**Dataset1.Cs**	0.7683	-0.23846	-2.05232	1.48072
Dataset1.Ds	**Dataset1.Df**	<.0001	3.51482	2.27469	4.20886
Dataset2.BS	**Dataset1.BS**	<.0001	-0.22561	-0.40445	-0.07707
Dataset2.BW	**Dataset1.BW**	0.0004	-0.16965	-0.33234	-0.05782
Dataset2.BW	**Dataset2.BS**	0.0118	-0.06001	-0.15655	-0.00819
Dataset2.Cf	**Dataset1.Cf**	0.256	0.00447	-0.00368	0.01175
Dataset2.Cf	**Dataset2.BS**	<.0001	-0.09592	-0.13758	-0.05522
Dataset2.Cf	**Dataset2.BW**	0.3035	-0.01237	-0.04926	0.00967
Dataset2.Cs	**Dataset1.Cs**	0.0027	-1.19724	-2.12927	-0.41601
Dataset2.Cs	**Dataset2.BS**	<.0001	2.16947	1.8506	2.63403
Dataset2.Cs	**Dataset2.BW**	<.0001	2.34997	1.85817	3.38577
Dataset2.Cs	**Dataset2.Cf**	<.0001	2.41497	2.10748	2.75728
Dataset2.Df	**Dataset1.Df**	0.8318	-0.00084	-0.00915	0.00719
Dataset2.Df	**Dataset2.BS**	0.0029	-0.02806	-0.06836	-0.00706
Dataset2.Df	**Dataset2.BW**	0.8123	0.00254	-0.02154	0.02418
Dataset2.Df	**Dataset2.Cf**	0.3006	0.00389	-0.00353	0.01267
Dataset2.Df	**Dataset2.Cs**	<.0001	-2.15277	-2.52604	-1.82743
Dataset2.Ds	**Dataset1.Ds**	0.0849	-1.50225	-2.50123	0.30038
Dataset2.Ds	**Dataset2.BS**	<.0001	2.21226	1.74455	2.50366
Dataset2.Ds	**Dataset2.BW**	<.0001	2.36559	1.90904	2.68806
Dataset2.Ds	**Dataset2.Cf**	<.0001	2.41689	2.1708	2.68458
Dataset2.Ds	**Dataset2.Cs**	0.948	-0.03178	-1.33601	0.8283
Dataset2.Ds	**Dataset2.Df**	<.0001	2.25772	1.72594	2.55501
Dataset3.BS	**Dataset1.BS**	0.0009	-0.10599	-0.2797	-0.02431
Dataset3.BS	**Dataset2.BS**	0.0046	0.04068	0.01002	0.11877
Dataset3.BW	**Dataset1.BW**	0.3084	-0.0558	-0.2088	0.05636

Dataset3.BW	**Dataset2.BW**	0.0034	0.10797	0.02984	0.21626
Dataset3.BW	**Dataset3.BS**	0.384	-0.03334	-0.19331	0.04233
Dataset3.Cf	**Dataset1.Cf**	0.2545	-0.00435	-0.0122	0.00319
Dataset3.Cf	**Dataset2.Cf**	0.0181	-0.00867	-0.01569	-0.00157
Dataset3.Cf	**Dataset3.BS**	<.0001	-0.25387	-0.31557	-0.16911
Dataset3.Cf	**Dataset3.BW**	<.0001	-0.1441	-0.21753	-0.08437
Dataset3.Cs	**Dataset1.Cs**	<.0001	-1.51465	-2.47479	-0.78692
Dataset3.Cs	**Dataset2.Cs**	0.3175	-0.3227	-0.98714	0.26993
Dataset3.Cs	**Dataset3.BS**	<.0001	1.73696	1.38141	2.08505
Dataset3.Cs	**Dataset3.BW**	<.0001	1.84641	1.32814	2.40169
Dataset3.Cs	**Dataset3.Cf**	<.0001	2.08179	1.7823	2.40533
Dataset3.Df	**Dataset1.Df**	0.7278	-0.00152	-0.01035	0.00756
Dataset3.Df	**Dataset2.Df**	0.6682	-0.00166	-0.00945	0.00705
Dataset3.Df	**Dataset3.BS**	<.0001	-0.07586	-0.19981	-0.03283
Dataset3.Df	**Dataset3.BW**	0.0046	-0.08269	-0.15823	-0.02138
Dataset3.Df	**Dataset3.Cf**	0.0012	0.01372	0.00526	0.02489
Dataset3.Df	**Dataset3.Cs**	<.0001	-1.85722	-2.20205	-1.4611
Dataset3.Ds	**Dataset1.Ds**	0.018	-2.4711	-3.3356	-0.8523
Dataset3.Ds	**Dataset2.Ds**	0.0082	-1.03519	-1.59377	-0.32382
Dataset3.Ds	**Dataset3.BS**	<.0001	1.08364	0.8079	1.20599
Dataset3.Ds	**Dataset3.BW**	<.0001	1.11901	0.92597	1.36041
Dataset3.Ds	**Dataset3.Cf**	<.0001	1.21405	1.15357	1.46254
Dataset3.Ds	**Dataset3.Cs**	0.1008	-0.64875	-1.50761	0.10598
Dataset3.Ds	**Dataset3.Df**	<.0001	1.18489	1.0743	1.44217
Dataset4.BS	**Dataset1.BS**	<.0001	-0.40028	-0.54516	-0.23104
Dataset4.BS	**Dataset2.BS**	<.0001	-0.05237	-0.09779	-0.01846
Dataset4.BS	**Dataset3.BS**	<.0001	-0.17975	-0.25975	-0.07774
Dataset4.BW	**Dataset1.BW**	<.0001	-0.20365	-0.36701	-0.09633
Dataset4.BW	**Dataset2.BW**	0.3739	-0.01445	-0.06073	0.01585
Dataset4.BW	**Dataset3.BW**	0.0002	-0.13451	-0.22896	-0.05664
Dataset4.BW	**Dataset4.BS**	0.1269	-0.0188	-0.05682	0.00565
Dataset4.Cf	**Dataset1.Cf**	0.8533	0.00075	-0.00766	0.00791
Dataset4.Cf	**Dataset2.Cf**	0.2634	-0.00364	-0.0104	0.00282
Dataset4.Cf	**Dataset3.Cf**	0.1359	0.00525	-0.00168	0.01177
Dataset4.Cf	**Dataset4.BS**	0.0002	-0.0248	-0.04427	-0.01004
Dataset4.Cf	**Dataset4.BW**	0.6859	-0.00302	-0.02091	0.0134
Dataset4.Cs	**Dataset1.Cs**	<.0001	-2.41522	-3.43407	-1.6579
Dataset4.Cs	**Dataset2.Cs**	<.0001	-1.19807	-1.78503	-0.63921
Dataset4.Cs	**Dataset3.Cs**	<.0001	-0.79894	-1.28138	-0.41456
Dataset4.Cs	**Dataset4.BS**	<.0001	1.11386	0.917	1.2715
Dataset4.Cs	**Dataset4.BW**	<.0001	1.15317	0.87443	1.44253
Dataset4.Cs	**Dataset4.Cf**	<.0001	1.16414	0.97396	1.37922
Dataset4.Df	**Dataset1.Df**	0.1325	-0.00554	-0.01469	0.00162
Dataset4.Df	**Dataset2.Df**	0.061	-0.00621	-0.01325	0.00027
Dataset4.Df	**Dataset3.Df**	0.13	-0.00632	-0.01653	0.00173
Dataset4.Df	**Dataset4.BS**	0.0859	-0.00904	-0.02362	0.00119
Dataset4.Df	**Dataset4.BW**	0.9844	0.00023	-0.01734	0.02028
Dataset4.Df	**Dataset4.Cf**	0.8257	0.00071	-0.00566	0.0082
Dataset4.Df	**Dataset4.Cs**	<.0001	-1.12481	-1.25037	-0.92266
Dataset4.Ds	**Dataset1.Ds**	0.0012	-3.17434	-3.91507	-1.66233
Dataset4.Ds	**Dataset2.Ds**	0.0002	-1.71145	-2.20347	-1.04758
Dataset4.Ds	**Dataset3.Ds**	0.0094	-0.63867	-1.03827	-0.2922
Dataset4.Ds	**Dataset4.BS**	<.0001	0.64452	0.45081	0.73746
Dataset4.Ds	**Dataset4.BW**	<.0001	0.68611	0.4839	0.80799

Dataset4.Ds	**Dataset4.Cf**	<.0001	0.69438	0.59675	0.79144
Dataset4.Ds	**Dataset4.Cs**	0.0398	-0.44998	-0.96524	-0.01644
Dataset4.Ds	**Dataset4.Df**	<.0001	0.66388	0.44804	0.76445

***Dataset1**: Prism P, WorldClim PET; **Dataset2**: Prism P, MODIS PET; **Dataset3**: WorldClim P, WorldClim PET; **Dataset4**: WorldClim P, MODIS PET.

**** Cs**: temperate, dry summer; **Ds**: cold, dry summer; **BW**: arid, desert; **BS**: arid, step; **Cf**: temperate, no dry season; **Df**: cold, no dry season.

*** **Hodges-Lehmann** is the estimator of the location shift. All paired differences consisting of observations in the first column minus observations in the second column are constructed. The Hodges-Lehmann estimator is the median of these differences.

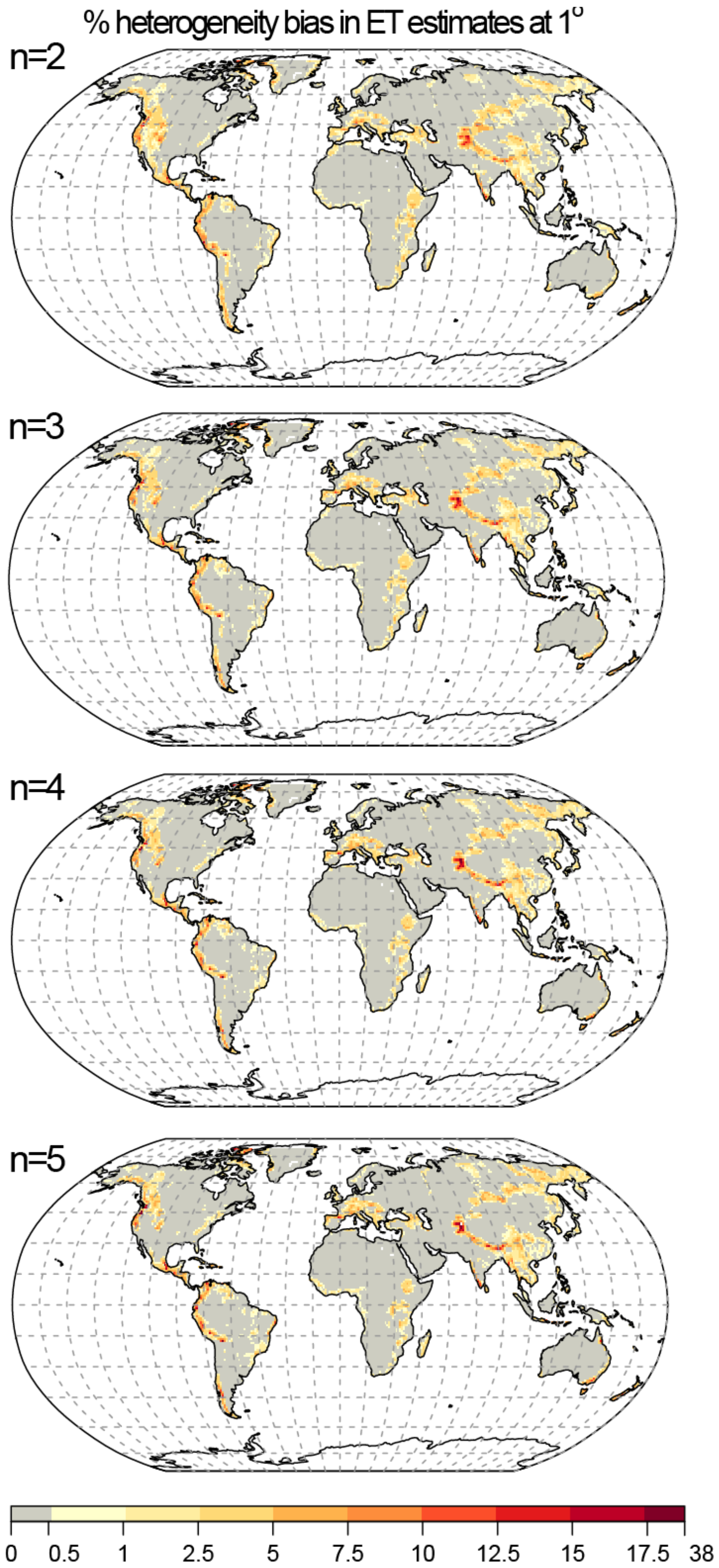

Figure S1. Sensitivity of estimates of aggregation bias to parameter value *n* in Budyko function (Eq. 1 in the manuscript). The values shown are % heterogeneity bias at 1° by 1° using Eq. (4) in the manuscript and 1km WorldClim P and 1km WorldClim PET data. As expected from Eqs. 3 and 4 in the manuscript, higher values of n lead to larger heterogeneity biases, but the spatial pattern remains largely unchanged with variations in Budyko's n parameter.

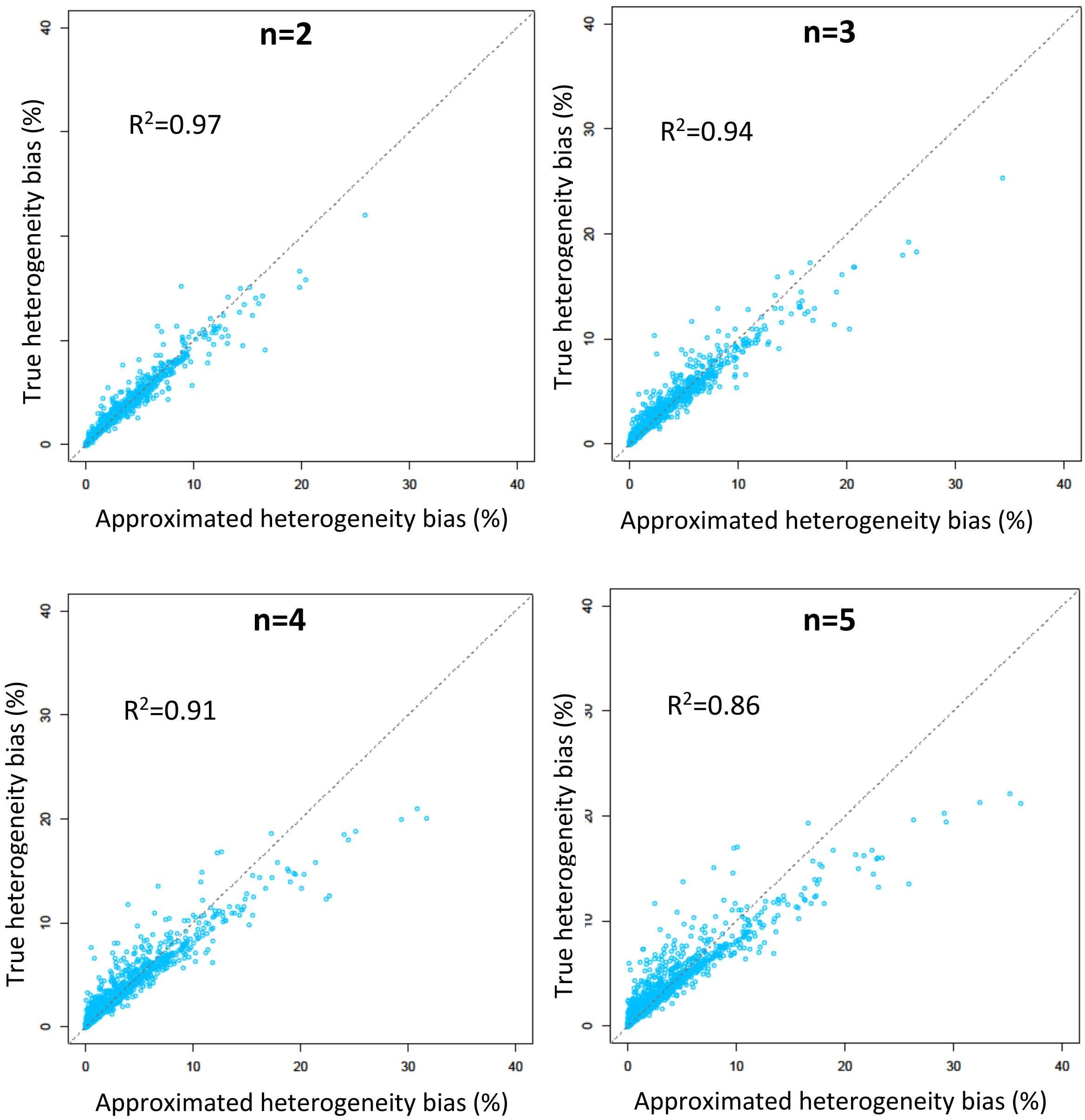

Figure S2. % approximated heterogeneity bias in ET estimates versus % true heterogeneity bias in ET estimates at 1° by 1° at global scale. Estimated heterogeneity biases are calculated using Eq. 4 in the manuscript. True heterogeneity biases are calculated as differences between the finer resolution ET estimates from finer resolution input data (one-km WorldClim P and PET), averaged over 1° by 1° spatial scales (average of functions) and ET values calculated from average inputs at 1° by 1° spatial scale (function of averages). The coefficients of determination (R^2) between the true and estimated heterogeneity biases verify the reliability of the Taylor expansion method and Eq. 4 as estimates of the heterogeneity bias.