



Supplement of

A 500-year annual runoff reconstruction for 14 selected European catchments

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	RMSE calibration						RMSE validation							
Orsova–Danube	47	29	28	27	25	24	20	91	35	35	32	32	36	39
Dresden–Elbe	49	34	34	33	37	32	31	62	40	41	41	40	37	38
Wasserburg–Inn	126	71	68	70	72	69	54	146	74	76	74	77	74	79
Blois–Loire	54	50	46	50	41	44	43	53	42	43	42	44	45	47
Montjean–Loire	50	43	39	43	37	35	35	53	45	49	44	47	42	44
NeuerHafen–Main	52	50	48	47	46	45	45	68	49	51	50	53	45	43
Wuerzburg–Main	58	54	50	51	46	48	39	70	42	49	37	45	39	45
BaselRheinhalle–Rhine	130	79	77	75	75	77	64	117	88	90	84	83	81	87
Baselschiffaende–Rhine	128	74	70	71	69	71	60	115	89	89	85	79	82	84
Koeln–Rhine	52	48	47	47	44	40	34	59	42	43	45	44	41	44
Rees–Rhine	59	47	43	45	43	40	35	64	54	54	56	59	54	56
Hann–Munden–Wesser	46	45	44	44	43	38	33	67	42	43	43	46	38	44
Bodenwerder–Wesser	46	45	42	45	44	38	28	57	47	45	47	47	43	54
Intschede–Wesser	49	45	42	45	45	37	40	56	56	52	55	50	51	48
Decin–Elbe	52	34	33	32	30	29	28	75	37	38	37	36	36	35
Elverum–Glama	71	58	52	55	55	57	49	94	90	88	95	85	90	107
Vargoens KRV– Goeta	116	71	65	69	67	51	51	81	66	84	67	69	65	59
Muroleekoski–Kokemenjoki	87	47	33	44	45	40	42	98	61	35	60	61	56	57
Smalininkai–Nemunas	70	33	33	32	32	31	29	52	33	33	32	33	34	33
Burghausen–Salzach	139	131	123	114	97	131	111	52	181	182	202	208	178	195
Vlotho–Wesser	53	45	45	45	44	37	41	84	68	63	70	64	65	63
	GR1A [P;T]	BRNN [P;T]	LSTM [P;T]	BRNN [P;T, PDSI]	LSTM [P;T, PDSI]	BRNN [P;T, Lag]	LSTM [P;T, Lag]	GR1A [P;T]	BRNN [P;T]	LSTM [P;T]	BRNN [P;T, PDSI]	LSTM [P;T, PDSI]	BRNN [P;T, Lag]	LSTM [P;T, Lag]

Figure S1. Same as Fig. 5 but for RMSE

	MAE calibration						MAE validation							
Orsova–Danube	37	24	22	22	19	19	14	78	28	28	26	25	28	30
Dresden–Elbe	39	27	26	26	28	24	23	50	31	32	32	31	29	29
Wasserburg–Inn	99	54	50	53	53	52	37	125	61	63	62	62	60	65
Blois–Loire	42	39	34	40	29	35	31	44	34	32	33	33	35	36
Montjean–Loire	40	33	29	34	26	29	25	44	37	40	36	38	31	33
NeuerHafen–Main	42	38	35	36	35	35	36	51	40	42	40	42	35	33
Wuerzburg–Main	46	42	38	40	36	38	28	59	34	39	31	36	32	36
BaselRheinhalle–Rhine	108	64	60	59	57	61	46	98	72	73	69	67	69	75
Baselschiffaende–Rhine	107	61	54	57	53	57	46	96	73	73	70	65	70	69
Koeln–Rhine	44	38	35	37	33	32	24	48	33	32	35	34	32	33
Rees–Rhine	46	37	32	35	33	32	27	51	35	37	38	39	35	37
Hann–Munden–Wesser	37	34	32	34	32	30	24	56	33	33	34	35	30	35
Bodenwerder–Wesser	38	33	30	33	32	30	21	46	38	36	38	36	35	45
Intschede–Wesser	40	34	30	34	34	29	31	48	44	42	43	40	41	37
Decin–Elbe	41	27	24	25	22	23	21	62	29	30	28	28	28	27
Elverum–Glama	55	46	38	44	43	45	36	72	66	64	69	63	64	79
Vargoens KRV– Goeta	98	58	48	57	53	42	40	64	55	71	52	56	54	50
Muroleekoski–Kokemenjoki	72	36	23	34	35	31	33	79	46	28	43	45	43	43
Smalininkai–Nemunas	62	24	24	23	22	22	20	44	26	26	25	26	28	27
Burghausen–Salzach	106	105	87	87	64	106	80	44	146	154	162	167	144	164
Vlotho–Wesser	44	34	33	34	32	30	32	70	56	51	57	52	54	50
	GR1A [P;T]	BRNN [P;T]	LSTM [P;T]	BRNN [P;T, PDSI]	LSTM [P;T, PDSI]	BRNN [P;T, Lag]	LSTM [P;T, Lag]	GR1A [P;T]	BRNN [P;T]	LSTM [P;T]	BRNN [P;T, PDSI]	LSTM [P;T, PDSI]	BRNN [P;T, Lag]	LSTM [P;T, Lag]

Figure S2. Same as Fig. 5 but for MAE

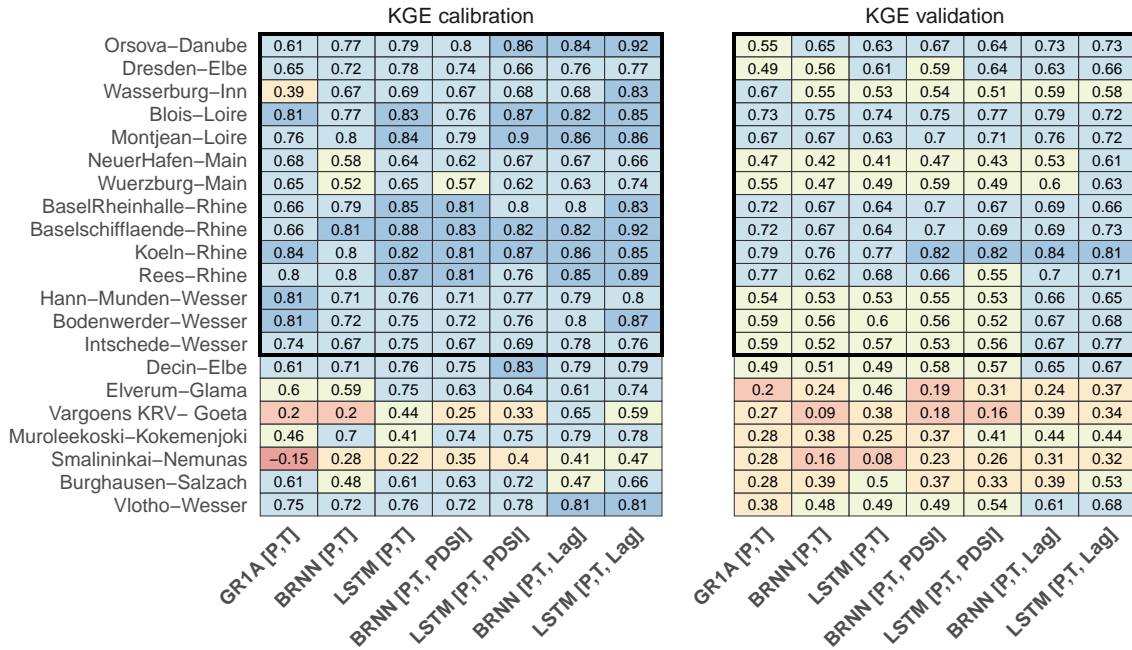


Figure S3. Same as Fig. 5 but for KGE

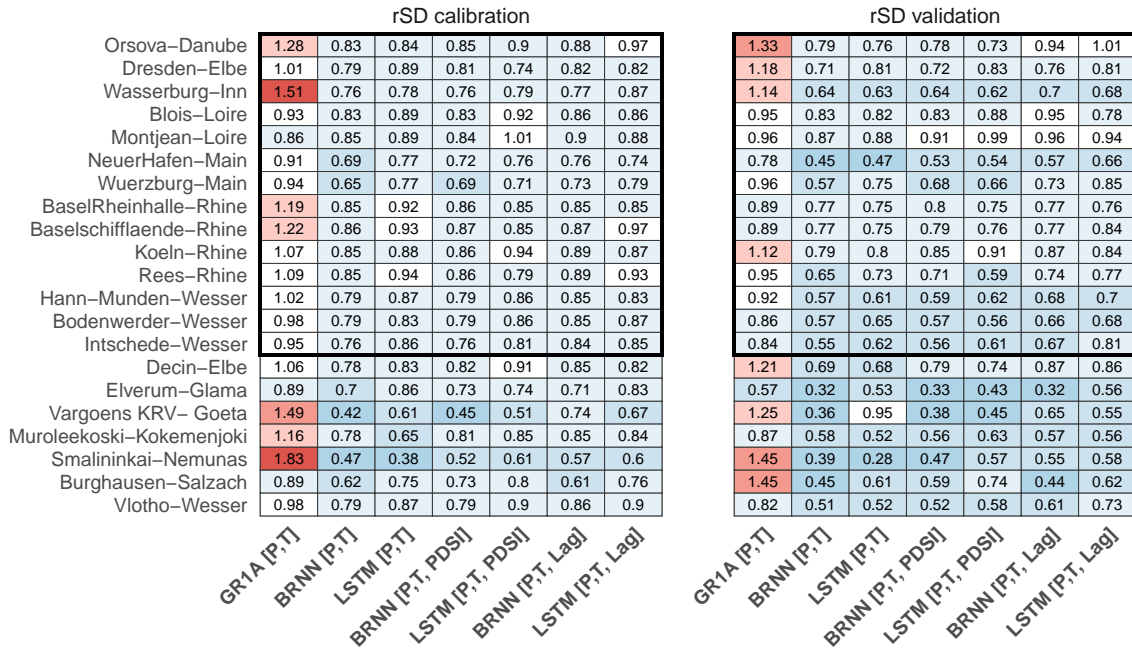


Figure S4. Same as Fig. 5 but for Standard deviation ratio

	relBIAS calibration							relBIAS validation						
Orsova–Danube	-0.007	-0.002	0.003	-0.002	-0.009	-0.001	0.006	0.247	0.031	0.029	0.02	-0.003	0.034	0.044
Dresden–Elbe	-0.013	-0.001	0.011	-0.001	-0.013	-0.002	-0.016	0.113	-0.033	-0.012	-0.057	-0.04	-0.014	-0.018
Wasserburg–Inn	0.005	0	0.002	-0.001	0.003	0	-0.013	0.126	0.001	0.005	-0.003	0.003	0.003	-0.027
Blois–Loire	-0.001	0	-0.013	0	-0.01	-0.002	-0.046	0.038	-0.002	-0.01	-0.002	-0.002	0.001	-0.05
Montjean–Loire	0.001	0.001	0.003	0	-0.017	-0.001	-0.021	0.133	0.066	0.065	0.062	0.057	0.058	0.038
NeuerHafen–Main	-0.003	0.002	0.022	0	-0.013	0.001	-0.008	0.16	-0.027	-0.016	-0.036	-0.028	-0.025	-0.032
Wuerzburg–Main	-0.007	0.001	-0.011	0	0.013	0.001	0.006	0.244	0.065	0.069	0.034	0.062	0.069	0.092
BaselRheinhalle–Rhine	0.011	0.002	-0.013	0.001	0.002	0.002	-0.003	0.105	0.056	0.046	0.052	0.045	0.048	0.046
Baselschiffaende–Rhine	0.012	0.002	-0.017	0.002	-0.005	0.002	-0.014	0.102	0.058	0.042	0.055	0.042	0.049	0.045
Koeln–Rhine	0	0	0.003	0.001	0.013	0.001	-0.003	0.069	-0.032	-0.031	-0.05	-0.03	-0.042	-0.043
Rees–Rhine	0.001	0.001	0.011	0.001	0.005	0.001	0.003	-0.056	-0.016	-0.014	-0.033	-0.015	-0.034	-0.025
Hann–Munden–Wesser	-0.004	-0.001	0.033	-0.001	0.006	-0.001	0.001	0.147	-0.03	0.004	-0.04	-0.028	-0.033	-0.063
Bodenwerder–Wesser	-0.003	-0.002	0.017	-0.002	0.03	-0.001	-0.017	0.084	-0.065	-0.042	-0.067	-0.042	-0.074	-0.12
Intschede–Wesser	-0.001	-0.001	0.037	-0.001	0.051	-0.001	0.021	0.026	-0.088	-0.059	-0.09	-0.051	-0.104	-0.093
Decin–Elbe	-0.017	-0.003	-0.004	0	-0.004	0	-0.01	0.324	0.037	0.026	0.019	0.001	0.044	0.033
Elverum–Glama	0.032	0	0.003	0	0.033	0.001	-0.003	-0.005	-0.081	-0.098	-0.086	-0.062	-0.081	-0.133
Vargoens KRV– Goeta	0.008	-0.003	-0.019	-0.004	0.018	-0.002	0.026	0.003	-0.085	-0.144	-0.101	-0.101	-0.095	-0.069
Muroleekoski–Kokemenjoki	0.056	-0.001	0.003	0	0	0.001	-0.019	0.253	-0.038	-0.061	-0.014	-0.021	-0.033	-0.036
Smalininkai–Nemunas	-0.037	-0.001	0.009	-0.001	0.005	-0.001	0.008	0.083	-0.044	-0.04	-0.025	-0.029	-0.066	-0.05
Burghausen–Salzach	0.002	-0.001	0.001	0	0.012	-0.001	-0.006	0.083	-0.083	-0.084	-0.089	-0.067	-0.081	-0.105
Vlotho–Wesser	0	-0.002	0.05	-0.002	0.041	-0.001	0.02	-0.102	-0.12	-0.087	-0.129	-0.096	-0.127	-0.114

Figure S5. Same as Fig. 5 but for relative BIAS

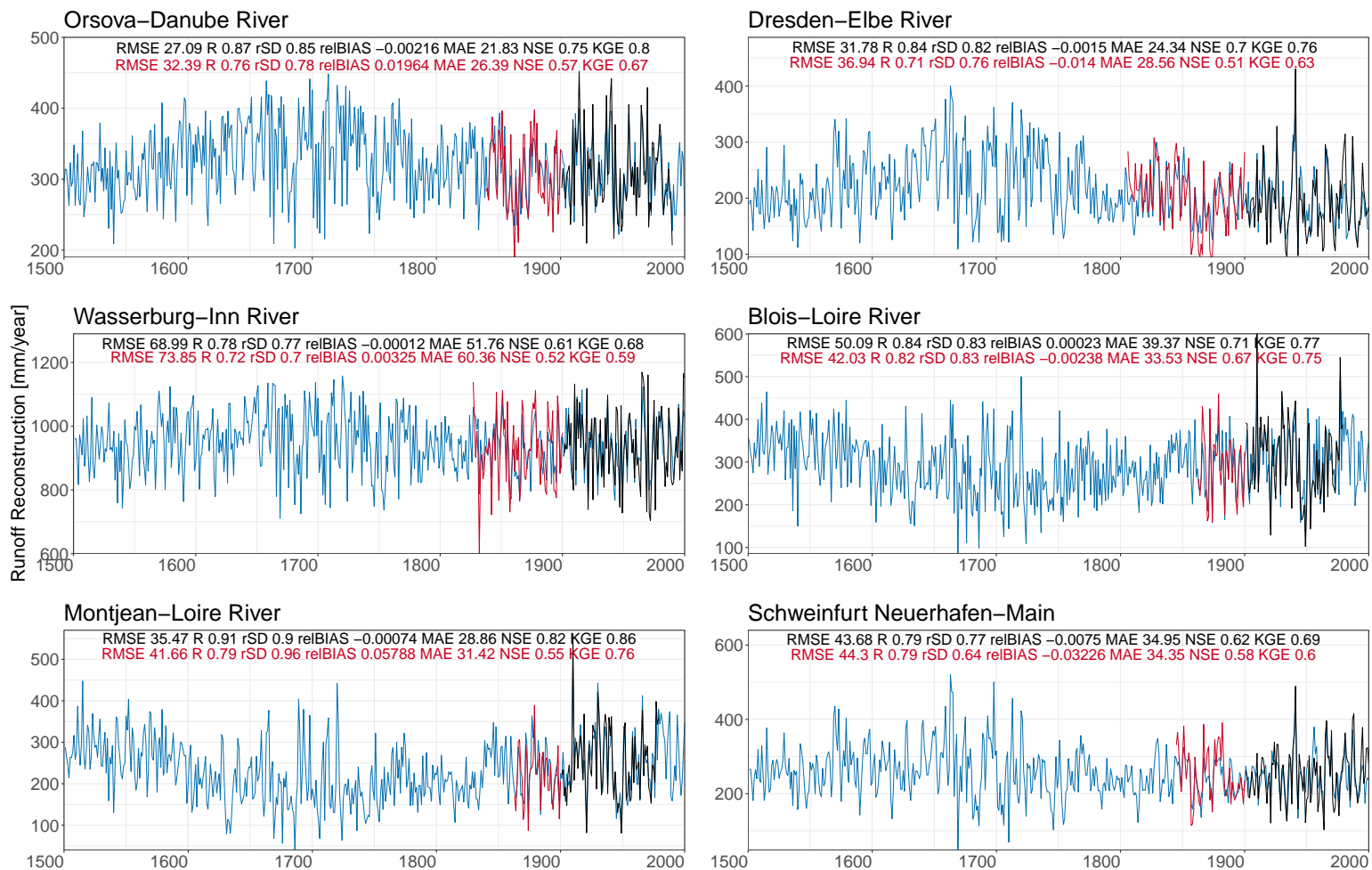


Figure S6. Reconstruction of Runoff over the past 500 years (data series are available in Orsova-Danube River, Dresden-Elbe River, Wasserburg-Inn River, Blois-Loire River, Montjean-Loire River, Schweinfurt Neuerhafen-Main). The black and red color indicate the GRDC observation runoff variable for calibrated and validated portion, whereas, the blue color represents reconstruction value of runoff simulated with the specific combinations. The observed statistic properties for calibration and validation data are displayed in top of the figure

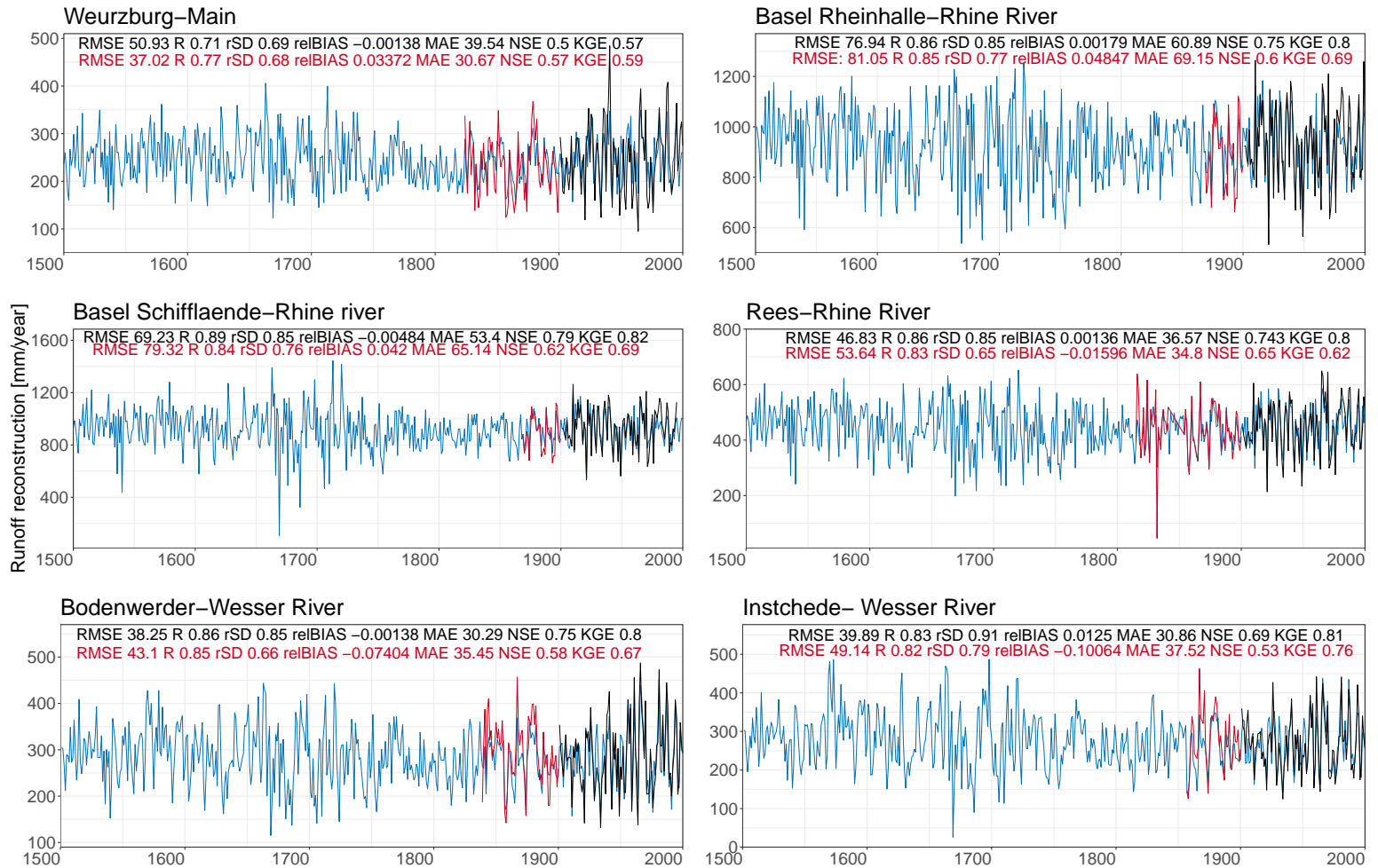


Figure S7. Same as Fig. S6 but runoff series are available in Weurzburg-Main, Basel Rheinhalde-Rhine River, Basel Schiffflaende-Rhine river, Rees-Rhine River, Bodenwerder and Intschede - Wesser river

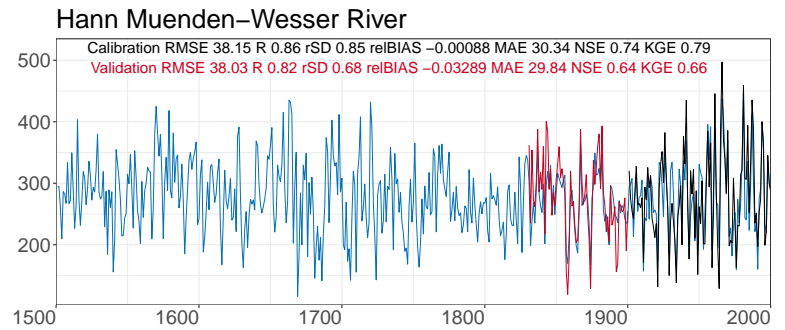
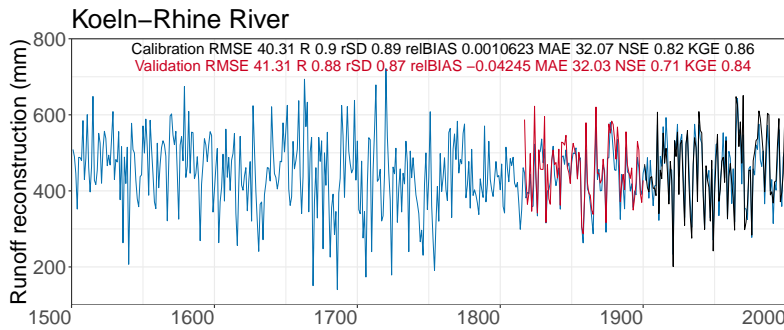


Figure S8. Reconstruction of runoff series for Köln- Main and Hann-Muenden Wesser Rivers

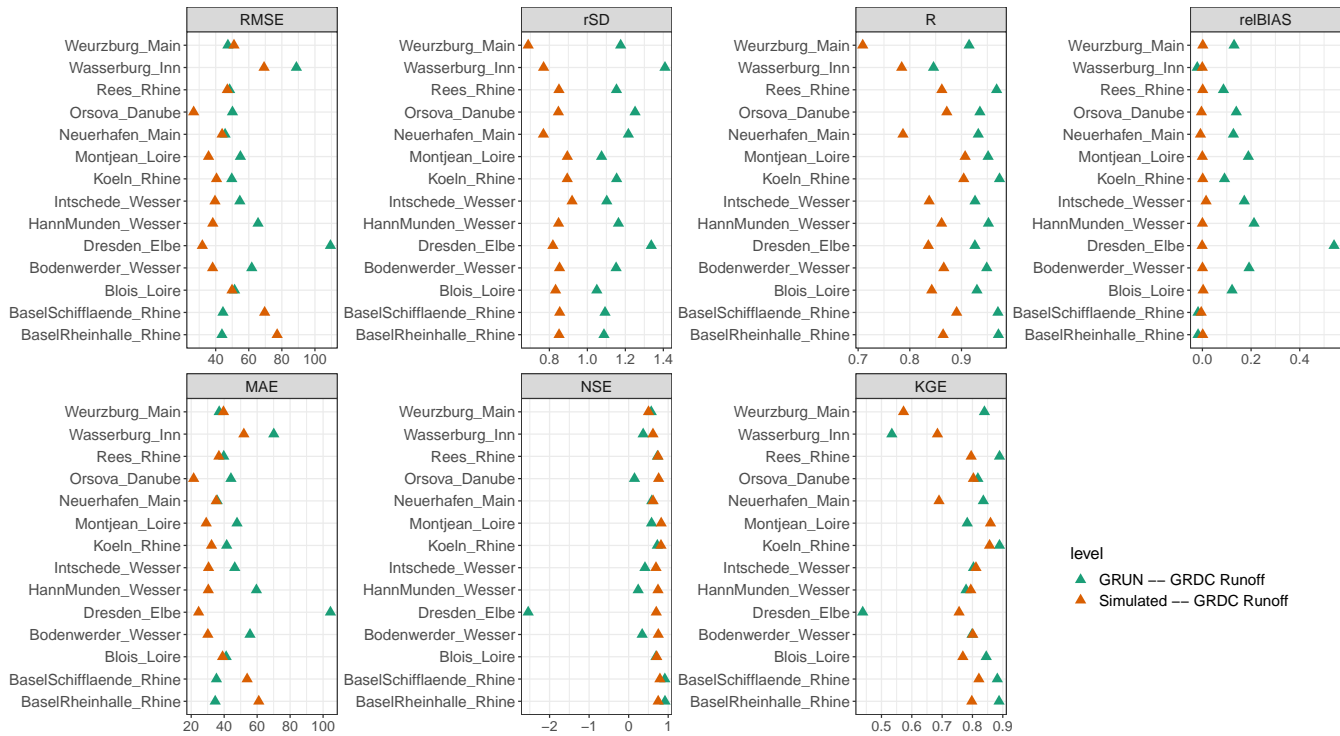


Figure S9. Statistical comparison between reconstructed and GRUN runoff with respect to observed GRDC Runoff for the common period 1902-2000

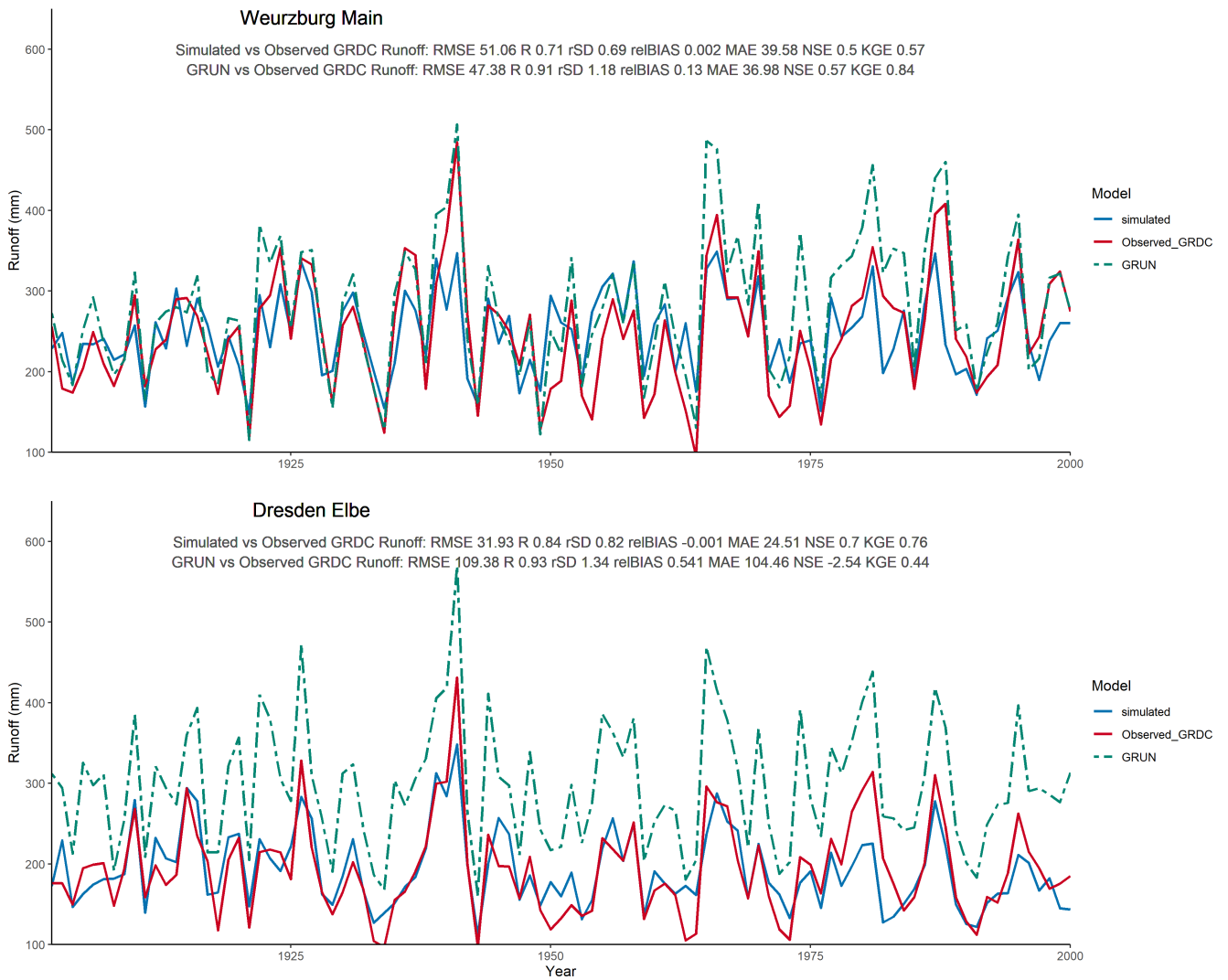


Figure S10. The simulated, observed, and GRUN time series for Dresden and Weurzburg catchments from 1900 to 2000. Model comparisons in terms of statistics can be seen at the top of the Figure.