Supplementary Materials for

Suitability of 17 rainfall and temperature gridded datasets for large-scale hydrological modelling in West Africa

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1 Content

This supplementary materials file contains additional figures and tables to support the analysis of the results presented in the main manuscript. The methodology used to obtain these results is explained in the main manuscript.

The following sections are presented:

- **Section 2: Spatial long-term averages of rainfall and temperature**
  Figure S1 to Figure S2
- **Section 3: Temporal long-term averages of rainfall and temperature**
  Figure S3 to Figure S6
- **Section 4: Ranking of rainfall and temperature datasets**
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- **Section 6: Model performance for terrestrial water storage**
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  Figure S47 to Figure S64; Table S16 to Table S17
- **Section 9: Model parameters**
  Figure S65 to Figure S66; Table S18

# 2 Spatial long-term averages of rainfall and temperature
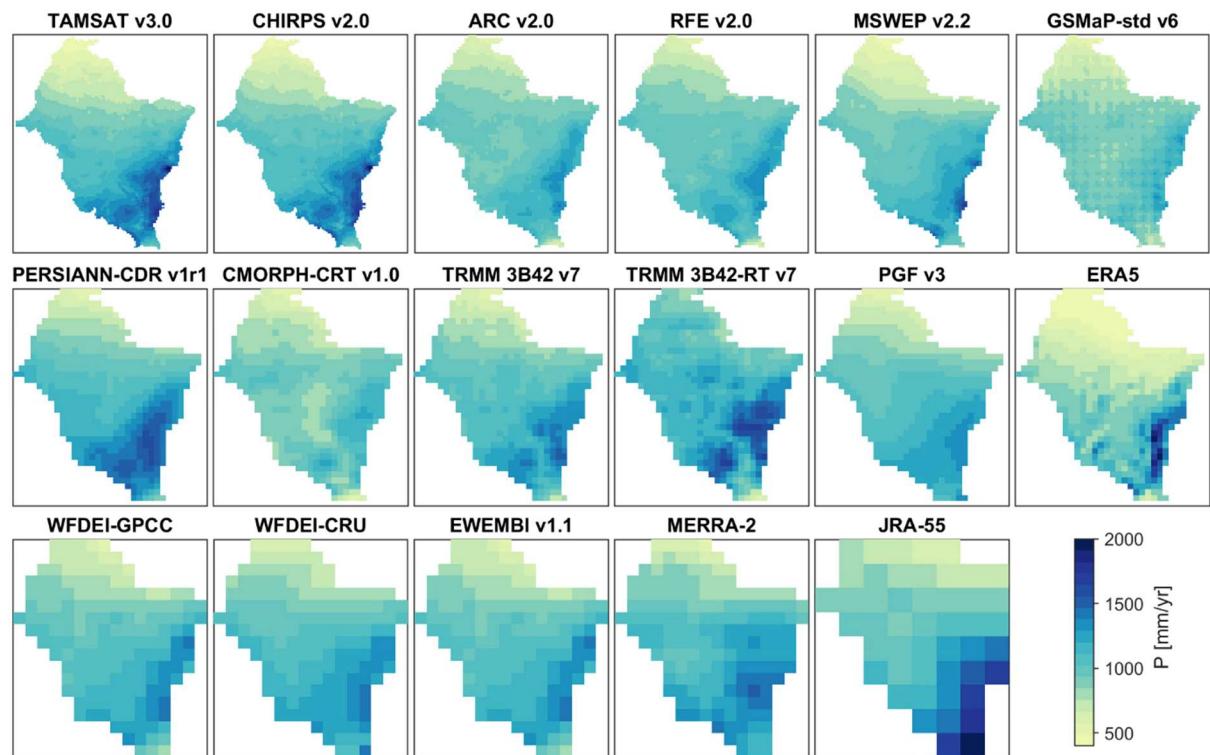
Figure S1. Mean annual rainfall totals over the period 2003-2012 for 17 rainfall datasets the Volta River basin
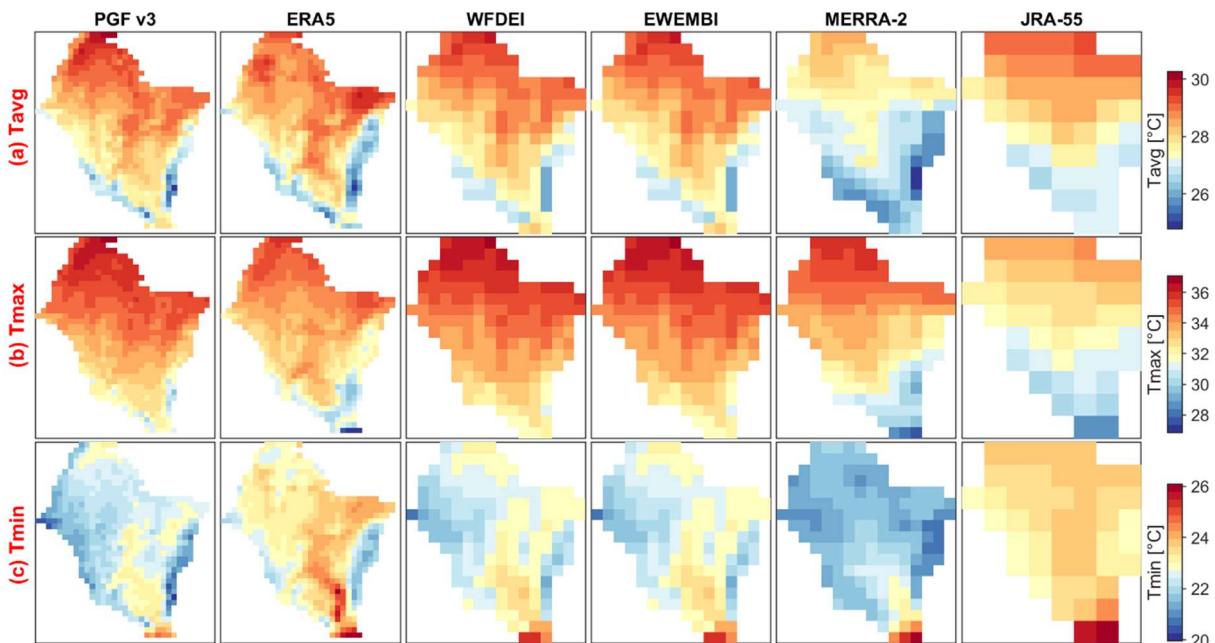

Figure S2. Mean annual air temperature (average (a), maximum (b) and minimum (c)) over the period 2003-2012 for 6 temperature datasets in the Volta River basin

3 Temporal long-term averages of rainfall and temperature
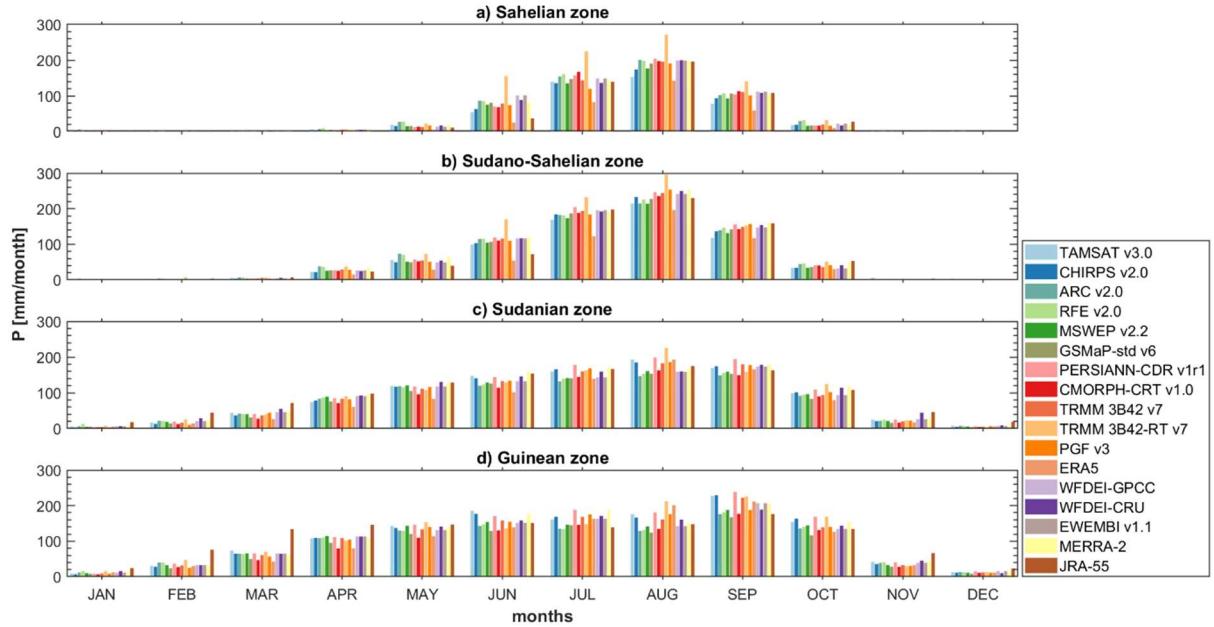

Figure S3. Climatology of mean monthly rainfall totals over the period 2003-2012, averaged over four climatic zones (a, b, c and d). . The colored bars represent 17 rainfall datasets.
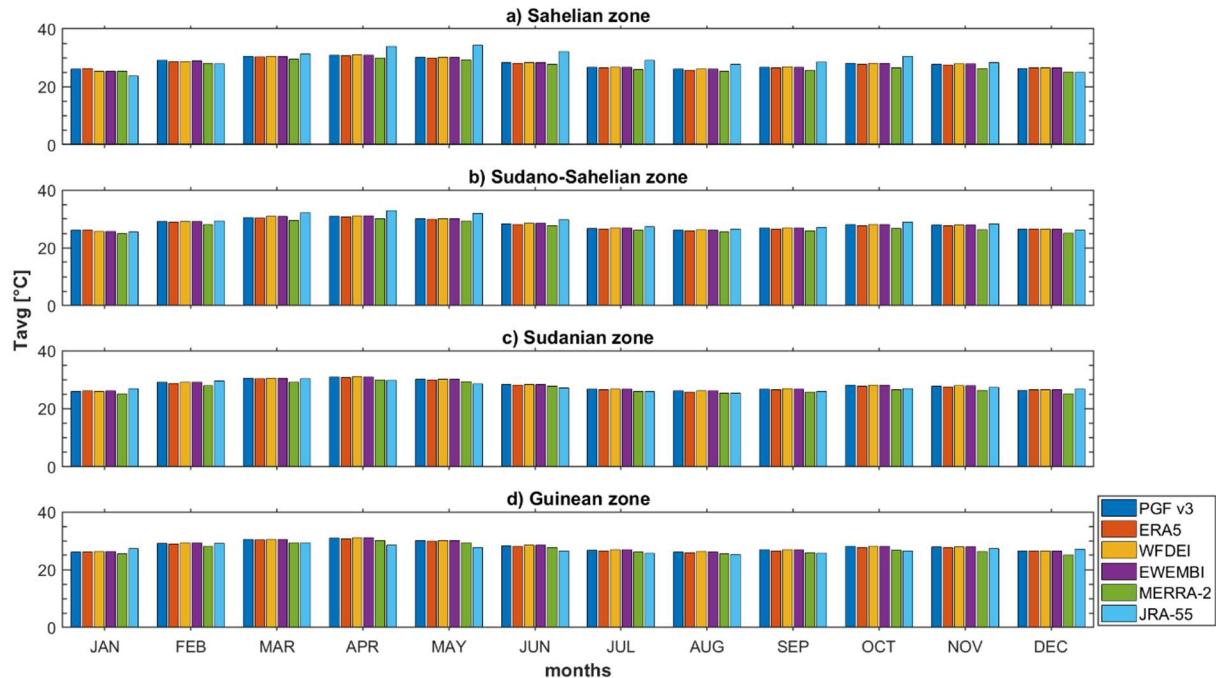
Figure S4. Climatology of mean monthly average air temperature over the period 2003-2012, averaged over four climatic zones (a, b, c and d). The colored bars represent 6 temperature datasets.
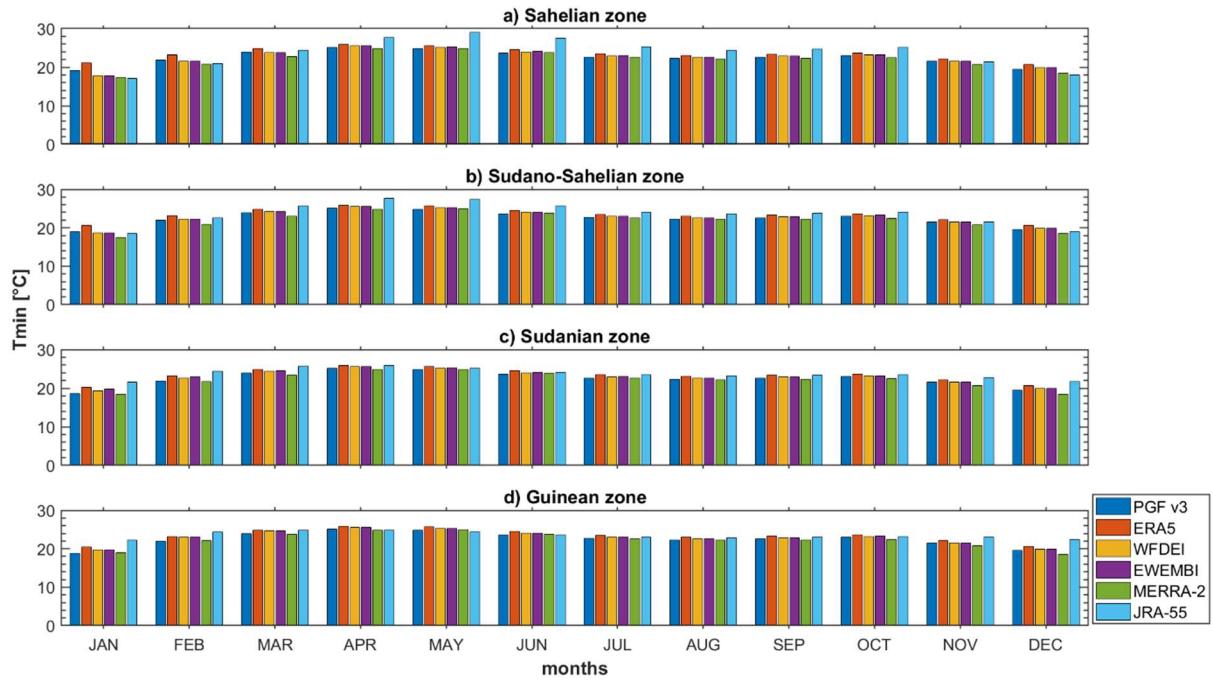
Figure S5. Climatology of mean monthly minimum air temperature over the period 2003-2012, averaged over four climatic zones (a, b, c and d). The colored bars represent 6 temperature datasets.
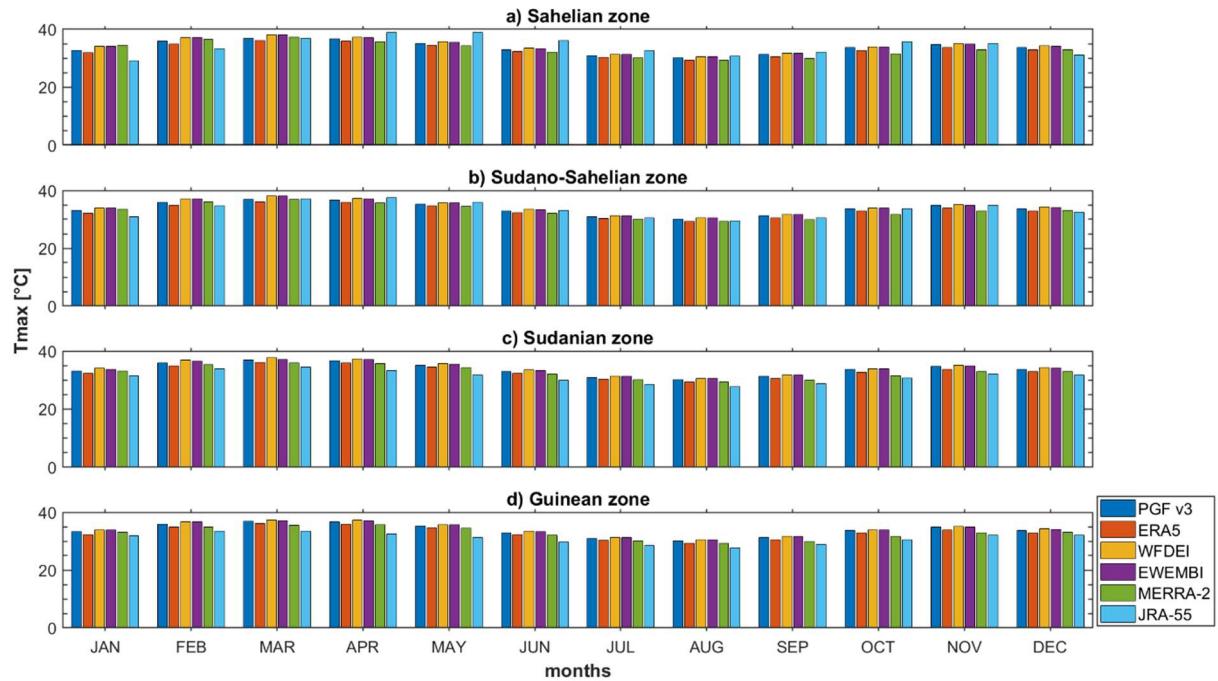

Figure S6. Climatology of mean monthly maximum air temperature over the period 2003-2012, averaged over four climatic zones (a, b, c and d). The colored bars represent 6 temperature datasets.

4 Ranking of rainfall and temperature datasets

		Top 5 rainfall datasets for a given temperature dataset				
		1	**2**	**3**	**4**	**5**
		Temporal dynamics of Q				
	JRA-55	TAMSAT	GSMaP-std	CHIRPS	MERRA-2	CMORPH-CRT
	MERRA-2	TAMSAT	GSMaP-std	PERSIANN-CDR	CHIRPS	CMORPH-CRT
	EWEMBI	TAMSAT	GSMaP-std	CHIRPS	MERRA-2	ARC
	WFDEI	TAMSAT	GSMaP-std	CHIRPS	MERRA-2	ARC
	ERA5	CHIRPS	TAMSAT	CMORPH-CRT	GSMaP-std	ARC
	PGF v3	TAMSAT	GSMaP-std	PERSIANN-CDR	CHIRPS	MERRA-2
		Temporal dynamics of St				
	JRA-55	CMORPH-CRT	ARC	RFE	TAMSAT	CHIRPS
	MERRA-2	ARC	RFE	TRMM 3B42-RT	WFDEI-CRU	CHIRPS
	EWEMBI	ARC	CHIRPS	TRMM 3B42-RT	GSMaP-std	ERA5
	WFDEI	ARC	CHIRPS	TRMM 3B42-RT	GSMaP-std	ERA5
	ERA5	ARC	RFE	CMORPH-CRT	TAMSAT	TRMM 3B42-RT
	PGF v3	CMORPH-CRT	RFE	ARC	CHIRPS	TAMSAT
		Temporal dynamics of Su				
	JRA-55	WFDEI-GPCC	EWEMBI	MERRA-2	PGF	TAMSAT
	MERRA-2	MERRA-2	WFDEI-GPCC	EWEMBI	PERSIANN-CDR	ERA5
	EWEMBI	WFDEI-CRU	PGF	PERSIANN-CDR	MERRA-2	GSMaP-std
	WFDEI	WFDEI-CRU	PGF	PERSIANN-CDR	MERRA-2	GSMaP-std
	ERA5	WFDEI-GPCC	EWEMBI	MERRA-2	PGF	ERA5
	PGF v3	WFDEI-GPCC	EWEMBI	WFDEI-CRU	MERRA-2	TAMSAT
		Temporal dynamics of Ea				
	JRA-55	ARC	RFE	TAMSAT	WFDEI-GPCC	EWEMBI
	MERRA-2	ARC	CMORPH-CRT	RFE	WFDEI-GPCC	EWEMBI
	EWEMBI	RFE	GSMaP-std	ARC	TAMSAT	PERSIANN-CDR
	WFDEI	RFE	GSMaP-std	ARC	TAMSAT	PERSIANN-CDR
	ERA5	ARC	RFE	WFDEI-GPCC	EWEMBI	GSMaP-std
	PGF v3	TAMSAT	WFDEI-GPCC	EWEMBI	WFDEI-CRU	ARC
		Spatial patterns of Su				
	JRA-55	WFDEI-GPCC	EWEMBI	TAMSAT	MSWEP	RFE
	MERRA-2	MSWEP	PGF	ARC	WFDEI-CRU	WFDEI-GPCC
	EWEMBI	TAMSAT	PERSIANN-CDR	MSWEP	WFDEI-GPCC	EWEMBI
	WFDEI	TAMSAT	PERSIANN-CDR	MSWEP	WFDEI-GPCC	EWEMBI
	ERA5	MSWEP	RFE	WFDEI-GPCC	EWEMBI	WFDEI-CRU
	PGF v3	RFE	TAMSAT	MSWEP	ARC	MERRA-2
		Spatial patterns of Ea				
	JRA-55	TAMSAT	WFDEI-GPCC	EWEMBI	MSWEP	MERRA-2
	MERRA-2	MSWEP	CHIRPS	MERRA-2	WFDEI-CRU	PGF
	EWEMBI	PERSIANN-CDR	TAMSAT	MSWEP	WFDEI-GPCC	EWEMBI
	WFDEI	PERSIANN-CDR	TAMSAT	MSWEP	WFDEI-GPCC	EWEMBI
	ERA5	MSWEP	MERRA-2	WFDEI-GPCC	EWEMBI	PERSIANN-CDR
	PGF v3	MSWEP	CHIRPS	TAMSAT	MERRA-2	PERSIANN-CDR

(Leftmost vertical label: **Temperature datasets**)

Figure S7. Best rainfall-temperature dataset combinations for simulating the spatial patterns and the temporal dynamics of streamflow (Q), terrestrial water storage (S_t), soil moisture (S_u) and actual evaporation (E_a) in the Volta River basin.

5 Model performance for streamflow

5.1 Ranking of rainfall and temperature datasets

5.1.1 Combined calibration and evaluation periods

Table S1. Ranking of rainfall and temperature datasets based on median Kling-Gupta efficiency (E_{KG}) of streamflow (Q) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Kling-Gupta Efficiency of Q	Temperature datasets						Statistics across temperature			
Simulation period 2003-2012	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V_2 (%)	Rank - on mean	Rank - on V_2
TAMSAT v3.0	0.727	0.771	0.719	0.719	0.718	0.730	0.73	2.81	1	16
CHIRPS v2.0	0.696	0.700	0.708	0.708	0.726	0.683	0.70	2.03	3	8
ARC v2.0	0.677	0.656	0.686	0.686	0.698	0.679	0.68	2.04	7	9
RFE v2.0	0.635	0.624	0.658	0.658	0.663	0.641	0.65	2.43	11	13
MSWEP v2.2	0.661	0.666	0.653	0.653	0.640	0.661	0.66	1.39	10	3
GSMaP-std v6	0.717	0.715	0.708	0.708	0.717	0.714	0.71	0.54	2	1
PERSIANN-CDR v1r1	0.678	0.704	0.667	0.667	0.683	0.689	0.68	2.08	6	10
CMORPH-CRT v1.0	0.683	0.695	0.684	0.684	0.717	0.673	0.69	2.21	4	11
TRMM 3B42 v7	0.524	0.563	0.543	0.543	0.524	0.535	0.54	2.73	16	15
TRMM 3B42-RT v7	0.543	0.542	0.544	0.544	0.521	0.545	0.54	1.72	15	4
PGF v3	0.664	0.686	0.652	0.652	0.664	0.650	0.66	2.02	9	7
ERA5	0.604	0.643	0.641	0.641	0.620	0.617	0.63	2.62	14	14
WFDEI-GPCC	0.642	0.659	0.631	0.631	0.634	0.629	0.64	1.76	12	5
WFDEI-CRU	0.656	0.692	0.652	0.652	0.674	0.669	0.67	2.40	8	12
EWEMBI v1.1	0.642	0.659	0.631	0.631	0.634	0.629	0.64	1.76	12	5
MERRA-2	0.692	0.687	0.688	0.688	0.667	0.683	0.68	1.30	5	2
JRA-55	0.439	0.487	0.443	0.443	0.451	0.457	0.45	3.87	17	17
Mean	0.64	0.66	0.64	0.64	0.64	0.64				
V_2 (%)	11.6	10.5	11.0	11.0	12.0	10.8				
Rank - on mean	6	1	4	3	2	5				
Rank - on V_2	5	1	4	3	6	2				

Table S2. Ranking of rainfall and temperature datasets based on median Pearson correlation coefficient (r) of streamflow (Q) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Correlation of Q	Temperature datasets						Statistics across temperature			
Simulation period 2003-2012	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V_2 (%)	Rank - on mean	Rank - on V_2
TAMSAT v3.0	0.907	0.904	0.907	0.907	0.898	0.906	0.90	0.40	4	10
CHIRPS v2.0	0.912	0.906	0.909	0.909	0.913	0.913	0.91	0.33	1	6
ARC v2.0	0.908	0.907	0.910	0.910	0.911	0.910	0.91	0.18	2	2
RFE v2.0	0.906	0.901	0.911	0.911	0.902	0.903	0.91	0.48	3	15
MSWEP v2.2	0.889	0.883	0.893	0.893	0.889	0.893	0.89	0.46	11	14
GSMaP-std v6	0.898	0.900	0.898	0.898	0.900	0.898	0.90	0.12	8	1
PERSIANN-CDR v1r1	0.906	0.899	0.902	0.902	0.906	0.903	0.90	0.32	5	4
CMORPH-CRT v1.0	0.890	0.896	0.908	0.908	0.903	0.887	0.90	1.00	7	17
TRMM 3B42 v7	0.883	0.888	0.893	0.893	0.886	0.891	0.89	0.46	14	13
TRMM 3B42-RT v7	0.892	0.891	0.893	0.893	0.886	0.890	0.89	0.32	10	5
PGF v3	0.895	0.901	0.897	0.897	0.897	0.892	0.90	0.34	9	7
ERA5	0.844	0.851	0.846	0.846	0.848	0.842	0.85	0.36	17	8
WFDEI-GPCC	0.887	0.887	0.894	0.894	0.891	0.886	0.89	0.42	12	11
WFDEI-CRU	0.870	0.885	0.871	0.871	0.878	0.885	0.88	0.82	15	16
EWEMBI v1.1	0.887	0.887	0.894	0.894	0.891	0.886	0.89	0.42	12	11
MERRA-2	0.900	0.895	0.901	0.901	0.897	0.901	0.90	0.27	6	3
JRA-55	0.855	0.862	0.856	0.856	0.856	0.862	0.86	0.40	16	9
Mean	0.89	0.89	0.89	0.89	0.89	0.89				
V_2 (%)	2.1	1.7	2.1	2.1	2.0	2.0				
Rank - on mean	6	5	2	1	3	4				
Rank - on V_2	6	1	4	5	3	2				

Table S3. Ranking of rainfall and temperature datasets based on median bias (β) of streamflow (Q) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Bias of Q		Temperature datasets						Statistics across temperature			
Simulation period 2003-2012		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.865	0.911	0.846	0.846	0.880	0.855	0.87	2.86	7	13
	CHIRPS v2.0	0.829	0.847	0.837	0.837	0.849	0.829	0.84	1.03	8	3
	ARC v2.0	0.979	0.987	0.982	0.982	1.012	0.988	0.99	1.22	2	7
	RFE v2.0	1.006	1.051	0.976	0.976	0.980	1.007	1.00	2.91	1	14
	MSWEP v2.2	0.829	0.822	0.829	0.829	0.832	0.838	0.83	0.65	9	1
	GSMaP-std v6	0.926	0.949	0.910	0.910	0.931	0.918	0.92	1.60	4	8
	PERSIANN-CDR v1r1	0.812	0.867	0.814	0.814	0.825	0.824	0.83	2.52	10	11
	CMORPH-CRT v1.0	0.931	0.950	0.936	0.936	0.918	0.928	0.93	1.12	3	6
	TRMM 3B42 v7	0.651	0.654	0.673	0.673	0.630	0.664	0.66	2.48	16	10
	TRMM 3B42-RT v7	0.701	0.743	0.701	0.701	0.646	0.706	0.70	4.43	15	16
	PGF v3	0.799	0.846	0.825	0.825	0.784	0.825	0.82	2.67	11	12
	ERA5	0.905	0.817	0.910	0.910	0.767	0.911	0.87	7.16	6	17
	WFDEI-GPCC	0.790	0.787	0.785	0.785	0.780	0.766	0.78	1.10	13	4
	WFDEI-CRU	0.886	0.898	0.873	0.873	0.852	0.871	0.88	1.75	5	9
	EWEMBI v1.1	0.790	0.787	0.785	0.785	0.780	0.766	0.78	1.10	13	4
	MERRA-2	0.812	0.820	0.800	0.800	0.803	0.805	0.81	0.96	12	2
	JRA-55	0.510	0.556	0.527	0.527	0.508	0.526	0.53	3.26	17	15
Statistics across rainfall	Mean	0.82	0.84	0.82	0.82	0.81	0.82				
	V2 (%)	14.6	14.1	13.7	13.7	15.5	14.3				
	Rank - on mean	3	1	5	4	6	2				
	Rank - on V2	5	3	1	2	6	4				

Table S4. Ranking of rainfall and temperature datasets based on median variability (γ) of streamflow (Q) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Variability of Q		Temperature datasets						Statistics across temperature			
Simulation period 2003-2012		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.953	0.963	0.970	0.970	0.911	0.968	0.96	2.40	11	15
	CHIRPS v2.0	0.989	0.984	0.998	0.998	0.959	0.977	0.98	1.50	2	9
	ARC v2.0	0.987	0.996	0.994	0.994	1.015	0.997	1.00	0.94	1	4
	RFE v2.0	0.964	0.964	0.953	0.953	0.969	0.981	0.96	1.08	10	5
	MSWEP v2.2	0.910	0.916	0.899	0.899	0.897	0.907	0.90	0.83	14	2
	GSMaP-std v6	0.962	0.993	0.987	0.987	0.976	0.979	0.98	1.11	4	6
	PERSIANN-CDR v1r1	0.979	0.927	0.982	0.982	0.963	0.963	0.97	2.19	9	13
	CMORPH-CRT v1.0	0.934	0.910	0.879	0.879	0.922	0.918	0.91	2.54	13	17
	TRMM 3B42 v7	0.836	0.845	0.803	0.803	0.836	0.802	0.82	2.44	17	16
	TRMM 3B42-RT v7	0.848	0.842	0.825	0.825	0.841	0.826	0.83	1.25	16	7
	PGF v3	0.984	0.984	0.973	0.973	0.997	0.979	0.98	0.91	3	3
	ERA5	0.971	0.995	0.946	0.946	0.995	0.984	0.97	2.30	8	14
	WFDEI-GPCC	0.995	0.995	0.954	0.954	0.984	0.984	0.98	1.95	6	10
	WFDEI-CRU	0.986	0.981	0.973	0.973	0.998	0.960	0.98	1.32	5	8
	EWEMBI v1.1	0.995	0.995	0.954	0.954	0.984	0.984	0.98	1.95	6	10
	MERRA-2	0.949	0.948	0.950	0.950	0.960	0.959	0.95	0.57	12	1
	JRA-55	0.872	0.849	0.845	0.845	0.867	0.888	0.86	2.03	15	12
Statistics across rainfall	Mean	0.95	0.95	0.93	0.93	0.95	0.94				
	V2 (%)	5.4	5.9	6.5	6.5	6.0	6.1				
	Rank - on mean	1	2	5	6	3	4				
	Rank - on V2	1	2	5	6	3	4				

5.1.2 Separated calibration and evaluation periods

Table S5. Ranking of rainfall and temperature datasets based on mean Kling-Gupta efficiency (E_{KG}) of streamflow (Q) over the calibration period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Kling-Gupta Efficiency of Q	Temperature datasets						Statistics across temperature			
Calibration period 2003-2008	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
TAMSAT v3.0	0.702	0.728	0.704	0.704	0.701	0.708	0.71	1.43	1	16
CHIRPS v2.0	0.660	0.674	0.672	0.672	0.674	0.666	0.67	0.83	5	7
ARC v2.0	0.694	0.698	0.695	0.695	0.705	0.698	0.70	0.61	2	4
RFE v2.0	0.672	0.666	0.657	0.657	0.678	0.666	0.67	1.27	6	15
MSWEP v2.2	0.626	0.623	0.622	0.622	0.621	0.627	0.62	0.38	11	2
GSMaP-std v6	0.667	0.681	0.678	0.678	0.677	0.676	0.68	0.71	3	5
PERSIANN-CDR v1r1	0.673	0.672	0.671	0.671	0.669	0.670	0.67	0.22	4	1
CMORPH-CRT v1.0	0.668	0.678	0.653	0.653	0.665	0.668	0.66	1.43	7	17
TRMM 3B42 v7	0.525	0.537	0.538	0.538	0.530	0.532	0.53	1.04	17	12
TRMM 3B42-RT v7	0.532	0.546	0.533	0.533	0.529	0.530	0.53	1.17	16	14
PGF v3	0.640	0.660	0.650	0.650	0.644	0.648	0.65	1.04	10	13
ERA5	0.574	0.582	0.578	0.578	0.571	0.570	0.58	0.79	14	6
WFDEI-GPCC	0.599	0.612	0.607	0.607	0.608	0.600	0.61	0.84	12	8
WFDEI-CRU	0.649	0.661	0.647	0.647	0.658	0.652	0.65	0.90	8	11
EWEMBI v1.1	0.599	0.612	0.607	0.607	0.608	0.600	0.61	0.84	12	8
MERRA-2	0.652	0.658	0.652	0.652	0.649	0.647	0.65	0.57	9	3
JRA-55	0.552	0.558	0.554	0.554	0.557	0.566	0.56	0.89	15	10
Mean	0.63	0.64	0.63	0.63	0.63	0.63				
V2 (%)	8.8	8.7	8.4	8.4	8.9	8.7				
Rank - on mean	6	1	5	4	2	3				
Rank - on V2	5	3	2	1	6	4				

Table S6. Ranking of rainfall and temperature datasets based on mean Kling-Gupta efficiency (E_{KG}) of streamflow (Q) over the evaluation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Kling-Gupta Efficiency of Q	Temperature datasets						Statistics across temperature			
Evaluation period 2008-2012	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
TAMSAT v3.0	0.674	0.726	0.676	0.676	0.667	0.683	0.68	3.11	1	14
CHIRPS v2.0	0.666	0.646	0.658	0.658	0.672	0.652	0.66	1.40	3	9
ARC v2.0	0.641	0.620	0.653	0.653	0.659	0.647	0.65	2.18	6	13
RFE v2.0	0.575	0.537	0.645	0.645	0.629	0.597	0.60	7.13	14	17
MSWEP v2.2	0.653	0.652	0.644	0.644	0.637	0.650	0.65	0.95	5	6
GSMaP-std v6	0.675	0.671	0.680	0.680	0.684	0.681	0.68	0.68	2	2
PERSIANN-CDR v1r1	0.634	0.652	0.627	0.627	0.624	0.634	0.63	1.62	11	12
CMORPH-CRT v1.0	0.644	0.650	0.647	0.647	0.670	0.650	0.65	1.43	4	10
TRMM 3B42 v7	0.497	0.534	0.514	0.514	0.486	0.505	0.51	3.23	16	15
TRMM 3B42-RT v7	0.529	0.542	0.532	0.532	0.525	0.531	0.53	1.05	15	7
PGF v3	0.633	0.646	0.635	0.635	0.635	0.634	0.64	0.74	9	3
ERA5	0.616	0.640	0.625	0.625	0.627	0.613	0.62	1.50	13	11
WFDEI-GPCC	0.636	0.647	0.645	0.645	0.635	0.635	0.64	0.87	7	4
WFDEI-CRU	0.634	0.631	0.640	0.640	0.639	0.633	0.64	0.64	10	1
EWEMBI v1.1	0.636	0.647	0.645	0.645	0.635	0.635	0.64	0.87	7	4
MERRA-2	0.629	0.634	0.630	0.630	0.615	0.634	0.63	1.12	12	8
JRA-55	0.343	0.383	0.347	0.347	0.351	0.355	0.35	4.05	17	16
Mean	0.61	0.62	0.61	0.61	0.61	0.61				
V2 (%)	13.6	12.5	13.1	13.1	13.6	13.0				
Rank - on mean	6	1	3	2	4	5				
Rank - on V2	5	1	4	3	6	2				

Table S7. Ranking of rainfall and temperature datasets based on mean Pearson correlation coefficient (*r*) of streamflow (*Q*) over the calibration period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Correlation of Q	Temperature datasets						Statistics across temperature			
Calibration period 2003-2008	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V_2 (%)	Rank - on mean	Rank - on V_2
TAMSAT v3.0	0.904	0.900	0.902	0.902	0.892	0.903	0.90	0.46	4	12
CHIRPS v2.0	0.911	0.913	0.910	0.910	0.914	0.913	0.91	0.22	1	4
ARC v2.0	0.905	0.906	0.904	0.904	0.902	0.904	0.90	0.12	2	1
RFE v2.0	0.898	0.895	0.901	0.901	0.901	0.896	0.90	0.33	5	9
MSWEP v2.2	0.891	0.887	0.894	0.894	0.892	0.892	0.89	0.30	6	7
GSMaP-std v6	0.886	0.885	0.888	0.888	0.892	0.887	0.89	0.27	10	6
PERSIANN-CDR v1r1	0.905	0.894	0.904	0.904	0.903	0.904	0.90	0.46	3	11
CMORPH-CRT v1.0	0.886	0.891	0.894	0.894	0.892	0.888	0.89	0.35	9	10
TRMM 3B42 v7	0.866	0.871	0.878	0.878	0.876	0.874	0.87	0.54	14	16
TRMM 3B42-RT v7	0.869	0.874	0.875	0.875	0.873	0.873	0.87	0.26	15	5
PGF v3	0.887	0.885	0.885	0.885	0.887	0.882	0.89	0.19	12	3
ERA5	0.864	0.859	0.866	0.866	0.855	0.863	0.86	0.52	16	15
WFDEI-GPCC	0.888	0.888	0.896	0.896	0.894	0.886	0.89	0.51	7	13
WFDEI-CRU	0.870	0.879	0.869	0.869	0.879	0.882	0.87	0.68	13	17
EWEMBI v1.1	0.888	0.888	0.896	0.896	0.894	0.886	0.89	0.51	7	13
MERRA-2	0.888	0.886	0.888	0.888	0.887	0.883	0.89	0.19	11	2
JRA-55	0.838	0.839	0.839	0.839	0.834	0.842	0.84	0.32	17	8
Mean	0.88	0.88	0.89	0.89	0.89	0.89				
V_2 (%)	2.1	2.0	2.0	2.0	2.2	1.9				
Rank - on mean	5	6	2	1	3	4				
Rank - on V_2	5	2	3	4	6	1				

Table S8. Ranking of rainfall and temperature datasets based on mean Pearson correlation coefficient (*r*) of streamflow (*Q*) over the evaluation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Correlation of Q	Temperature datasets						Statistics across temperature			
Evaluation period 2008-2012	JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V_2 (%)	Rank - on mean	Rank - on V_2
TAMSAT v3.0	0.896	0.900	0.895	0.895	0.891	0.896	0.90	0.31	1	9
CHIRPS v2.0	0.893	0.892	0.889	0.889	0.894	0.893	0.89	0.27	2	7
ARC v2.0	0.881	0.880	0.877	0.877	0.872	0.877	0.88	0.36	10	11
RFE v2.0	0.880	0.876	0.884	0.884	0.881	0.879	0.88	0.34	9	10
MSWEP v2.2	0.885	0.879	0.885	0.885	0.883	0.887	0.88	0.29	7	8
GSMaP-std v6	0.883	0.880	0.880	0.880	0.886	0.884	0.88	0.26	8	6
PERSIANN-CDR v1r1	0.889	0.890	0.887	0.887	0.888	0.890	0.89	0.14	3	1
CMORPH-CRT v1.0	0.880	0.887	0.887	0.887	0.889	0.883	0.89	0.37	4	12
TRMM 3B42 v7	0.880	0.881	0.890	0.890	0.888	0.885	0.89	0.48	5	14
TRMM 3B42-RT v7	0.872	0.876	0.877	0.877	0.873	0.875	0.87	0.24	11	4
PGF v3	0.870	0.868	0.865	0.865	0.868	0.866	0.87	0.22	12	3
ERA5	0.800	0.811	0.800	0.800	0.807	0.794	0.80	0.73	17	17
WFDEI-GPCC	0.862	0.864	0.872	0.872	0.868	0.862	0.87	0.54	13	15
WFDEI-CRU	0.855	0.862	0.857	0.857	0.860	0.864	0.86	0.41	15	13
EWEMBI v1.1	0.862	0.864	0.872	0.872	0.868	0.862	0.87	0.54	13	15
MERRA-2	0.887	0.885	0.885	0.885	0.885	0.882	0.88	0.18	6	2
JRA-55	0.841	0.840	0.840	0.840	0.842	0.846	0.84	0.26	16	5
Mean	0.87	0.87	0.87	0.87	0.87	0.87				
V_2 (%)	2.7	2.4	2.6	2.6	2.5	2.8				
Rank - on mean	6	4	2	3	1	5				
Rank - on V_2	5	1	4	3	2	6				

Table S9. Ranking of rainfall and temperature datasets based on mean bias (β) of streamflow (Q) over the calibration period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Bias of Q		Temperature datasets						Statistics across temperature			
Calibration period 2003-2008		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.869	0.895	0.869	0.869	0.906	0.878	0.88	1.77	1	15
	CHIRPS v2.0	0.820	0.843	0.828	0.828	0.840	0.840	0.83	1.12	10	11
	ARC v2.0	0.884	0.879	0.878	0.878	0.879	0.879	0.88	0.26	2	1
	RFE v2.0	0.872	0.881	0.871	0.871	0.870	0.869	0.87	0.49	5	3
	MSWEP v2.2	0.831	0.821	0.829	0.829	0.835	0.832	0.83	0.57	11	5
	GSMaP-std v6	0.881	0.885	0.870	0.870	0.887	0.876	0.88	0.81	3	8
	PERSIANN-CDR v1r1	0.859	0.857	0.856	0.856	0.855	0.864	0.86	0.38	6	2
	CMORPH-CRT v1.0	0.874	0.881	0.886	0.886	0.868	0.872	0.88	0.85	4	9
	TRMM 3B42 v7	0.747	0.755	0.781	0.782	0.741	0.768	0.76	2.27	16	17
	TRMM 3B42-RT v7	0.815	0.794	0.824	0.824	0.791	0.822	0.81	1.87	12	16
	PGF v3	0.832	0.845	0.846	0.846	0.820	0.846	0.84	1.29	8	12
	ERA5	0.764	0.762	0.779	0.779	0.755	0.762	0.77	1.30	15	13
	WFDEI-GPCC	0.795	0.804	0.807	0.807	0.801	0.792	0.80	0.76	13	6
	WFDEI-CRU	0.850	0.852	0.852	0.852	0.841	0.853	0.85	0.53	7	4
	EWEMBI v1.1	0.795	0.804	0.807	0.807	0.801	0.792	0.80	0.76	13	6
	MERRA-2	0.837	0.839	0.831	0.831	0.855	0.823	0.84	1.33	9	14
	JRA-55	0.751	0.760	0.762	0.762	0.750	0.772	0.76	1.09	17	10
Statistics across rainfall	Mean	0.83	0.83	0.83	0.83	0.83	0.83				
	V2 (%)	5.4	5.5	4.5	4.4	6.0	4.9				
	Rank - on mean	6	3	2	1	5	4				
	Rank - on V2	4	5	2	1	6	3				

Table S10. Ranking of rainfall and temperature datasets based on mean bias (β) of streamflow (Q) over the evaluation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Bias of Q		Temperature datasets						Statistics across temperature			
Evaluation period 2008-2012		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.788	0.900	0.779	0.779	0.797	0.798	0.81	5.74	10	15
	CHIRPS v2.0	0.896	0.908	0.918	0.918	0.886	0.871	0.90	2.06	5	2
	ARC v2.0	1.054	1.105	1.020	1.020	0.995	1.040	1.04	3.66	1	8
	RFE v2.0	1.161	1.217	1.006	1.006	1.056	1.118	1.09	7.85	3	16
	MSWEP v2.2	0.754	0.774	0.740	0.740	0.727	0.749	0.75	2.14	14	3
	GSMaP-std v6	0.903	0.940	0.879	0.879	0.863	0.884	0.89	3.04	7	6
	PERSIANN-CDR v1r1	0.749	0.794	0.730	0.730	0.710	0.746	0.74	3.83	15	9
	CMORPH-CRT v1.0	0.961	0.987	0.907	0.907	0.862	0.951	0.93	4.88	2	14
	TRMM 3B42 v7	0.580	0.615	0.611	0.611	0.557	0.602	0.60	3.87	16	10
	TRMM 3B42-RT v7	0.801	0.852	0.782	0.782	0.754	0.787	0.79	4.12	11	12
	PGF v3	0.841	0.897	0.834	0.834	0.791	0.845	0.84	4.02	9	11
	ERA5	0.984	0.827	0.938	0.938	0.779	0.966	0.91	9.10	4	17
	WFDEI-GPCC	0.781	0.816	0.777	0.777	0.752	0.769	0.78	2.69	12	4
	WFDEI-CRU	0.909	0.947	0.887	0.887	0.865	0.891	0.90	3.14	6	7
	EWEMBI v1.1	0.781	0.816	0.777	0.777	0.752	0.769	0.78	2.69	12	4
	MERRA-2	0.896	0.915	0.871	0.871	0.875	0.882	0.89	1.94	8	1
	JRA-55	0.409	0.458	0.419	0.419	0.415	0.415	0.42	4.18	17	13
Statistics across rainfall	Mean	0.84	0.87	0.82	0.82	0.79	0.83				
	V2 (%)	20.2	19.2	17.6	17.6	18.5	19.2				
	Rank - on mean	2	1	5	4	6	3				
	Rank - on V2	6	5	2	1	3	4				

Table S11. Ranking of rainfall and temperature datasets based on mean variability (γ) of streamflow (Q) over the calibration period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Variability of Q		Temperature datasets						Statistics across temperature			
Calibration period 2003-2008		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.969	0.995	0.987	0.987	0.918	0.983	0.97	2.91	6	16
	CHIRPS v2.0	0.992	0.988	0.991	0.991	0.944	0.995	0.98	1.96	3	13
	ARC v2.0	0.950	0.968	0.971	0.971	0.983	0.971	0.97	1.12	10	4
	RFE v2.0	0.969	0.984	0.970	0.970	0.968	0.994	0.98	1.07	4	2
	MSWEP v2.2	0.935	0.954	0.924	0.924	0.924	0.932	0.93	1.26	15	6
	GSMaP-std v6	0.927	0.957	0.967	0.967	0.932	0.954	0.95	1.79	12	10
	PERSIANN-CDR v1r1	0.983	0.943	0.987	0.987	0.965	0.972	0.97	1.77	7	9
	CMORPH-CRT v1.0	0.964	0.940	0.915	0.915	0.951	0.951	0.94	2.17	13	14
	TRMM 3B42 v7	0.893	0.898	0.849	0.849	0.889	0.853	0.87	2.74	17	15
	TRMM 3B42-RT v7	0.920	0.917	0.901	0.901	0.920	0.898	0.91	1.15	16	5
	PGF v3	0.960	0.977	0.970	0.970	0.991	0.983	0.98	1.11	5	3
	ERA5	0.953	0.990	0.924	0.924	0.986	0.945	0.95	3.02	11	17
	WFDEI-GPCC	0.988	0.984	0.948	0.948	0.972	0.983	0.97	1.90	8	11
	WFDEI-CRU	0.995	0.982	0.988	0.988	0.997	0.955	0.98	1.55	2	7
	EWEMBI v1.1	0.988	0.984	0.948	0.948	0.972	0.983	0.97	1.90	8	11
	MERRA-2	0.980	0.977	0.987	0.987	0.986	0.994	0.99	0.61	1	1
	JRA-55	0.937	0.922	0.917	0.917	0.942	0.958	0.93	1.77	14	8
Statistics across rainfall	Mean	0.96	0.96	0.95	0.95	0.96	0.96				
	V2 (%)	3.0	3.0	4.2	4.2	3.2	3.9				
	Rank - on mean	2	1	5	6	4	3				
	Rank - on V2	1	2	6	5	3	4				

Table S12. Ranking of rainfall and temperature datasets based on mean variability (γ) of streamflow (Q) over the evaluation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for the Volta River basin (VRB)

Variability of Q		Temperature datasets						Statistics across temperature			
Evaluation period 2008-2012		JRA-55	MERRA-2	EWEMBI	WFDEI	ERA5	PGF v3	Mean	V2 (%)	Rank - on mean	Rank - on V2
Rainfall datasets	TAMSAT v3.0	0.896	0.920	0.912	0.912	0.859	0.907	0.90	2.46	14	16
	CHIRPS v2.0	0.985	0.993	0.986	0.986	0.954	0.990	0.98	1.45	4	8
	ARC v2.0	0.970	0.975	0.975	0.975	1.006	0.979	0.98	1.32	5	5
	RFE v2.0	0.940	0.940	0.935	0.935	0.952	0.952	0.94	0.86	10	2
	MSWEP v2.2	0.943	0.958	0.928	0.928	0.943	0.939	0.94	1.21	12	3
	GSMaP-std v6	0.949	0.973	0.979	0.979	0.961	0.969	0.97	1.22	7	4
	PERSIANN-CDR v1r1	0.970	0.917	0.974	0.974	0.958	0.957	0.96	2.24	9	14
	CMORPH-CRT v1.0	0.942	0.922	0.892	0.892	0.936	0.929	0.92	2.38	13	15
	TRMM 3B42 v7	0.822	0.848	0.787	0.787	0.821	0.788	0.81	3.17	16	17
	TRMM 3B42-RT v7	0.838	0.833	0.814	0.814	0.838	0.816	0.83	1.46	15	9
	PGF v3	0.971	0.980	0.964	0.964	0.998	0.968	0.97	1.34	6	6
	ERA5	0.964	0.986	0.941	0.941	0.987	0.968	0.96	2.11	8	13
	WFDEI-GPCC	1.008	1.002	0.966	0.966	0.998	0.998	0.99	1.87	2	10
	WFDEI-CRU	1.004	1.010	0.999	0.999	1.026	0.985	1.00	1.37	1	7
	EWEMBI v1.1	1.008	1.002	0.966	0.966	0.998	0.998	0.99	1.87	2	10
	MERRA-2	0.935	0.937	0.939	0.939	0.957	0.943	0.94	0.83	11	1
	JRA-55	0.796	0.783	0.779	0.779	0.804	0.819	0.79	2.01	17	12
Statistics across rainfall	Mean	0.94	0.94	0.93	0.93	0.94	0.94				
	V2 (%)	6.8	6.9	7.4	7.4	7.3	7.0				
	Rank - on mean	3	2	6	5	1	4				
	Rank - on V2	1	2	6	5	4	3				

5.2 Boxplots and range plots

### 5.2.1 Combined calibration and evaluation periods
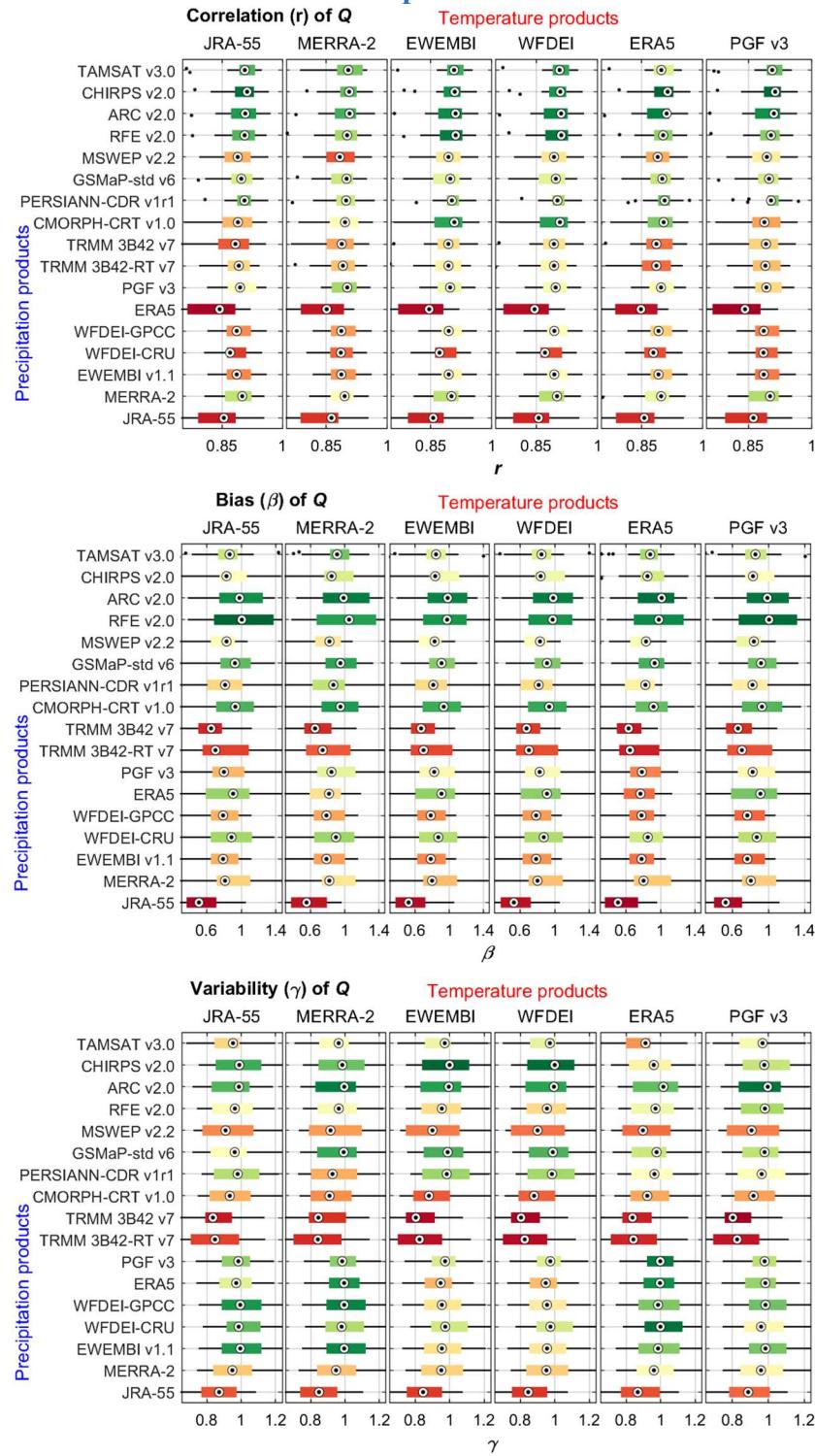
Figure S8. Pearson correlation coefficient (*r*), bias (*β*) and variability (*γ*) of daily streamflow (Q) over the simulation period (2003-2012) using different combinations of precipitation and temperature datasets as inputs for hydrological modelling. Each boxplot has 22 values representing the combined performance of the calibration and evaluation periods for 11 streamflow stations. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

5.2.2 Separated calibration and evaluation periods
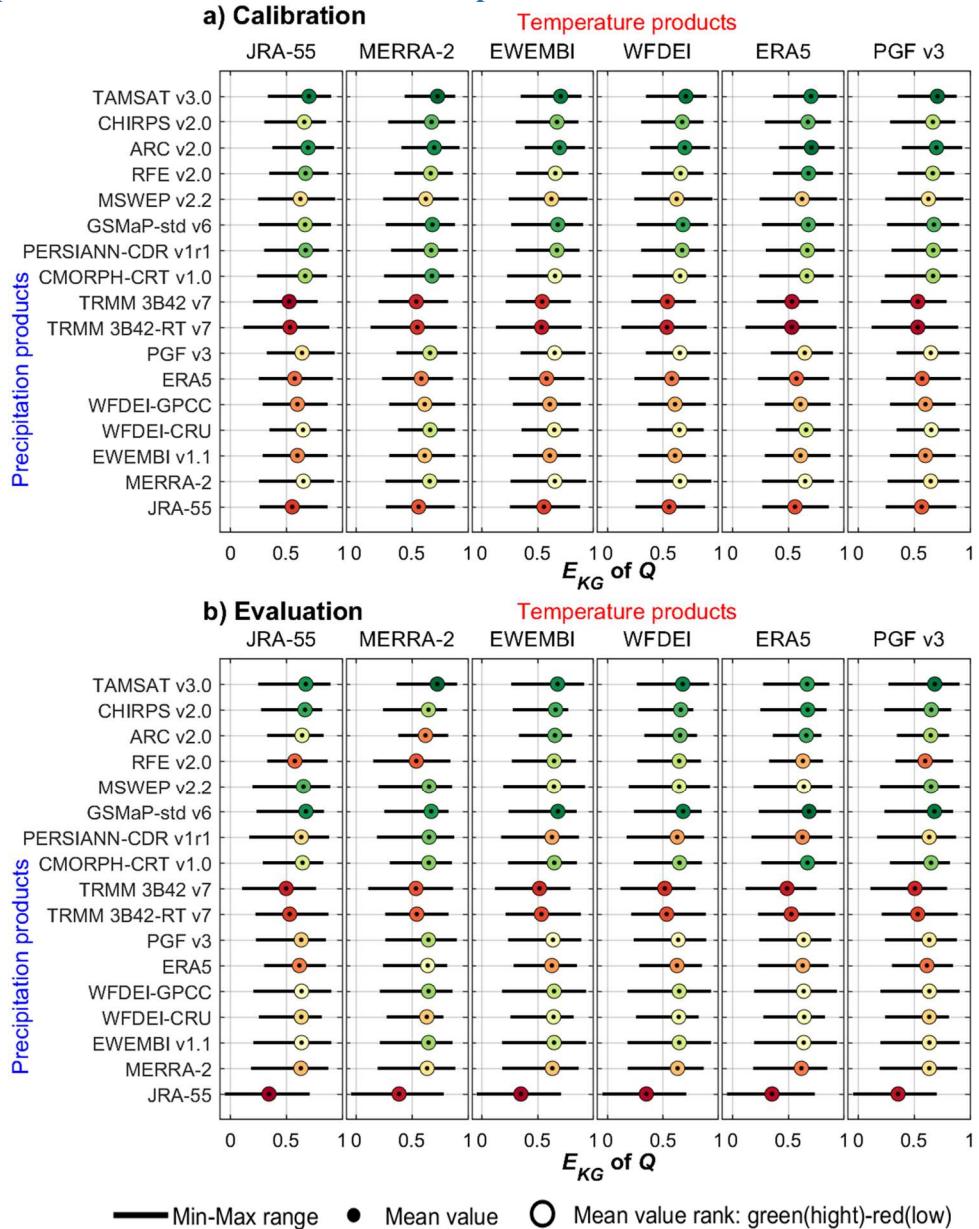
Figure S9. Kling-Gupta efficiency (E_{KG}) of daily streamflow (Q) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature datasets as inputs for hydrological modelling. The dots give the mean score and the bars represent the min-max range of values for 11 streamflow gauges. The mean values are colored from the best (green) to the worst performance (red).
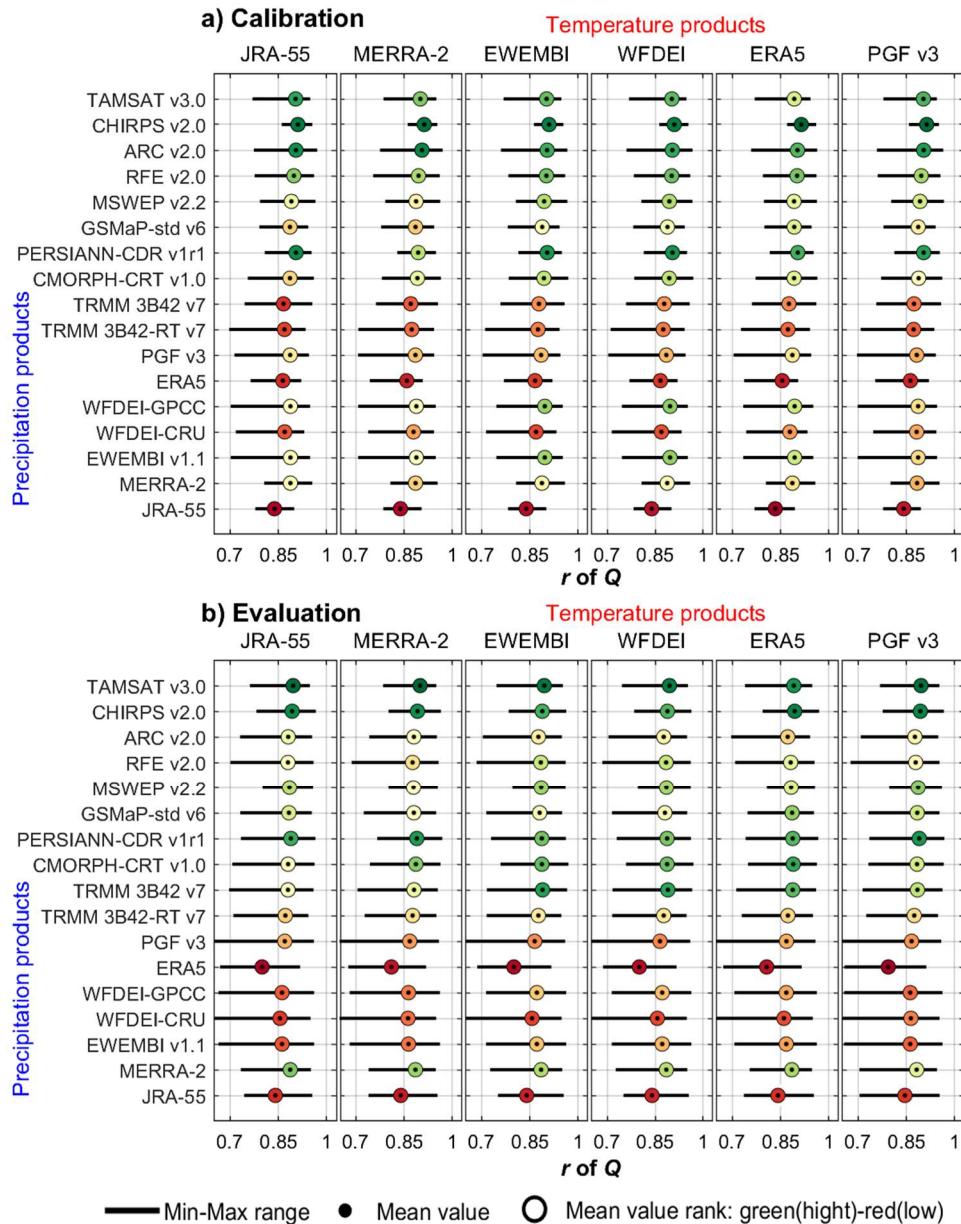
Figure S10. Pearson correlation coefficient (*r*) of daily streamflow (*Q*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature datasets as inputs for hydrological modelling. The dots give the mean score and the bars represent the min-max range of values for 11 streamflow gauges. The mean values are colored from the best (green) to the worst performance (red).

Figure S11. Bias (β) of daily streamflow (Q) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature datasets as inputs for hydrological modelling. The dots give the mean score and the bars represent the min-max range of values for 11 streamflow gauges. The mean values are colored from the best (green) to the worst performance (red).

Figure S12. Variability (γ) of daily streamflow (*Q*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature datasets as inputs for hydrological modelling. The dots give the mean score and the bars represent the min-max range of values for 11 streamflow gauges. The mean values are colored from the best (green) to the worst performance (red).

Table S13. Ranking of rainfall and temperature datasets based on the Pearson correlation coefficient (r) of terrestrial water storage (St) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for four climatic zones in the Volta River basin (VRB)

Pearson's correlation coefficient of St / Simulation period 2003-2012	Mean Sahelian zone	Mean Sudano-Sahelian zone	Mean Sudanian zone	Mean Guinean zone	Mean VRB	V_2 (%) Sahelian zone	V_2 (%) Sudano-Sahelian zone	V_2 (%) Sudanian zone	V_2 (%) Guinean zone	V_2 (%) VRB	Rank - on mean Sahelian zone	Rank - on mean Sudano-Sahelian zone	Rank - on mean Sudanian zone	Rank - on mean Guinean zone	Rank - on mean VRB	Rank - on V_2 Sahelian zone	Rank - on V_2 Sudano-Sahelian zone	Rank - on V_2 Sudanian zone	Rank - on V_2 Guinean zone	Rank - on V_2 VRB
Rainfall datasets																				
TAMSAT v3.0	0.686	0.777	0.857	0.740	0.856	5.01	2.90	3.92	6.39	3.37	9	3	3	2	6	12	8	10	11	8
CHIRPS v2.0	0.671	0.740	0.824	0.715	0.863	7.38	2.14	2.60	3.55	1.49	12	7	8	5	4	14	4	5	6	3
ARC v2.0	0.732	0.799	0.918	0.667	0.910	1.74	2.14	1.34	1.85	1.30	1	1	1	8	1	2	3	3	1	1
RFE v2.0	0.709	0.780	0.890	0.648	0.882	3.88	3.14	4.66	3.82	4.56	4	2	2	10	2	8	9	11	7	11
MSWEP v2.2	0.579	0.681	0.728	0.490	0.719	3.07	2.80	3.63	6.71	3.54	15	14	16	16	16	6	6	9	12	9
GSMaP-std v6	0.718	0.756	0.845	0.656	0.842	3.29	2.65	1.33	3.33	1.63	3	5	5	9	7	7	5	2	4	4
PERSIANN-CDR v1r1	0.594	0.718	0.807	0.637	0.804	3.91	3.20	2.94	7.68	2.70	14	10	11	11	11	9	10	7	13	7
CMORPH-CRT v1.0	0.691	0.764	0.856	0.775	0.875	4.06	4.31	5.46	4.09	5.16	7	4	4	1	3	10	11	13	9	13
TRMM 3B42 v7	0.671	0.717	0.780	0.516	0.769	5.74	5.96	6.72	8.29	5.93	11	11	13	15	13	13	13	14	16	14
TRMM 3B42-RT v7	0.677	0.744	0.834	0.724	0.860	1.37	1.63	0.79	2.04	1.38	10	6	6	3	5	1	1	1	2	2
PGF v3	0.688	0.729	0.824	0.715	0.823	4.50	2.85	2.63	3.47	2.44	8	9	9	4	9	11	7	6	5	6
ERA5	0.574	0.704	0.814	0.691	0.823	11.55	7.68	3.12	2.08	4.18	16	13	10	7	10	17	15	8	3	10
WFDEI-GPCC	0.707	0.678	0.756	0.546	0.748	8.67	8.21	8.29	7.98	7.48	5	15	14	13	14	15	16	15	14	15
WFDEI-CRU	0.720	0.730	0.829	0.697	0.829	2.99	4.39	5.23	5.17	4.64	2	8	7	6	8	5	12	12	10	12
EWEMBI v1.1	0.707	0.678	0.756	0.546	0.748	8.67	8.21	8.29	7.98	7.48	5	15	14	13	14	15	16	15	14	15
MERRA-2	0.558	0.712	0.807	0.615	0.800	2.75	1.85	2.34	4.09	2.10	17	12	12	12	12	4	2	4	8	5
JRA-55	0.658	0.558	0.385	-0.185	0.377	2.55	7.48	30.03	25.54	20.23	13	17	17	17	17	3	14	17	17	17
Temperature datasets																				
JRA-55	0.682	0.733	0.817	0.609	0.811	9.85	6.47	8.86	31.60	11.08	1	2	1	2	1	4	1	1	1	1
MERRA-2	0.659	0.706	0.785	0.594	0.785	10.88	9.00	15.83	36.09	16.01	6	6	4	3	4	5	3	3	5	3
EWEMBI	0.663	0.713	0.776	0.593	0.781	8.52	9.52	16.98	34.65	16.68	4	4	6	5	6	3	6	6	4	6
WFDEI	0.663	0.713	0.776	0.593	0.781	8.52	9.52	16.83	34.60	16.63	5	5	5	4	5	2	5	5	3	5
ERA5	0.665	0.736	0.808	0.587	0.808	11.98	9.35	16.27	36.70	16.43	3	1	2	6	3	6	4	4	6	4
PGF v3	0.670	0.728	0.807	0.620	0.808	7.68	7.42	15.47	33.23	15.28	2	3	3	1	2	1	2	2	2	2

6.2 Boxplots

### 6.2.1 Combined calibration and evaluation periods
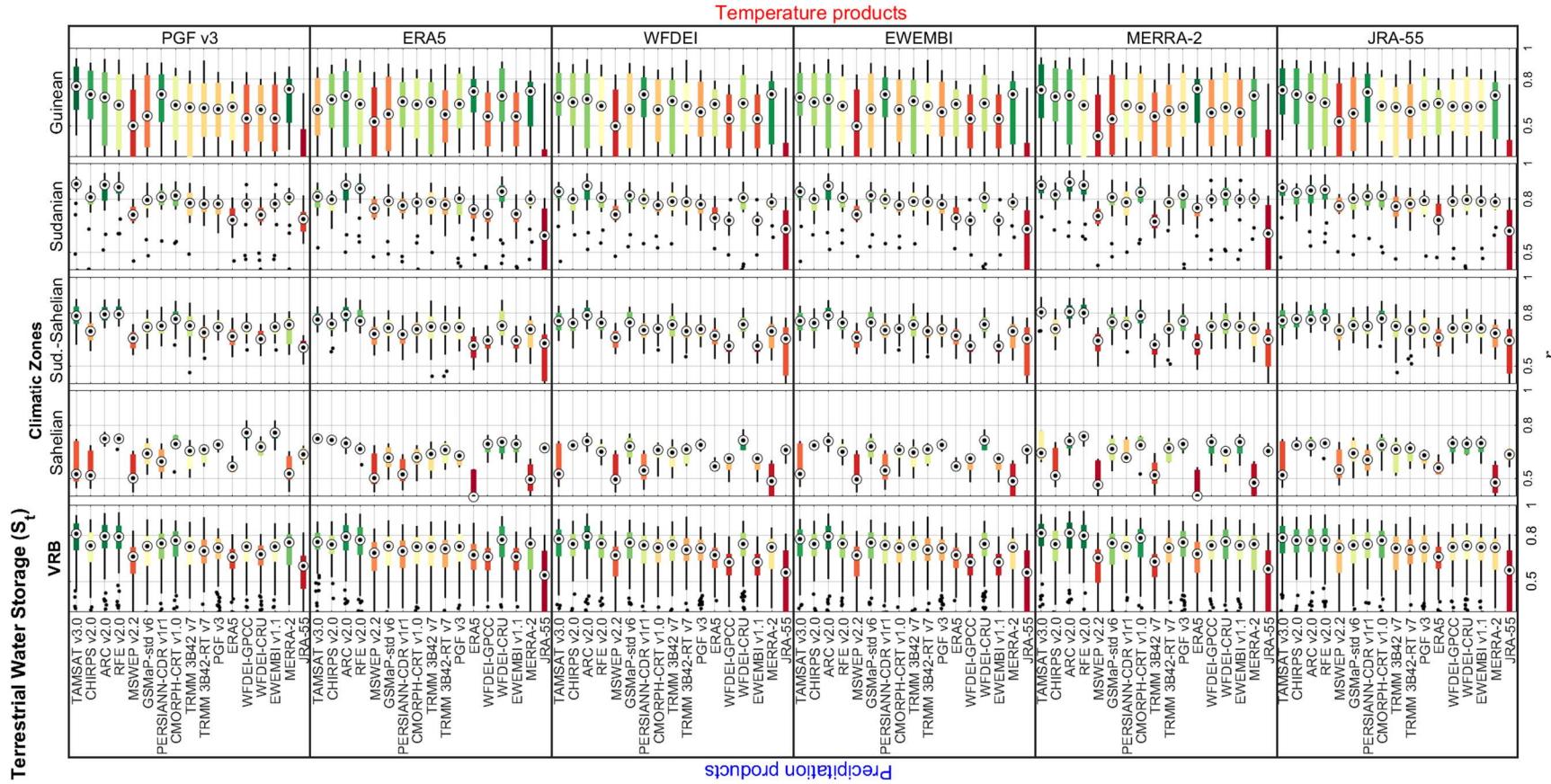
Figure S13. Pearson correlation coefficient (r) of terrestrial water storage (S_t) over the entire simulation period (2003-2012) for the Volta River basin (VRB) and its climatic zones, using different combinations of precipitation and temperature products for hydrological modelling. Each boxplot has 120 values corresponding to the number of months. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
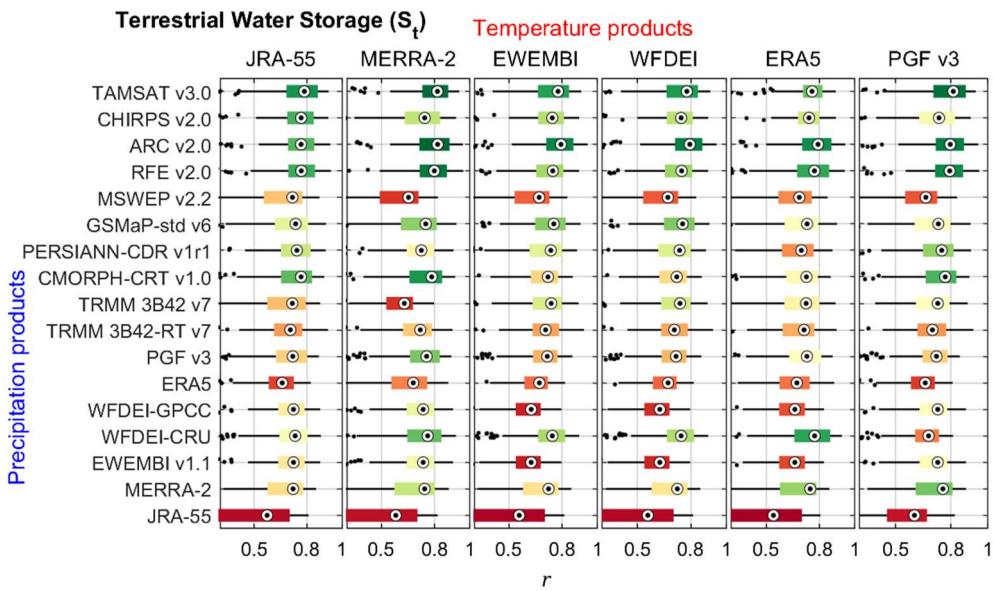
Figure S14. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over the entire simulation period (2003-2012) for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. Each boxplot has 104 values representing the combined performance of the calibration and evaluation periods for 52 pixels. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
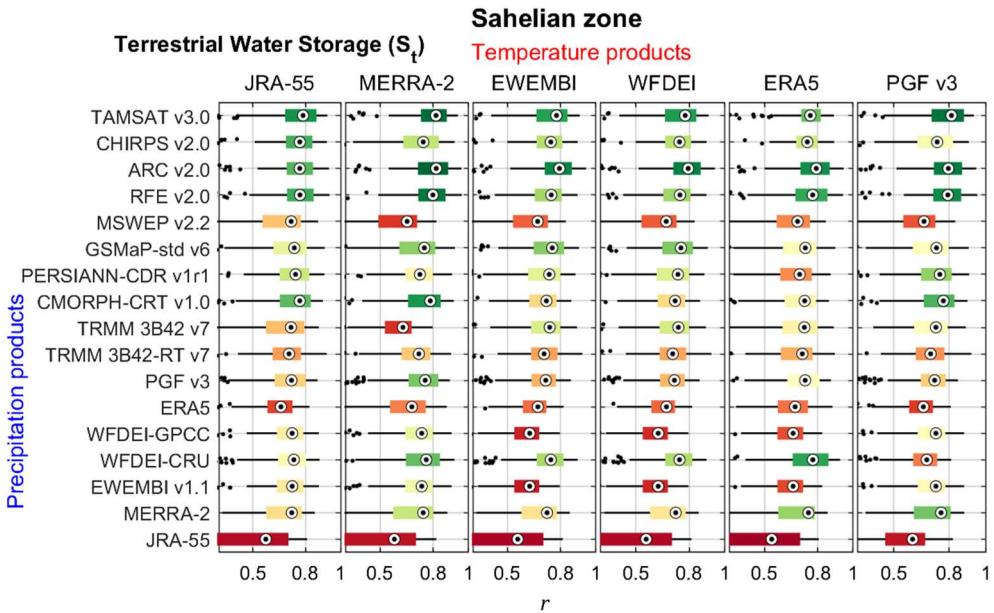
Figure S15. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over the entire simulation period (2003-2012) for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

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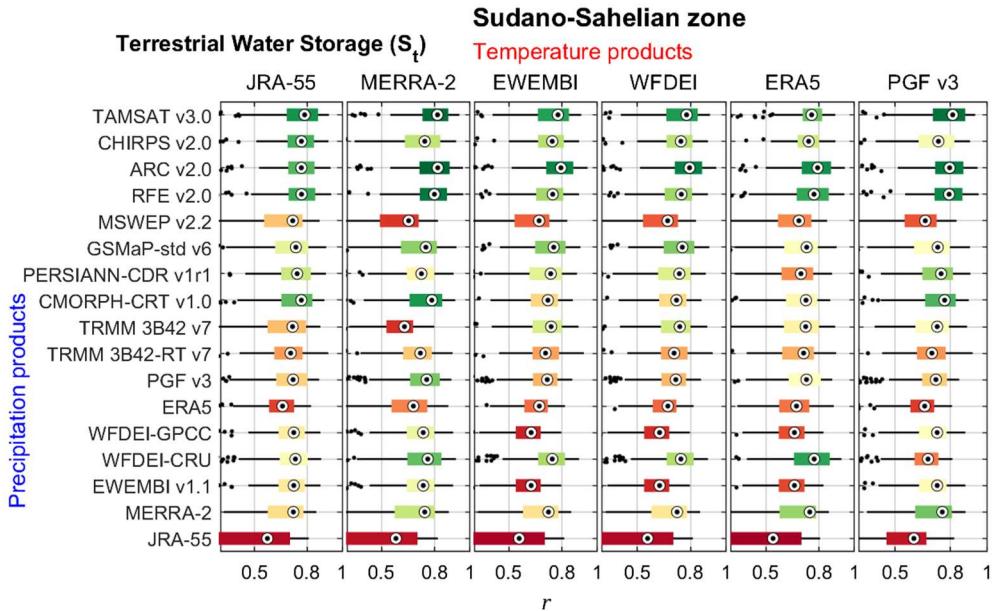
Figure S16. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over the entire simulation period (2003-2012) for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
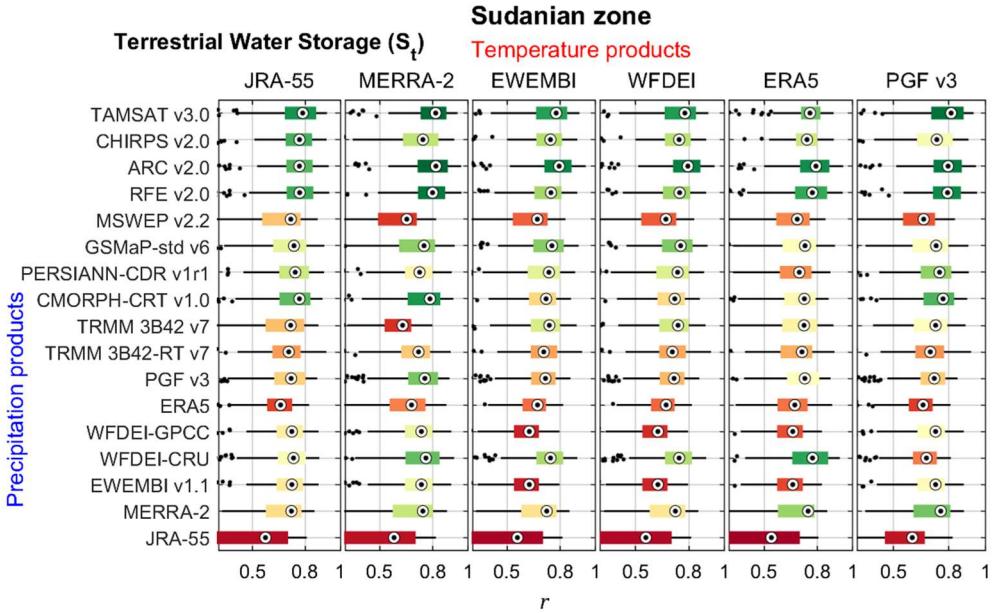
Figure S17. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over the entire simulation period (2003-2012) for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
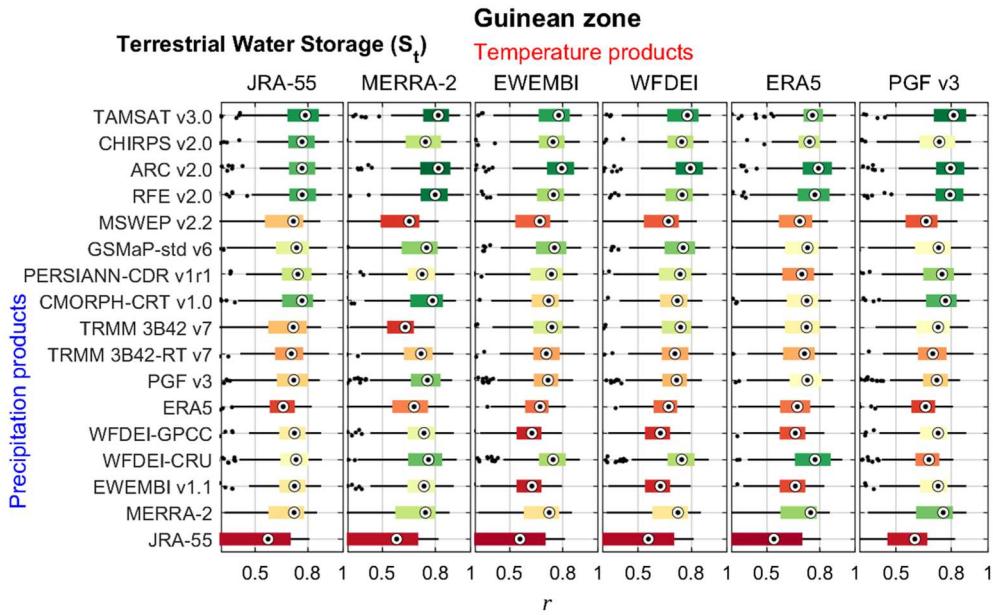
Figure S18. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over the entire simulation period (2003-2012) for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

## 6.2.2 Separated calibration and evaluation periods
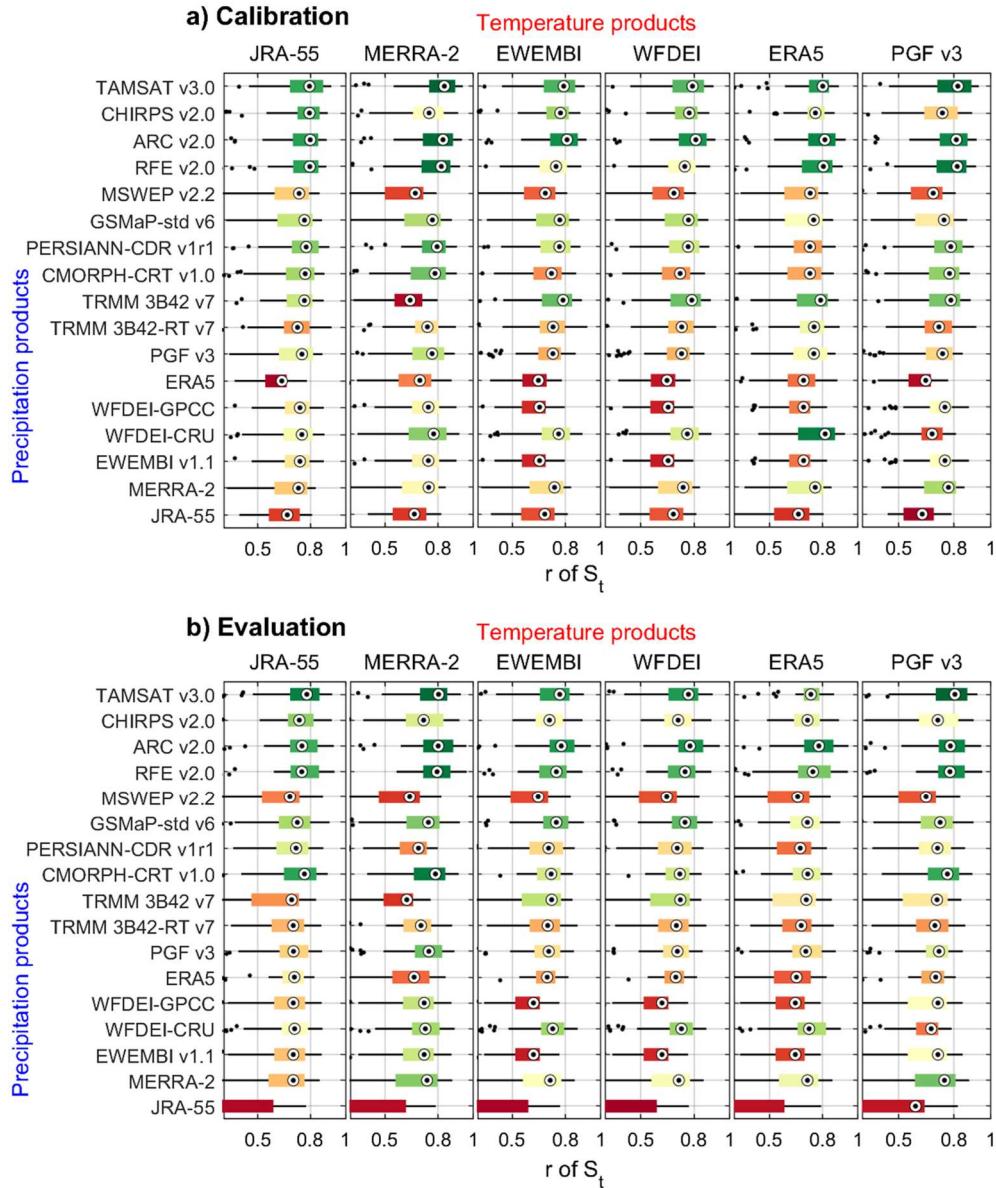
Figure S19. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
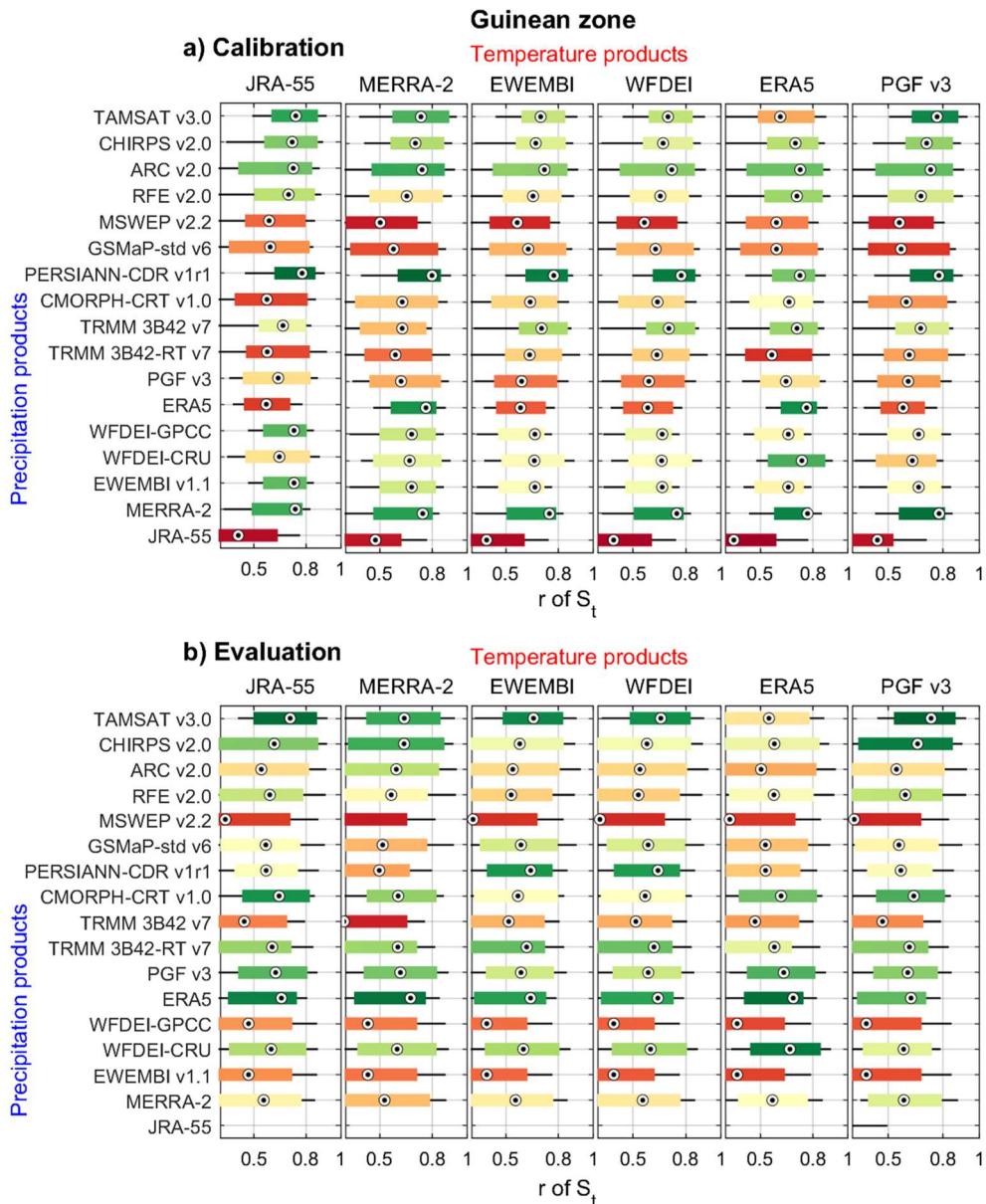
Figure S20. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
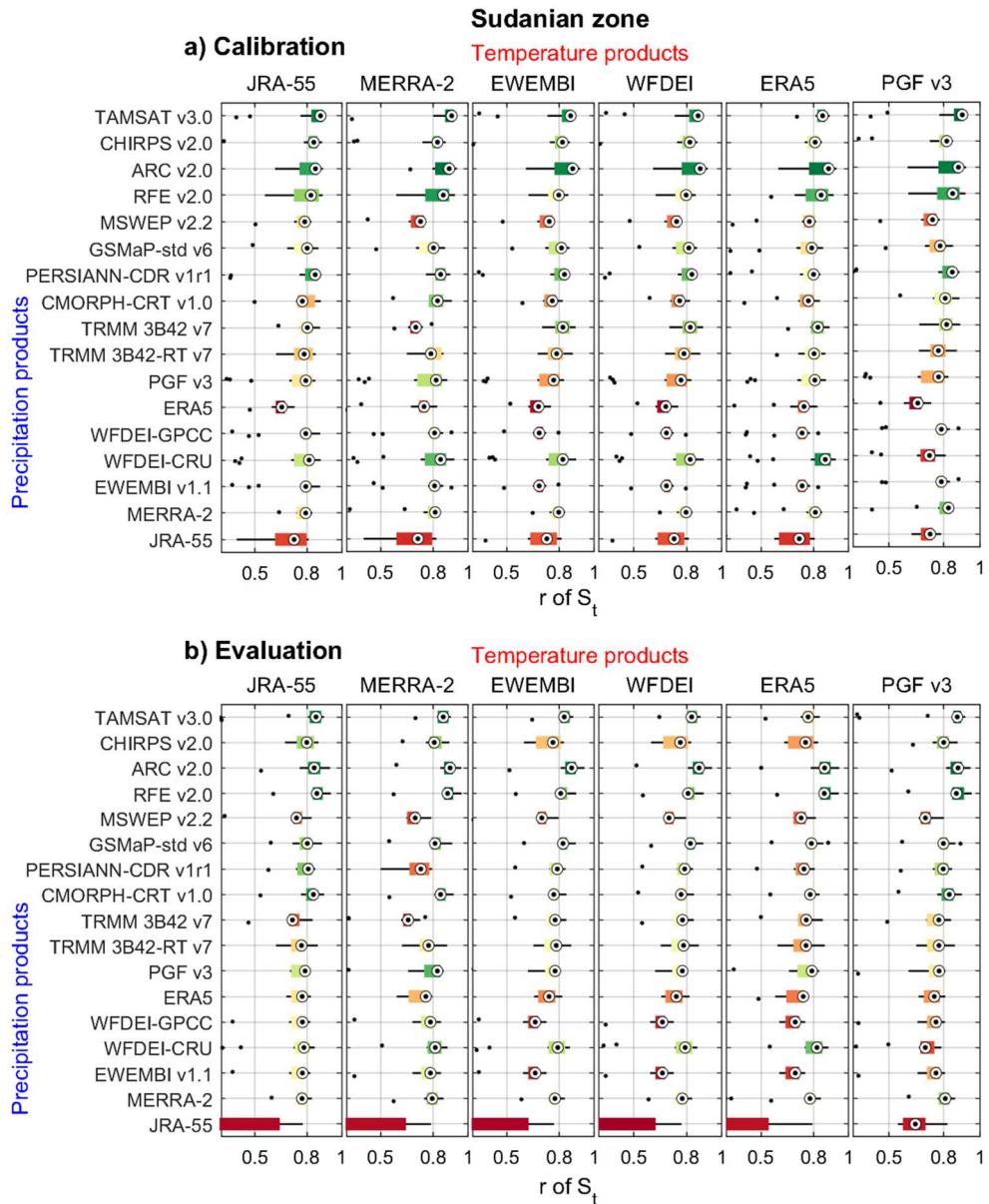
Figure S21. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
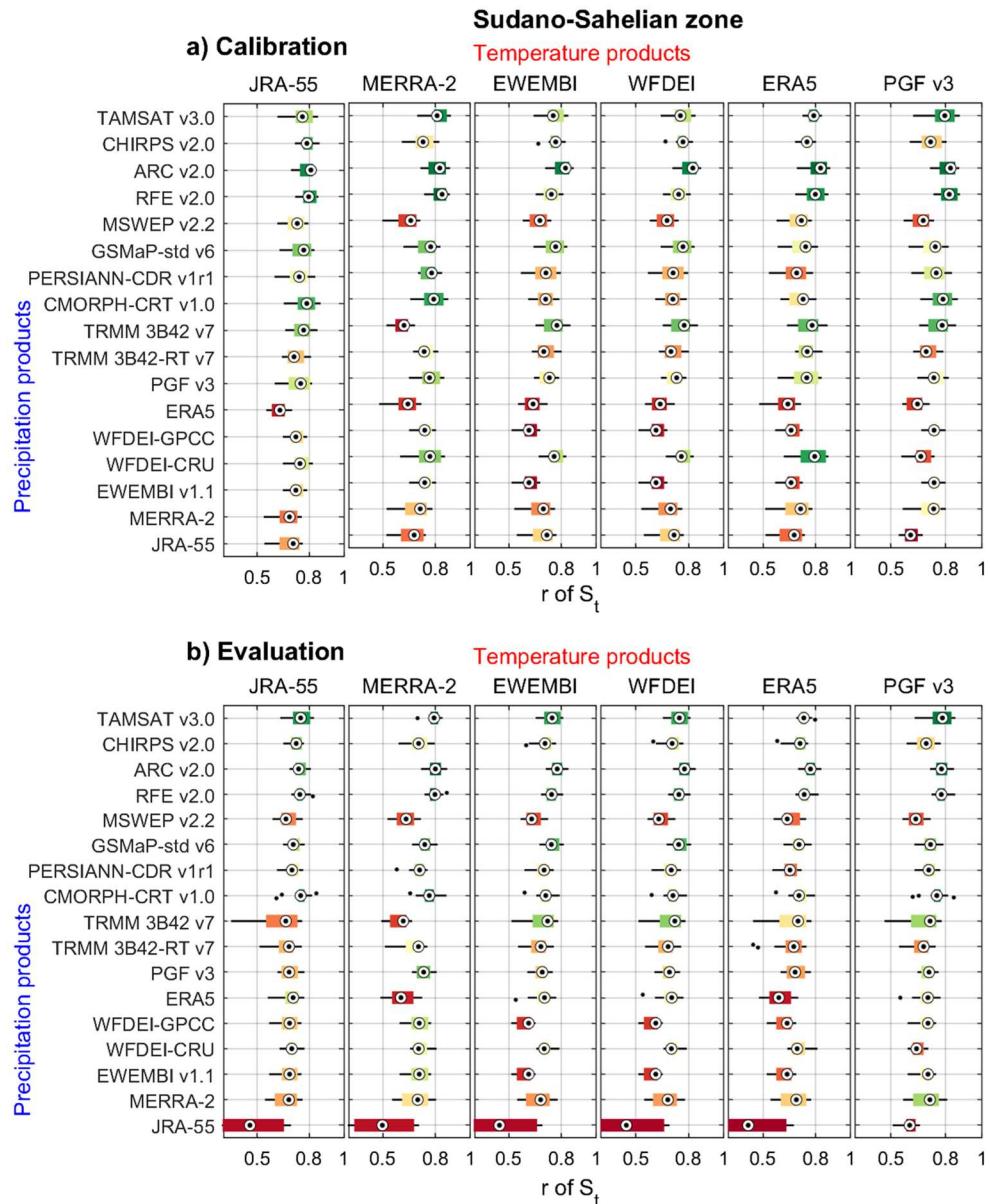
Figure S22. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
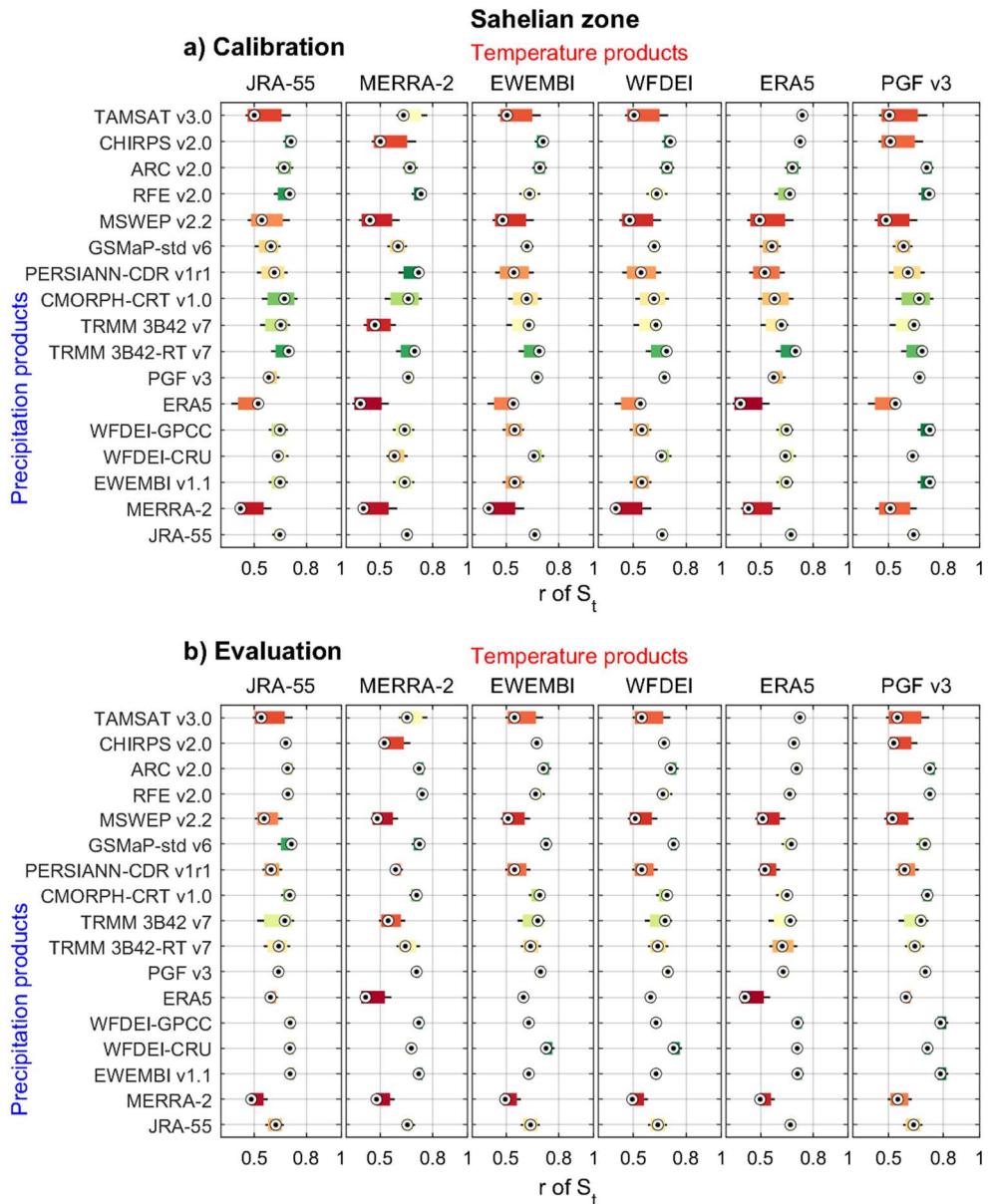
Figure S23. Pearson correlation coefficient (*r*) of terrestrial water storage (*St*) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

6.3 Time series
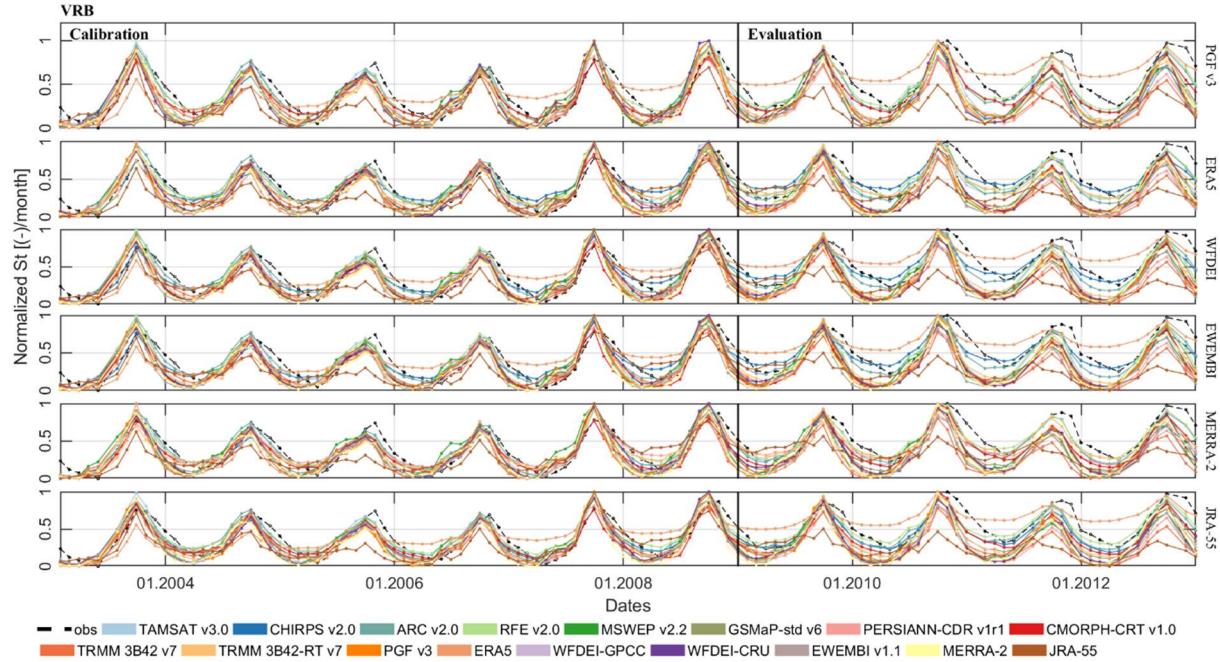
Figure S24. Monthly time series of terrestrial water storage (St) in the Volta River basin (VRB) obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
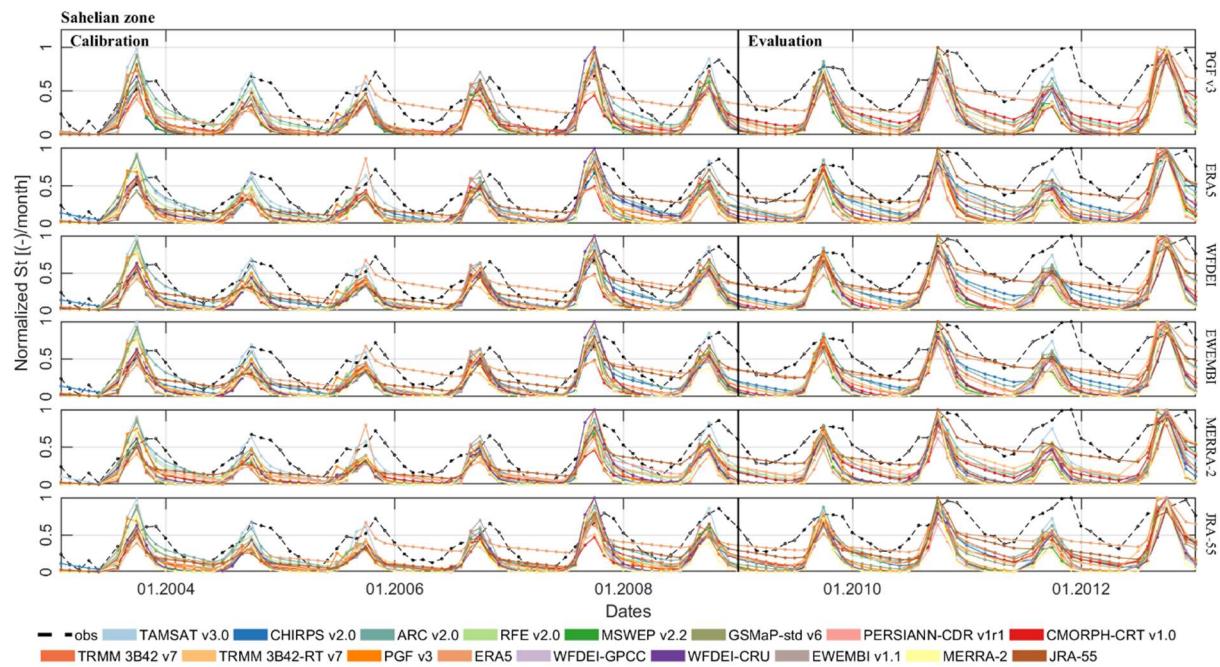
Figure S25. Monthly time series of terrestrial water storage (St) in the Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
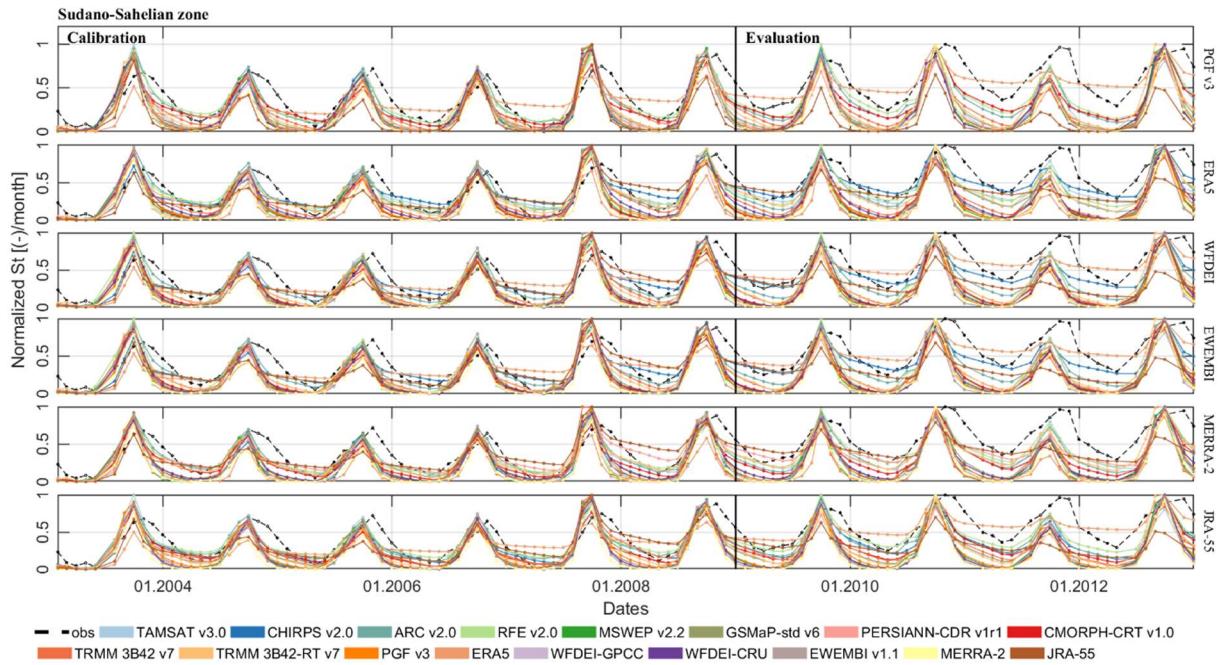
Figure S26. Monthly time series of terrestrial water storage (St) in the Sudano-Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
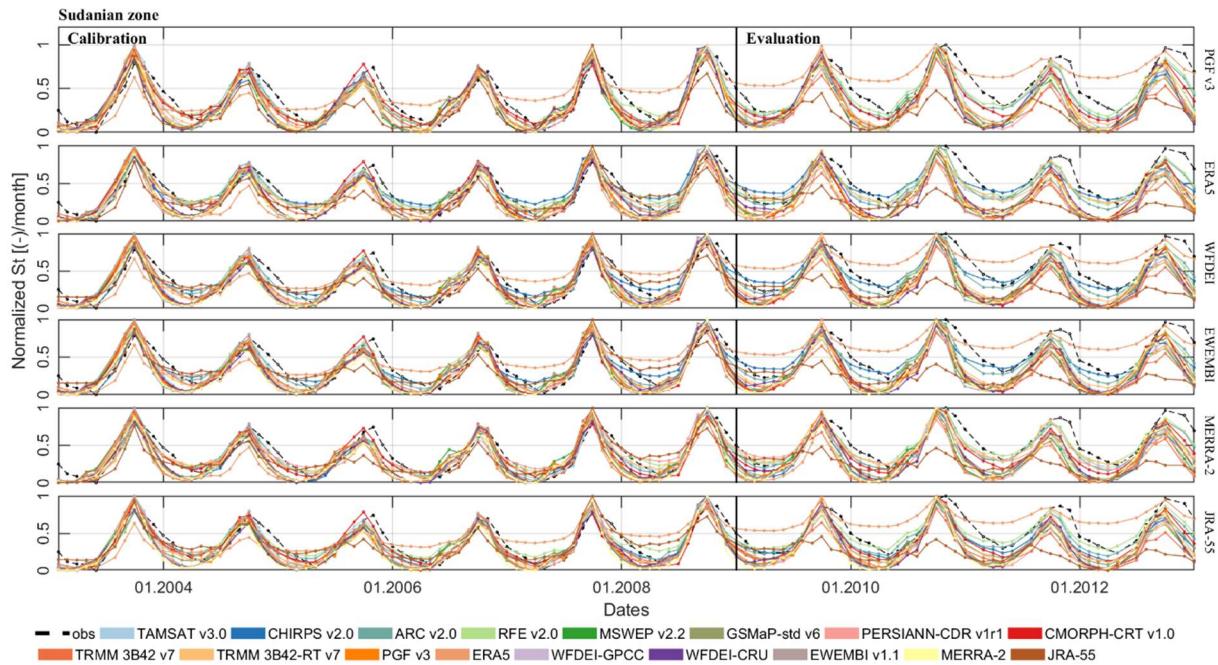

Figure S27. Monthly time series of terrestrial water storage (St) in the Sudanian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
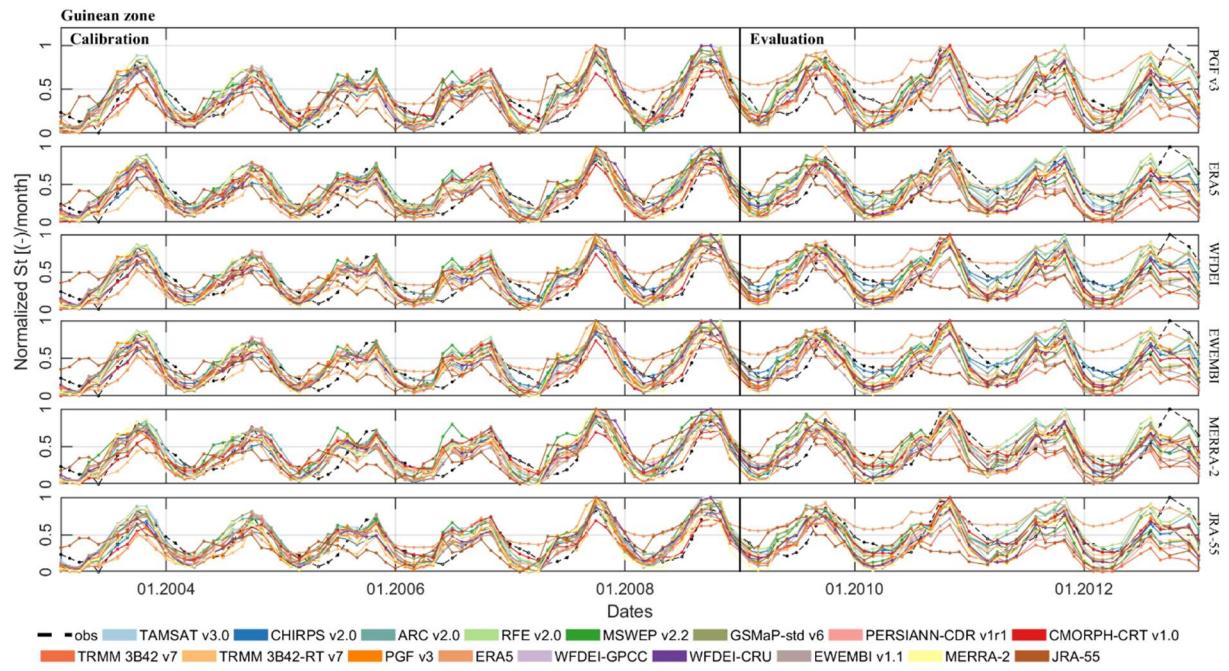
Figure S28. Monthly time series of terrestrial water storage (St) in the Guinean zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.

7 Model performance for soil moisture

7.1 Ranking of rainfall and temperature datasets

Table S14. Ranking of rainfall and temperature datasets based on the Pearson correlation coefficient (*r*) of soil moisture (S_u) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for 4 climatic zones in the Volta River basin (VRB)

Pearson's correlation coefficient of Su — Simulation period 2003-2012		Mean					V_2 (%)					Rank - on mean					Rank - on V_2				
		Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB
Rainfall datasets	TAMSAT v3.0	0.931	0.936	0.927	0.901	0.937	1.38	3.93	4.93	3.06	3.22	13	11	8	5	9	13	16	15	13	15
	CHIRPS v2.0	0.923	0.915	0.919	0.891	0.933	1.66	2.93	3.24	3.37	2.47	15	14	11	7	10	14	14	14	15	14
	ARC v2.0	0.968	0.948	0.926	0.840	0.932	0.77	0.83	1.06	1.35	0.81	5	8	10	14	11	5	4	4	4	4
	RFE v2.0	0.969	0.935	0.913	0.833	0.920	0.49	1.21	1.36	1.37	1.43	4	12	12	15	12	4	6	5	5	6
	MSWEP v2.2	0.945	0.937	0.911	0.822	0.918	0.40	1.35	1.86	1.50	1.51	10	10	13	16	13	3	7	7	7	7
	GSMaP-std v6	0.973	0.956	0.938	0.878	0.945	0.88	1.96	2.46	3.27	2.24	3	6	7	10	7	7	11	9	14	9
	PERSIANN-CDR v1r1	0.952	0.956	0.950	0.921	0.957	2.49	2.65	3.04	2.82	2.07	9	7	5	2	6	15	13	13	11	8
	CMORPH-CRT v1.0	0.953	0.940	0.926	0.915	0.939	0.32	0.42	0.68	0.95	0.31	8	9	9	3	8	1	1	2	3	1
	TRMM 3B42 v7	0.934	0.918	0.890	0.842	0.907	0.94	1.15	1.66	1.41	1.27	11	13	14	13	16	10	5	6	6	5
	TRMM 3B42-RT v7	0.929	0.905	0.890	0.849	0.907	0.86	0.50	1.03	0.49	0.52	14	15	15	12	14	6	3	3	2	2
	PGF v3	0.954	0.973	0.951	0.900	0.960	0.38	1.98	2.57	2.33	2.33	7	3	4	6	4	2	12	10	8	12
	ERA5	0.868	0.893	0.874	0.870	0.907	3.49	4.74	5.97	5.84	4.25	17	17	16	11	15	17	17	17	16	16
	WFDEI-GPCC	0.974	0.975	0.955	0.884	0.965	0.90	1.55	2.72	2.38	2.26	1	1	2	8	2	8	8	11	9	10
	WFDEI-CRU	0.967	0.972	0.946	0.902	0.958	0.97	1.77	2.30	3.02	2.39	6	5	6	4	5	11	10	8	12	13
	EWEMBI v1.1	0.974	0.975	0.955	0.884	0.965	0.90	1.55	2.72	2.38	2.26	1	1	2	8	2	8	8	11	9	10
	MERRA-2	0.934	0.973	0.970	0.932	0.974	1.31	0.46	0.63	0.37	0.56	12	4	1	1	1	12	2	1	1	3
	JRA-55	0.904	0.894	0.839	0.505	0.830	2.64	3.27	5.84	15.48	6.20	16	16	17	17	17	16	15	16	17	17
Temperature datasets	JRA-55	0.950	0.950	0.933	0.869	0.943	3.08	3.34	4.16	7.95	3.32	1	1	1	1	1	3	2	2	1	1
	MERRA-2	0.943	0.934	0.913	0.848	0.924	3.05	3.49	4.21	12.72	4.17	5	6	6	6	6	2	3	3	6	2
	EWEMBI	0.944	0.940	0.920	0.855	0.931	3.67	3.84	4.84	12.28	4.58	2	3	4	4	3	5	4	5	4	4
	WFDEI	0.944	0.940	0.920	0.855	0.931	3.67	3.84	4.84	12.28	4.58	3	4	3	3	4	6	5	4	5	5
	ERA5	0.944	0.947	0.932	0.861	0.940	2.81	3.28	4.11	12.19	4.25	4	2	2	2	2	1	1	1	3	3
	PGF v3	0.940	0.936	0.916	0.854	0.927	3.47	3.87	5.02	11.59	4.70	6	5	5	5	5	4	6	6	2	6

Table S15. Ranking of rainfall and temperature datasets based on the spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for 4 climatic zones in the Volta River basin (VRB)

Spatial pattern efficiency of Su — Simulation period 2003-2012		Mean					V_2 (%)					Rank - on mean					Rank - on V_2				
		Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB
Rainfall datasets	TAMSAT v3.0	-0.223	-0.313	-0.371	-0.503	-0.044	18.04	4.97	5.96	14.29	83.58	1	2	11	16	2	16	11	4	5	16
	CHIRPS v2.0	-0.337	-0.359	-0.411	-0.318	-0.114	8.51	7.38	12.00	25.95	27.72	3	6	12	4	13	12	15	15	15	6
	ARC v2.0	-0.477	-0.330	-0.337	-0.416	-0.055	5.92	2.78	6.21	14.58	46.93	7	4	2	10	3	7	4	6	6	11
	RFE v2.0	-0.546	-0.343	-0.354	-0.380	-0.066	4.31	6.20	3.84	31.76	58.89	13	5	5	8	6	6	14	2	17	12
	MSWEP v2.2	-0.365	-0.299	-0.359	-0.270	-0.003	4.21	4.29	6.85	16.11	98.92	4	1	8	1	1	3	8	9	9	17
	GSMaP-std v6	-0.582	-0.372	-0.360	-0.371	-0.100	4.05	1.32	6.71	19.54	18.64	15	8	9	6	10	2	3	8	10	4
	PERSIANN-CDR v1r1	-0.405	-0.361	-0.347	-0.453	-0.082	6.51	8.18	18.25	25.01	63.36	6	7	3	12	8	9	16	16	14	13
	CMORPH-CRT v1.0	-0.549	-0.383	-0.352	-0.293	-0.110	6.02	1.20	10.87	15.30	30.83	14	10	4	3	11	8	2	14	8	7
	TRMM 3B42 v7	-0.599	-0.373	-0.448	-0.276	-0.157	13.31	4.07	9.79	30.72	16.59	16	9	14	2	14	15	7	13	16	3
	TRMM 3B42-RT v7	-0.613	-0.399	-0.486	-0.376	-0.295	2.17	0.73	1.43	15.11	8.99	17	14	15	7	17	1	1	1	7	1
	PGF v3	-0.540	-0.421	-0.334	-0.431	-0.080	11.91	4.59	9.53	20.89	40.78	11	17	1	11	7	14	10	12	12	9
	ERA5	-0.396	-0.398	-0.500	-0.327	-0.195	6.62	9.18	20.15	23.13	27.38	5	13	17	5	16	10	17	17	13	5
	WFDEI-GPCC	-0.517	-0.384	-0.356	-0.496	-0.065	4.30	5.68	7.97	12.70	76.28	9	11	6	14	4	4	12	10	3	14
	WFDEI-CRU	-0.545	-0.415	-0.367	-0.470	-0.091	9.92	3.15	4.02	12.41	40.85	12	16	10	13	9	13	6	3	2	10
	EWEMBI v1.1	-0.517	-0.384	-0.356	-0.496	-0.065	4.30	5.68	7.97	12.70	76.28	9	11	6	14	4	4	12	10	3	14
	MERRA-2	-0.274	-0.318	-0.429	-0.530	-0.112	18.69	2.98	6.01	4.10	35.68	2	3	13	17	12	17	5	5	1	8
	JRA-55	-0.501	-0.413	-0.494	-0.395	-0.185	8.22	4.44	6.42	19.71	15.52	8	15	16	9	15	11	9	7	11	2
Temperature datasets	JRA-55	-0.494	-0.373	-0.411	-0.371	-0.115	22.78	9.80	15.15	28.23	59.42	6	5	6	1	5	1	2	2	5	1
	MERRA-2	-0.452	-0.361	-0.388	-0.393	-0.101	27.57	11.03	14.04	20.12	60.15	1	1	3	2	1	6	3	1	1	2
	EWEMBI	-0.454	-0.368	-0.398	-0.403	-0.102	24.74	11.87	18.25	26.84	61.27	2	3	4	4	2	4	5	4	3	4
	WFDEI	-0.454	-0.368	-0.400	-0.403	-0.102	24.69	11.86	18.60	26.85	61.28	3	4	5	3	3	3	4	5	4	5
	ERA5	-0.478	-0.367	-0.370	-0.396	-0.105	26.45	8.49	19.23	24.76	61.35	4	2	1	3	4	5	1	6	2	6
	PGF v3	-0.484	-0.374	-0.385	-0.434	-0.116	22.93	12.60	16.29	29.02	60.32	5	6	2	6	6	2	6	3	6	3

7.2 Boxplots

### 7.2.1 Combined calibration and evaluation periods
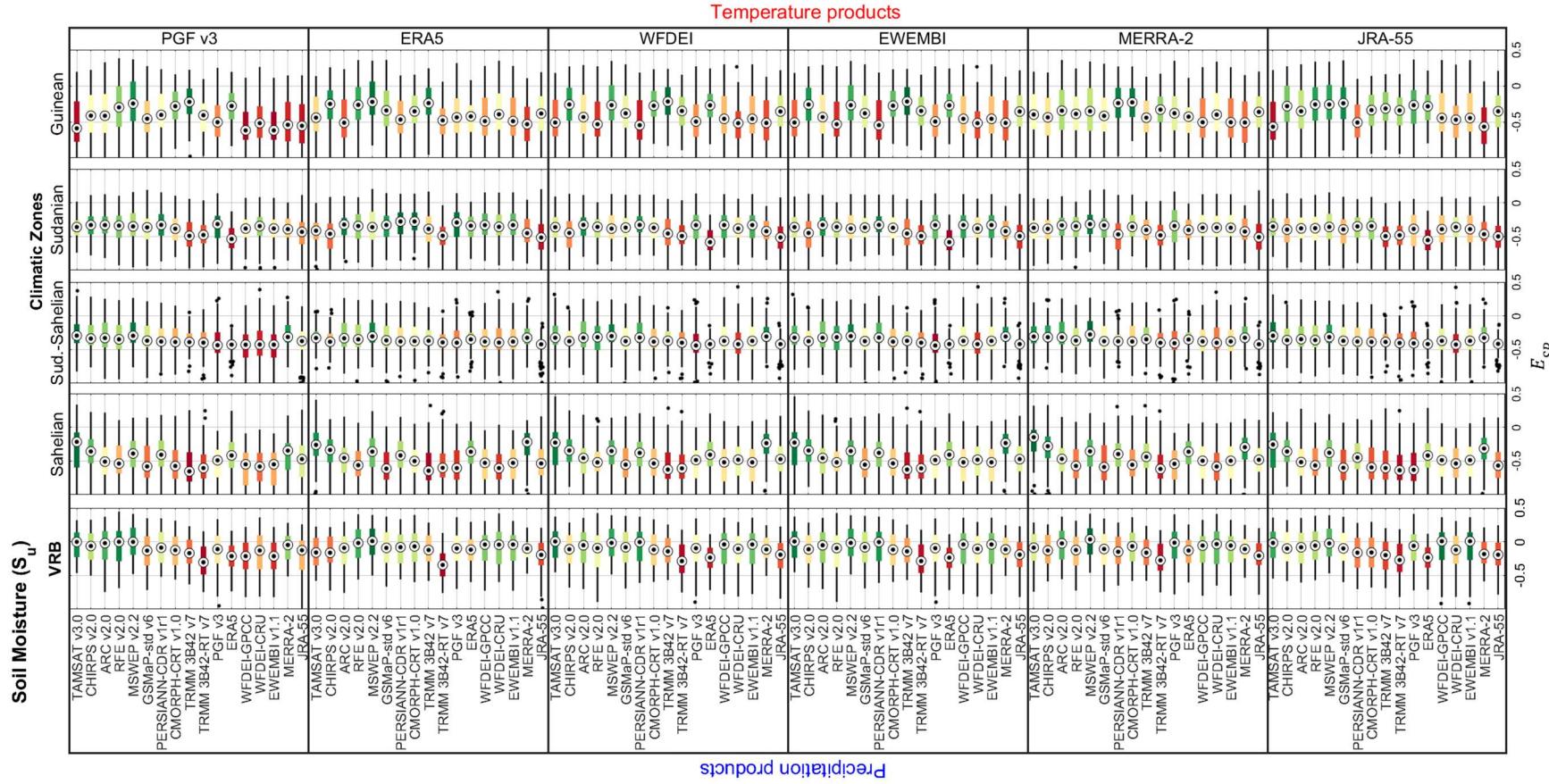
Figure S29. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Volta River basin (VRB) and its climatic zones, using different combinations of precipitation and temperature products for hydrological modelling. Each boxplot has 120 values corresponding to the number of months. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
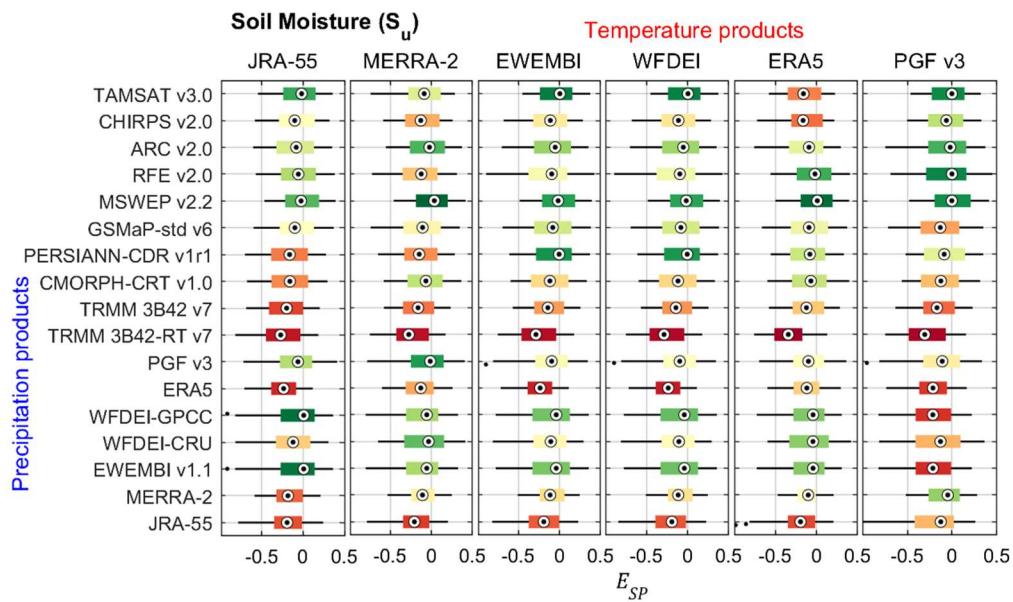
Figure S30. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
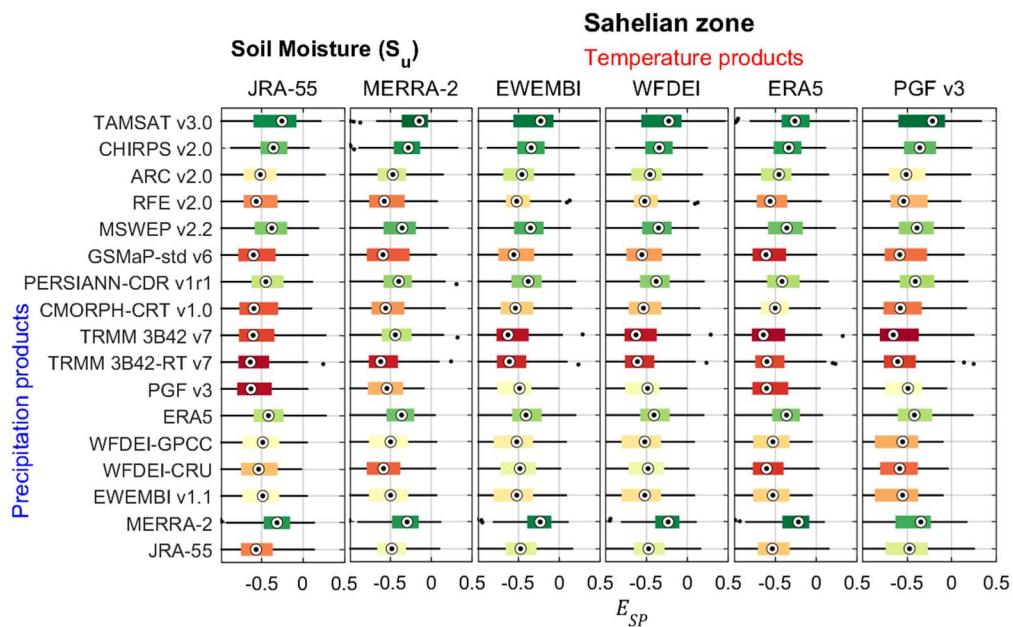
Figure S31. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
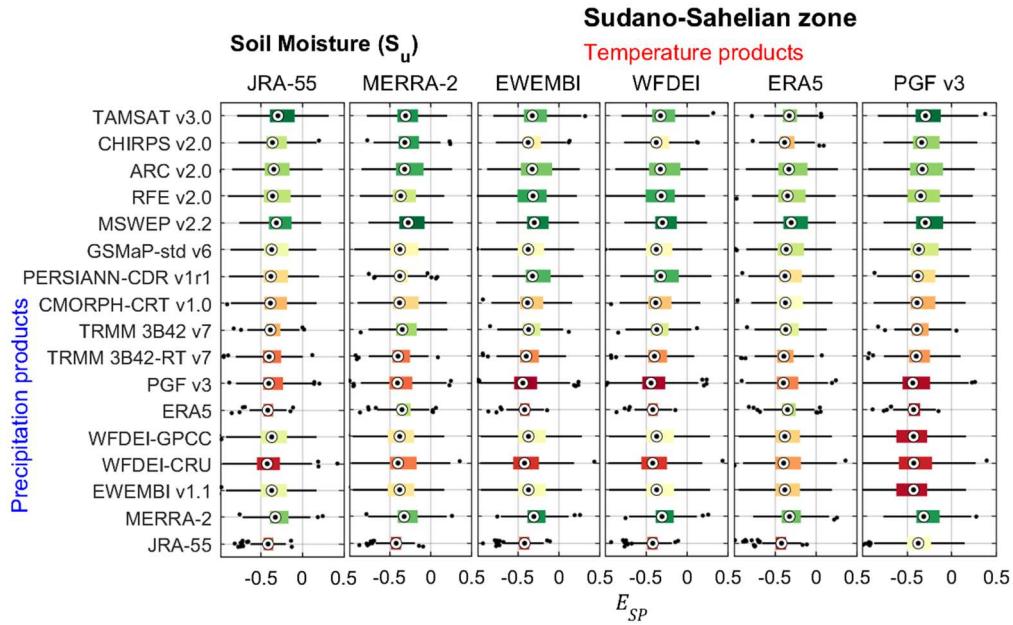
Figure S32. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
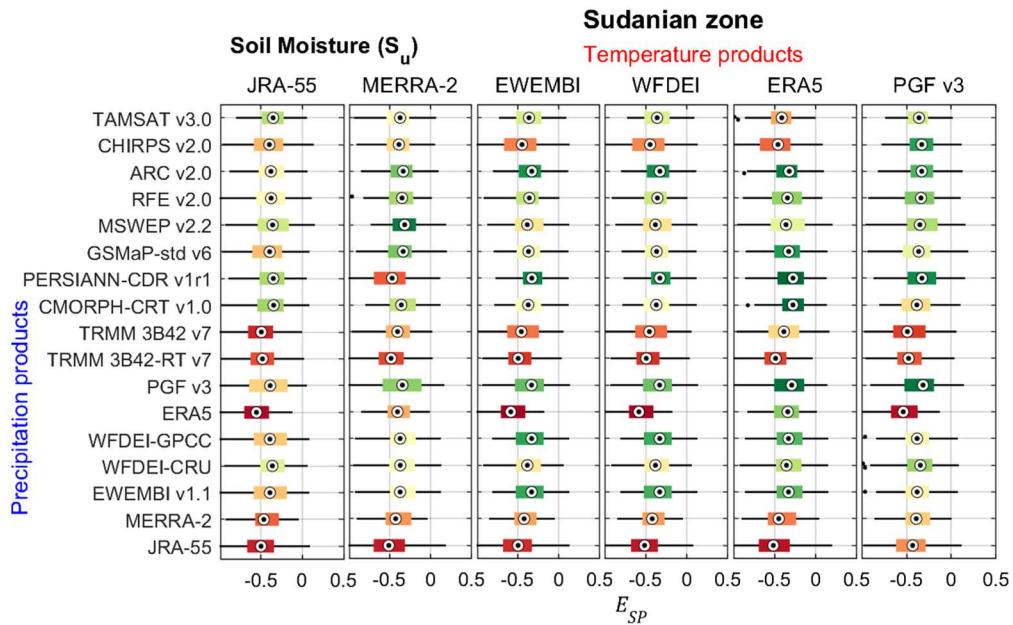
Figure S33. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
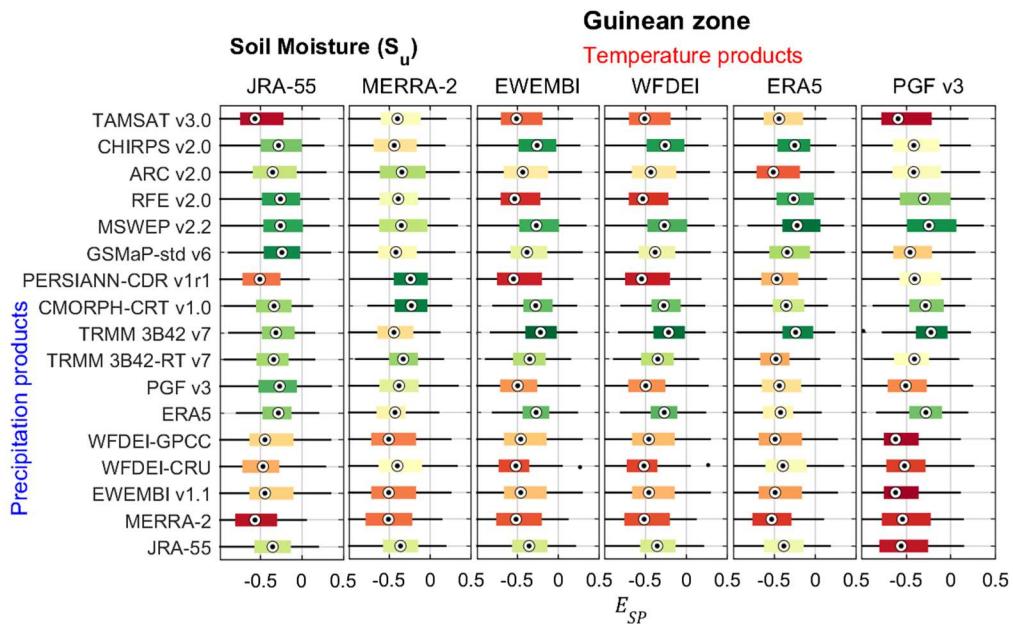
Figure S34. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over the entire simulation period (2003-2012) for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

7.2.2 Separated calibration and evaluation periods
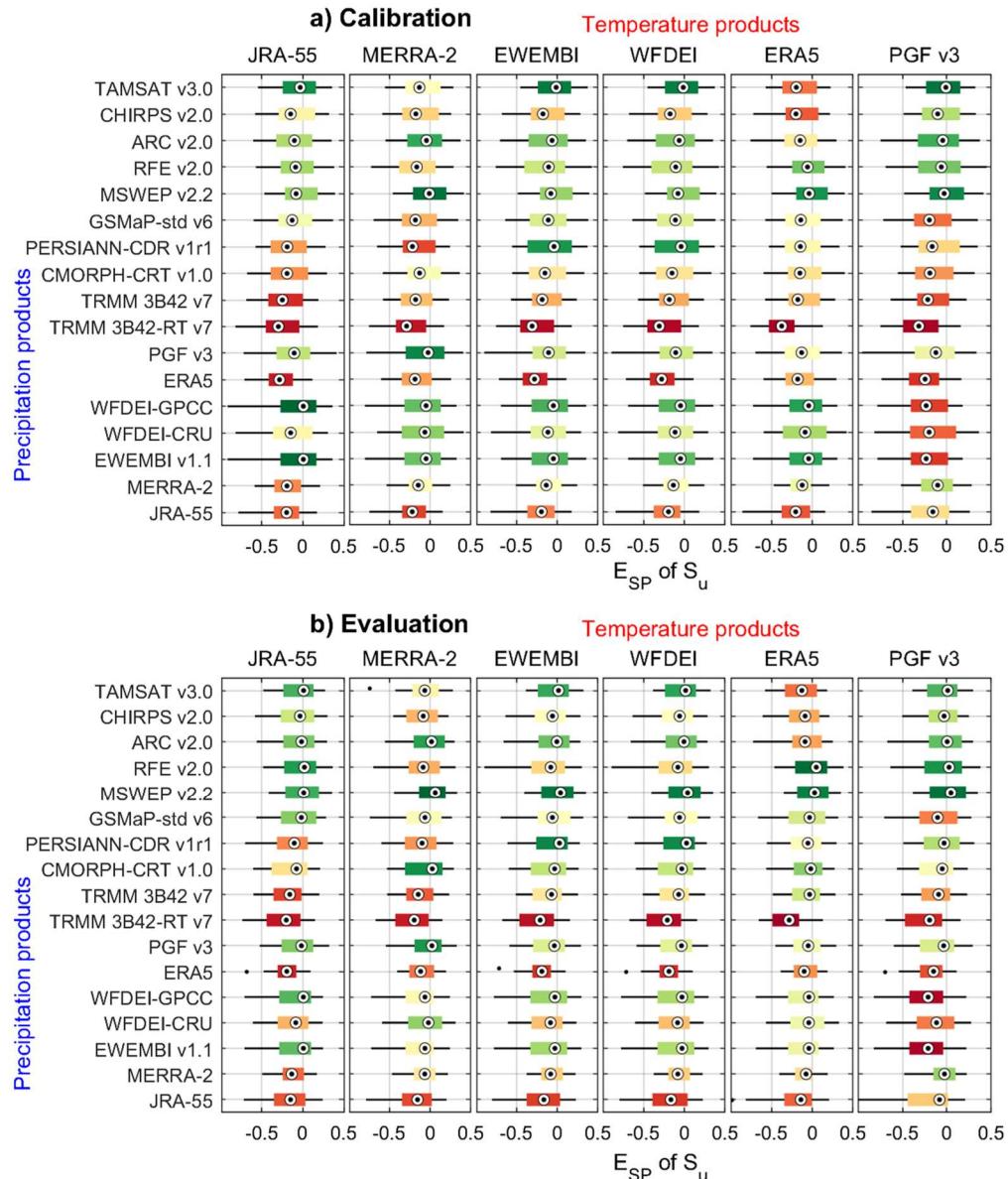
Figure S35. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
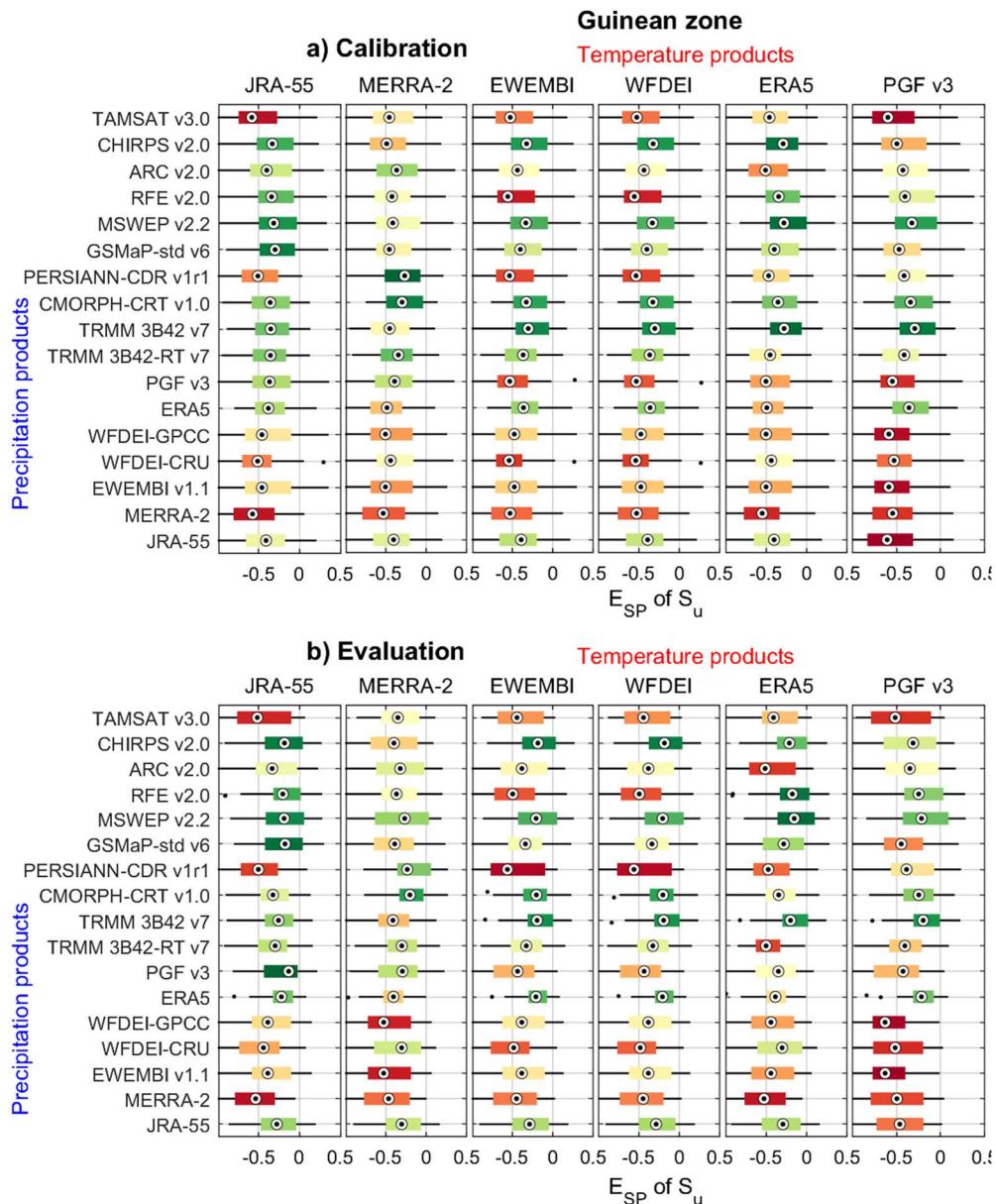
Figure S36. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
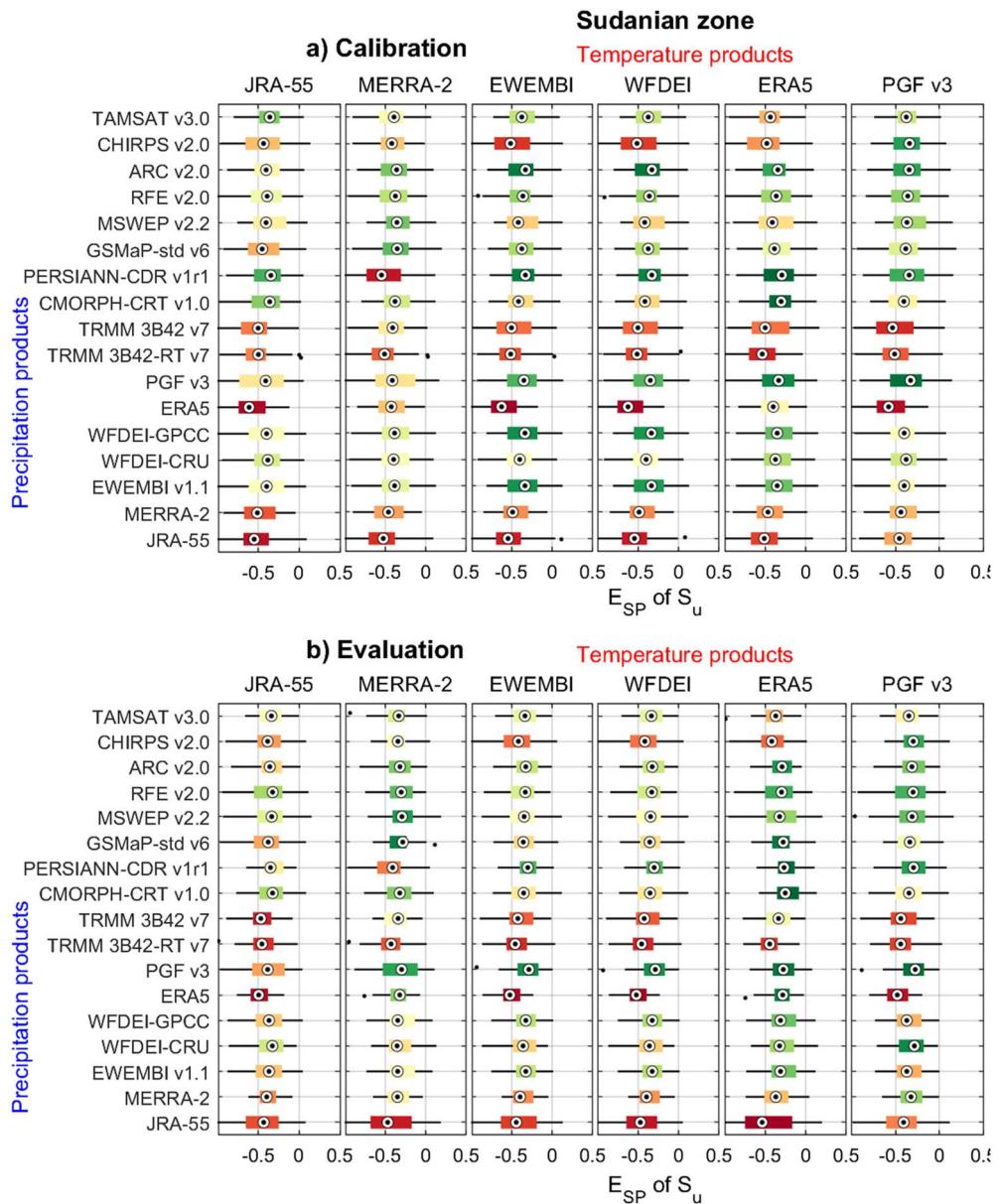
Figure S37. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
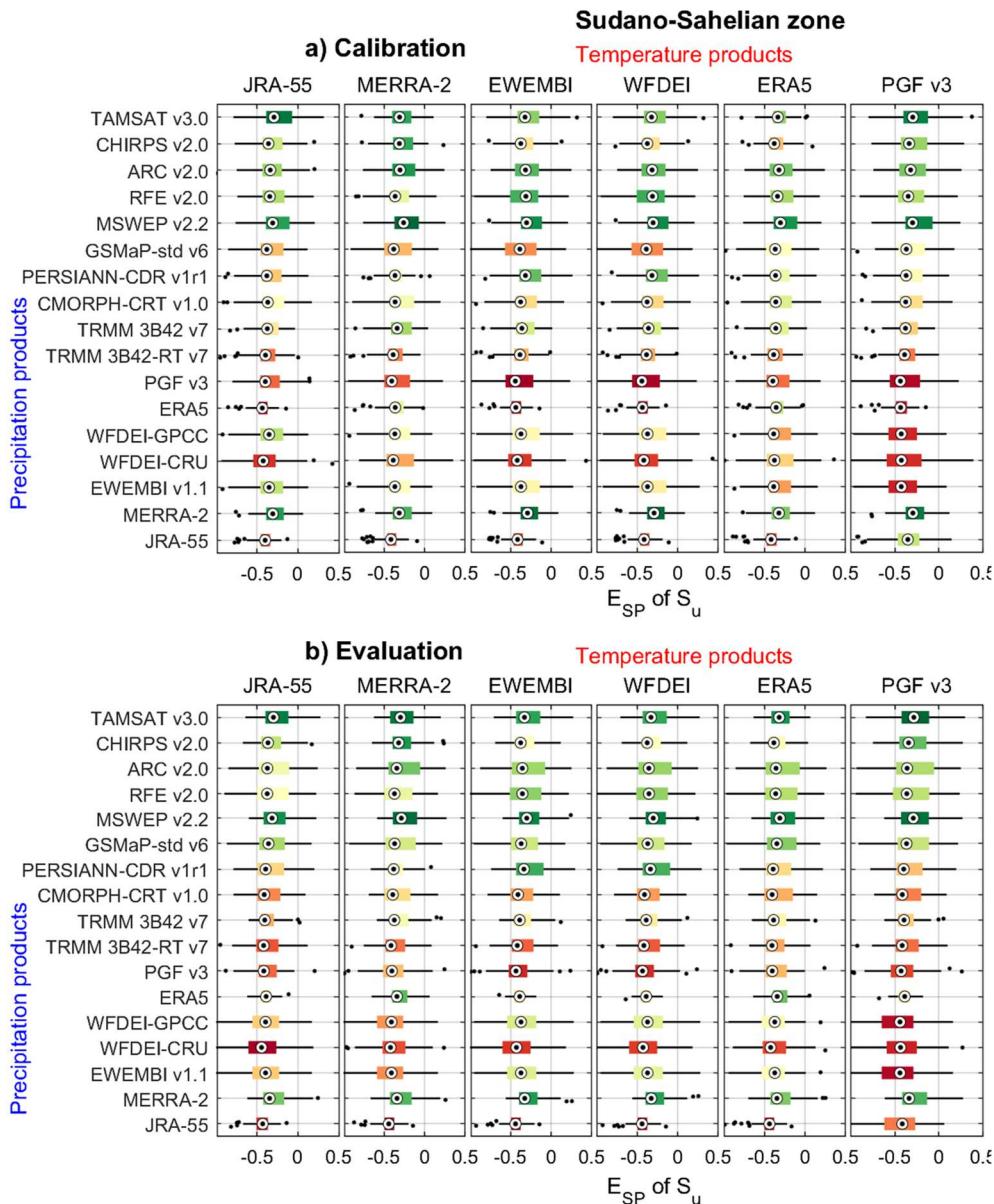
Figure S38. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
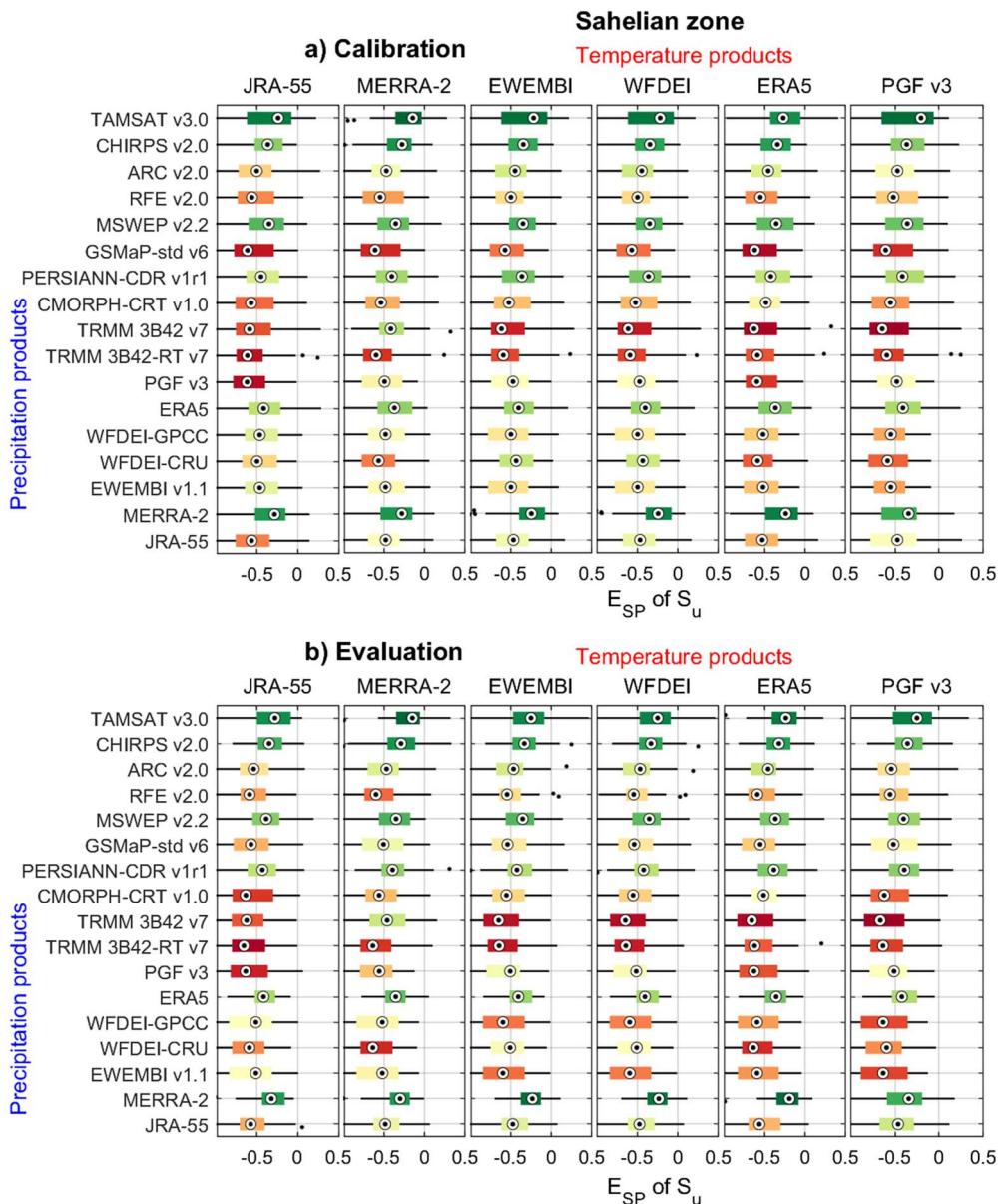
Figure S39. Spatial pattern efficiency (E_{SP}) of soil moisture (S_u) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

7.3 Time series
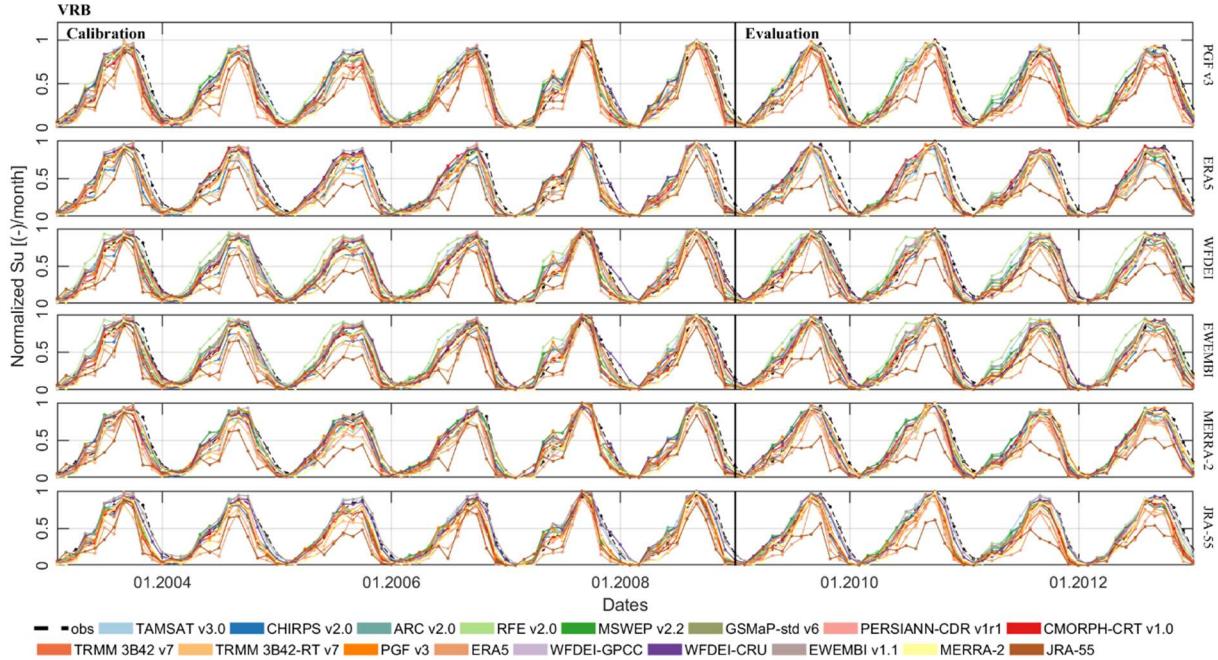
Figure S40. Monthly time series of soil moisture (S_u) in the Volta River basin (VRB) obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
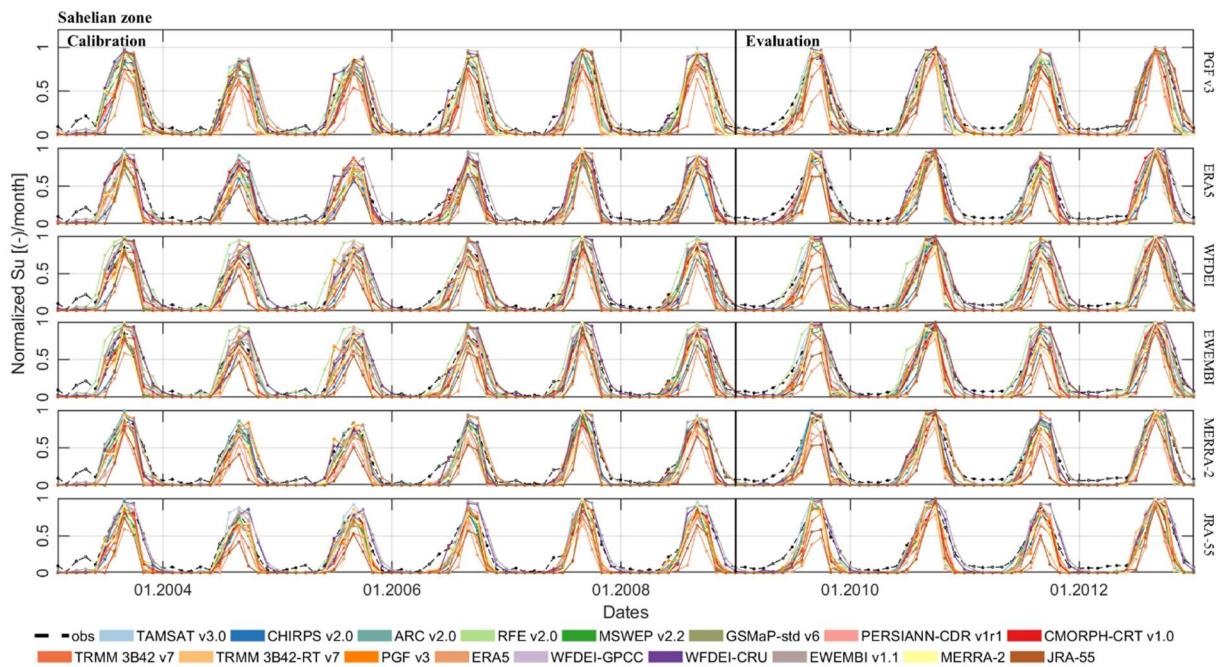
Figure S41. Monthly time series of soil moisture (S_u) in the Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
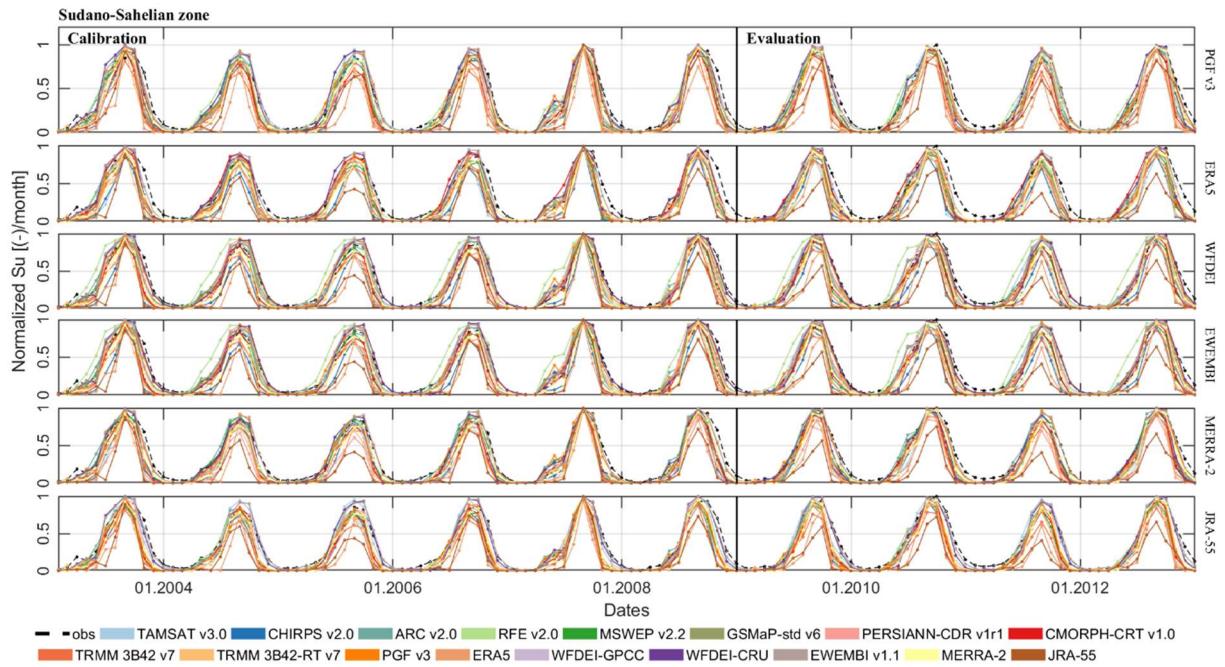
Figure S42. Monthly time series of soil moisture (S_u) in the Sudano-Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
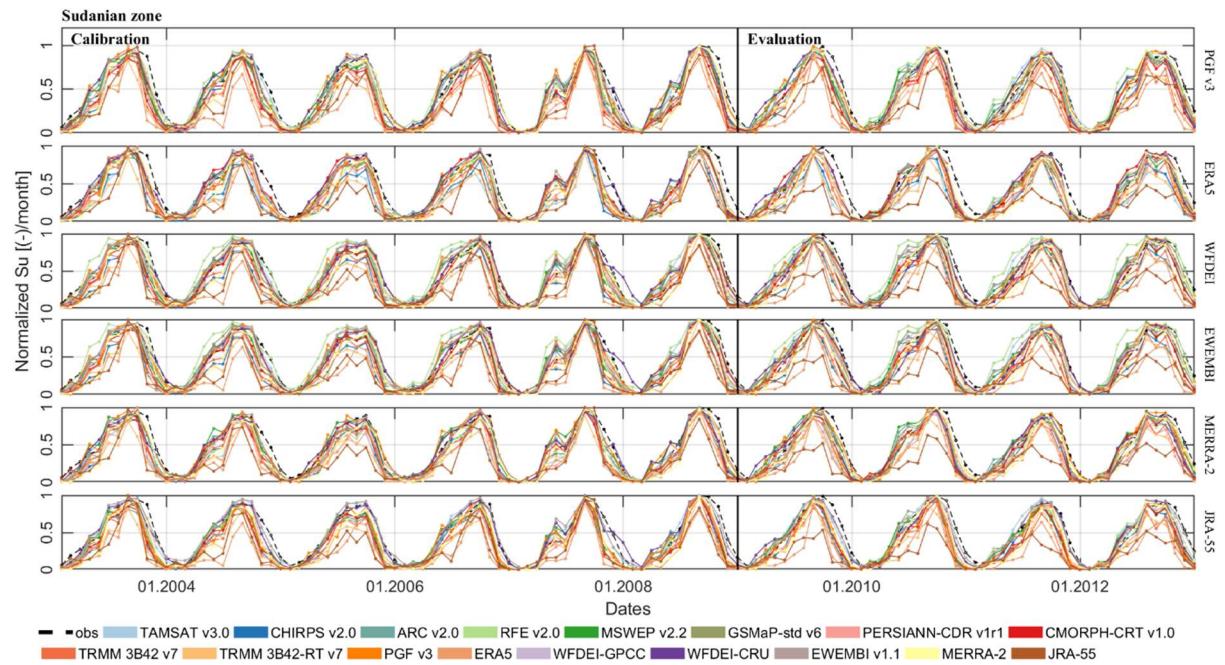
Figure S43. Monthly time series of soil moisture (S_u) in the Sudanian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
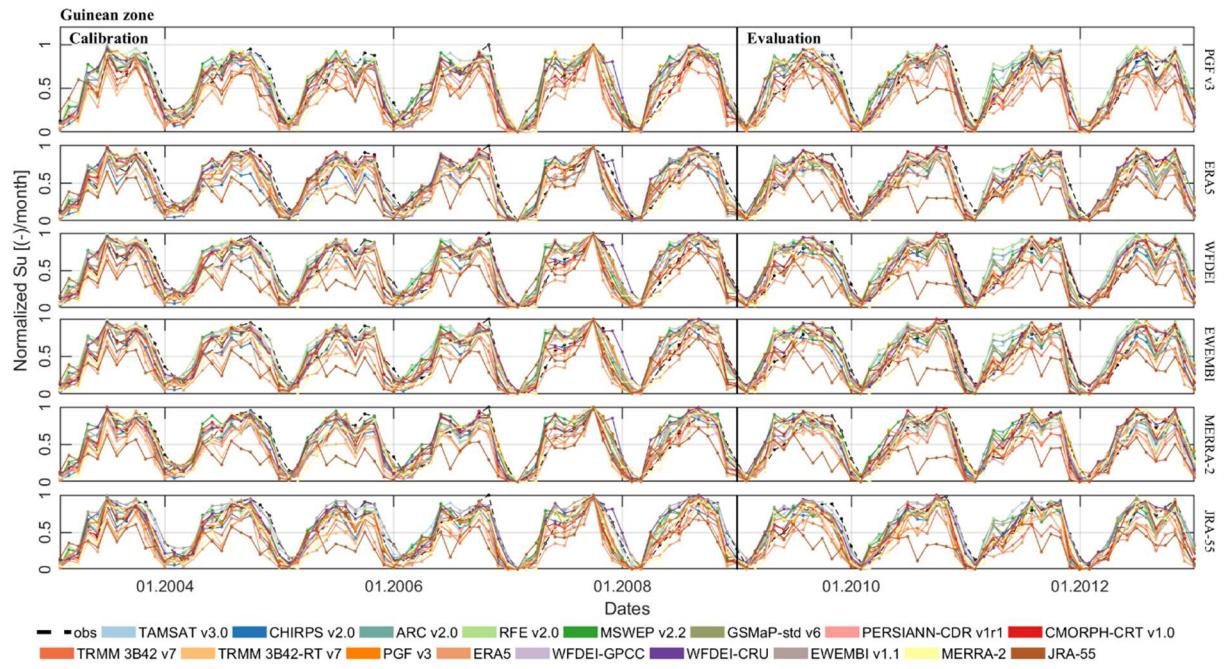
Figure S44. Monthly time series of soil moisture (S_u) in the Guinean zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.

7.4 Maps of long-term average
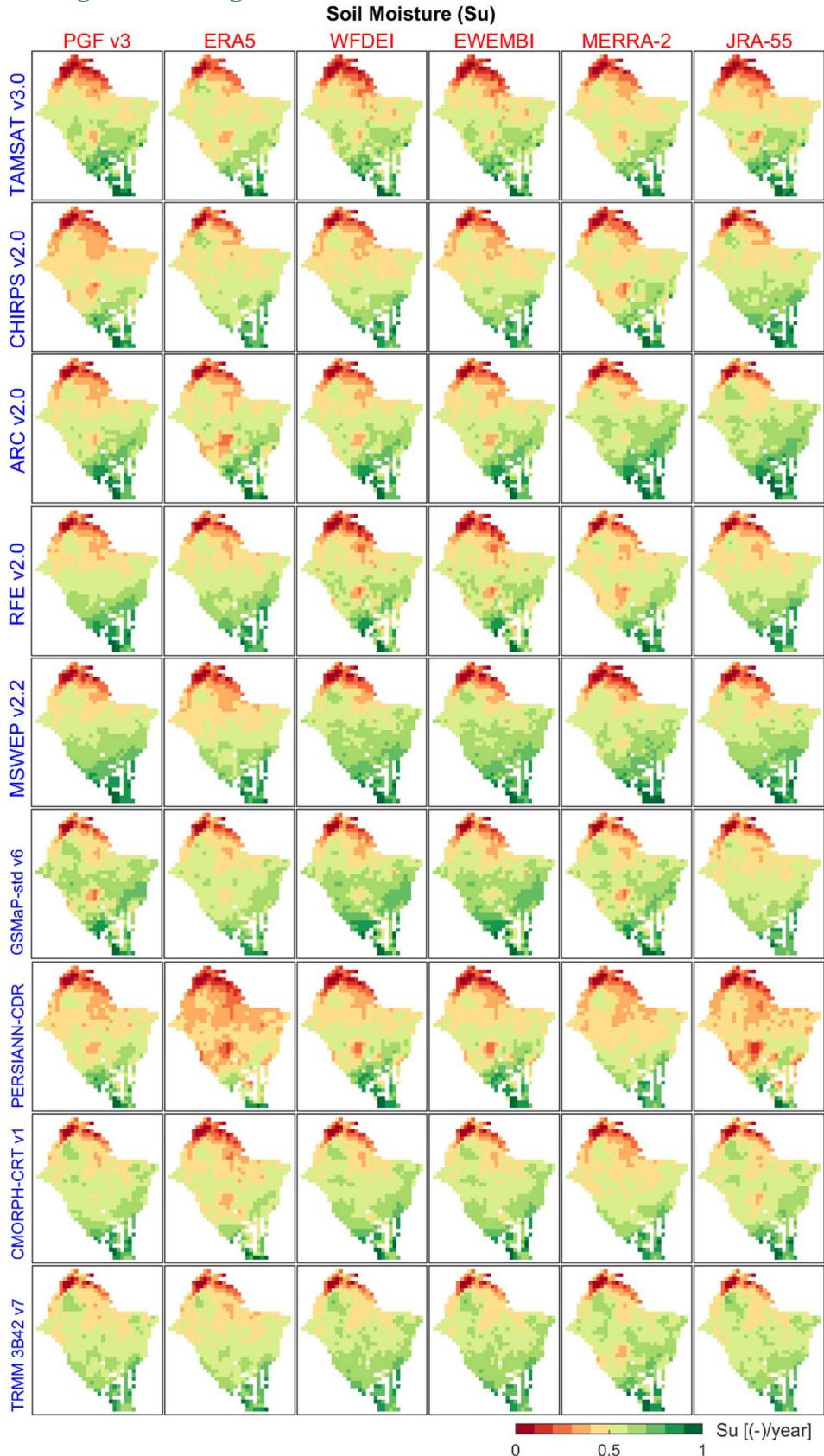
Figure S45. (Part1/2) Maps of long-term (2003-2012) annual average of soil moisture (S_u) obtained as outputs of hydrological modelling using different combinations of rainfall datasets (y-axis, blue font) and temperature datasets (x-axis, red font). The values are normalized for better emphasizing on patterns and using a unique color scale.
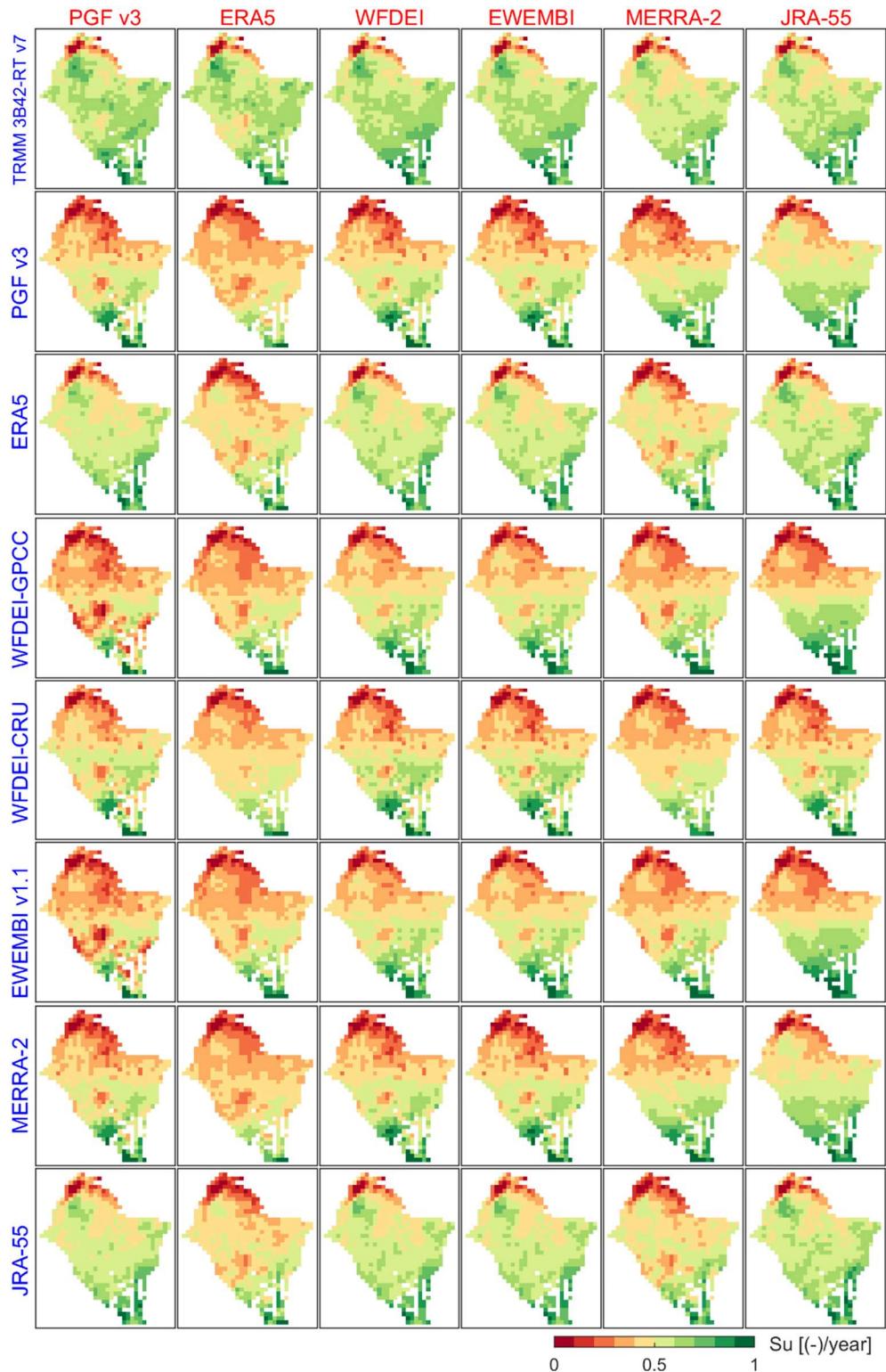
Figure S46. (Part2/2) Maps of long-term (2003-2012) annual average of soil moisture (S_u) obtained as outputs of hydrological modelling using different combinations of rainfall datasets (y-axis, blue font) and temperature datasets (x-axis, red font). The values are normalized for better emphasizing on patterns and using a unique color scale.

8 Model performance for evaporation

8.1 Ranking of rainfall and temperature datasets

Table S16. Ranking of rainfall and temperature datasets based on the Pearson correlation coefficient (r) of actual evaporation (E_a) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for 4 climatic zones in the Volta River basin (VRB)

Pearson's correlation coefficient of Ea / Simulation period 2003-2012	Mean					V_2 (%)					Rank - on mean					Rank - on V_2				
	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB
Rainfall datasets																				
TAMSAT v3.0	0.929	0.954	0.916	0.808	0.945	1.13	3.52	3.83	2.03	2.80	11	10	4	9	6	7	17	16	14	16
CHIRPS v2.0	0.958	0.920	0.880	0.819	0.919	1.38	3.16	3.08	1.77	2.41	7	13	13	6	13	11	16	14	11	14
ARC v2.0	0.952	0.969	0.940	0.887	0.965	1.50	0.40	0.92	1.19	0.61	8	6	1	1	1	12	1	5	6	3
RFE v2.0	0.948	0.976	0.938	0.886	0.964	2.61	1.41	2.27	1.02	1.52	9	4	2	2	2	14	10	12	4	10
MSWEP v2.2	0.965	0.950	0.904	0.863	0.937	0.43	0.90	0.88	0.35	0.69	5	12	10	3	10	2	7	4	1	4
GSMaP-std v6	0.971	0.970	0.924	0.856	0.949	0.98	1.49	2.54	1.67	1.67	2	5	3	4	3	6	11	13	9	12
PERSIANN-CDR v1r1	0.974	0.954	0.905	0.820	0.938	1.17	3.10	3.53	1.97	2.78	1	9	8	5	8	9	14	15	13	15
CMORPH-CRT v1.0	0.966	0.956	0.905	0.809	0.937	0.97	1.12	1.69	0.84	1.00	3	8	9	8	9	5	9	9	2	9
TRMM 3B42 v7	0.965	0.897	0.833	0.776	0.880	0.34	1.80	1.82	1.70	1.53	4	14	15	13	15	1	13	10	10	11
TRMM 3B42-RT v7	0.943	0.890	0.842	0.752	0.887	0.68	0.89	0.79	0.89	0.72	10	15	14	15	14	3	6	3	3	5
PGF v3	0.904	0.968	0.888	0.762	0.928	3.05	1.03	1.08	1.95	0.84	16	7	12	14	12	15	8	6	12	6
ERA5	0.903	0.888	0.813	0.697	0.867	1.28	3.16	4.21	3.92	3.11	17	16	16	17	16	10	15	17	17	17
WFDEI-GPCC	0.909	0.980	0.912	0.806	0.948	3.12	0.81	1.10	1.33	0.88	14	1	5	10	4	16	4	7	7	7
WFDEI-CRU	0.927	0.977	0.909	0.791	0.945	2.47	0.54	0.71	3.23	0.55	12	3	7	12	7	13	3	2	16	2
EWEMBI v1.1	0.909	0.980	0.912	0.806	0.948	3.12	0.81	1.10	1.33	0.88	14	1	5	10	4	16	4	7	7	7
MERRA-2	0.959	0.952	0.904	0.809	0.932	1.16	0.44	0.36	1.03	0.37	6	11	11	7	11	8	2	1	5	1
JRA-55	0.909	0.865	0.804	0.748	0.838	0.71	1.61	2.14	3.11	2.26	13	17	17	16	17	4	12	11	15	13
Temperature datasets																				
JRA-55	0.934	0.948	0.892	0.801	0.928	4.37	3.89	4.82	6.42	3.78	6	1	1	6	1	6	1	3	4	1
MERRA-2	0.943	0.938	0.886	0.810	0.921	2.89	4.20	4.66	5.81	3.80	2	6	6	1	6	4	4	2	1	2
EWEMBI	0.942	0.944	0.891	0.804	0.925	2.72	4.68	5.75	7.08	4.64	4	4	3	4	4	2	5	5	6	6
WFDEI	0.942	0.944	0.891	0.804	0.925	2.72	4.68	5.76	7.08	4.64	3	3	4	5	3	1	6	6	5	5
ERA5	0.939	0.946	0.892	0.807	0.927	2.86	3.97	4.48	5.93	3.86	5	2	2	2	2	3	2	1	2	3
PGF v3	0.944	0.943	0.888	0.807	0.925	3.30	4.14	5.00	6.16	4.14	1	5	5	3	5	5	3	4	3	4

Table S17. Ranking of rainfall and temperature datasets based on the spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the simulation period. The mean and the second-order coefficient of variation (V_2) are calculated across 6 temperature datasets for each rainfall dataset, and across 17 rainfall datasets for each temperature dataset. The rank is given from the best (green) to the worst performance (red) for 4 climatic zones in the Volta River basin (VRB)

Spatial pattern efficiency of Ea / Simulation period 2003-2012	Mean					V_2 (%)					Rank - on mean					Rank - on V_2				
	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB	Sahelian zone	Sudano-Sahelian zone	Sudanian zone	Guinean zone	VRB
Rainfall datasets																				
TAMSAT v3.0	-1.21	-0.29	-0.22	-0.61	0.21	17.7	13.1	32.9	22.1	34.1	13	7	4	6	2	10	9	12	17	10
CHIRPS v2.0	-1.60	-0.24	-0.36	-0.82	0.18	49.4	22.7	36.9	14.0	38.5	15	5	9	12	4	16	12	15	14	13
ARC v2.0	-0.58	-0.24	-0.44	-0.59	0.03	6.4	10.9	8.1	4.1	74.5	3	4	11	3	12	4	6	3	2	17
RFE v2.0	-0.49	-0.22	-0.35	-0.67	0.10	28.1	27.3	12.1	10.5	34.6	2	2	8	10	10	13	14	6	10	11
MSWEP v2.2	-1.90	-0.32	-0.19	-0.53	0.26	16.7	36.0	26.9	11.4	20.1	16	8	2	1	1	9	17	11	11	6
GSMaP-std v6	-0.40	-0.19	-0.36	-0.81	0.08	7.8	7.4	4.4	3.9	35.5	1	1	10	11	11	5	4	1	1	12
PERSIANN-CDR v1r1	-1.13	-0.22	-0.29	-0.65	0.17	33.4	21.2	49.5	16.8	55.3	12	3	5	9	7	14	11	17	16	15
CMORPH-CRT v1.0	-0.72	-0.28	-0.53	-1.04	-0.12	21.7	11.7	10.3	5.0	32.2	6	6	13	15	14	12	8	5	3	9
TRMM 3B42 v7	-0.79	-0.34	-0.55	-0.89	-0.06	45.1	29.0	9.2	7.5	74.4	8	10	14	13	13	15	15	4	8	16
TRMM 3B42-RT v7	-0.92	-0.59	-0.85	-1.61	-0.16	3.7	4.5	5.5	5.2	8.7	11	17	17	17	15	1	1	2	5	3
PGF v3	-0.61	-0.33	-0.15	-0.58	0.16	18.0	7.7	39.8	14.6	10.1	4	9	1	2	8	11	5	16	15	4
ERA5	-1.42	-0.50	-0.75	-1.43	-0.23	51.0	29.6	15.0	12.0	53.9	14	15	15	16	17	17	16	9	12	14
WFDEI-GPCC	-0.79	-0.39	-0.30	-0.62	0.17	5.1	6.9	34.2	5.7	30.4	9	12	6	7	5	2	2	13	6	7
WFDEI-CRU	-0.69	-0.36	-0.20	-0.59	0.14	12.3	21.1	18.8	10.2	18.0	5	11	3	4	9	6	10	10	9	5
EWEMBI v1.1	-0.79	-0.39	-0.30	-0.62	0.17	5.1	6.9	34.2	5.7	30.4	9	12	6	7	5	2	2	13	6	7
MERRA-2	-2.00	-0.48	-0.45	-0.60	0.20	14.5	11.0	13.0	5.2	3.2	17	14	12	5	3	7	7	8	4	1
JRA-55	-0.73	-0.55	-0.83	-0.85	-0.18	15.9	24.3	12.3	13.3	6.0	7	16	16	13	16	8	13	7	13	2
Temperature datasets																				
JRA-55	-0.84	-0.33	-0.39	-0.77	0.07	40.0	33.3	52.3	37.8	93.2	1	1	2	2	2	1	3	5	3	3
MERRA-2	-1.14	-0.37	-0.44	-0.76	0.07	58.1	40.8	46.7	34.3	90.8	6	5	5	1	3	6	6	2	2	2
EWEMBI	-0.96	-0.33	-0.42	-0.81	0.06	44.4	32.5	48.2	39.0	94.3	3	2	4	5	4	2	1	4	4	4
WFDEI	-0.96	-0.33	-0.41	-0.81	0.06	44.4	32.5	47.2	39.0	94.4	2	3	3	4	5	3	2	3	5	5
ERA5	-1.01	-0.34	-0.45	-0.83	0.08	54.6	39.1	42.6	32.7	88.0	5	4	6	6	1	5	5	1	1	1
PGF v3	-1.01	-0.38	-0.39	-0.78	0.06	50.1	38.4	54.3	39.2	95.4	4	6	1	3	6	4	4	6	6	6

8.2 Boxplots

### 8.2.1 Combined calibration and evaluation periods
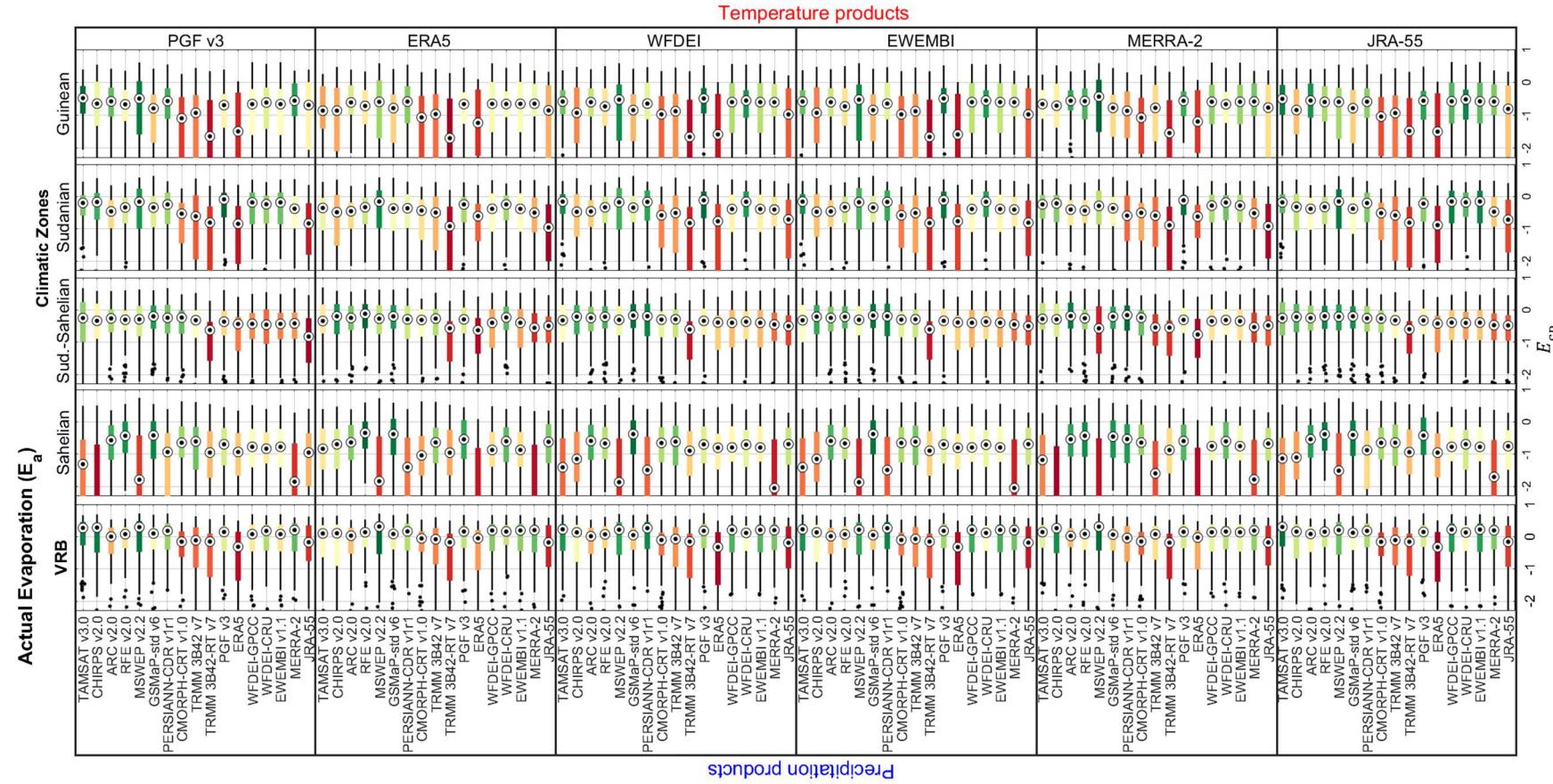
Figure S47. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Volta River basin (VRB) and its climatic zones, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
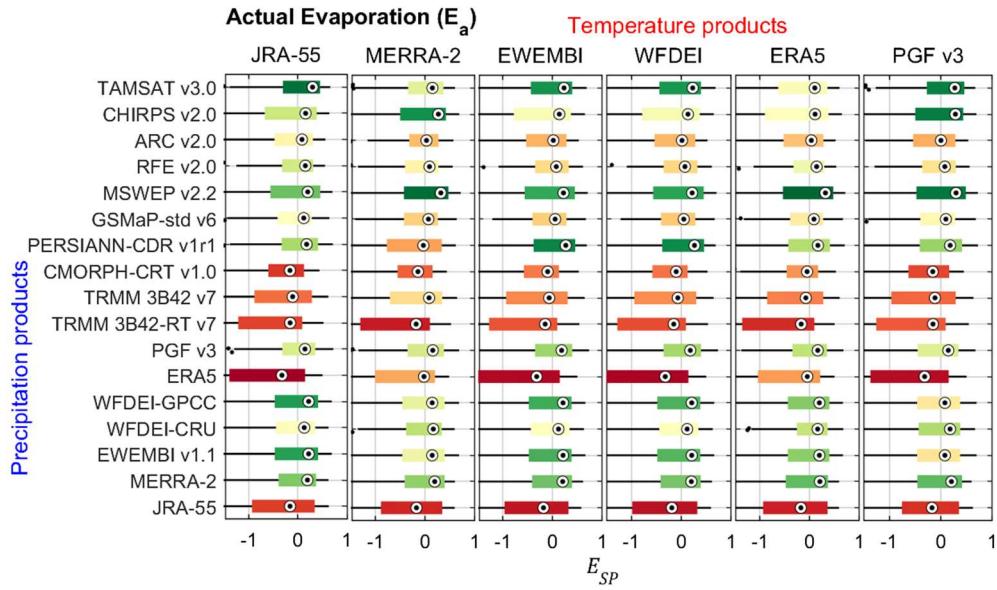
Figure S48. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
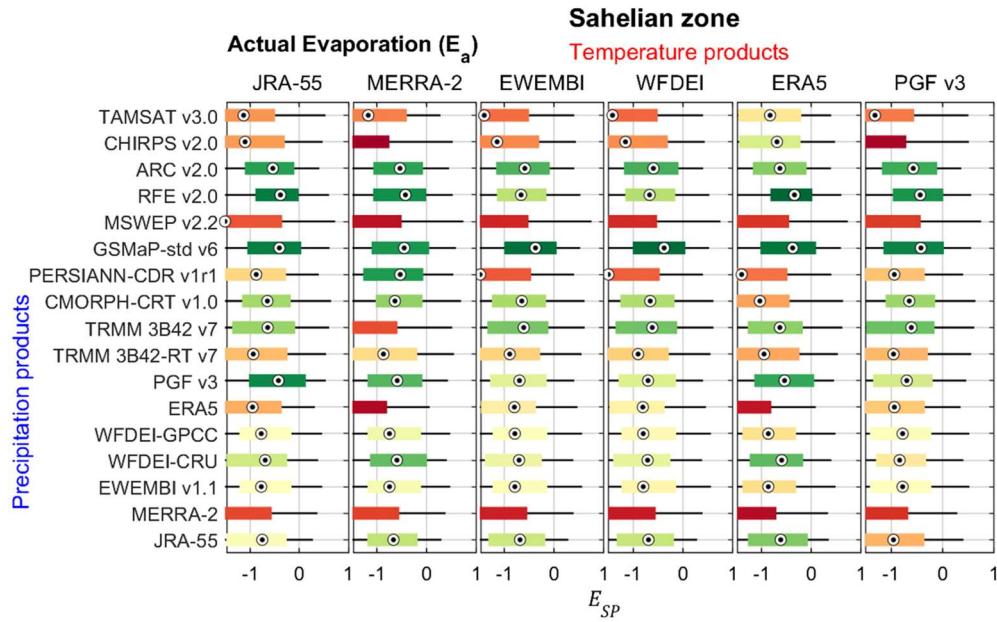
Figure S49. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
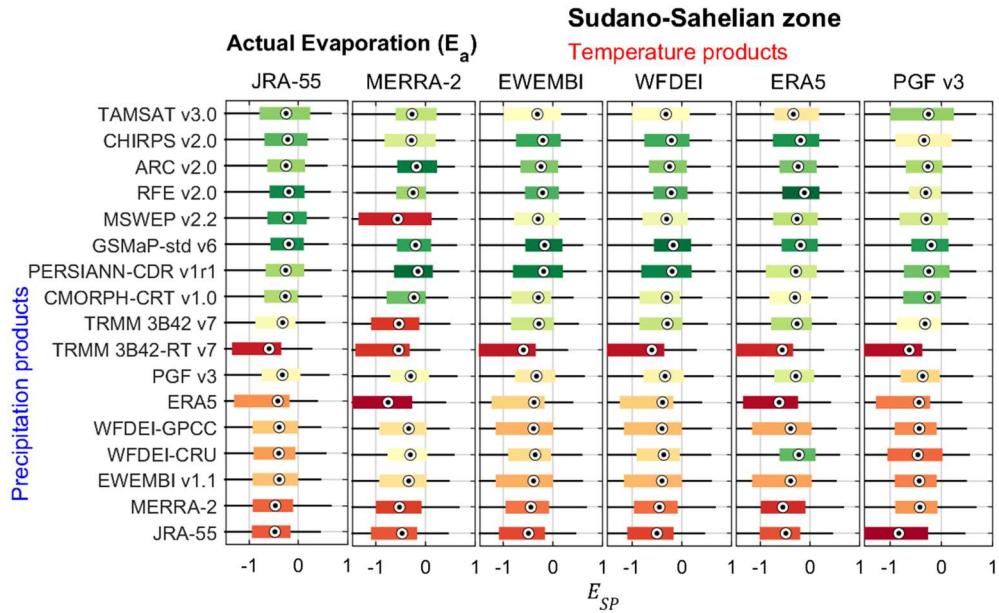
Figure S50. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
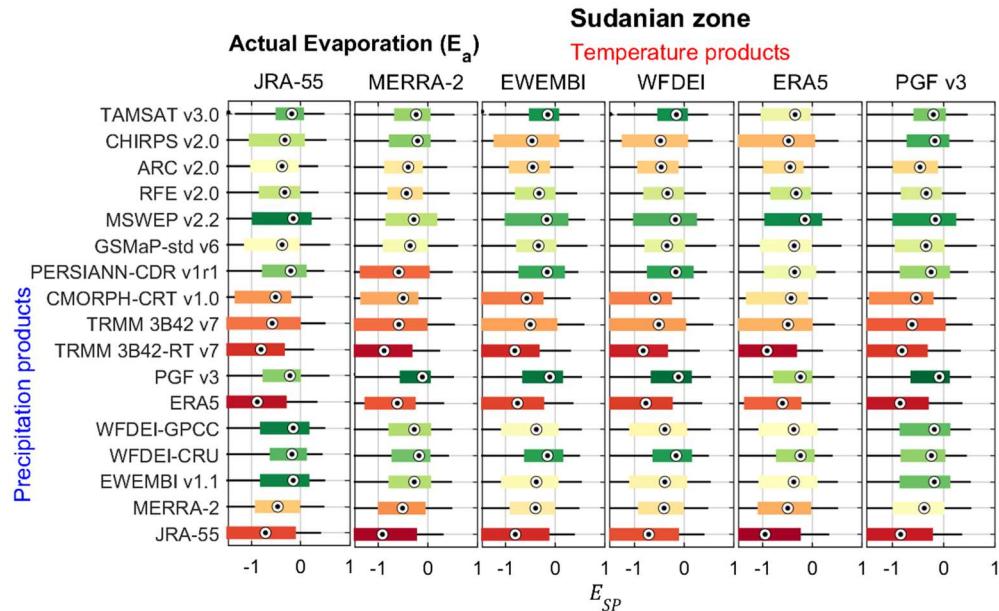
Figure S51. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
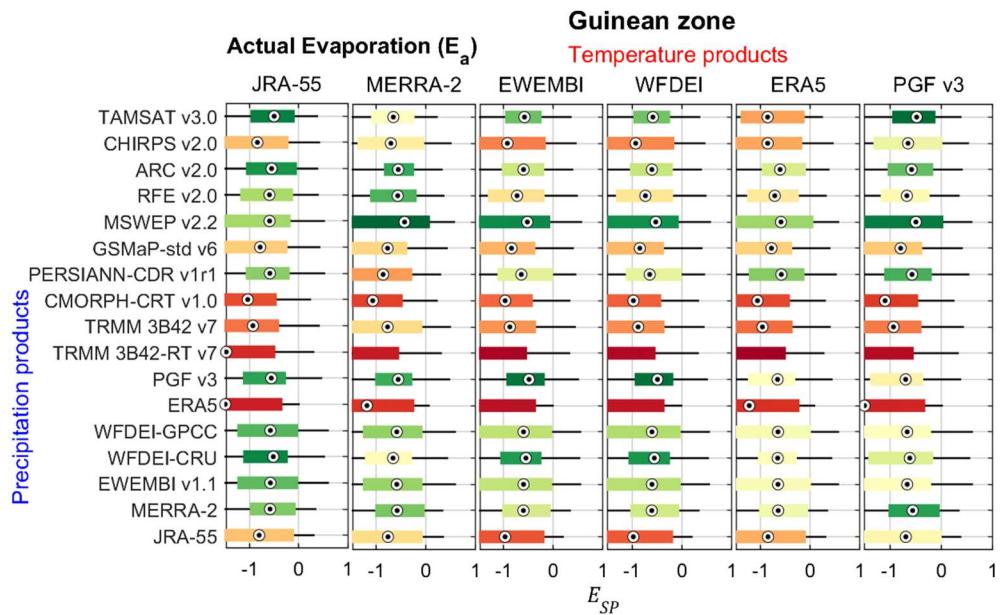
Figure S52. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over the entire simulation period (2003-2012) for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

8.2.2 Separated calibration and evaluation periods
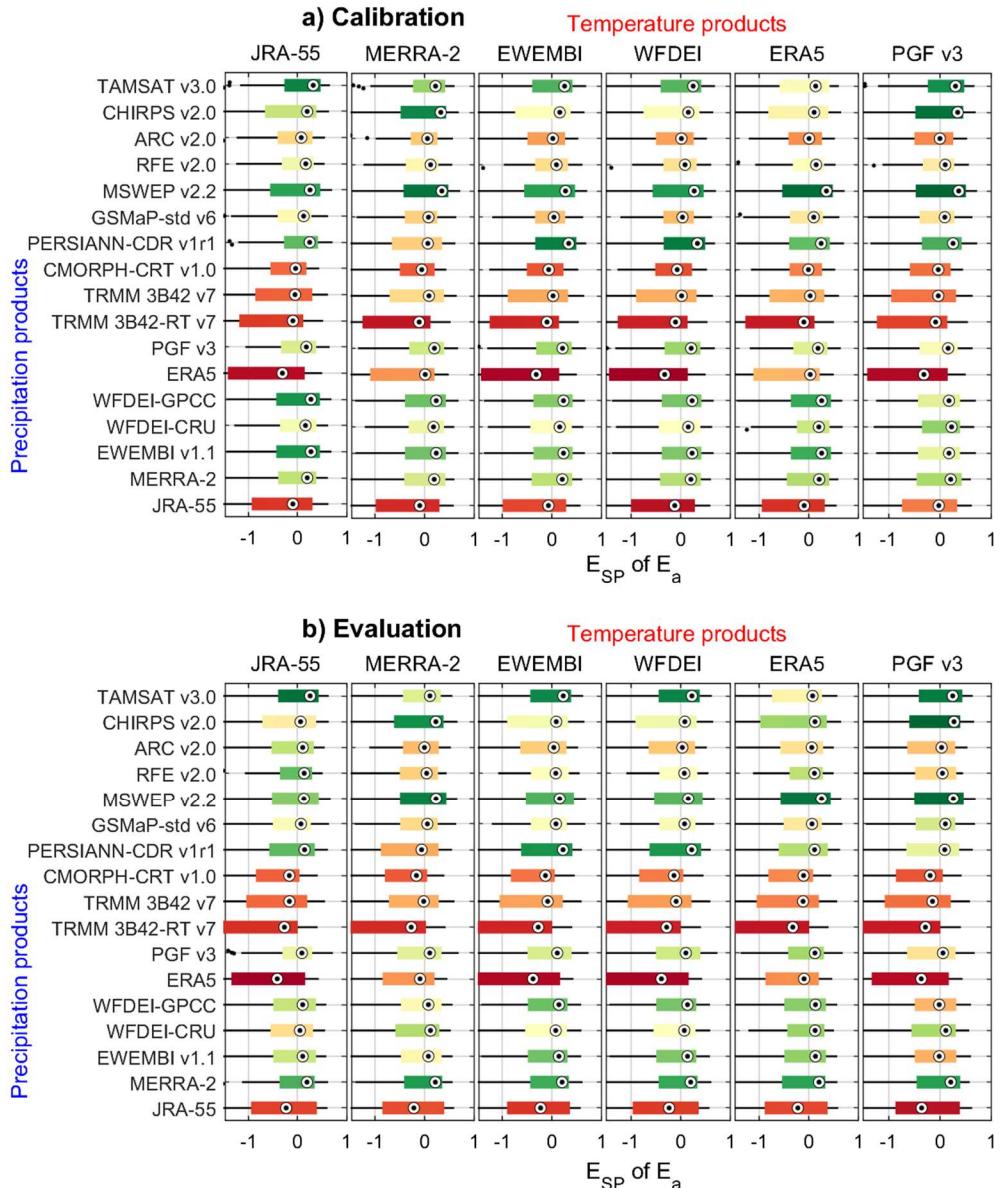
Figure S53. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Volta River basin (VRB), using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
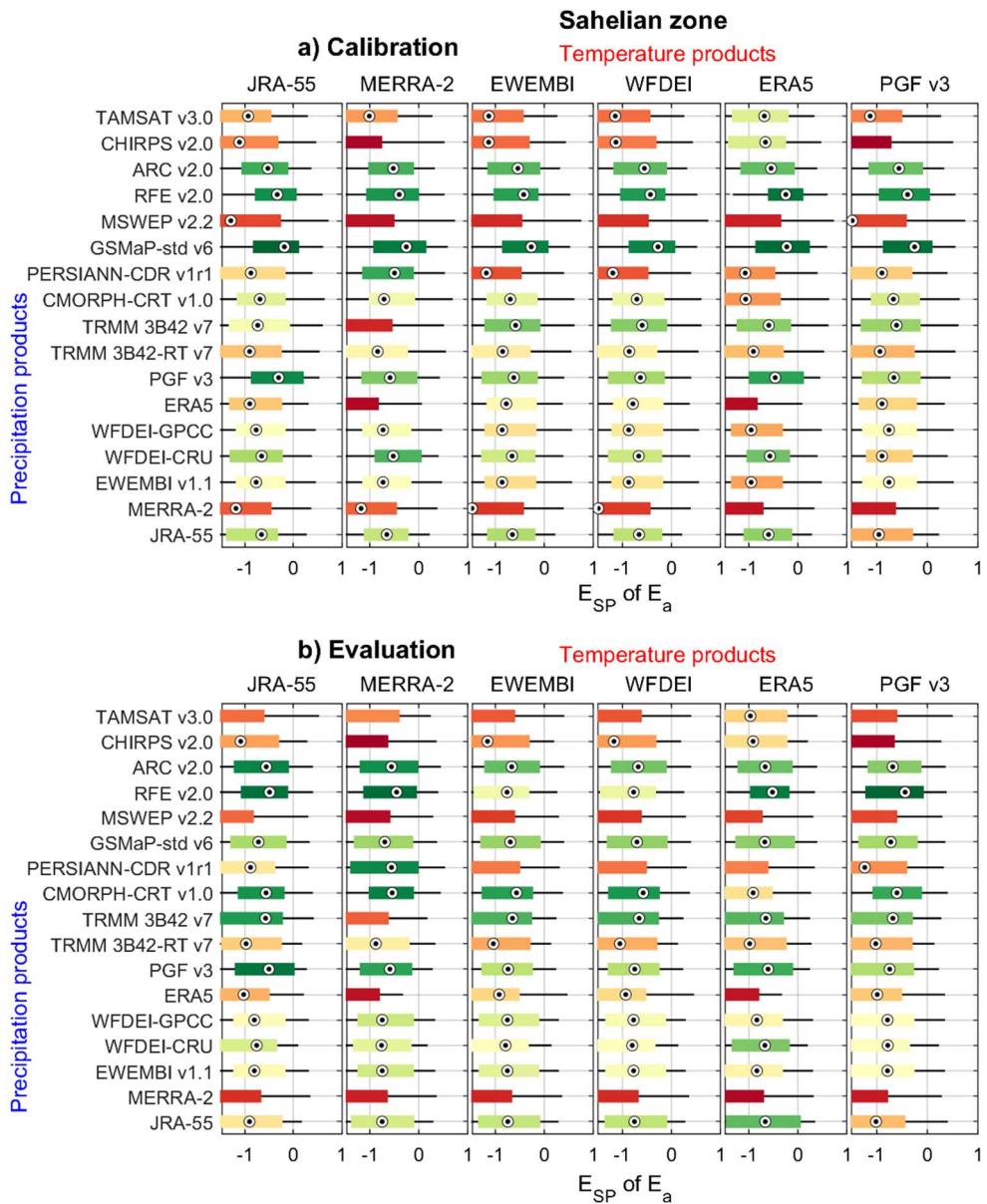
Figure S54. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
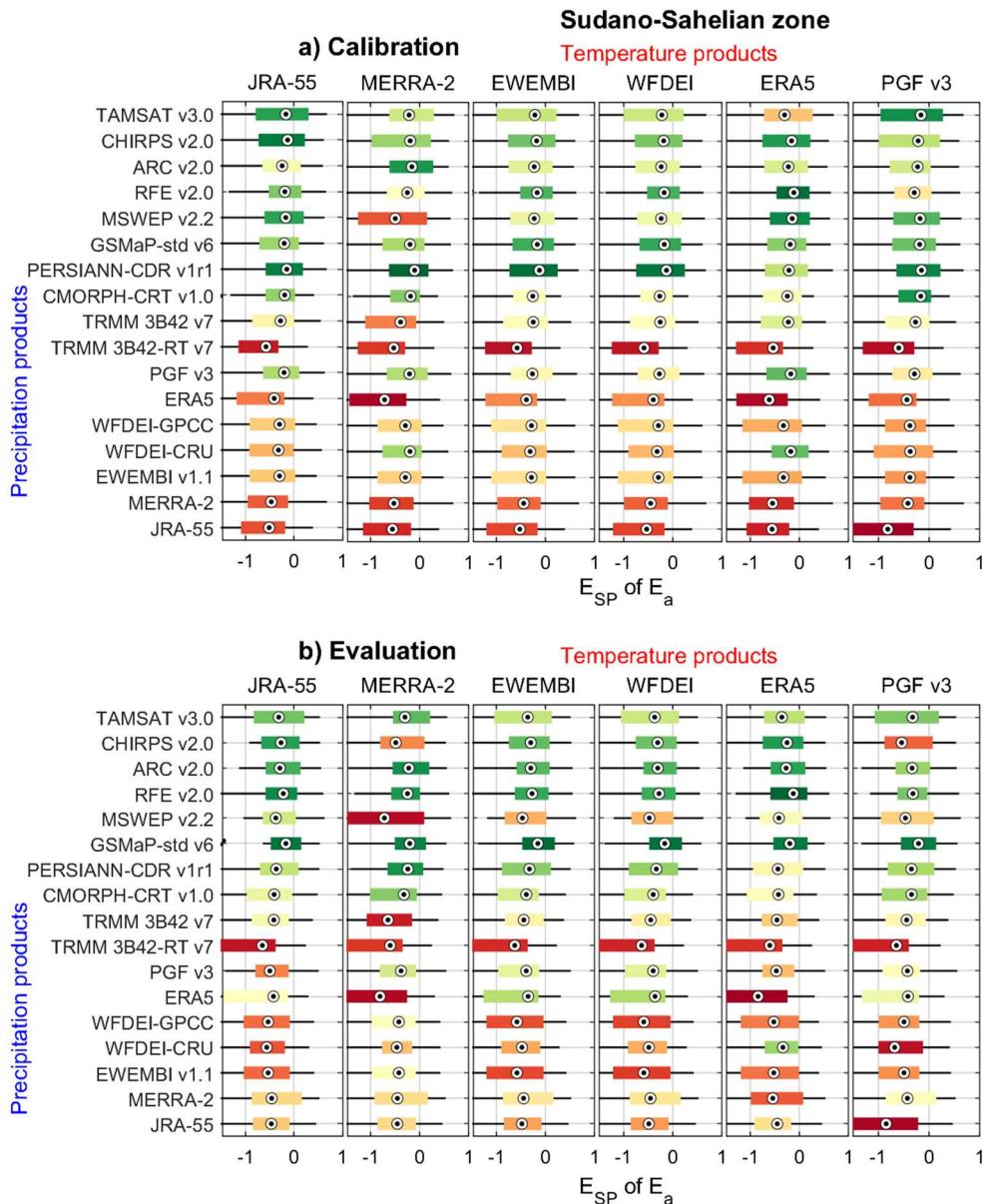
Figure S55. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudano-Sahelian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
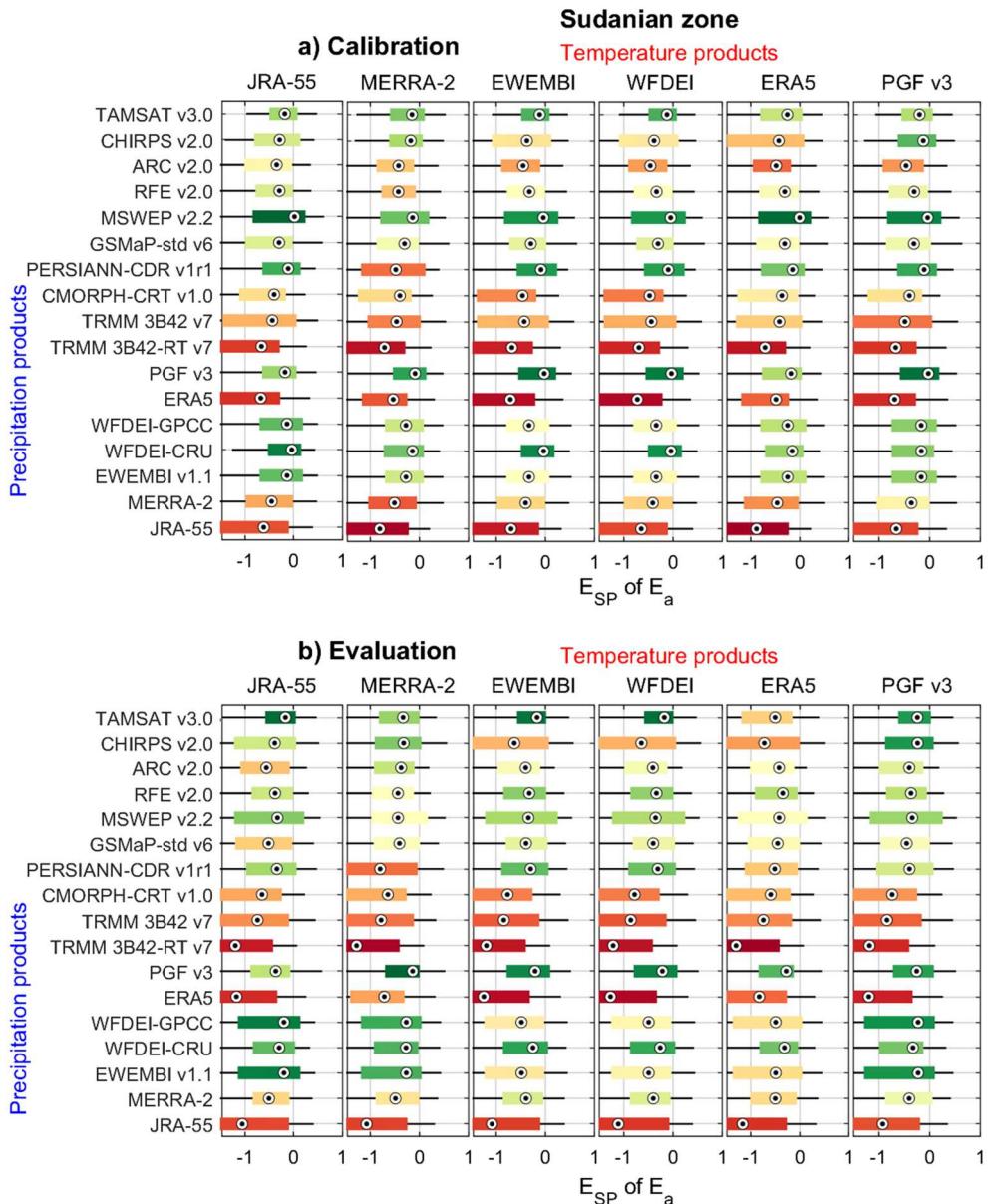
Figure S56. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Sudanian zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.
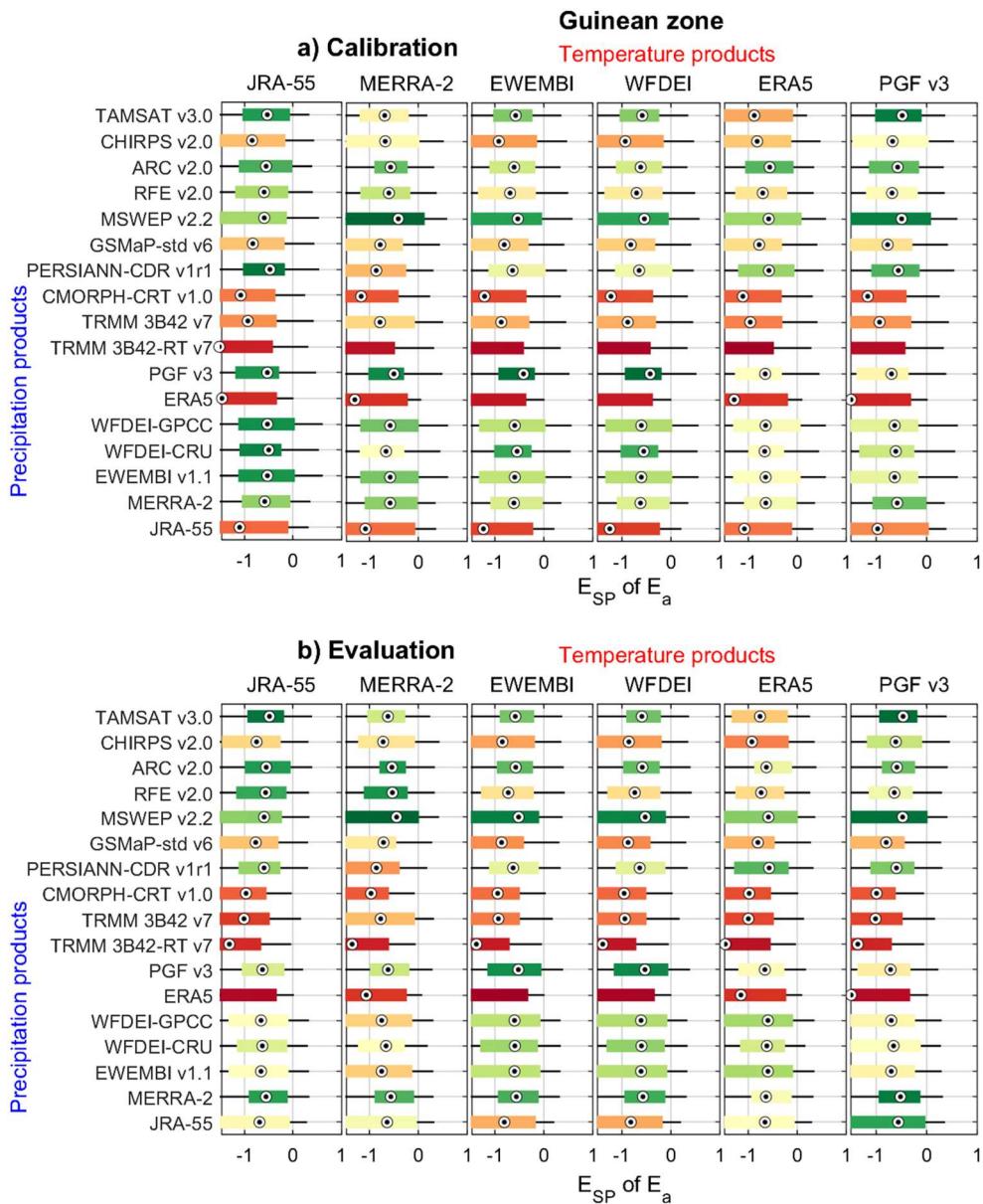
Figure S57. Spatial pattern efficiency (E_{SP}) of actual evaporation (E_a) over (a) the calibration (2003-2008) and (b) the evaluation (2009-2012) periods for the Guinean zone, using different combinations of precipitation and temperature products for hydrological modelling. The boxplots are colored from the best (green) to the worst performance (red) based on the median value.

8.3 Time series
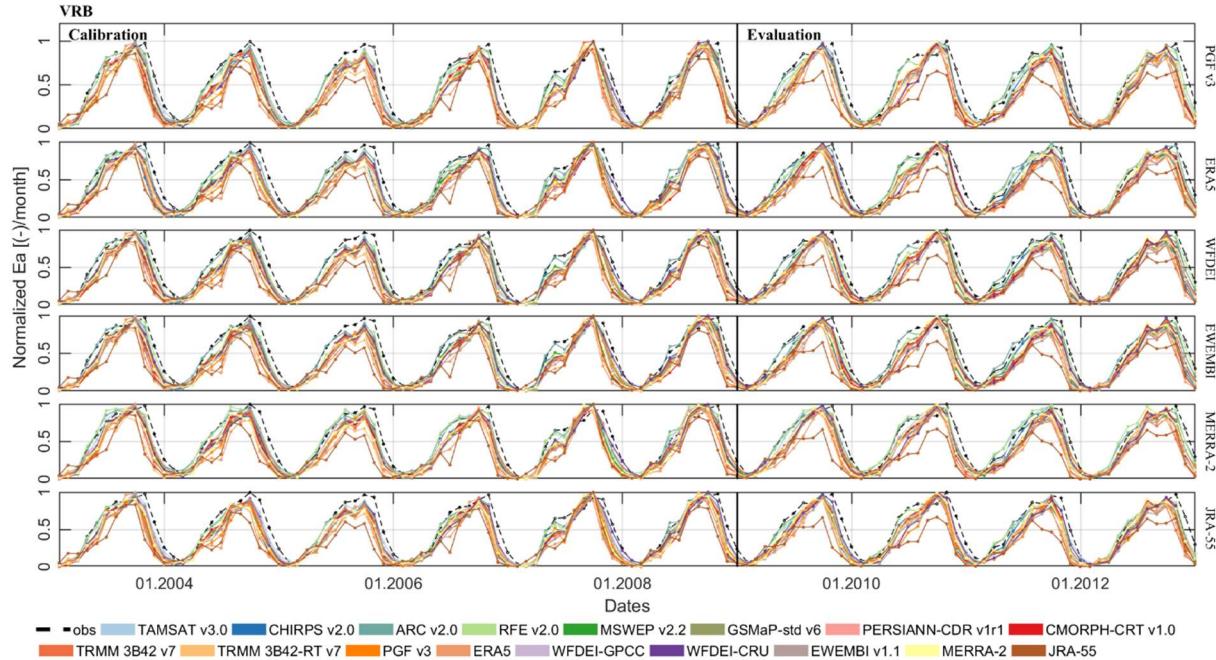
Figure S58. Monthly time series of actual evaporation (E_a) in the Volta River basin (VRB) obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
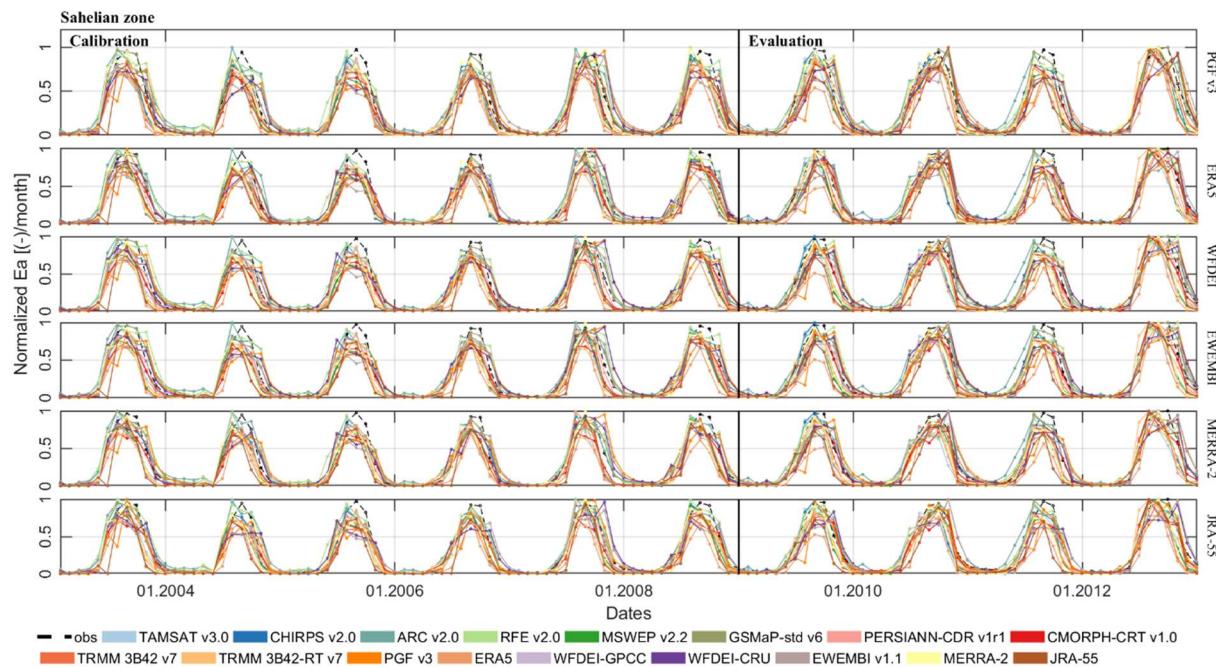

Figure S59. Monthly time series of actual evaporation (E_a) in the Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
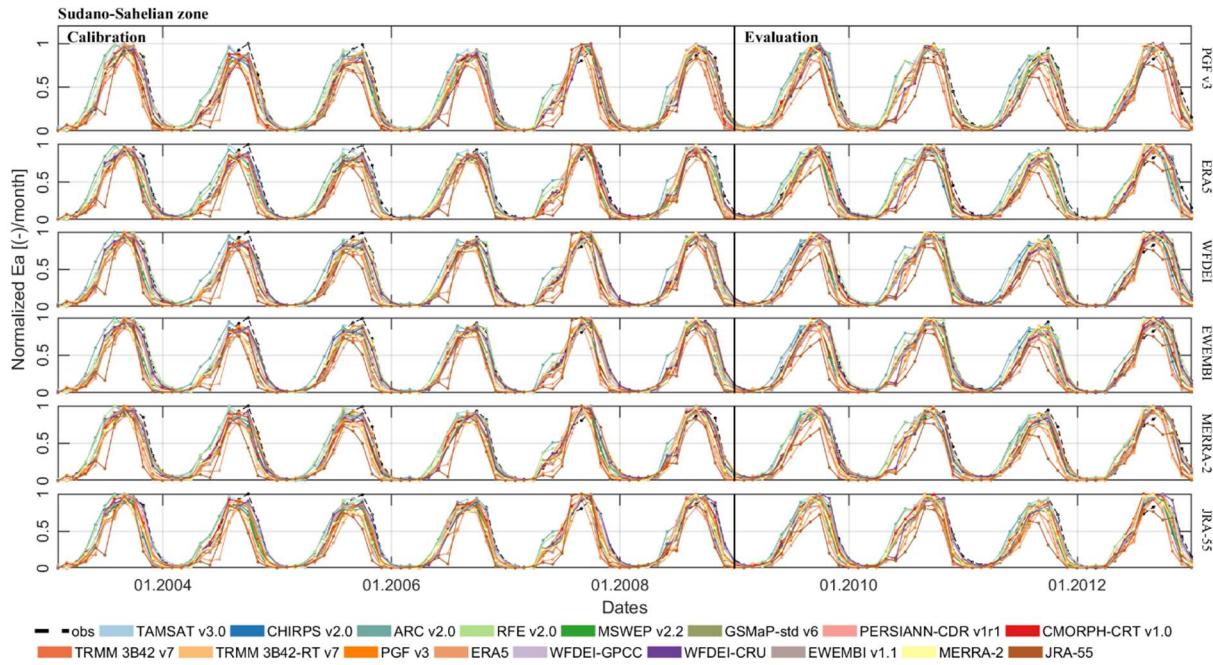
Figure S60. Monthly time series of actual evaporation (E_a) in the Sudano-Sahelian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.
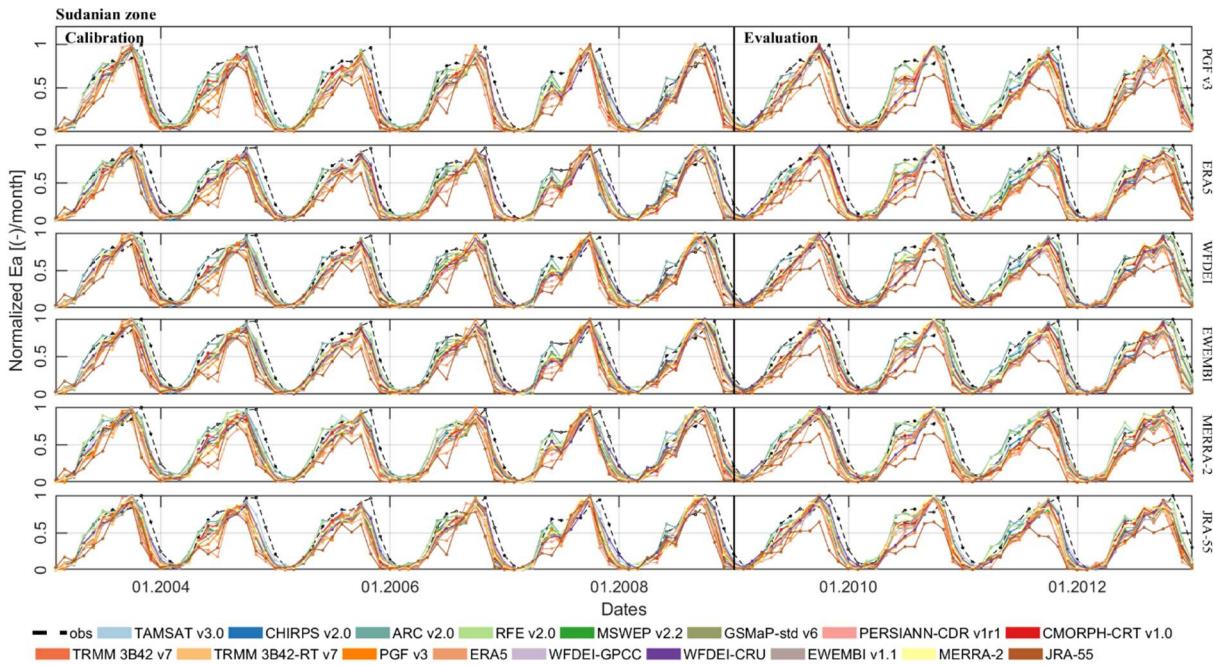
Figure S61. Monthly time series of actual evaporation (E_a) in the Sudanian zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.

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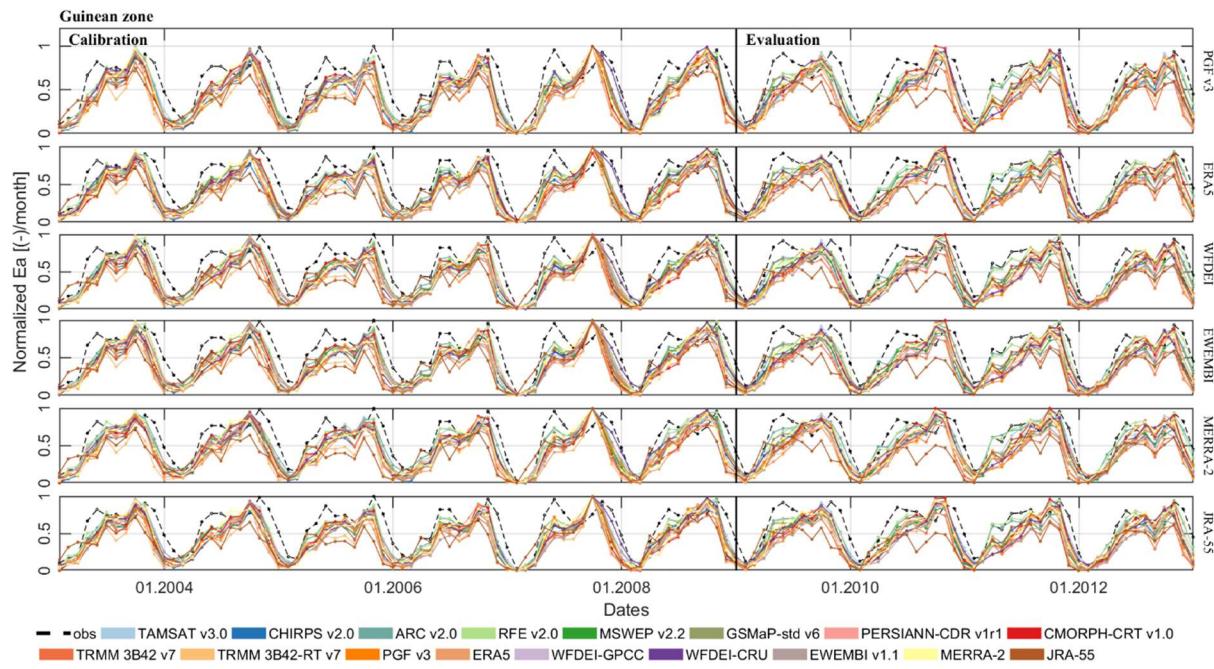
Figure S62. Monthly time series of actual evaporation (E_a) in the Guinean zone of the Volta basin obtained for different combinations of rainfall datasets (colors in legend) and temperature datasets (right y-axis of the 6 subplots) used as inputs in a hydrological model (i.e. mHM). All values are normalized between 0 and 1.

8.4 Maps of long-term average
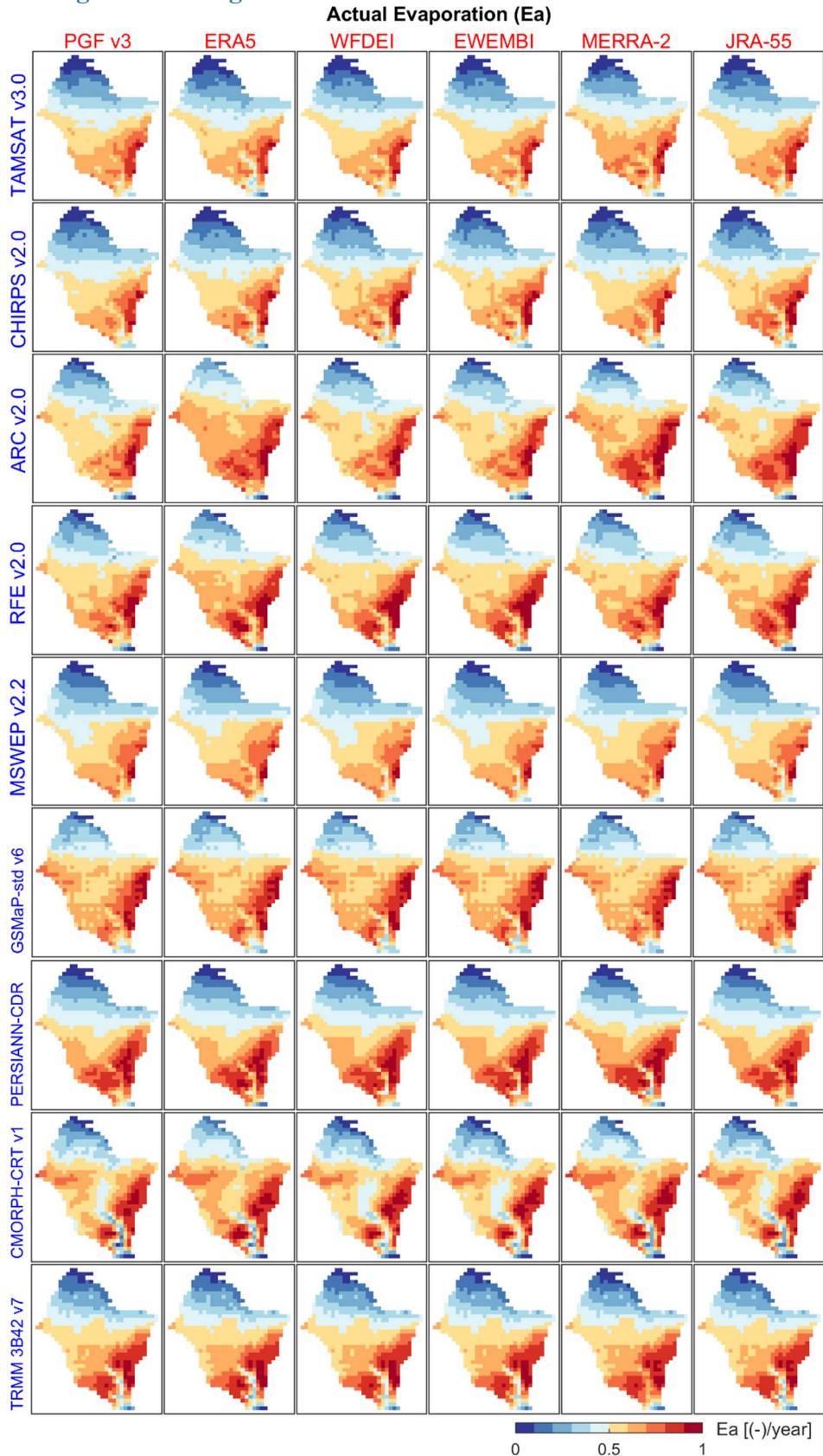
Figure S63. (Part1/2) Maps of long-term (2003-2012) annual average of actual evaporation (E_a) obtained as outputs of hydrological modelling using different combinations of rainfall datasets (y-axis, blue font) and temperature datasets (x-axis, red font). The values are normalized for better emphasizing on patterns and using a unique color scale.
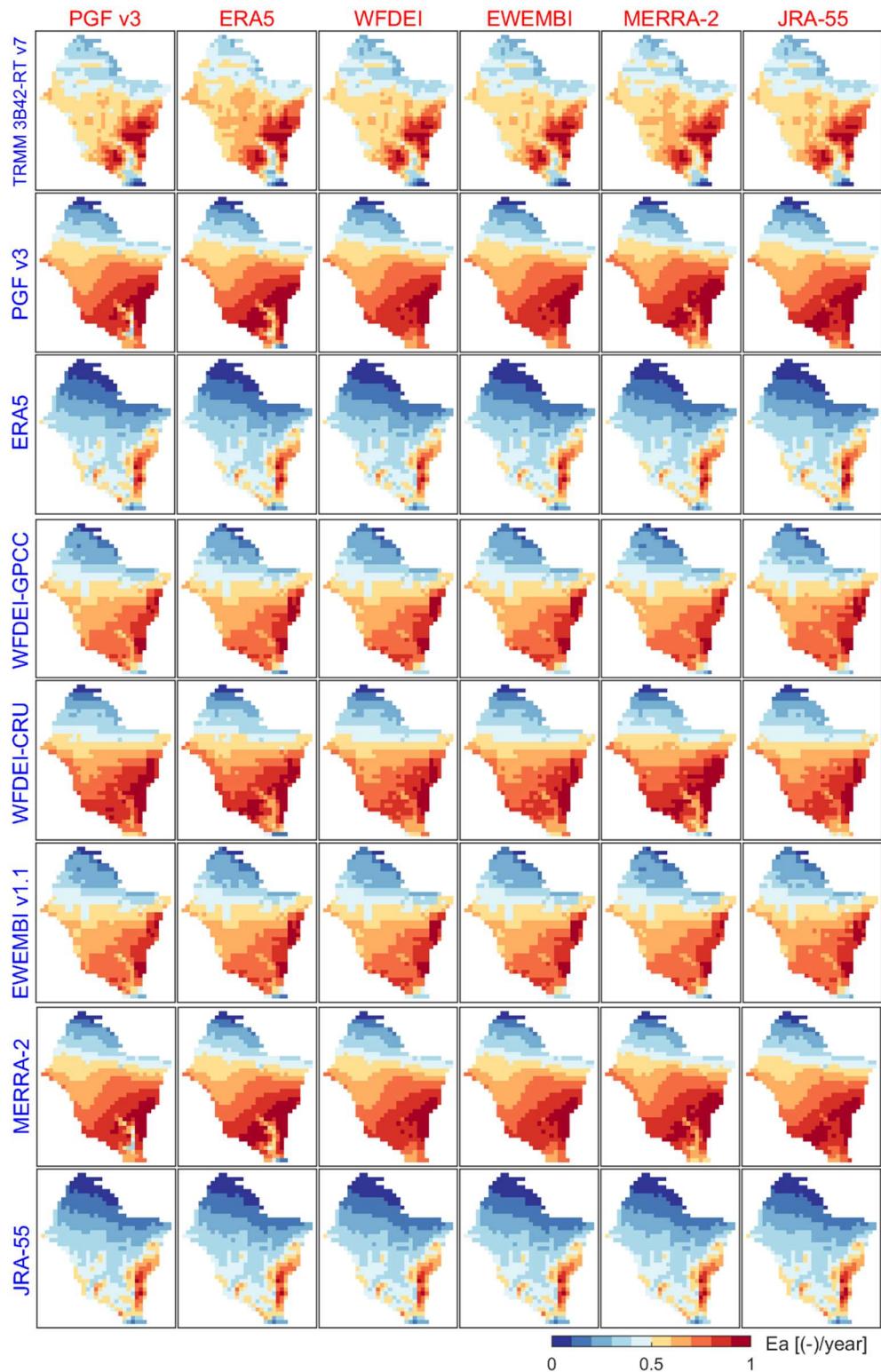
Figure S64. (Part2/2) Maps of long-term (2003-2012) annual average of actual evaporation (E_a) obtained as outputs of hydrological modelling using different combinations of rainfall datasets (y-axis, blue font) and temperature datasets (x-axis, red font). The values are normalized for better emphasizing on patterns and using a unique color scale.

9 Model parameters

9.1 Initial global parameter set used for model calibration

Table S18. mHM global parameters. The description of the model parameters can be found in the work of Samaniego et al. (2010).

Parameters	Lower bound	Upper bound	Initial value
Interception			
canopyInterceptionFactor	0.01	0.40	0.278
Soil Moisture			
orgMatterContent_forest	0.00	200.00	105.84
orgMatterContent_impervious	0.00	1.00	0.755
orgMatterContent_pervious	0.00	4.00	2.967
PTF_lower66_5_constant	0.65	1.00	0.939
PTF_lower66_5_clay	0.000	0.004	0.003
PTF_lower66_5_Db	-0.373	-0.187	-0.204
PTF_higher66_5_constant	0.536	1.123	0.924
PTF_higher66_5_clay	-0.009	0.005	-0.001
PTF_higher66_5_Db	-0.551	-0.091	-0.107
PTF_Ks_constant	-1.700	-0.285	-0.424
PTF_Ks_sand	0.0060	0.0260	0.0064
PTF_Ks_clay	0.001	0.013	0.005
rootFractionCoefficient_forest	0.800	0.999	0.864
rootFractionCoefficient_impervious	0.800	0.950	0.912
rootFractionCoefficient_pervious	0.001	0.090	0.022
infiltrationShapeFactor	1.000	4.000	3.945
Direct sealed area runoff			
imperviousStorageCapacity	0.00	100.00	5.340
Potential evapotranspiration			
PET_a_forest	0.30	1.30	0.5282
PET_a_impervious	0.90	1.30	0.9743
PET_a_pervious	0.30	1.30	0.5088
PET_b	0.00	1.50	1.4993
PET_c	-3.00	0.00	-1.0330
HargreavesSamaniCoeff	0.0020	0.0027	0.0023
Interflow			
interflowStorageCapacityFactor	75.00	400.00	313.85
interflowRecession_slope	0.00	10.00	5.51
fastInterflowRecession_forest	0.00	3.00	2.52
slowInterflowRecession_Ks	1.00	30.00	22.21
exponentSlowInterflow	0.005	0.300	0.283
Percolation			
rechargeCoefficient	0.00	200.00	183.51
Routing			
streamflow_celerity	0.10	15.00	12.47
Geology			
GeoParam1	1.00	1500.00	1037.16
GeoParam2	1.00	1500.00	709.99
GeoParam3	1.00	1500.00	381.09
GeoParam4	1.00	1500.00	525.30
GeoParam5	1.00	1500.00	783.83

## 9.2 Distribution of model parameters after model calibration
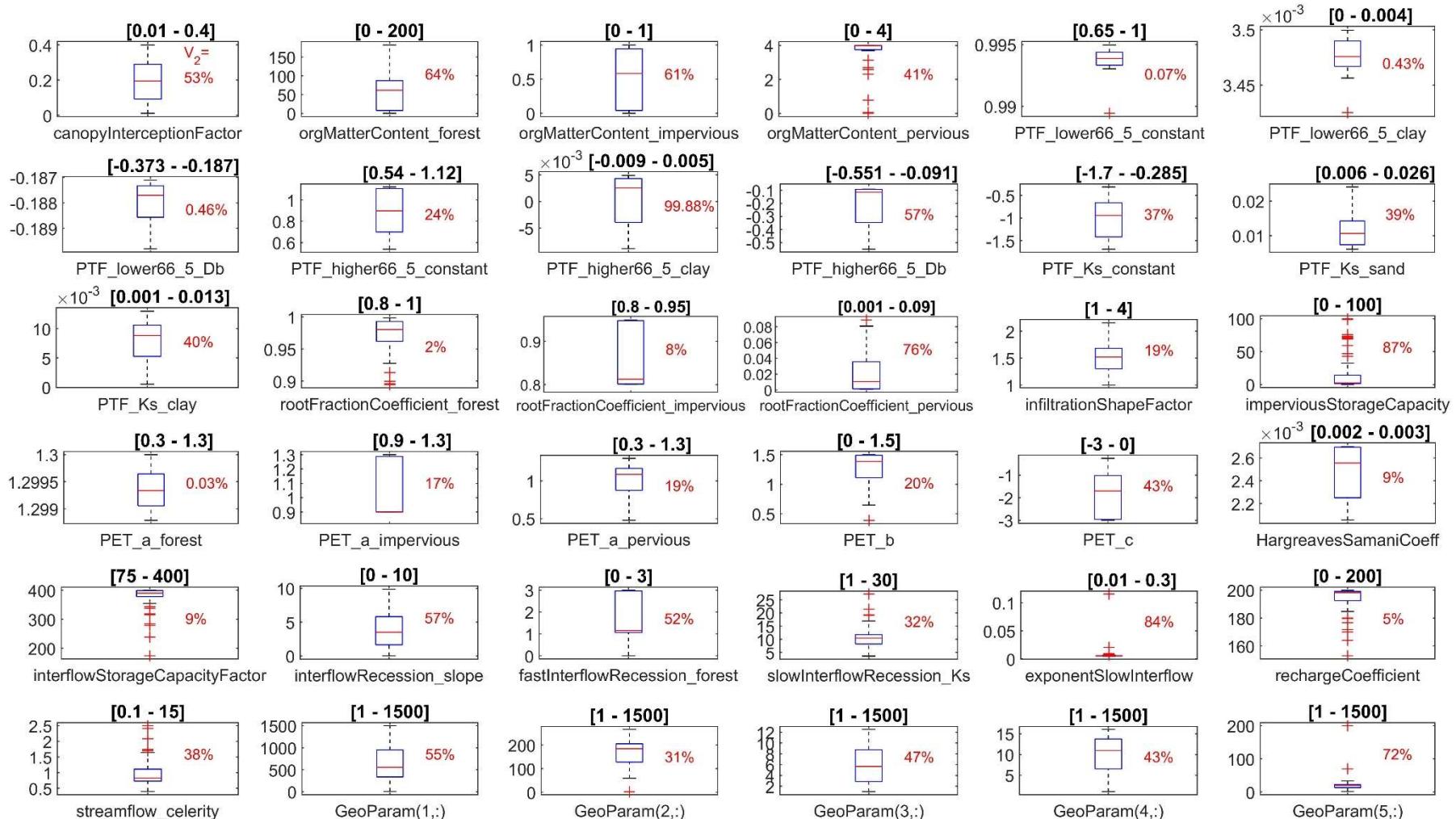
Figure S65: Distribution of mHM global parameters after model calibration with different combinations of precipitation and temperature datasets as inputs. Each boxplot has 102 elements corresponding to parameter values obtained with different input datasets. The initial parameters' ranges are provided in squared brackets. The second-order coefficient of variation (V_2) is given in percentage.
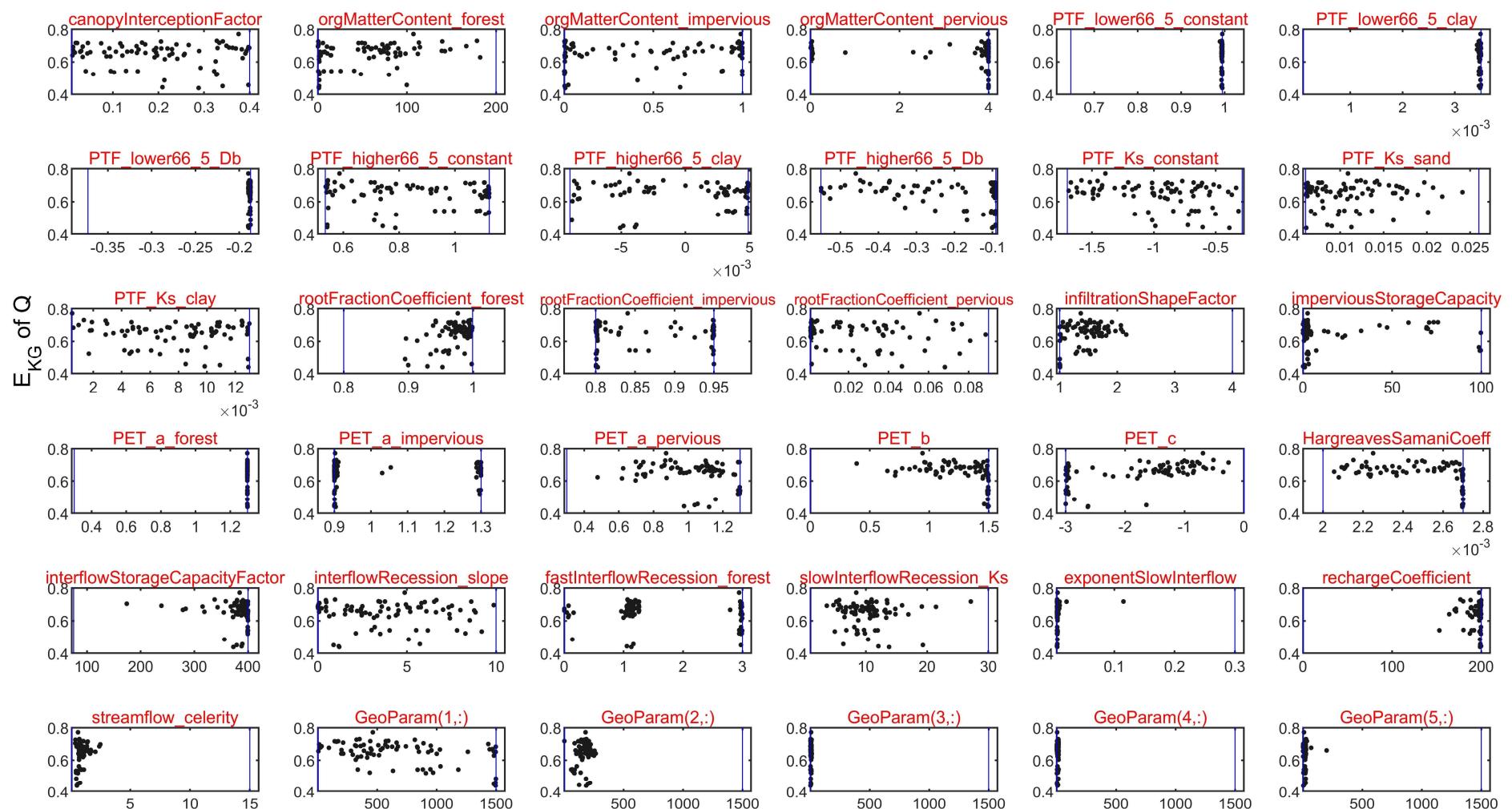
Figure S66: Model performance for streamflow (Q) as a function of final global parameters (subplot titles) obtained after model calibration with different combinations of precipitation and temperature datasets as inputs. The x-axis give the parameter values for 102 different input datasets. The y-axis gives the Kling-Gupta efficiency (E_{KG}) of Q over the simulation period (2003-2012). The vertical lines (in blue) show the lower and upper bounds of the parameter ranges.