A systematic evaluation of 15 actual evapotranspiration formulations within conceptual hydrological models - supplementary materials

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S1. Timeseries figures

S1.1 Wombat Forest

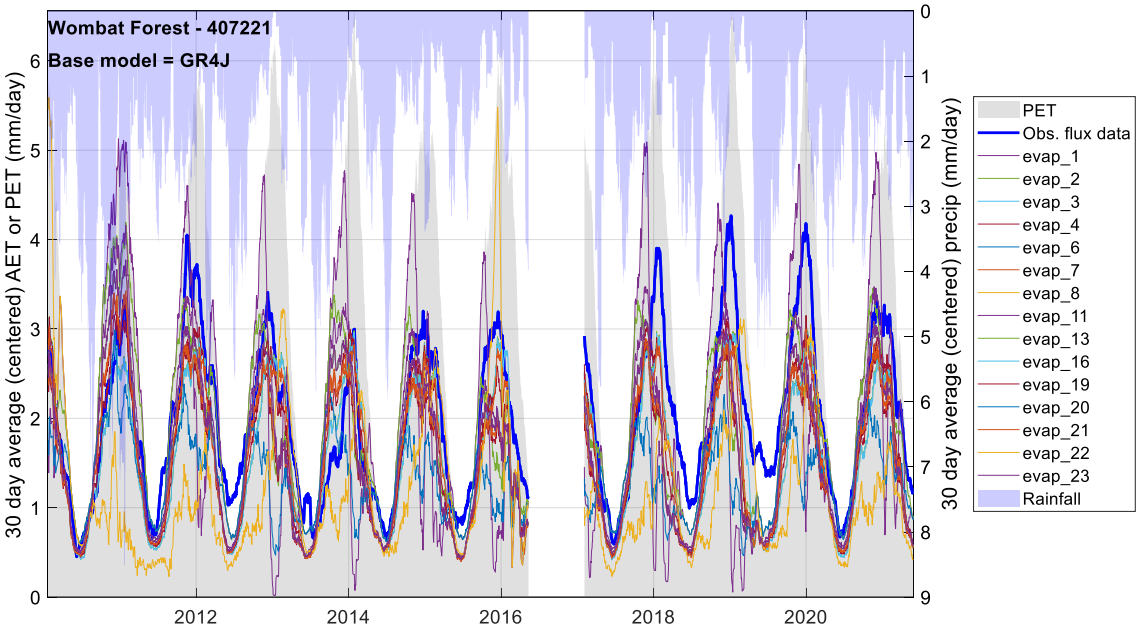

Figure S1.1.1 Observed flux tower data, precipitation, and PET for Wombat Forest, Victoria, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).

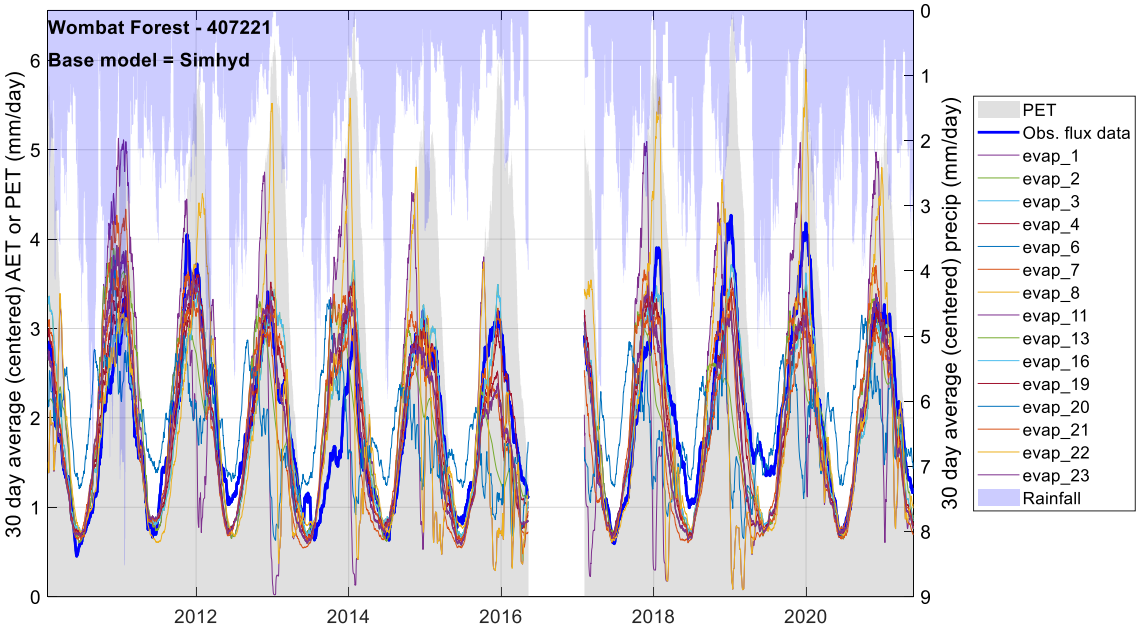

Figure S1.1.2 Observed flux tower data, precipitation, and PET for Wombat Forest, Victoria, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Simhyd).

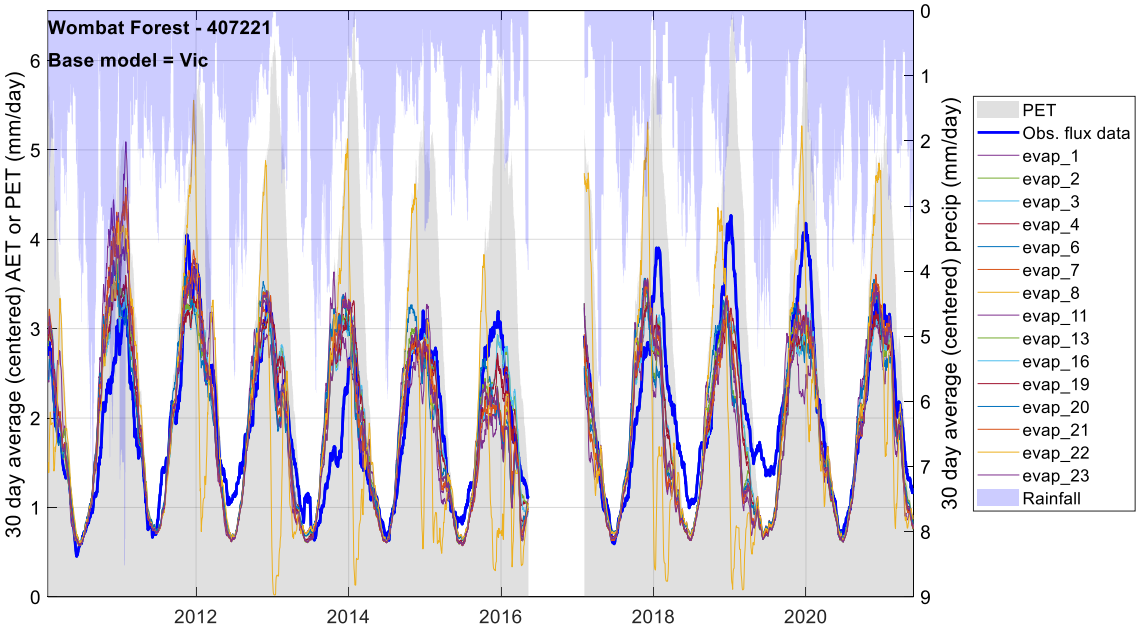

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Figure S1.1.3 Observed flux tower data, precipitation, and PET for Wombat Forest, Victoria, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S1.2 Whroo

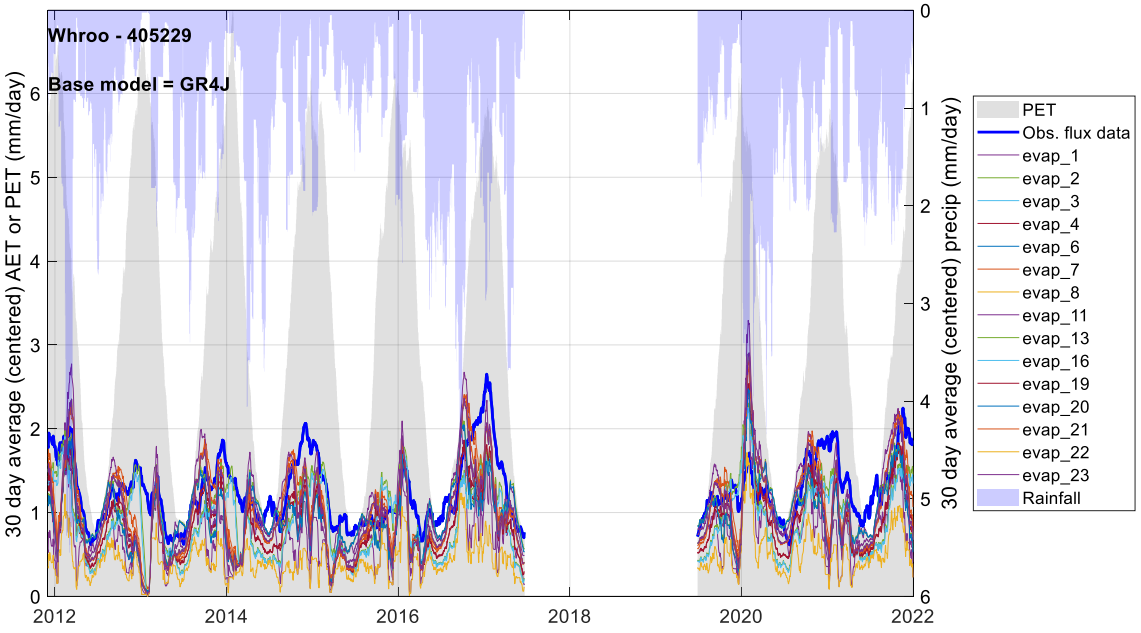
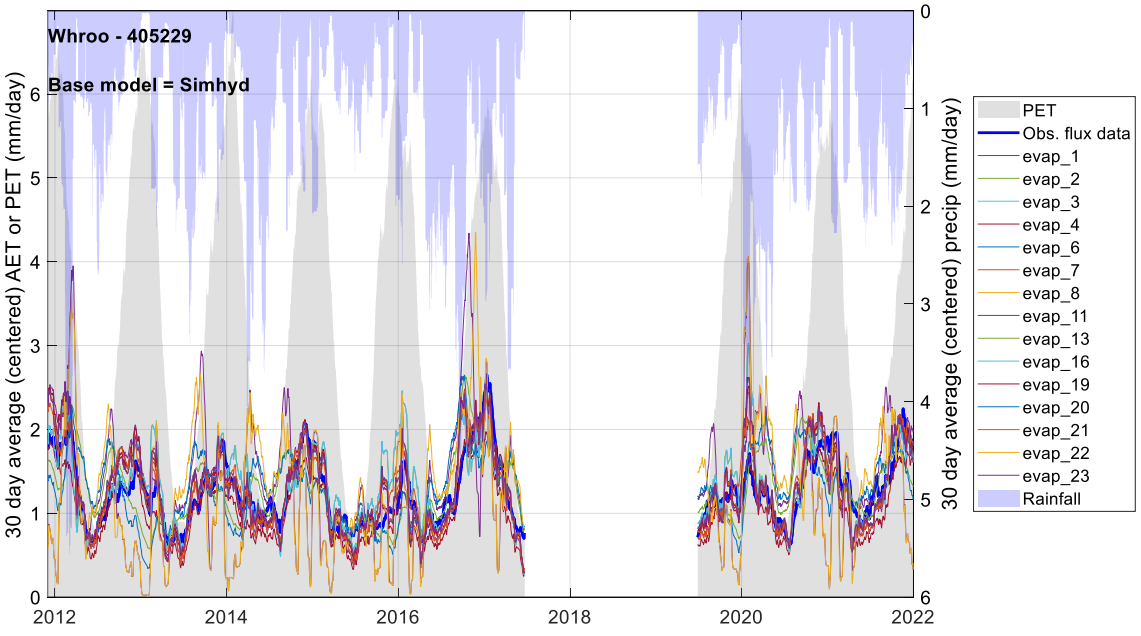


Figure S1.2.1 Observed flux tower data, precipitation, and PET for Whroo, Victoria, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).



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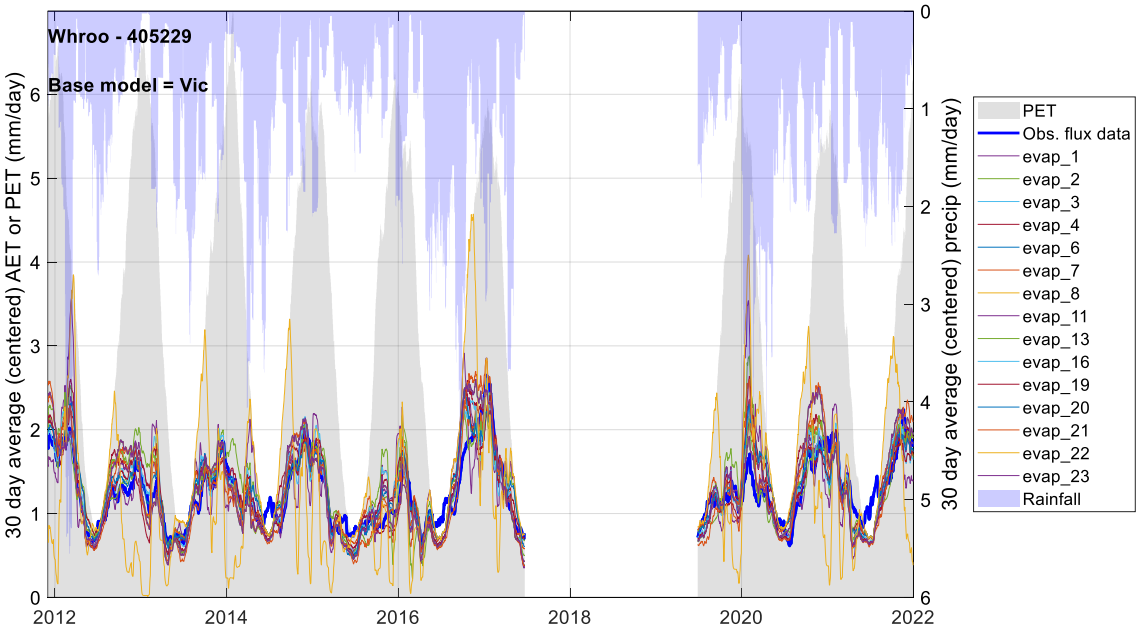

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Figure S1.2.3 Observed flux tower data, precipitation, and PET for Whroo, Victoria, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S1.3 Litchfeild

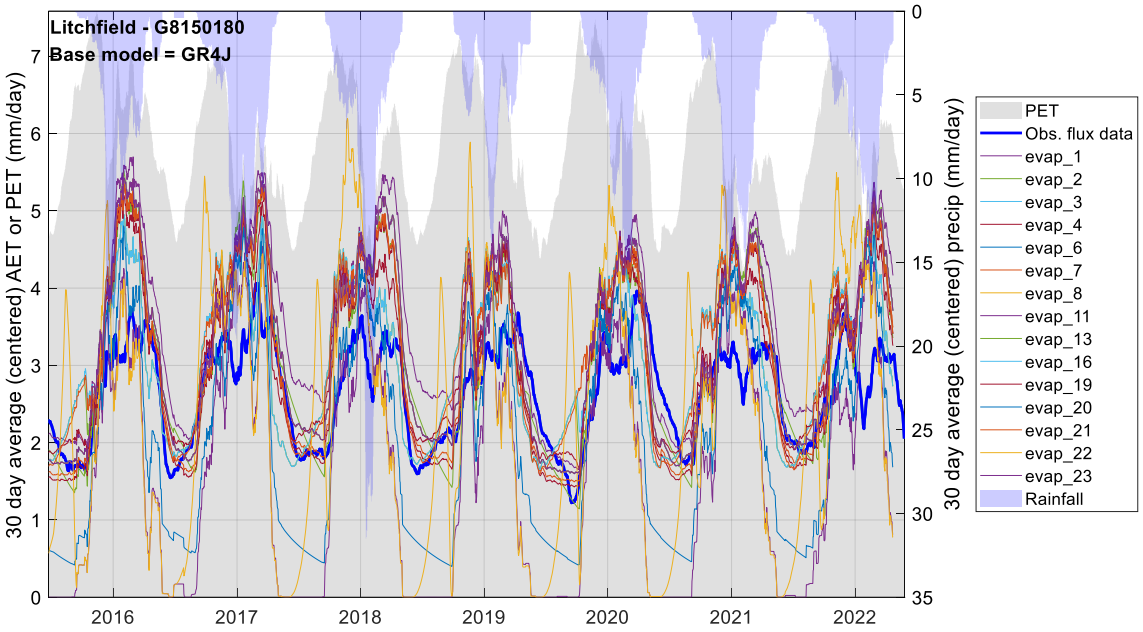
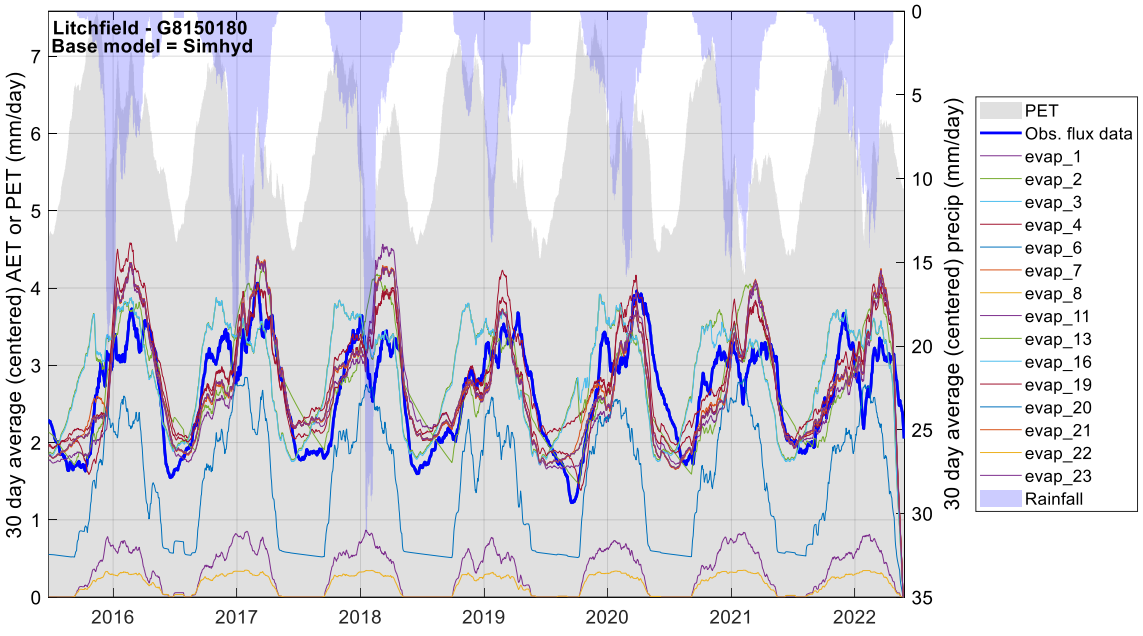


Figure S1.3.1 Observed flux tower data, precipitation, and PET for Litchfield, Northern Territory, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).



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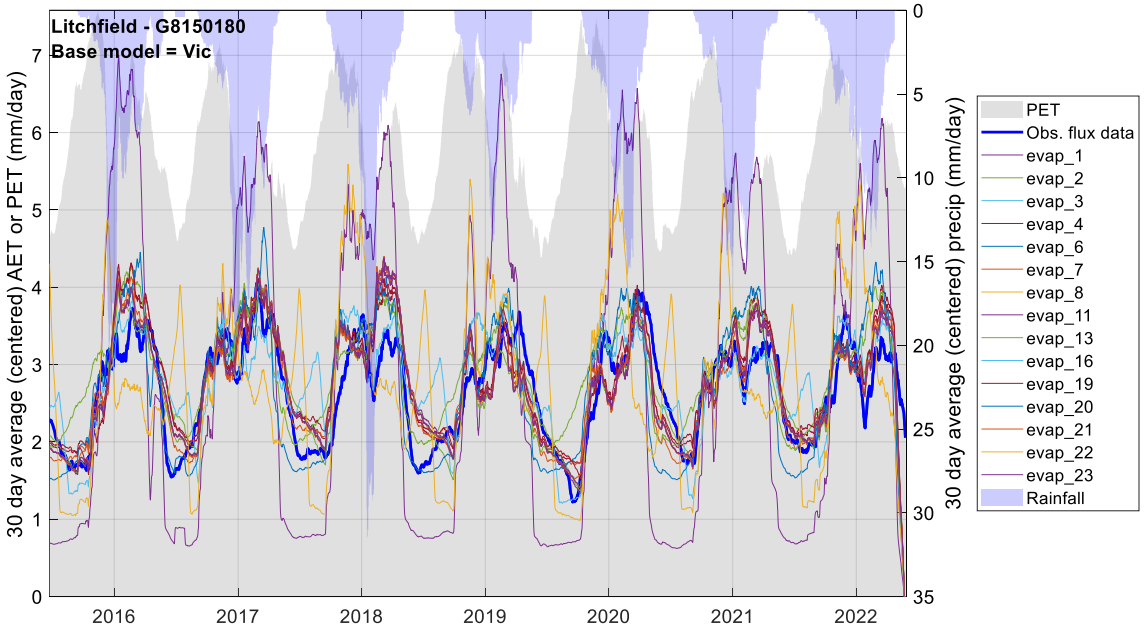

Figure S1.3.3 Observed flux tower data, precipitation, and PET for Litchfield, Northern Territory, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

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S1.4 Dry River

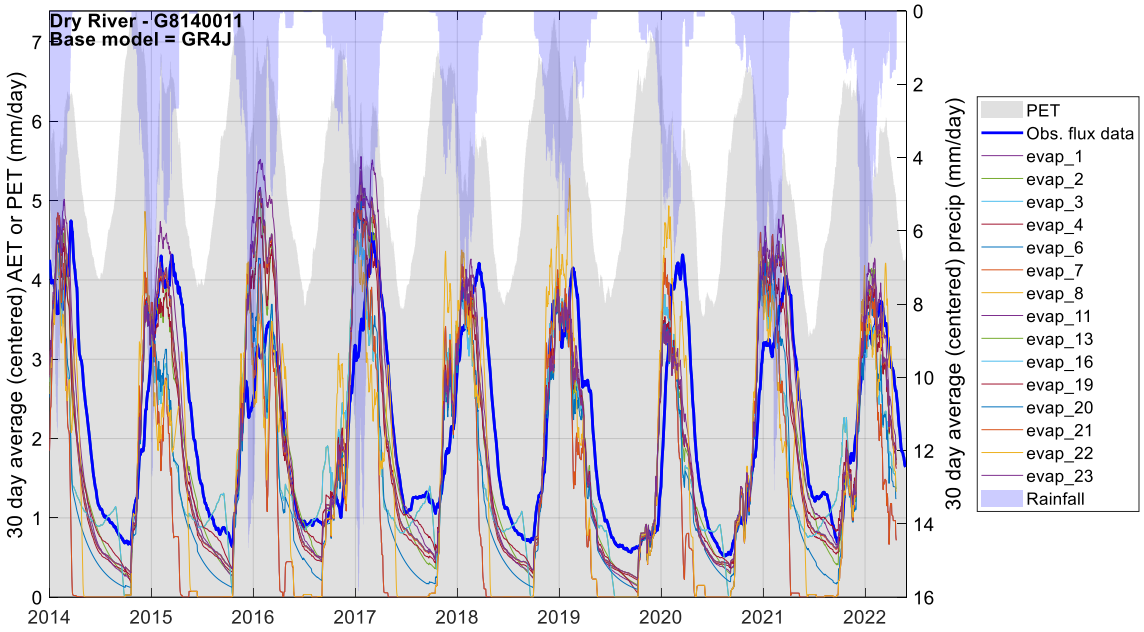

Figure S1.4.1 Observed flux tower data, precipitation, and PET for Dry River, Northern Territory, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).

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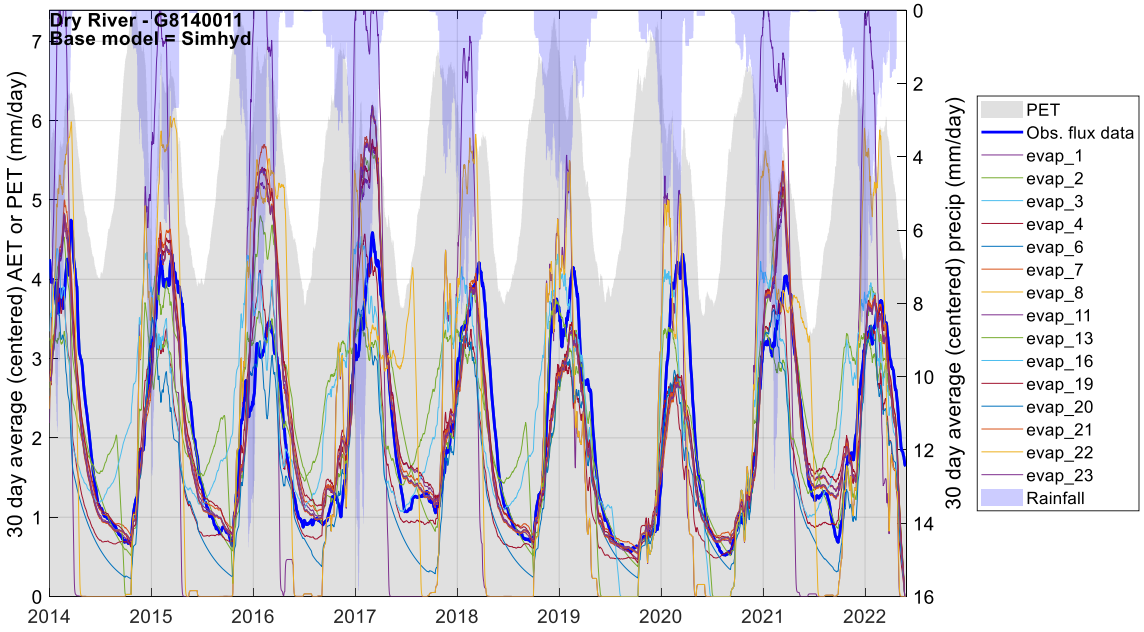

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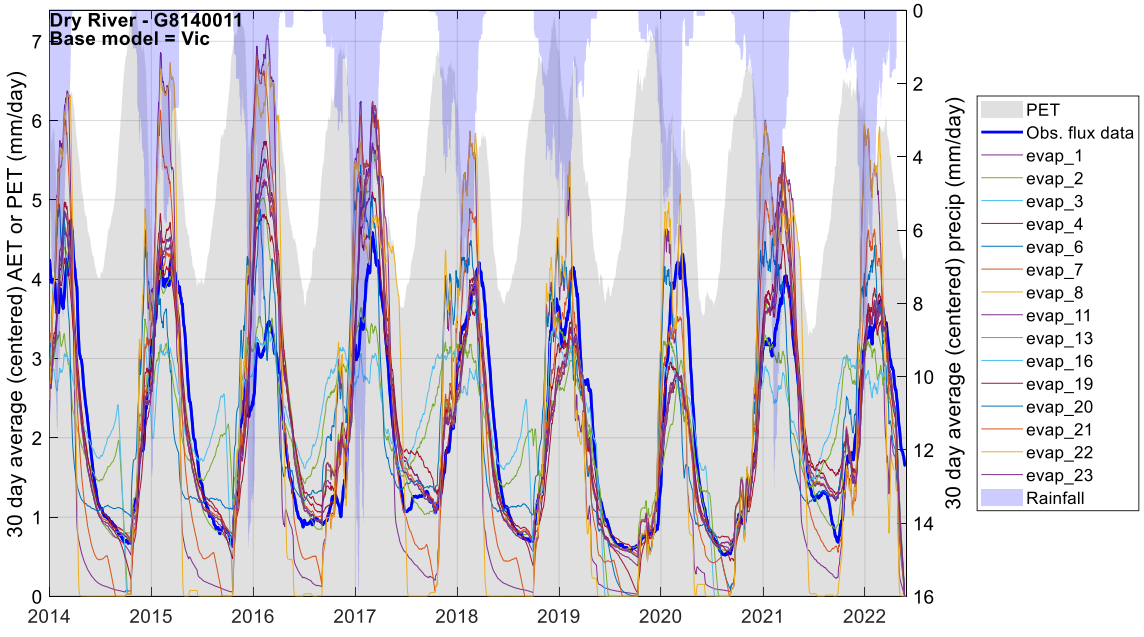

Figure S1.4.3 Observed flux tower data, precipitation, and PET for Dry River, Northern Territory, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S1.5 Robson Creek

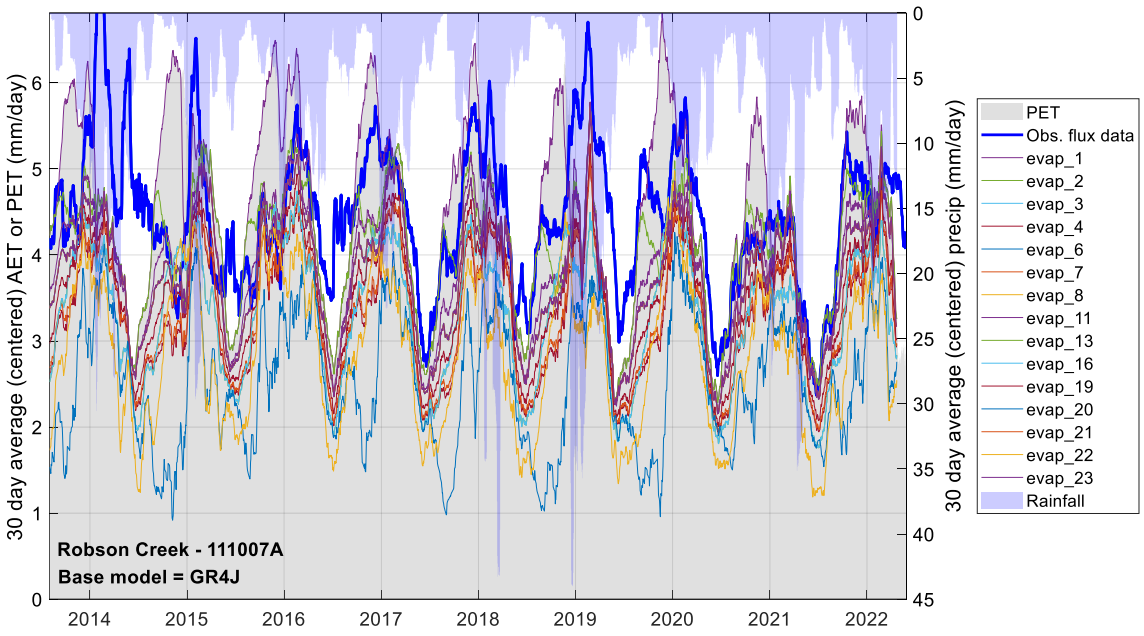

Figure S1.5.1 Observed flux tower data, precipitation, and PET for Robson Creek, Queensland, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).

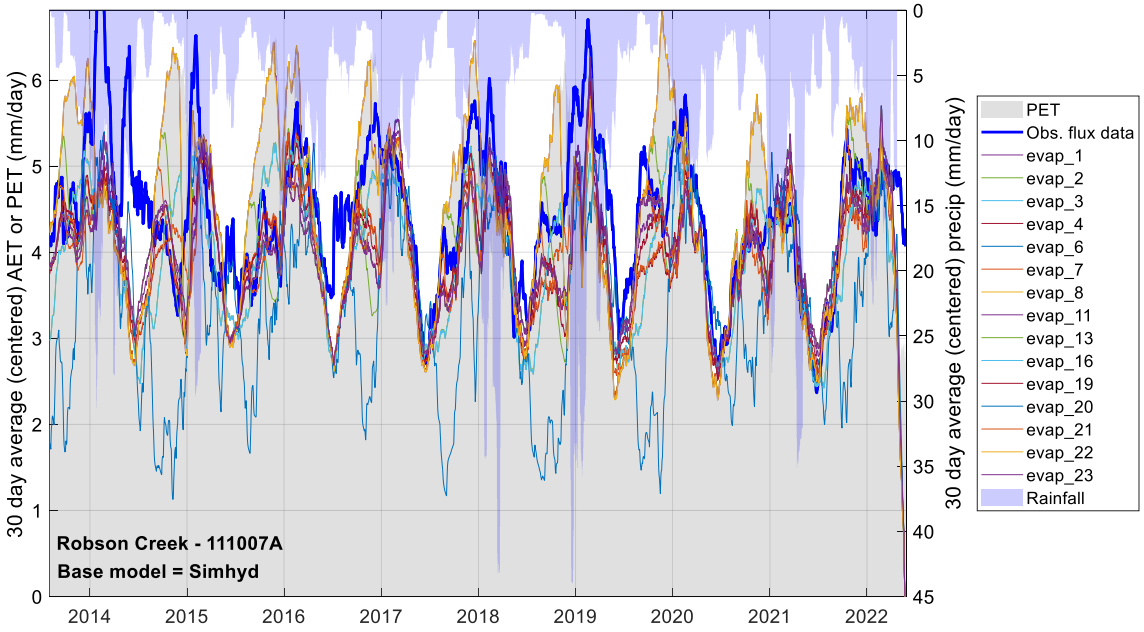

Figure S1.5.2 Observed flux tower data, precipitation, and PET for Robson Creek, Queensland, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Simhyd).

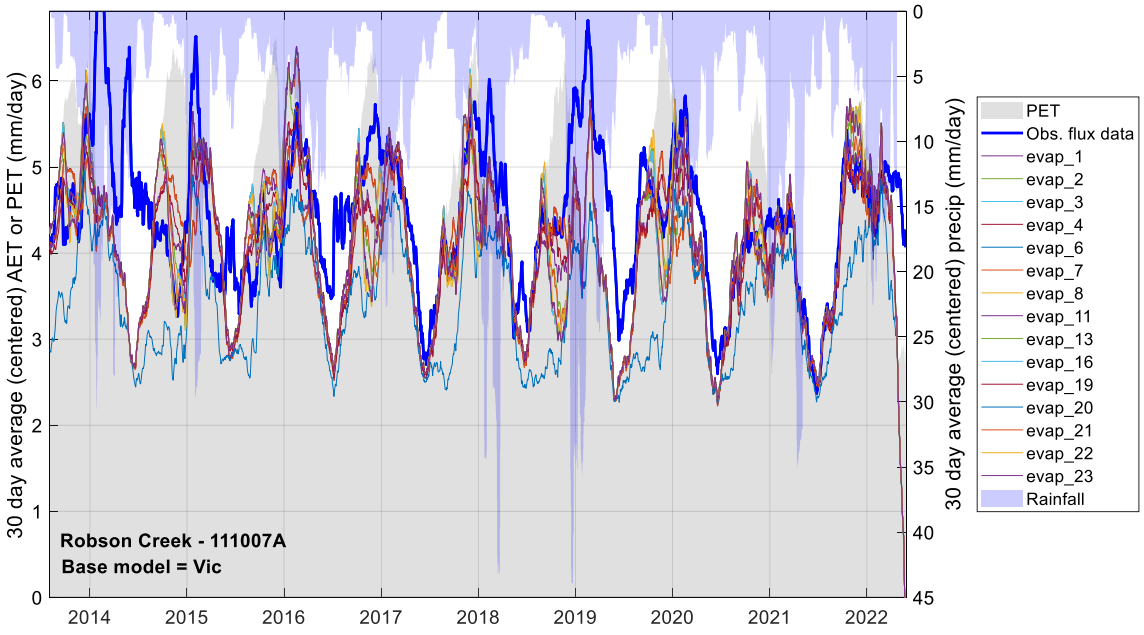

Figure S1.5.3 Observed flux tower data, precipitation, and PET for Robson Creek, Queensland, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S1.6 Gingin

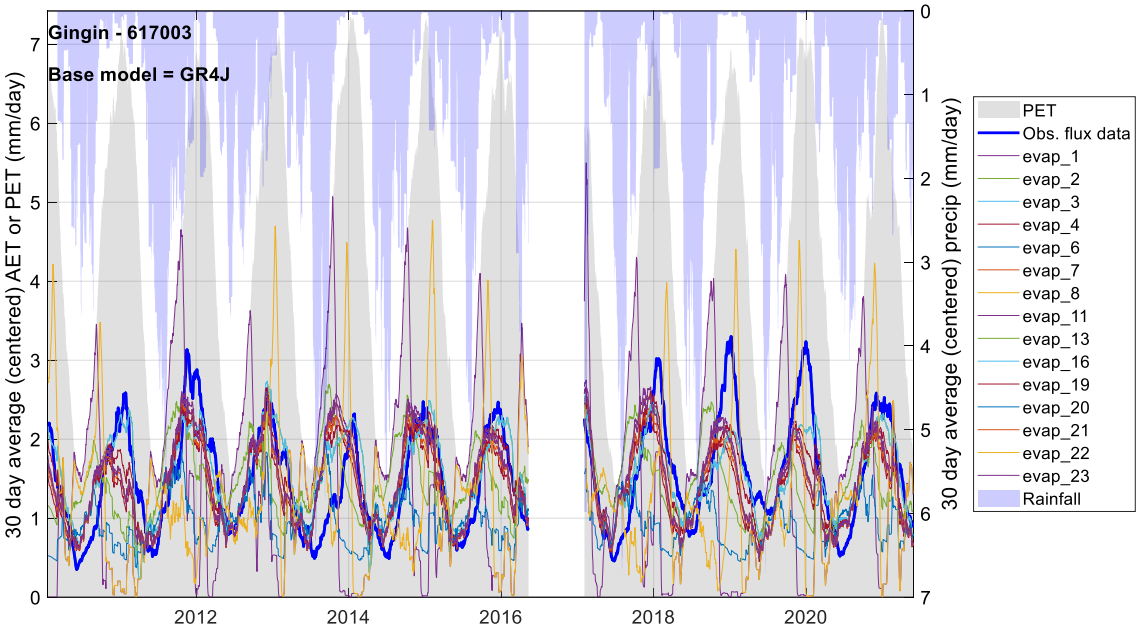

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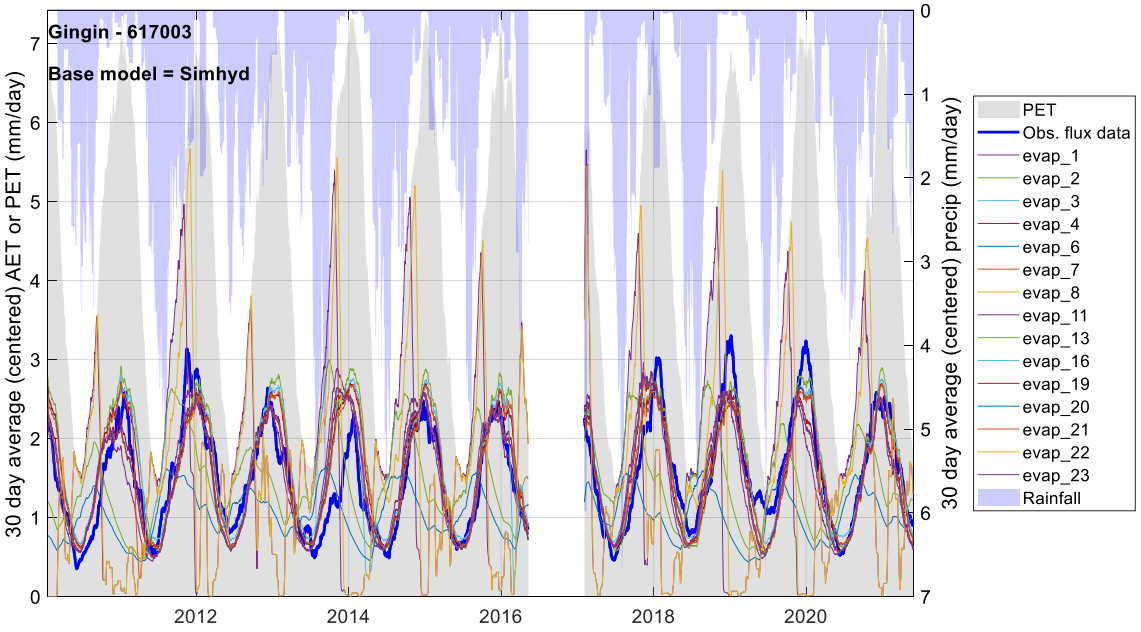
Figure S1.6.1 Observed flux tower data, precipitation, and PET for Gingin, Western Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).



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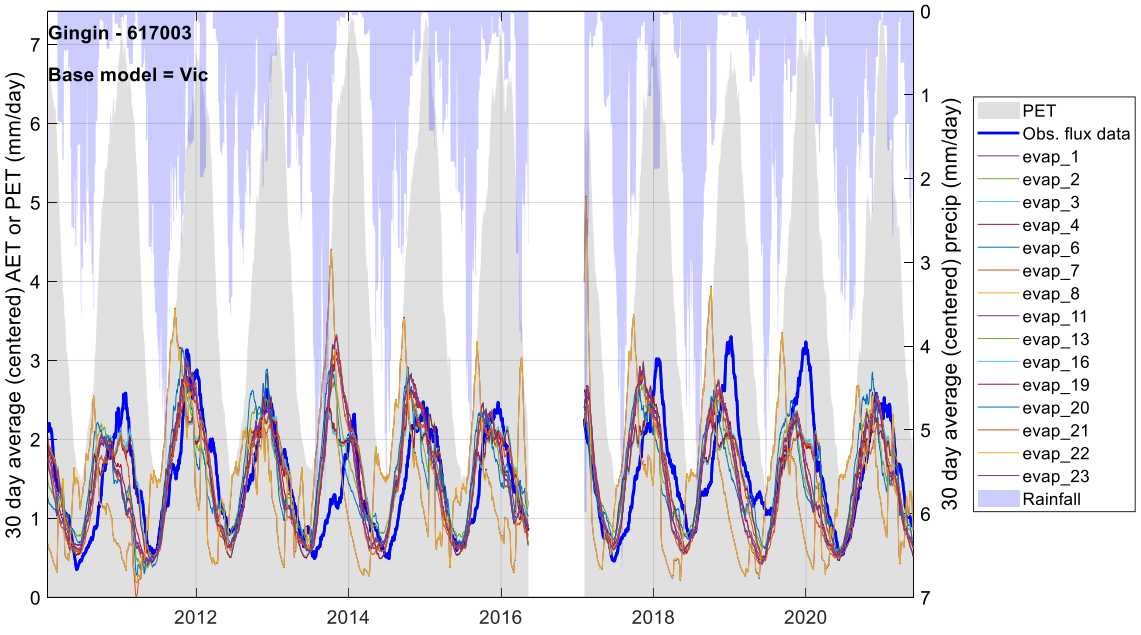


Figure S1.6.3 Observed flux tower data, precipitation, and PET for Gingin, Western Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S1.7 Tumbarumba

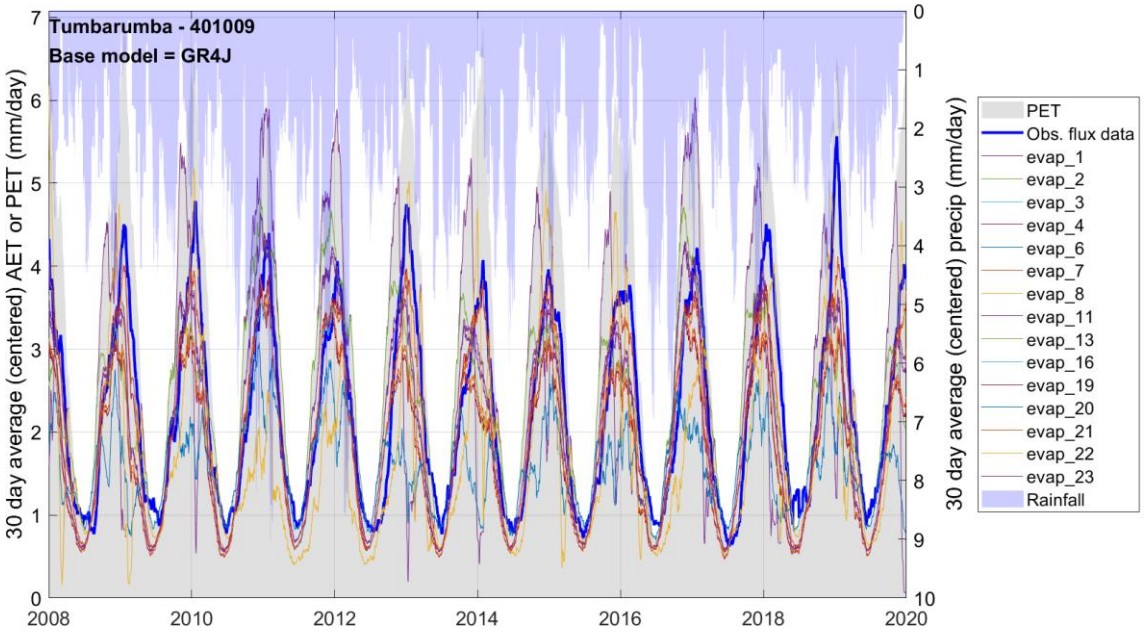
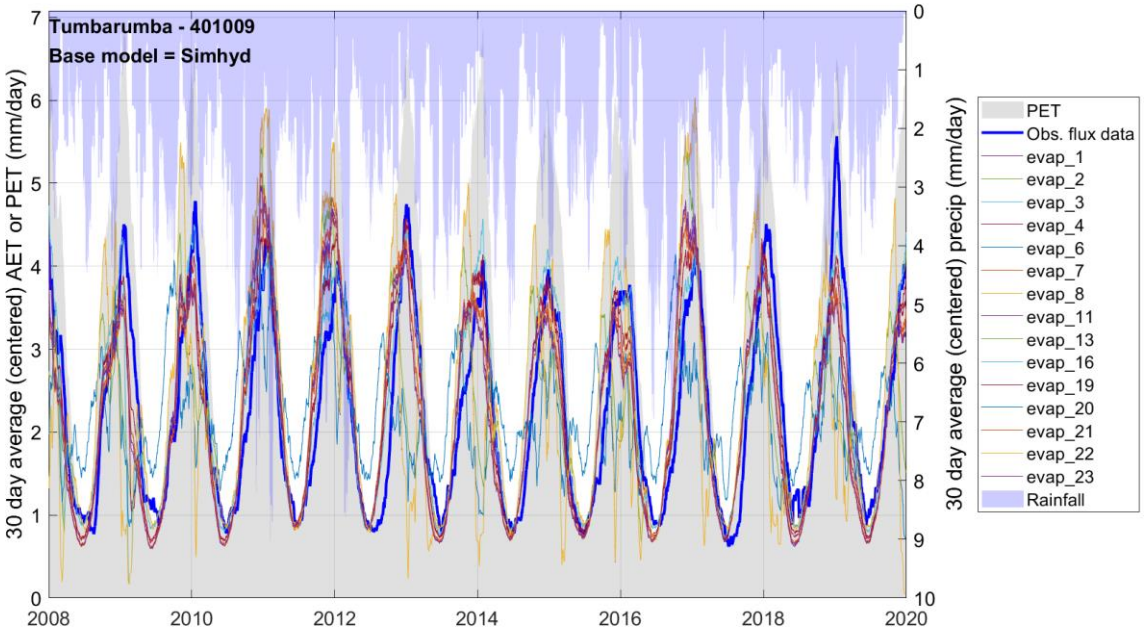


Figure S1.7.1 Observed flux tower data, precipitation, and PET for Tumbarumba, New South Wales, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (GR4J).



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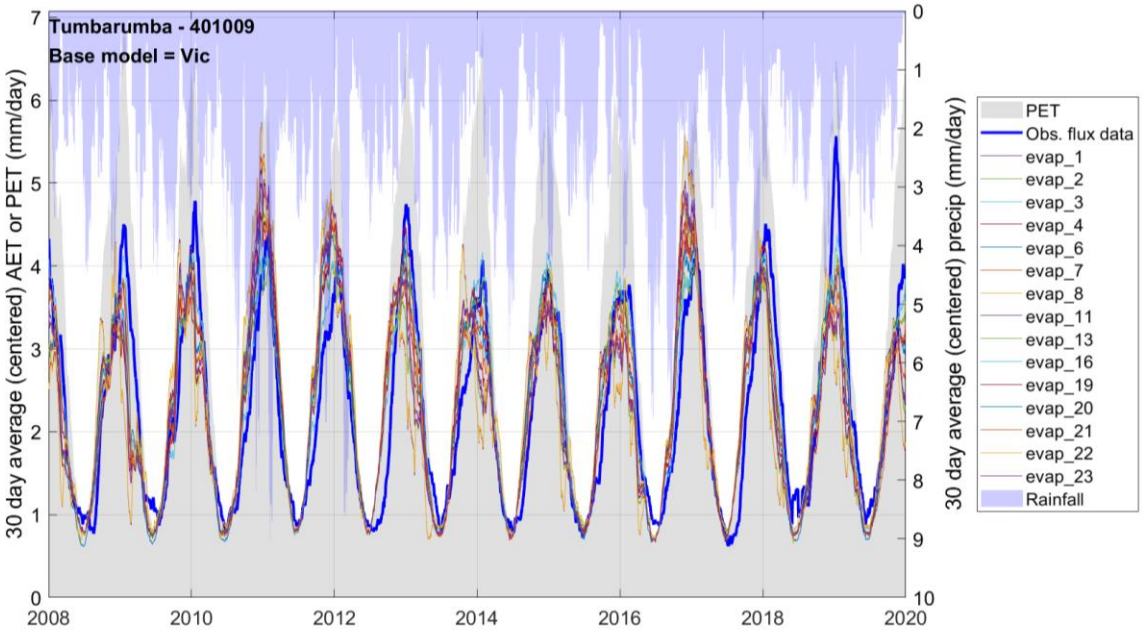

Figure S1.7.3 Observed flux tower data, precipitation, and PET for Tumbarumba, New South Wales, Australia. 15 calibrations showing simulated AET at the site (evap_1, evap_2, etc.) for the base model (Vic).

S2. Objective function value tables

	GR4J													
	Wombat		Whroo		Litchfield		DryRiver		RobsonCreek		Gingin		Tumbarumba	
Evap eqn	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank
1	0.49	14	-0.02	13	-0.48	15	0.13	15	0.61	13	-0.03	15	0.51	15
2	0.72	12	0.14	8	0.51	12	0.49	7	0.68	10	0.45	12	0.76	12
3	0.76	9	0.14	5	0.54	8	0.50	4	0.70	3	0.70	7	0.83	8
4	0.74	11	0.15	2	0.52	11	0.46	9	0.69	9	0.68	11	0.79	11
6	0.76	7	0.14	7	0.54	8	0.50	4	0.70	3	0.70	7	0.83	8
7	0.75	10	-0.14	14	0.54	5	0.50	6	0.69	8	0.69	10	0.80	10
8	0.76	9	0.14	5	0.54	8	0.50	4	0.70	3	0.70	7	0.83	8
11	0.76	5	0.08	12	0.52	10	0.46	8	0.69	7	0.70	9	0.84	5
13	0.79	3	0.10	11	0.58	2	0.42	12	0.66	12	0.71	1	0.87	3
16	0.79	4	0.10	10	0.58	3	0.42	11	0.66	11	0.71	2	0.87	2
19	0.80	1	0.17	1	0.63	1	0.53	1	0.69	6	0.71	3	0.87	4
20	0.54	13	0.14	9	0.26	13	0.42	10	0.52	15	0.28	13	0.52	14
21	0.79	2	0.15	3	0.58	4	0.13	14	0.70	5	0.70	4	0.87	1
22	0.26	15	-0.33	15	-0.32	14	0.22	13	0.59	14	0.21	14	0.69	13
23	0.76	7	0.14	7	0.54	8	0.50	4	0.70	3	0.70	7	0.83	8

	Simhyd													
	Wombat		Whroo		Litchfield		DryRiver		RobsonCreek		Gingin		Tumbarumba	
Evap eqn	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank
1	0.73	14	0.48	13	-0.05	15	0.18	14	0.60	10	0.24	14	0.68	14
2	0.79	6	0.61	2	0.66	3	0.65	5	0.60	7	0.57	12	0.76	11
3	0.76	12	0.52	11	0.66	6	0.66	4	0.60	3	0.65	7	0.77	4
4	0.80	4	0.62	1	0.67	2	0.57	9	0.58	14	0.67	4	0.75	12
6	0.76	11	0.52	11	0.66	8	0.66	2	0.60	5	0.65	9	0.77	6
7	0.80	5	0.55	7	0.65	10	0.65	6	0.58	13	0.64	10	0.76	9
8	0.76	9	0.52	11	0.66	5	0.66	4	0.60	6	0.65	7	0.77	3
11	0.75	13	0.56	6	0.65	9	0.63	7	0.60	1	0.63	11	0.77	7
13	0.81	2	0.53	8	0.61	12	0.50	10	0.60	8	0.72	1	0.76	10
16	0.81	3	0.57	5	0.62	11	0.46	11	0.60	9	0.72	2	0.76	8
19	0.82	1	0.59	4	0.68	1	0.63	8	0.59	12	0.72	3	0.78	2
20	0.77	7	0.60	3	0.46	13	0.40	12	0.39	15	0.56	13	0.52	15
21	0.77	8	0.46	14	0.66	4	0.26	13	0.60	2	0.67	5	0.80	1
22	0.32	15	0.07	15	0.34	14	0.04	15	0.60	11	0.23	15	0.68	13
23	0.76	11	0.52	11	0.66	8	0.66	2	0.60	5	0.65	9	0.77	6

	VIC													
	Wombat		Whroo		Litchfield		DryRiver		RobsonCreek		Gingin		Tumbarumba	
Evap eqn	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank	OFV	Rank
1	0.49	14	0.02	15	-0.57	15	-0.03	15	0.58	14	0.01	14	0.53	14
2	0.70	12	0.42	13	0.62	10	0.59	4	0.65	12	0.38	12	0.69	12
3	0.74	9	0.51	8	0.64	6	0.58	6	0.65	11	0.70	7	0.74	10
4	0.81	1	0.54	2	0.65	2	0.52	10	0.66	5	0.70	10	0.80	2
6	0.74	11	0.51	6	0.64	8	0.58	8	0.65	9	0.70	9	0.74	8
7	0.77	4	0.51	9	0.64	4	0.75	2	0.66	4	0.70	5	0.78	3
8	0.74	9	0.51	8	0.64	6	0.58	6	0.65	11	0.70	7	0.74	10
11	0.74	7	0.51	12	0.63	9	0.59	3	0.66	2	0.70	11	0.76	6
13	0.75	5	0.51	10	0.61	11	0.47	12	0.65	6	0.73	4	0.76	5
16	0.75	6	0.51	11	0.60	12	0.42	13	0.65	7	0.73	2	0.76	4
19	0.77	2	0.52	4	0.67	1	0.75	1	0.68	1	0.74	1	0.81	1
20	0.43	15	0.54	1	0.22	14	0.50	11	0.43	15	-0.07	15	0.37	15
21	0.77	3	0.53	3	0.64	3	0.58	9	0.66	3	0.73	3	0.74	11
22	0.56	13	0.06	14	0.27	13	0.03	14	0.58	13	0.05	13	0.53	13
23	0.74	11	0.51	6	0.64	8	0.58	8	0.65	9	0.70	9	0.74	8

S3. Litchfield calibration, GR4J cal AET only.

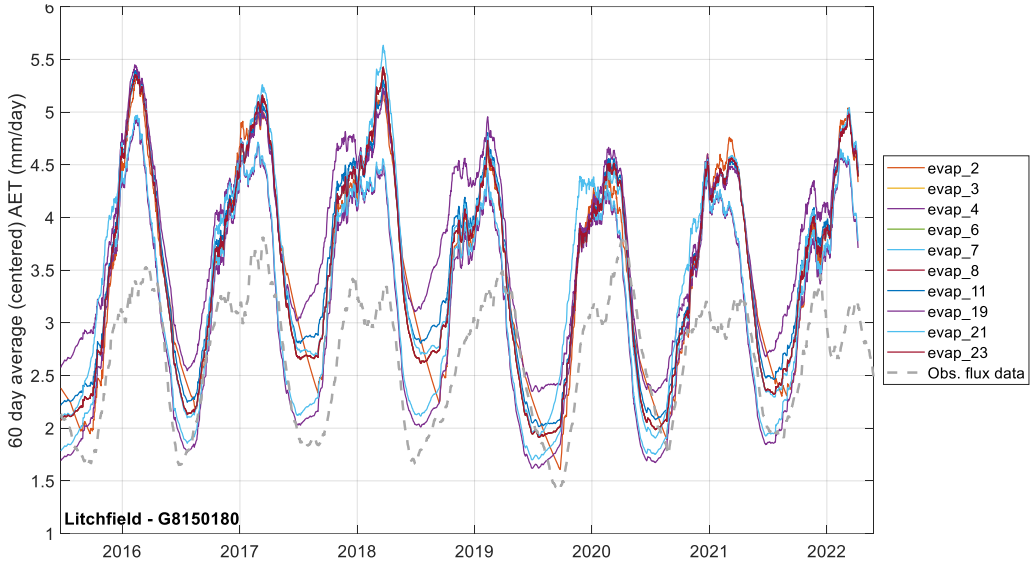

Figure S3.1. Modelled AET vs. observed flux tower data for the best equations (in this specific case) at Litchfield, under AET-only calibration, for GR4J only (streamflow not considered).

S4. Signature scatterplots

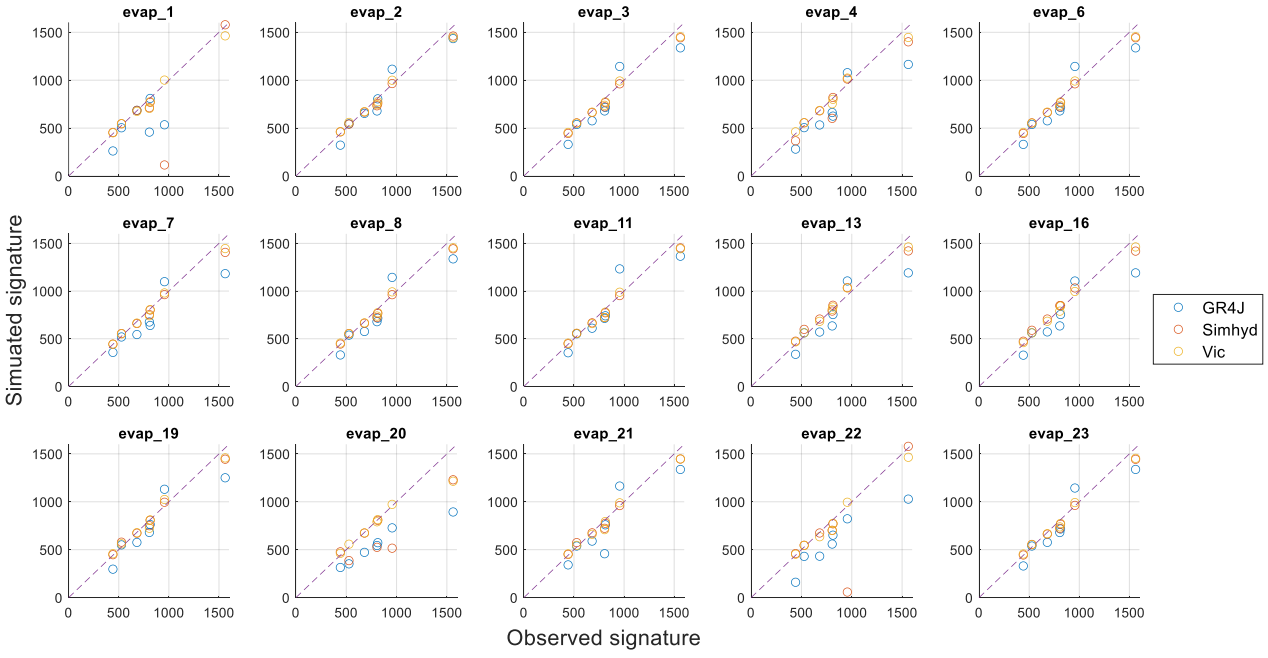

Figure S4.1. Long-term median: observed vs. simulated AET across all equations and models. Annual signature.

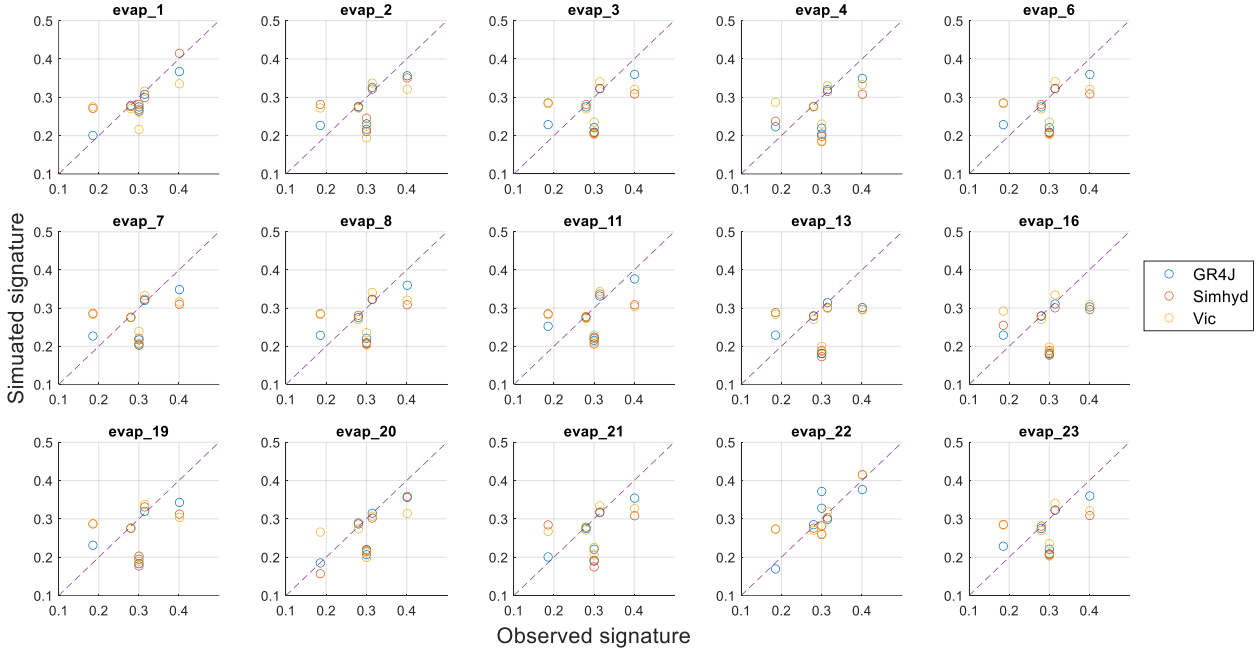

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Figure S4.2. Interannual variability: observed vs. simulated AET across all equations and models. Annual signature, expressed as the coefficient of variation of annual AET.

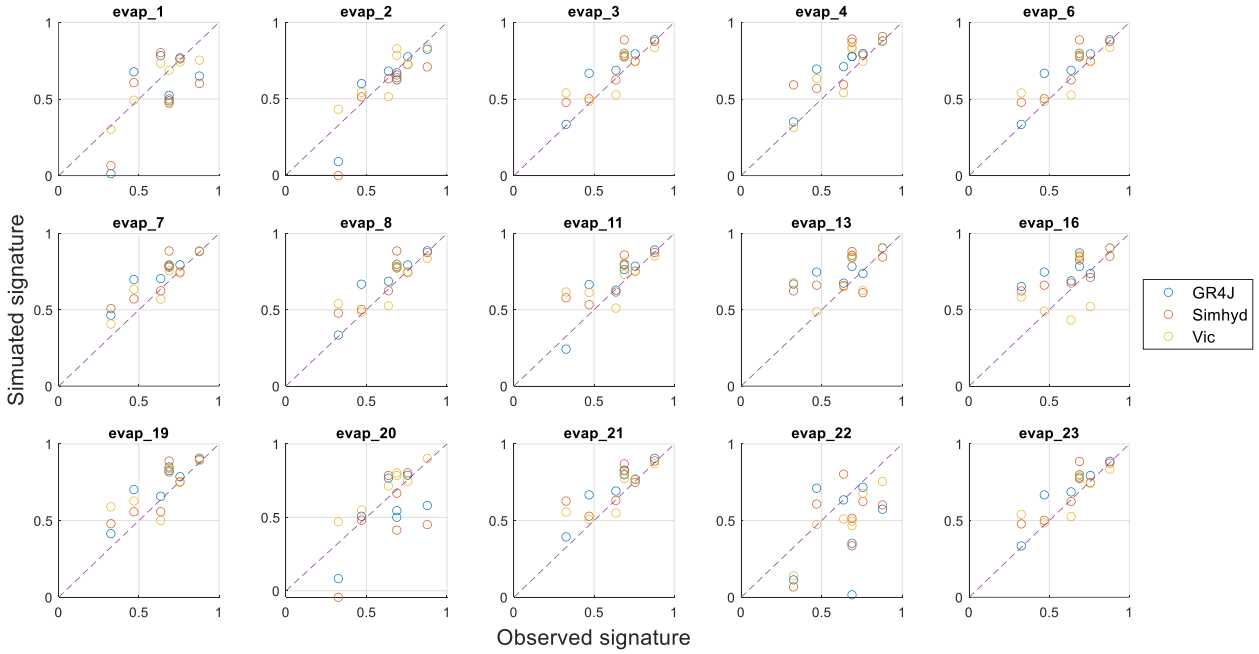

Figure S4.3. Periodicity: observed vs. simulated AET across all equations and models. Seasonal signature, quantifying the tendency for AET variation to recur with the seasonal cycle (12 month period), calculated as the lag-12 autocorrelation of monthly AET.

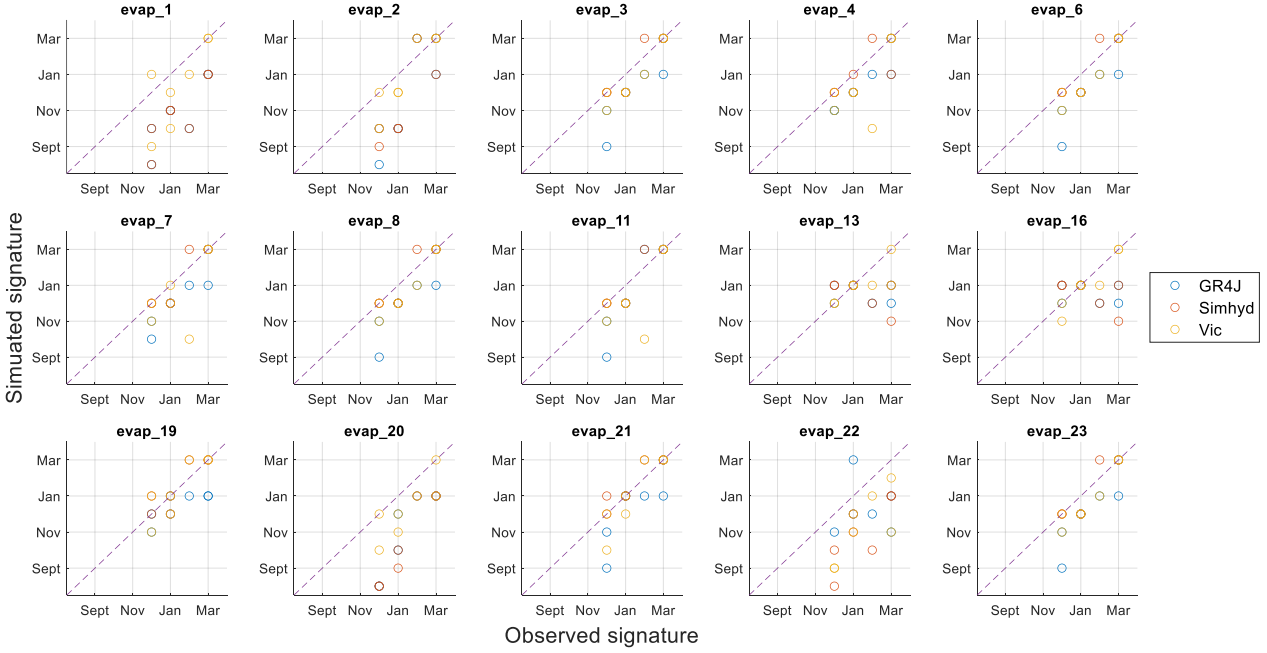

Figure S4.4. Seasonal peak timing: observed vs. simulated AET across all equations and models. Seasonal signature, determined from monthly timestep data by examining the median AET for each of the 12 calendar months and identifying the month with the maximum median AET.

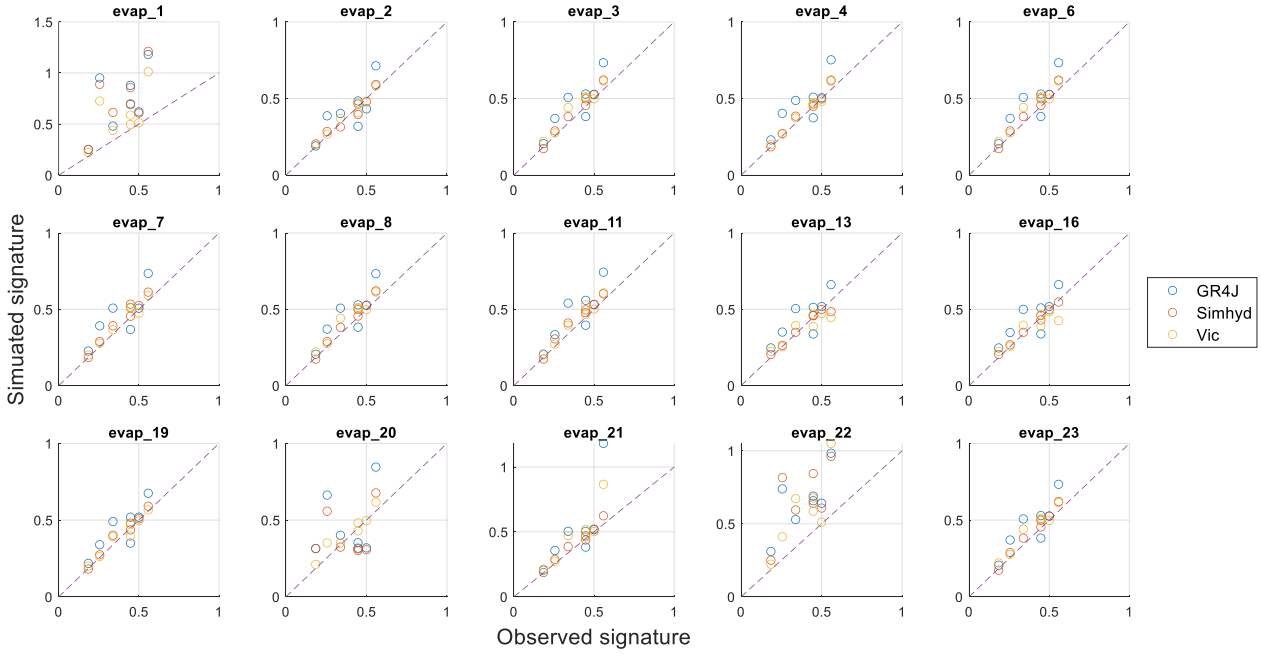

Figure S4.5. Monthly variability: observed vs. simulated AET across all equations and models. Monthly signature.

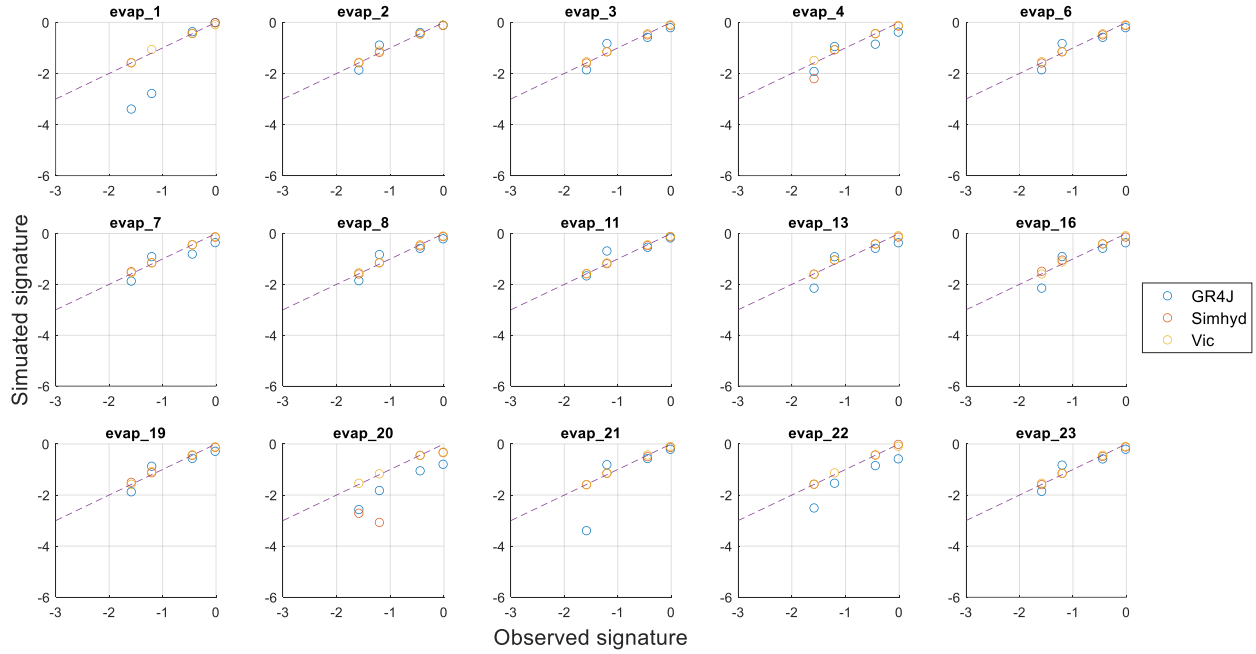

Figure S4.6. Water stress: observed vs. simulated AET across all equations and models. Monthly water stress signature, defined as the difference between average monthly PET and average monthly AET, divided by the average monthly PET. Higher values of this water stress signature indicate less rainfall and/or high PET.

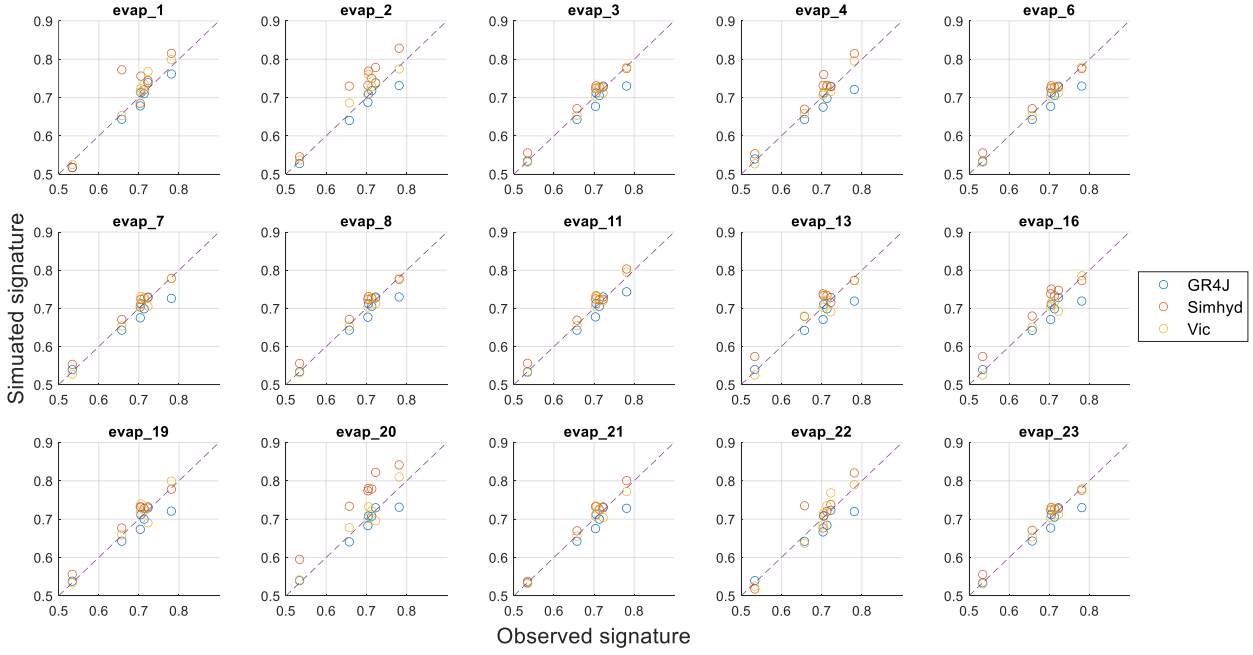

Figure S4.7. Index of AET responsiveness to a rainfall event: observed vs. simulated AET across all equations and models. Event scale signature, calculated by selecting rainfall events greater than a threshold, identify the maximum daily AET value after the given rainfall event, up to a certain window duration (in days) after that event. Then a standard linear correlation equation is applied to the anomalies of these ordered pairs of numbers.

S5. Split sample test, calibration and evaluation dates

Catchment / Flux tower	First calibration / second evaluation dates	Second calibration / first evaluation dates
407221 - Wombat Forest	21-Jan-2010 → 09-Feb-2015	09-Feb-2015 → 28-Feb-2020
405229 - Whroo	02-Dec-2011 → 16-Dec-2016	16-Dec-2016 → 31-Dec-2021
G8150180 - Litchfield	24-Jun-2015 → 26-Oct-2018	26-Oct-2018 → 27-Feb-2022
G8140011 - Dry River	01-Jan-2014 → 29-Jan-2018	30-Jan-2018 → 27-Feb-2022
111007A - Robson Creek	02-Aug-2013 → 14-Nov-2017	15-Nov-2017 → 27-Feb-2022
617003 - Gingin	21-Jan-2010 → 24-Sep-2015	25-Sep-2015 → 28-May-2021
401009 - Tumbarumba	01-Jan-2008 → 31-Dec-2013	31-Dec-2013 → 31-Dec-2019

S6. Evap_19 calibrated parameter values

Evap_19	GR4J		Simhyd		VIC	
	p1	p2	p1	p2	p1	p2
Wombat Forest	0.60	0.24	0.83	0.24	0.54	0.16
Whroo	0.51	0.88	0.80	0.45	0.84	1.00
Litchfield	0.57	0.29	0.61	0.30	0.58	0.37
Dry River	0.64	0.61	0.88	0.75	1.00	0.57
Robson Creek	1.00	0.76	1.00	0.25	1.00	0.34
Gingin	0.54	0.34	0.41	0.05	0.28	0.05
Tumbarumba	0.59	0.05	0.87	0.17	0.79	0.23