Supporting Information for "Enhancements to Simulation- and Discretization-Free Explicit Stochastic Reservoir Operation Optimization Method"

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Contents of this file

Introduction

This supporting information provides additional figures and tables.

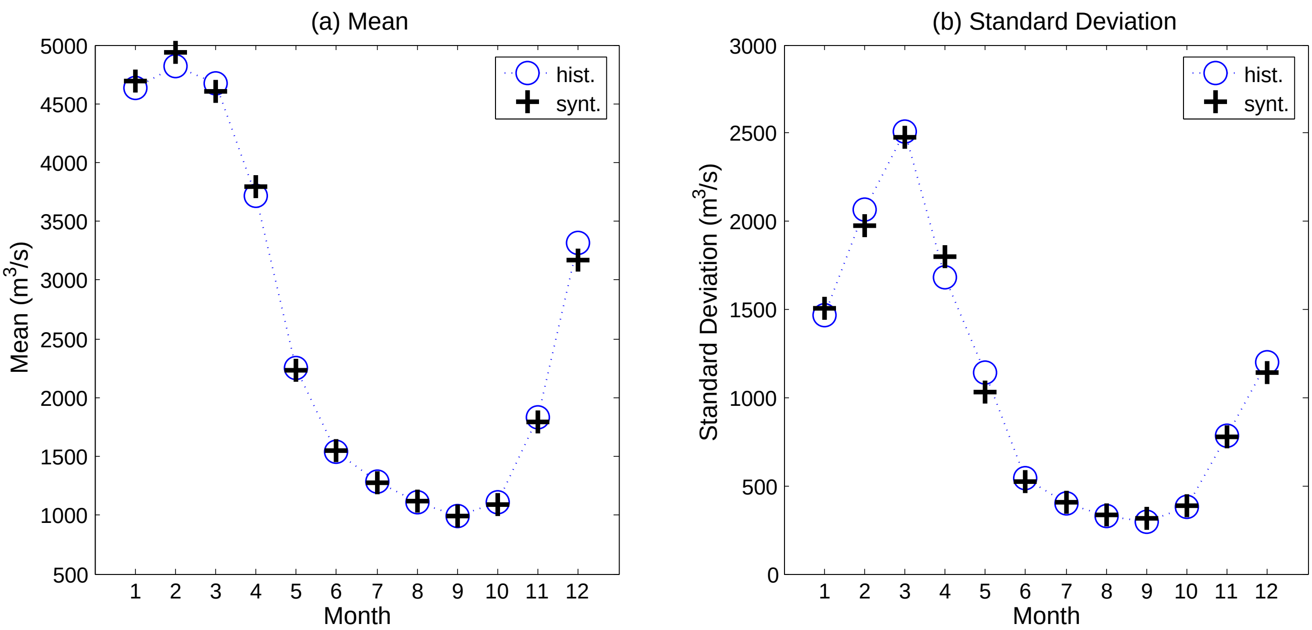

Figure S1. Comparison of (a) mean and (b) standard deviation of historical inflow records against synthetic scenario values.

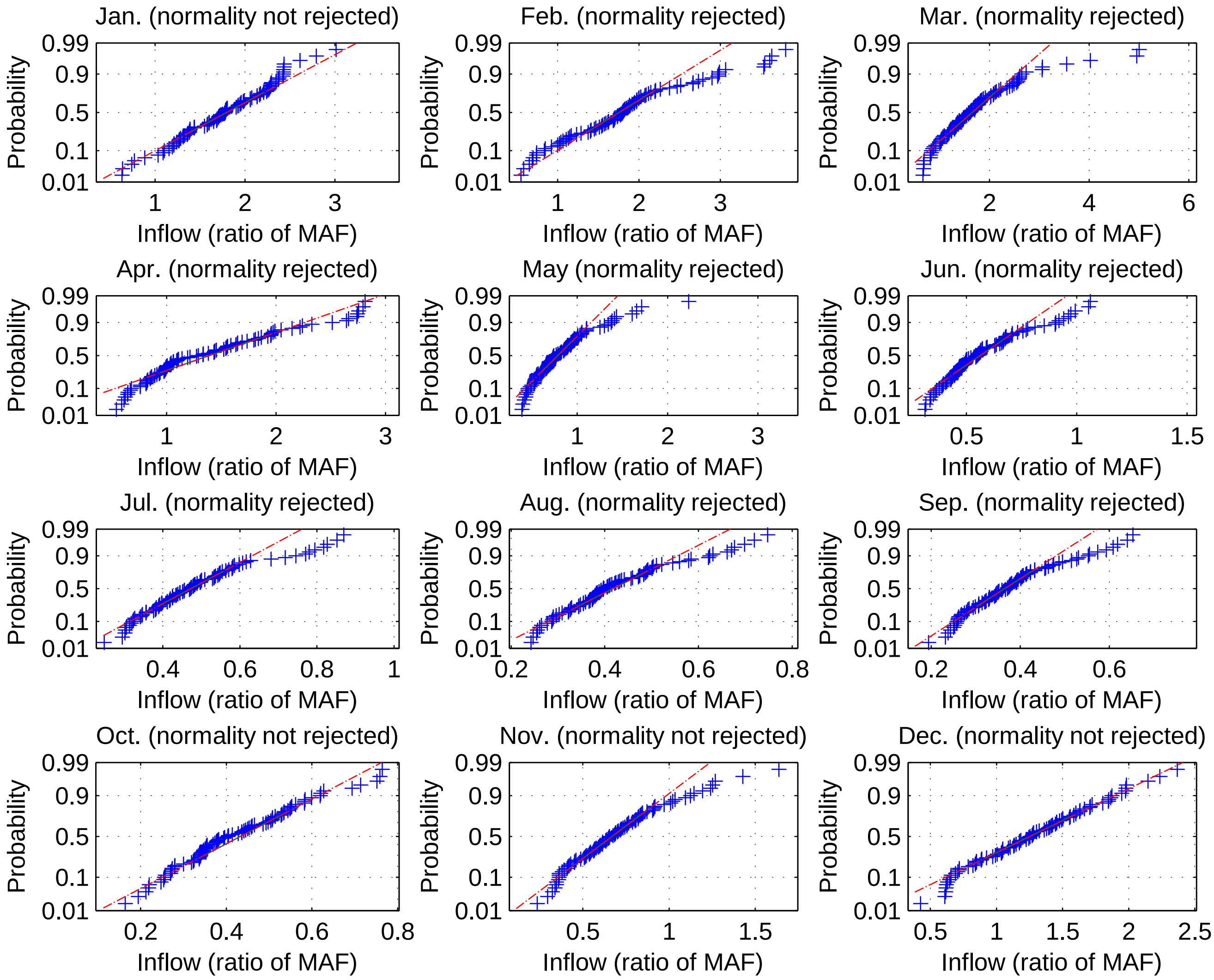

Figure S2. Normality plots and results from the Lilliefors test for each month in the inflow records. When all data points fall near the line, the assumption of normality is reasonable.

Table S1. Results from the FP Optimization: Moments of Storage, Probabilities and LDR Parameters

Month	1st Moment (RMAF)	2nd Moment (RMAF^2)	Variance (RMAF^2)	Prob. of Containment	Prob. of Deficit	Prob. of Spill	LDR Parameter (RMAF)
t	$\mathbb{E}(S_t)$	$\mathbb{E}(S_t^2)$	$\text{Var}(S_t)$	$\mathbb{P}_t^{\text{con}}$	$\mathbb{P}_t^{\text{def}}$	$\mathbb{P}_t^{\text{sp}}$	k_t
1	1.6087	2.8613	0.2733	0.92	0.08	0.00	0.1907
2	2.3746	6.2396	0.6011	0.98	0.02	0.00	-0.5177
3	3.1131	10.5700	0.8785	0.97	0.01	0.02	-1.3273
4	3.4661	12.4244	0.4109	0.99	0.00	0.01	-2.0419
5	3.2466	10.7316	0.1911	1.00	0.00	0.00	-2.3836
6	2.7537	7.6265	0.0437	1.00	0.00	0.00	-2.1641
7	2.1637	4.7046	0.0232	1.00	0.00	0.00	-1.6712
8	1.5074	2.2882	0.0159	1.00	0.00	0.00	-1.0812
9	0.8063	0.6502	0.0000	0.00	1.00	0.00	-0.0291
10	0.8069	0.6511	0.0001	0.01	0.99	0.00	-0.0482
11	0.8063	0.6502	0.0000	0.00	1.00	0.00	3.2033
12	0.9652	0.9947	0.0631	0.45	0.55	0.00	0.5191

RMAF: ratio of MAF (mean annual flow)

Table S2. Results from the FP Optimization: Moments of Deficit and Spill

	Deficit			Spill		
	1st Moment	2nd Moment	Variance	1st Moment	2nd Moment	Variance
Month	(RMAF)	(RMAF^2)	(RMAF^2)	(RMAF)	(RMAF^2)	(RMAF^2)
t	$\mathbb{E}(\delta_t)$	$\mathbb{E}(\delta_t^2)$	$\mathrm{Var}(\delta_t)$	$\mathbb{E}(Sp_t)$	$\mathbb{E}(Sp_t^2)$	$\mathrm{Var}(Sp_t)$
1	0.0211	0.0096	0.0091	0.0000	0.0000	0.0000
2	0.0073	0.0040	0.0039	0.0001	0.0000	0.0000
3	0.0026	0.0016	0.0015	0.0081	0.0053	0.0052
4	0.0000	0.0000	0.0000	0.0015	0.0006	0.0006
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.3958	0.1695	0.0129	0.0000	0.0000	0.0000
10	0.3325	0.1313	0.0208	0.0000	0.0000	0.0000
11	3.3061	11.0209	0.0909	0.0000	0.0000	0.0000
12	0.2114	0.1271	0.0824	0.0000	0.0000	0.0000

Table S3. Results from the Monte Carlo Simulation: Sample Moments of Storage and Frequencies

Month	Sample 1st Moment (RMAF)	Sample 2nd Moment (RMAF^2)	Sample Variance (RMAF^2)	Freq. of Containment	Freq. of Deficit	Freq. of Spill
t	$\mathbb{M}_1(S_t)$	$\mathbb{M}_2(S_t)$	$\text{var}(S_t)$	$\mathbb{F}_t^{\text{con}}$	$\mathbb{F}_t^{\text{def}}$	$\mathbb{F}_t^{\text{sp}}$
1	1.6170	2.8687	0.2543	0.93	0.07	0.00
2	2.3984	6.3328	0.5813	1.00	0.00	0.00
3	3.0392	9.8646	0.6284	0.97	0.00	0.03
4	3.4864	12.6751	0.5204	0.98	0.00	0.02
5	3.2357	10.6288	0.1594	1.00	0.00	0.01
6	2.7583	7.6494	0.0414	1.00	0.00	0.00
7	2.1623	4.6994	0.0240	1.00	0.00	0.00
8	1.5091	2.2936	0.0161	1.00	0.00	0.00
9	0.8070	0.6514	0.0001	0.01	0.99	0.00
10	0.8072	0.6516	0.0001	0.01	0.99	0.00
11	0.8063	0.6502	0.0000	0.00	1.00	0.00
12	0.9451	0.9475	0.0543	0.39	0.61	0.00

Table S4. Results from the Monte Carlo Simulation: Sample Moments of Deficit and Spill

	Deficit			Spill		
Month	Sample 1st Moment (RMAF)	Sample 2nd Moment (RMAF^2)	Sample Variance (RMAF^2)	Sample 1st Moment (RMAF)	Sample 2nd Moment (RMAF^2)	Sample Variance (RMAF^2)
t	$\mathbb{M}_1(\delta_t)$	$\mathbb{M}_2(\delta_t)$	$\text{var}(\delta_t)$	$\mathbb{M}_1(Sp_t)$	$\mathbb{M}_2(Sp_t)$	$\text{var}(Sp_t)$
1	0.0208	0.0077	0.0073	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0401	0.0869	0.0854
4	0.0000	0.0000	0.0000	0.0014	0.0004	0.0004
5	0.0000	0.0000	0.0000	0.0034	0.0024	0.0023
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.3964	0.1705	0.0133	0.0000	0.0000	0.0000
10	0.3360	0.1329	0.0200	0.0000	0.0000	0.0000
11	3.3153	11.0726	0.0817	0.0000	0.0000	0.0000
12	0.2311	0.1268	0.0735	0.0000	0.0000	0.0000