

Supplementary Material:

Table S1: Lake characteristics and locations. Lake names, latitudes, and longitudes are those given in the USDA water level database. Lake characteristics are from the HydroLakes database.

Lake	Lat	Long	Lake Area (km ²)	Mean Depth (m)	Watershed Area (km ²)	Elevation (m)
Aberdeen	64.48	-98.77	1102.6	31.6	150856.5	51
Amadjuak	64.89	-71.16	2994.9	24.8	19638.2	91
Aral_Sea_1	44.98	59.81	23865.9	1.1	622506.9	29
Aral_Sea_2	46.42	60.83	2964.4	26.8	325885.8	39
Arapa	-15.15	-70.06	101.9	21.0	478.9	3812
Athabasca	59.13	-110.12	7528.7	20.6	291489.3	207
Atitla	14.70	-91.14	122.7	72.2	551.6	1556
Baikal	52.67	107.00	31967.9	738.7	569176.2	449
Baker	64.17	-95.48	1664.7	60.0	244118.8	2
Balaton	46.85	17.82	577.2	3.3	5746.8	100
Balkhash	46.25	74.50	16717.9	6.7	404800.5	338
Becharof	57.89	-156.40	1166.4	55.6	3385.5	4
Beysehir	37.78	31.55	626.9	6.6	4092.2	1122
Boeng_Tonle	13.00	104.00	2416.0	12.7	54970.1	4
Bosten	42.00	87.00	961.8	9.1	40982.3	1050
Buhayrat_ath_Thartha	34.00	43.25	1698.9	25.6	27149.5	44
Cabora_Bassa	-15.67	32.00	2048.7	30.8	1068237.0	317
Caspian	40.00	51.00	377001.9	200.5	1404108.0	-29
Cedar	53.22	-100.19	2504.3	3.9	331739.0	253
Chad	13.00	14.17	18751.5	0.1	980211.9	282
Chany	54.83	77.50	1966.6	2.1	25548.3	101
Chardarinskoye	41.13	68.13	745.1	9.0	199564.0	248
Chiquita	-30.75	-62.58	6132.9	2.4	129875.5	69
Chiuta	-14.80	35.87	143.9	3.9	4341.1	628
Chukchagirskoye	52.00	136.58	372.3	15.6	1099.3	68
Diefenbaker	51.00	-107.00	391.7	25.2	118913.8	551
Dorgon	47.70	93.42	370.4	6.6	6654.4	1128
Dubawnt	62.92	-101.37	3583.2	25.5	54612.5	218
Elton	49.12	46.65	185.7	9.3	10531.2	-22
Erie	42.17	-81.00	25767.8	19.4	679903.4	172
Gaoyou	32.83	119.33	703.1	7.9	171466.1	2
Gilgel_Gibe_3	7.40	37.38	NA	NA	NA	NA
Great_Bear	65.90	-120.20	30450.6	72.2	147665.4	145

Great_Slave	61.51	-114.91		26734.3		59.1	995312.3	148
Guri	7.55	-62.92		3661.1		36.9	87349.9	270
Hammar_4	31.53	47.73	NA		NA		NA	
Har_2	48.00	93.17		574.5		4.1	80448.2	1129
Hollow	36.67	-85.33		89.6		23.5	2408.3	195
Hongze	33.25	118.67		1374.4		9.8	165046.9	10
Hovs_Gol	51.00	100.42		2767.8		138.6	7714.6	1642
Hulun	49.00	117.50		2121.4		6.2	133702.3	540
Huron	44.67	-82.67		59399.3		59.8	576017.7	175
Ijsselmeer	52.67	5.42		1962.7		4.5	10569.5	0
Issyk_kul	42.42	77.33		6195.9		280.5	21917.0	1601
Itaipu	-25.00	-54.45		1156.4		25.1	824128.6	217
Kafue	-15.69	27.76	NA		NA		NA	
Kainji	10.33	4.55		1034.9		14.5	1571130.0	139
Kajakai	32.33	65.18		42.7		62.7	46815.2	1010
Kapchagayskoye	43.83	77.50		1206.0		23.3	113657.6	475
Kara_Bogaz_Gol	41.18	53.67		18666.8		101.0	25529.4	-30
Kariba	-17.00	28.00		5276.9		35.1	679343.6	487
Khanka	45.00	132.42		4118.8		4.4	17049.4	64
Kinkony	-16.17	45.76		154.7		6.7	2789.5	12
Kiyevskoye	50.77	30.50		636.2		5.9	245547.0	98
Kremenshugskoye	49.25	32.58		1849.1		7.3	388063.7	77
Kwania	1.75	32.67		2788.2		3.0	318838.0	1034
Kyoga	1.50	33.00		2788.2		3.0	318838.0	1034
La_ang	30.67	81.23		261.3		32.5	6584.7	4570
Ladoga	61.00	31.00		17444.0		48.0	279581.2	-10
Lesser_Slave	55.42	-115.50		1186.5		11.4	13479.0	572
Madaba_Grande	-2.37	-56.55		5.6		1.3	18.0	2
Malawi	-12.00	34.50		29544.0		261.3	128727.2	476
Mallery	63.84	-98.37		460.6		14.1	7699.5	121
Mangueira	-33.17	-52.83		763.4		2.6	1841.9	0
Manitoba	50.42	-98.28		4751.1		3.6	79354.2	245
Martre	63.13	-117.50		1679.9		10.0	13423.7	249
Michigan	44.00	-87.00		57726.8		84.2	176006.4	175
Mosul	36.66	42.91		346.9		36.0	50755.1	307
Mweru	-9.00	28.75		5042.6		7.6	216298.5	921
Naivasha	-0.77	36.37		128.2		13.6	3253.0	1881
Napaktuluk	66.14	-112.94		1031.7		48.1	7177.5	366
Nasser	23.17	32.25		5385.3		30.1	2764126.0	179

Nettiling	66.14	-71.03	4872.7	23.4	63399.7	18
Ngoring	34.92	97.74	617.8	17.4	18713.7	4267
Nicaragua	11.50	-85.50	7833.3	13.3	25625.4	31
Nipigon	49.74	-88.47	4506.0	55.0	24626.2	258
Nuozhadu	23.01	100.26	NA	NA	NA	NA
Onegh	61.67	35.50	9961.9	26.3	59064.3	13
Ontario	43.58	-78.00	19347.4	84.8	766137.4	73
Orba	34.48	81.00	91.2	21.5	523.3	5194
Oulujarvi	64.33	27.31	889.8	7.0	20744.5	106
Peipus	58.67	27.50	3489.0	7.2	47673.7	28
Powell	37.00	-111.47	120.8	207.6	278954.7	1124
Primrose	54.88	-109.78	436.4	9.8	3378.7	595
Reindeer	57.68	-101.99	5435.5	17.0	62727.5	335
Rukwa	-7.83	32.00	5894.8	3.5	79610.1	801
Rybinkskoye	58.50	38.50	4042.3	6.3	150073.6	97
Saitlan	54.97	78.58	226.5	3.4	2602.0	103
Salton_Sea	33.25	-115.75	956.9	8.9	20050.8	-71
Sasykkol	46.58	81.00	744.8	3.2	19020.6	348
Shui_Feng	40.57	125.17	NA	NA	NA	NA
Sivash	46.08	34.34	468.6	6.7	8952.3	0
Southern_Indian	57.24	-98.39	2307.5	10.1	265491.1	256
St.Jean	48.58	-72.00	1112.8	11.0	72559.1	96
Superior_1	47.83	-87.00	81843.9	146.7	209219.5	179
Talbot	54.03	-99.87	184.4	8.8	429.4	255
Tana	12.00	37.25	3059.3	9.3	15133.2	1786
Tanganyika	-6.00	29.58	32826.7	577.0	239411.9	767
Towuti	-2.70	121.64	559.8	120.0	2444.4	319
Turkana	4.00	36.00	7473.4	31.8	149328.6	361
Ulungar	47.25	87.25	854.9	8.0	39719.2	478
Urmia	37.67	45.50	4932.8	0.4	52200.3	1267
Vanern	59.00	13.50	5486.2	27.9	48421.0	44
Vermelha	-20.00	-49.86	507.1	21.9	139428.8	379
Victoria_1	-1.00	33.00	67166.2	41.1	265372.8	1134
Vilyuyskoye	62.57	111.27	2190.5	16.4	137267.0	223
Volta	7.00	0.17	6045.2	24.5	404374.9	75
Windsor	21.03	-73.52	162.4	1.5	550.4	2
Winnebago	44.00	-88.42	645.5	6.4	15194.9	226
Winnipeg	52.00	-98.00	23923.0	11.9	919611.5	215
Winnipegosis	52.42	-100.00	5035.5	3.2	53350.1	251

Wollaston	58.27	-103.35		2269.6	20.2	17770.0	395
Woods	49.08	-95.00		3472.8	10.7	69313.9	320
Xiaowan	24.86	100.17	NA	NA	NA	NA	
Yellowstone	44.42	-110.33		340.5	42.9	2579.2	2360
Zeyaskoye	54.42	127.75		2234.7	30.6	82118.9	308
Zhalauly	52.87	74.17		213.2	3.4	19671.8	66

Table S2: Goodness of fit metric and for the best BRTs, and long-term water level trends associated with each lake. Slope-pre refers to the slope fit to the raw lake level data and slope-post refers to the slope fit after accounting for the effects of background climate variation.

Lake	Slope-pre (cm year ⁻¹)	Slope-pre p-value	Slope-post (cm year ⁻¹)	Slope-post p-value	PRESS (m)	n
Aberdeen	1.67	0.116	1.85	0.024	0.113	318
Amadjuak	2.92	0.001	2.72	0.008	0.027	318
Aral_Sea_1	-41.03	0.000	-43.89	0.000	0.016	319
Aral_Sea_2	6.37	0.009	6.96	0.003	0.037	319
Arapa	4.46	0.354	3.42	0.346	0.163	290
Athabasca	1.62	0.298	1.34	0.071	0.093	319
Atitla	14.78	0.013	7.73	0.007	0.106	237
Baikal	-1.11	0.007	-1.24	0.004	0.013	319
Baker	2.37	0.008	2.49	0.001	0.043	317
Balaton	-0.42	0.379	-0.42	0.024	0.014	244
Balkhash	6.61	0.001	6.68	0.000	0.010	319
Becharof	0.16	0.387	0.24	0.019	0.012	319
Beysehir	2.57	0.211	2.31	0.128	0.053	318
Boeng_Tonle	0.32	0.448	-0.97	0.354	0.763	248
Bosten	-4.56	0.193	-5.35	0.134	0.261	319
Buhayrat_ath_Thartha	-58.36	0.001	-56.40	0.002	0.723	319
Cabora_Bassa	23.58	0.009	23.85	0.005	0.947	319
Caspian	-5.11	0.000	-4.87	0.000	0.003	319
Cedar	3.07	0.064	2.29	0.017	0.113	319
Chad	-0.47	0.367	-0.80	0.283	0.019	318
Chany	2.34	0.091	2.26	0.081	0.028	318
Chardarinskoye	2.47	0.364	3.50	0.197	0.726	318
Chiquita	-7.26	0.060	-7.49	0.096	0.037	318
Chiuta	1.37	0.532	0.76	0.502	0.170	253
Chukchagirskoye	4.33	0.004	4.06	0.001	0.044	319
Diefenbaker	2.24	0.410	2.05	0.142	0.825	261

Dorgon	-6.38	0.013	-6.37	0.042	0.038	319
Dubawnt	3.91	0.002	3.50	0.003	0.040	318
Elton	0.76	0.086	0.96	0.000	0.002	238
Erie	0.33	0.501	0.32	0.554	0.009	319
Gaoyou	2.45	0.049	2.75	0.000	0.116	319
Gilgel_Gibe_3	5.96	0.052	-1.60	0.291	12.400	245
Great_Bear	3.35	0.001	2.93	0.002	0.014	318
Great_Slave	1.43	0.050	1.47	0.000	0.027	318
Guri	-0.10	0.585	-8.41	0.338	4.658	319
Hammar_4	-11.13	0.008	-3.58	0.001	0.134	252
Har_2	-3.28	0.025	-2.97	0.011	0.115	318
Hollow	3.33	0.414	3.41	0.048	0.427	243
Hongze	2.19	0.445	2.59	0.316	0.292	318
Hovs_Gol	0.93	0.209	0.71	0.175	0.025	318
Hulun	-16.94	0.023	-16.57	0.034	0.023	318
Huron	-0.55	0.402	-0.60	0.471	0.006	319
Ijsselmeer	-0.04	0.509	0.03	0.458	0.004	319
Issyk_kul	2.01	0.056	2.17	0.010	0.003	319
Itaipu	1.53	0.350	1.18	0.172	0.223	318
Kafue	1.32	0.357	2.52	0.008	0.161	249
Kainji	4.32	0.052	3.52	0.135	0.632	319
Kajakai	1.36	0.465	-2.40	0.449	11.386	247
Kapchagayskoye	6.77	0.047	6.67	0.000	0.263	259
Kara_Bogaz_Gol	-4.62	0.113	-5.32	0.067	0.130	319
Kariba	9.46	0.364	9.96	0.360	0.736	318
Khanka	4.21	0.006	3.34	0.001	0.050	319
Kinkony	1.47	0.487	2.32	0.031	0.207	246
Kiyevskoye	3.49	0.010	3.50	0.000	0.125	318
Kremenshugskoye	1.56	0.054	2.07	0.028	0.116	318
Kwania	1.75	0.449	0.27	0.488	0.048	318
Kyoga	-1.34	0.360	-0.34	0.385	0.037	319
La_ang	-20.23	0.000	-19.86	0.000	0.039	318
Ladoga	0.89	0.424	1.37	0.061	0.061	319
Lesser_Slave	0.91	0.361	1.36	0.011	0.060	318
Madaba_Grande	1.45	0.476	0.83	0.446	0.283	247
Malawi	-0.76	0.439	-0.39	0.548	0.036	318
Mallery	1.03	0.146	0.96	0.000	0.033	304
Mangueira	1.64	0.398	1.97	0.484	0.172	319
Manitoba	0.97	0.334	1.21	0.026	0.026	318

Martre	0.35	0.274	0.44	0.007	0.005	319
Michigan	-0.71	0.374	-0.48	0.442	0.005	318
Mosul	-39.27	0.027	-37.12	0.005	6.895	247
Mweru	2.62	0.301	2.52	0.009	0.097	318
Naivasha	8.66	0.092	4.53	0.063	0.164	248
Napaktuluk	-0.73	0.163	-0.41	0.236	0.007	297
Nasser	0.21	0.472	-1.95	0.547	1.523	319
Nettiling	1.68	0.021	1.21	0.002	0.055	319
Ngoring	11.18	0.001	10.33	0.001	0.048	318
Nicaragua	0.22	0.461	0.10	0.511	0.050	318
Nipigon	0.11	0.388	0.05	0.370	0.028	319
Nuozhadu	221.95	0.008	0.00	0.000	4594.476	190
Onegh	0.54	0.442	0.83	0.036	0.019	318
Ontario	-0.22	0.446	-0.34	0.170	0.019	318
Orba	0.80	0.491	0.93	0.014	0.044	244
Oulujarvi	3.04	0.009	2.77	0.000	0.064	317
Peipus	0.16	0.520	0.18	0.507	0.041	318
Powell	-94.30	0.068	-105.90	0.006	7.860	245
Primrose	3.43	0.007	3.08	0.000	0.049	319
Reindeer	4.86	0.016	5.18	0.002	0.047	319
Rukwa	-14.39	0.001	-14.90	0.000	0.072	318
Rybinkskoye	3.52	0.141	3.25	0.000	0.208	319
Saitlan	1.93	0.082	1.55	0.129	0.007	318
Salton_Sea	-10.70	0.000	-11.03	0.000	0.022	319
Sasykkol	1.94	0.012	1.68	0.001	0.040	319
Shui_Feng	3.90	0.495	20.28	0.164	22.481	247
Sivash	-0.87	0.245	-0.03	0.432	0.063	250
Southern_Indian	3.78	0.006	3.57	0.000	0.041	317
St.Jean	1.28	0.480	1.45	0.050	0.243	318
Superior_1	-0.31	0.525	-1.46	0.304	0.006	319
Talbot	3.11	0.004	3.00	0.003	0.015	318
Tana	0.53	0.442	0.37	0.466	0.043	319
Tanganyika	1.48	0.412	0.74	0.371	0.035	318
Towuti	1.96	0.247	1.91	0.001	0.075	262
Turkana	8.39	0.092	7.70	0.114	0.084	318
Ulungar	6.10	0.010	4.93	0.000	0.064	248
Urmia	-30.57	0.000	-30.54	0.000	0.083	319
Vanern	0.28	0.377	0.30	0.124	0.024	318
Vermelha	-9.45	0.115	-9.90	0.002	1.288	247

Victoria_1	0.53	0.496	0.25	0.496	0.015	319
Vilyuyskoye	-6.68	0.076	-7.98	0.003	0.717	317
Volta	-0.88	0.493	-0.41	0.403	1.330	318
Windsor	1.39	0.128	1.15	0.081	0.013	281
Winnebago	-0.63	0.054	-0.67	0.006	0.012	318
Winnipeg	2.04	0.038	1.68	0.004	0.039	319
Winnipegosis	4.57	0.027	4.34	0.006	0.029	319
Wollaston	1.33	0.029	1.00	0.000	0.026	318
Woods	-0.69	0.128	-0.91	0.003	0.039	319
Xiaowan	486.89	0.001	0.01	0.000	2483.202	244
Yellowstone	1.95	0.046	1.82	0.000	0.055	319
Zeyaskoye	24.60	0.021	22.13	0.017	1.207	318
Zhalauly	-1.03	0.293	-1.42	0.012	0.165	248

Table #: Summary statistics for the PCs used in this study including Eigen values, mean relative importance across lake models.

Variable	Number of Lakes	Mean Relative Influence	PCA % Variance Explained
year	117	29.05	NA
month	117	11.07	NA
PC1	16	1.45	10.85
PC2	43	4.18	7.84
PC3	15	0.92	7.23
PC4	42	4.26	5.54
PC5	32	3.17	4.76
PC6	26	2.31	3.50
PC7	19	1.80	2.86
PC8	8	0.64	2.77
PC9	20	1.56	2.53
PC10	14	0.78	2.31
PC11	25	2.33	2.17
PC12	12	0.79	2.06
PC13	8	0.68	1.77
PC14	18	1.45	1.53
PC15	18	1.48	1.47
PC16	7	0.51	1.42
PC17	10	0.67	1.37
PC18	10	0.70	1.34
PC19	14	0.96	1.27

PC20	12	0.94	1.22
PC21	5	0.25	1.10
PC22	10	0.62	1.03
PC23	11	0.75	1.03
PC24	13	0.88	0.95
PC25	10	0.85	0.93
PC26	14	1.05	0.88
PC27	8	0.56	0.87
PC28	2	0.11	0.81
PC29	12	0.98	0.76
PC30	13	0.86	0.72
PC31	8	0.76	0.71
PC32	20	1.32	0.69
PC33	2	0.08	0.68
PC34	10	0.71	0.65
PC35	9	0.52	0.62
PC36	6	0.38	0.60
PC37	3	0.15	0.58
PC38	4	0.32	0.57
PC39	7	0.44	0.54
PC40	4	0.40	0.53
PC41	3	0.19	0.51
PC42	6	0.39	0.50
PC43	12	0.76	0.46
PC44	2	0.08	0.45
PC45	6	0.46	0.44
PC46	4	0.37	0.43
PC47	4	0.35	0.41
PC48	7	0.51	0.39
PC49	5	0.27	0.38
PC50	3	0.13	0.37
PC51	8	0.55	0.36
PC52	1	0.10	0.36
PC54	4	0.21	0.35
PC55	7	0.56	0.34
PC56	2	0.13	0.32
PC57	6	0.28	0.32
PC58	2	0.11	0.32
PC59	2	0.12	0.29

PC60	8	0.57	0.28
PC62	6	0.36	0.28
PC63	5	0.38	0.27
PC64	8	0.48	0.26
PC65	1	0.06	0.25
PC66	3	0.18	0.25
PC67	10	0.71	0.24
PC68	6	0.38	0.23
PC69	8	0.50	0.23
PC70	7	0.33	0.22
PC71	3	0.15	0.21
PC72	3	0.14	0.21
PC73	2	0.08	0.20
PC74	6	0.43	0.20
PC75	3	0.19	0.20
PC76	3	0.16	0.19
PC77	5	0.29	0.18
PC78	5	0.34	0.18
PC79	2	0.14	0.17
PC80	4	0.22	0.17
PC81	5	0.34	0.17
PC83	5	0.49	0.16
PC84	4	0.24	0.16
PC85	5	0.35	0.15
PC86	2	0.10	0.15
PC87	4	0.19	0.15
PC88	4	0.19	0.14
PC89	12	0.84	0.14
PC90	2	0.20	0.14
PC91	1	0.06	0.14
PC93	2	0.09	0.13
PC94	2	0.19	0.13
PC95	4	0.38	0.13
PC96	5	0.49	0.12
PC97	2	0.21	0.12
PC98	2	0.09	0.11
PC99	2	0.12	0.11
PC100	2	0.10	0.11

