S1 Explanation of data assimilation parameters and equation

The following two equations describe the data assimilation methodology at each timestep:

$$x_b = x_b + K[y - y_e] \,, \tag{S1}$$

5 $$K = \frac{w_{loc} * cov(y_e, x_b)}{cov(y_e, y_e) + R} \,, \tag{S2}$$

In equation S1, the matrices x_b and x_a describe vectors of the prior and posterior respectively. Each matrix includes an ensemble of values for each climate variable and geographic location. The innovation $(y - y_e)$ is the difference between the proxy observations and the prior estimate of the proxy value as calculated by the proxy system model. The innovation is spread to each location and variable according to the Kalman gain matrix (K) which is a square root ensemble Kalman filter

10 (Whitaker & Hamill, 2002).

As quantified by equation S2, K is a function of the covariance between the prior estimate (y_e) with each climate variable at every grid cell (x_b). This is the invaluable step of DA which updates the target climate variables according to the information contained by proxy values and which creates a uniform gridded dataset. Two additional factors are also included in K: a localization radius matrix (w_{loc}) and positive diagonal error covariance matrix (R).

15 As the geographic coordinates in the x_b matrix become more distant from the proxy observations, w_{loc} can decrease from 1 to 0 according to a predefined localization radius and is unitless. For the DAMP-21ka reanalysis, the w_{loc} matrix weights the innovation according to a fifth-order polynomial so that the K is reduced with distance from a given proxy sites and locations further than the cut-off radius are not updated (Gaspari & Cohn, 1999; Tardif et al., 2019). R represents the uncertainty of the proxy observation in the squared units of y_e. Specifically, a radius of 8,000 km and R of 302 (900) was selected based on

20 validation experiments to test the sensitivity of each parameter (Table S3). Overall, reconstruct skill is relatively insensitive to these parameter choices, but lake status reconstruction skill is generally highest with small localization radius and R values due to coherent trends among nearby lakes throughout many regions. However, skill metrics calculated using the withheld pollen data suggest that larger values may be more appropriate. We selected the chosen parameters based on their high skill as measured by correlation with calibrated precipitation records both globally and in North America which is the

25 one region with high densities of both lake status and pollen proxy records.

Table S1: List of lake status proxy records used in the data assimilation. The TSid is a unique identifier for the appropriate time series in the LiPD file. Duration represents the difference between the maximum and minimum age of the record. Any records spanning more than 21,000 years were assigned a duration of 21 kyr. Source indicates the data compilation from which the data was sourced. OLS indicates Oxford Lake Status Databank (Street-Perrott et al., 1989) and L&S refers to Liefert and Shuman (2020). The publication column references the original data generators as identified by the data compilations.

site	TSid	lat	lon	elevation (m)	duration (kyr)	source	original publication
Almora Lake (Parker's)	pdRdEGWYw7cNROLp8sM	46.21	-95.3	440	13	L&S (2020)	Digerfeldt et al. (1992)
Cayuga Lake	pdRHn2Pz80FEgrQMUn0	43	-75.25	125	13	L&S (2020)	Mullins (1998)
Crooked Pond	pdRFvsGhWnaWLNCJZOB	41.89	-70.65	25	14.3	L&S (2020)	Shuman et al. (2001)
Mirror Lake	pdRmwkDfwe6u28KuWTk	43.95	-71.7	350	16.9	L&S (2020)	Davis & Ford (1982); Davis et al., (1984)
Owasco Lake	pdR95vmKthSzyI9ntp3	42.75	-77.5	350	13.6	L&S (2020)	Dwyer et al. (1996)
Owens Lake	pdRKlOXqPCWJFftTUyC	36.45	-117.97	1085	21	L&S (2020)	Bacon et al. (2006)
Rice Lake - Middle Basin	pdRQvUAgiTzsooiU2HT	44.21	-78.13	185	13	L&S (2020)	Yu and McAndrews (1994)
Rice Lake - West Basin	pdRyrnRCmOiv8zpgLvf	44.11	-78.3	185	13	L&S (2020)	Yu and McAndrews (1994)
Sevier Lake	pdRYwqALFxQB0DnOiiQ	39	-113	1500	14.6	L&S (2020)	Oviatt (1988)
Adley Lake (Parker's)	pdRrmkVD3TsBOeoXn7g	46	-95	440	12.2	L&S (2020)	Digerfeldt et al. (1992)
Bosumptwi	WEB25059875	6.5	1.42	76	21	Original Pub	Shanahan (2006)
Bufflehead Pond	pdRtg8eM5mtBLKQ8gkF	44.98	-93.53	300	14	L&S (2020)	Shuman et al. (2009)
Carson Sink	pdR3iBvTlj5zwy8bjTI	39.83	-118.61	1180	15.5	L&S (2020)	Adams et al. (2009)
Makepeace Cedar Swamp	pdRXoXk6qKsU102x2C4	41.93	-70.77	35	13.7	L&S (2020)	Newby et al. (2000); Shuman et al. (2004)
Pyramid Lake	pdRAD0OoGMqGUoHfFHZ	40.06	-119.56	1155	21	L&S (2020)	Benson et al. (2002); Briggs et al. (2005)
Ruby Lake/Marshes	pdRUteHT9P1yzhdRamQ	40.12	-115.49	1820	21	L&S (2020)	Thompson et al. (1990; 1992)
Ryder Pond (MA)	pdRtkSoE1Q93x2JFV5i	41.97	-70.03	0	16.9	L&S (2020)	Winkler et al. (1995)
Abhe	OLS_RfBMrSLi0j3	11.25	42	240	21	OLS (1989)	Fontes (1975)
Agadem	OLS_RF7pv7UUDFw	16.83	13.33	350	10.8	OLS (1989)	Commelin (1980)
Alexandersfontein	OLS_RrOZmMhgLUP	-28.83	24.8	1119	21	OLS (1989)	Butzer (1973)
Alsacia	OLS_RhL9KDPT14X	3.9	-73.85	3100	20.9	OLS (1989)	Melief (1982)
ArdElAkhdar	OLS_R5sFsSYnjHw	23.18	26.03	950	12.3	OLS (1989)	Kropelin (1987)
Bancannia	OLS_RXfu7xAGzWB	-30.82	141.93	107	18.8	OLS (1989)	Dury (1973)
Beaver Lake	pdRMMxRg4ypwnub7vhk	42.45	-100.65	910	12.9	L&S (2020)	Schmieder et al. (2011); Schmieder et al. (2013)
Bebedero	OLS_R4idEFGElHM	-33.33	-66.75	380	21	OLS (1989)	Gonzalez (1983)
Beysehir	OLS_RaIxqdb5VXZ	37.75	31.5	1120	21	OLS (1989)	Roberts (1980)
Bonneville	OLS_RLueiGtvS3m	40.5	-113	1280	21	OLS (1989)	Bright (1966)
Breadalbane	OLS_RnZixdO7vMV	-34.78	149.48	697	12.3	OLS (1989)	Dodson (1986)
Bullenmerri	OLS_R9bib9fXM0c	-38.25	143.12	146	19.9	OLS (1989)	Barton (1981)
Cahaba	OLS_RhSooYiv8NM	33.5	-86.53	210	14.7	OLS (1989)	Delcourt (1983)
Carp	OLS_Rn9jxxYJDzK	45.92	-122.88	714	21	OLS (1989)	Barnosky (1985)
CheshiMweruWantipa	OLS_RIUAKxfcWiL	-8.87	29.68	928	21	OLS (1989)	Stager (1988)

Clovis	OLS_RGC5Y4gspKt	34.25	-103.33	1250	13.4	OLS (1989)	Damon et al. (1964)
Duck	OLS_RSzZCo2C7Xj	41.93	-70	3	14.7	OLS (1989)	Winkler (1985)
Duncan Lake	pdRiNPVIQECAx9xVLKu	44.65	-107.45	2820	19.9	L&S (2020)	Shuman & Serravezza (2016)
ElAbra	OLS_RFTxPMAWS1C	5	-74	2570	21	OLS (1989)	Schreve-Brinkman (1978)
Emerald Lake Leadville	pdRfvT1wuHIGXRlmUju	39.15	-106.41	3055	15.6	L&S (2020)	Shuman et al. (2014)
FortRock	OLS_RHt0P2iCpt5	43.17	-120.75	1311	21	OLS (1989)	Gilman (1975)
Frome	OLS_RTxbwsdvMwm	-30.75	139.83	-2	21	OLS (1989)	Bowler (1986)
Fuquene	OLS_Rbr7K7EZgsy	5.5	-73.75	2580	21	OLS (1989)	Van Geel (1973)
George	OLS_RfoenkHHXTE	-35.08	149.42	800	21	OLS (1989)	Bowler et al. (1976)
George	OLS_Ree2SxMXXUS	43.52	-73.65	96	14.7	OLS (1989)	Hutchinson et al. (1981)
Gnotuk	OLS_RSllKp5JECx	-38.22	143.1	102	18.8	OLS (1989)	Barton (1981)
HassiElMejna	OLS_R2KxxymoXwo	31.5	2.3	470	10.8	OLS (1989)	Delibrias (1971)
Hay	OLS_R9wwlYbD32V	34	-109.5	2780	21	OLS (1989)	Haynes (1983)
Hook	OLS_RpZvDDmAq2c	42.95	-89.33	260	14.7	OLS (1989)	Winkler (1985)
Isle	OLS_RvAYM4Zh3Pk	52.62	-114.43	700	12.3	OLS (1989)	Heusser (1983)
Jacob	OLS_REuK7XDcRTY	34.42	-110.83	2285	21	OLS (1989)	Jacobs (1983)
Keilambete	OLS_Rwm0onKGDHv	-38.04	142.87	95	21	OLS (1989)	Barton (1981)
KettleHole	OLS_Ro4FH6vkuLB	43	-95	350	14.7	OLS (1989)	Collins (1968)
Kirchner	OLS_Rcoxn5kpPMy	44.83	-92.77	275	16.3	OLS (1989)	Brugam (1980)
Kow	OLS_RoBxNxe0ixb	-36.2	144.3	83	17.7	OLS (1989)	Macumber (1977)
LaGuitarra	OLS_RusPjLSBZcB	3.87	-74	3450	18.8	OLS (1989)	Melief (1984)
Lake of the Woods (WY)	pdRPXtR2BTqSS5KCkTm	43.48	-109.89	2820	17.9	L&S (2020)	Shuman et al. (2010); Pribyl and Shuman (2014)
Lake O' Pines	pdRn4uVv5xmEy3QbRZo	46.14	-89.25	520	13	L&S (2020)	Ewing (2000)
Lake West Okoboji	pdR889sQHzAg5FOKA7S	46.3	-95.2	430	14	L&S (2020)	Van Zant (1979)
Leconte	OLS_Rt3bq8OIkfc	33.33	-116	-71	16.3	OLS (1989)	Crane (1958)
Little Windy Hill Pond	pdRkoO11xxFGVWJeL62	41.43	-106.34	3000	17.1	L&S (2020)	Pribyl and Shuman (2014)
Lubbock	OLS_RF4kqHZt5Ej	33.63	-101.9	975	13.4	OLS (1989)	Holliday (1985)
Lunkaransar	OLS_REKcgVZxfZQ	28.5	73.75	200	13.4	OLS (1989)	Singh (1972)
MaineSoroa	OLS_RPogGSF6ido	13.12	12	315	13.4	OLS (1989)	Durand (1984)
Mendota	OLS_Rxv9LmnnQsQ	43.1	-89.42	259	14.7	OLS (1989)	Steventon et al. (1986)
MobutuSeseSeko	OLS_R0IYyZ8sKNw	1.5	31	619	21	OLS (1989)	Harvey (1976)
Moore	OLS_RwLxfQP11eP	53	-110.5	500	14.7	OLS (1989)	Schweger (1983)
Okoboji	OLS_R4a8rMDILX2	43.33	-95.2	425	16.3	OLS (1989)	Van Zant (1979)
Pickerel	OLS_RifcIdFjsr2	43.5	-97.33	395	12.3	OLS (1989)	Haworth (1972)
Poukawa	OLS_RE8t9IMfyob	-39.77	176.73	21	17.7	OLS (1989)	McGlone (1978)
Rainbow Lake (Beartooths)	pdRsQ687U7RBI0qSdyE	44.94	-109.5	2960	17.9	L&S (2020)	Shuman & Serravezza (2016)
Ruby	OLS_RXjJiwKiDO4	40.58	-115.33	1818	21	OLS (1989)	Thompson (1984)
Russell	OLS_R28mFojQksk	38.05	-118.77	1951	21	OLS (1989)	Fergusson et al. (1962)
Rutz	OLS_RAcSotekegB	44.87	-93.87	314	14.7	OLS (1989)	Waddington (1969)
Sambhar	OLS_RO2T7DUh8l2	27	75	360	13.4	OLS (1989)	Agrawal (1971)
Searles	OLS_RfD6MNlONoM	35.6	-117.7	493	21	OLS (1989)	Flint et al. (1958)

Silver Lake (Lake Mohave)	pdR0bHPwOODs54avzaw	35.34	-116.11	275	21	L&S (2020)	Wells et al. (2003)
TaguaTagua	OLS_ROVfSZGskJH	-34.5	-71.17	890	21	OLS (1989)	Heusser (1984)
Tauca	OLS_R4P4Wwpe8Jd	-19.5	-68	3660	21	OLS (1989)	Servant (1978)
Tigalmamine	OLS_RTKjwB4I61Z	32.9	-5.35	1626	18.5	OLS (1989)	Lamb (NA)
Tritrivakely	OLS_RM81PKgdBEz	-19.78	46.92	1800	13.4	OLS (1989)	Burney (1987)
Tyrrell	OLS_RIAO1405W9b	-35.33	142.78	42	21	OLS (1989)	Bowler (1986)
Upper Big Creek Lake	pdRopkg65IV11NRNtq6	40.91	-106.62	2750	12.7	L&S (2020)	Shuman, Pribyl, and Buettner (2015)
Urmia	OLS_RnQ2dbxrFsX	37.63	45.5	1284	16.3	OLS (1989)	Kelts et al. (1986)
Valencia	OLS_RVw6wlN8ACI	10.1	-67.75	402	16.3	OLS (1989)	Bradbury (1981)
Victoria	OLS_RrW4ZPeL6bM	-1	33	0	21	OLS (1989)	Kendall (1969)
Wabamun	OLS_RblGnR4xJrB	53.5	-114.25	732	10.8	OLS (1989)	Fritz (1973)
Washburn	OLS_RXKCFWVRanL	43.53	-89.65	248	12.3	OLS (1989)	Winkler (1985)
Weber	OLS_Rh1QgEylyEm	47.47	-91.65	559	13.4	OLS (1989)	Fries (1962)
Wedge	OLS_RtESqFQmPOU	50.87	-115.17	1500	12.3	OLS (1989)	MacDonald (1982)
West Twin Lake (NE)	pdRfOJh6SjJ3emsFmsY	42.4	-101.44	1045	15	L&S (2020)	Schmieder et al. (2011); Schmieder et al. (2013)
White	OLS_R4QPDsP0JVX	34.16	-80.76	90	21	OLS (1989)	Watts (1980)
WielkeGacno	OLS_Rnp35KKbNIN	53.73	17.2	130	13.4	OLS (1989)	Hjelmroos-Ericsson (1982)
Wintergreen	OLS_RzEmio4JrEJ	42.4	-85.38	271	16.3	OLS (1989)	Manny (1978)
Zeribar	OLS_R14ZgdIg3vP	35.53	46.12	1300	21	OLS (1989)	Hutchinson et al. (1963)
Afrera	OLS_R7luETutJOR	13.42	40.83	-82	12.3	OLS (1989)	Bannert et al. (1970)
Asal	OLS_ResQaXkZnvE	11.6	42.5	-155	14.7	OLS (1989)	Eldridge et al. (1975)
Bilma	OLS_RPARZQXyu1l	18.75	13	310	21	OLS (1989)	Delibrias et al. (1974)
Bogoria	OLS_RtPtAFW735C	0.3	36.1	990	18.8	OLS (1989)	Young et al. (1979)
Bougdouma	OLS_RgJGZeaw0md	13.3	11.7	320	14.7	OLS (1989)	Gasse (1987)
Bromfield	OLS_RwqOkY17CbA	-17.38	145.55	755	12.3	OLS (1989)	Kershaw (1975)
Chad	OLS_Raj0ajWk8Z1	13	14	282	21	OLS (1989)	Buckley (1970)
ChemchaneAderg	OLS_RajLAejX7H1	21	-12.12	260	21	OLS (1989)	Chamard (1973)
Chenghai	WEB2b92ddec	26.5	100.66	1500	14.1	Original Pub	Xu et al. (2020)
Chiconahuapan	OLS_R2IDZP9z5wp	19.13	-99.67	2575	13.4	OLS (1989)	Metcalfe et al. (1991)
Dali Lake	WEB40d3e7b3	43.43	116.71	1226	15.2	Original Pub	Goldsmith et al. (2017); Goldsmith et al. (2020)
Didwana	OLS_R4YTlXp5Scl	27.33	74.58	350	17.7	OLS (1989)	Singh et al. (1972)
DobiHanle	OLS_RcDGJfqpBeC	11.5	42	120	21	OLS (1989)	Fontes (1973)
ElGobernador	OLS_R91mklW7AkS	3.85	-74.35	3815	12.3	OLS (1989)	Melief (1983)
EnneriBardague	OLS_RphnQDokp38	21.5	17	1025	21	OLS (1989)	Bottcher (1972)
Euramoo	OLS_Rr8es7LpU7s	-17.17	145.63	730	12.3	OLS (1989)	Kershaw (1970)
Fachi	OLS_RKoQn911SXJ	18.12	11.67	275	21	OLS (1989)	Delibrias (1966)
Kivu	OLS_R4Ijw8OPsjM	-2	29	1462	17.7	OLS (1989)	Haberyan et al. (1987)
Lake Cochise	pdRNyQeqaj6PkSQYY4b	32.17	-109.87	1260	16.4	L&S (2020)	Waters (1989)
LisanDeadSea	OLS_Rz4NEhuh5D0	31.5	35.5	-395	21	OLS (1989)	Bedwell (1973)

LynchsCrater	OLS_RFZ5ftnO2t2	-17.37	145.7	760	18.8	OLS (1989)	Kershaw (1974)
MagadiNatron	OLS_Rl1U1UXxAIf	-2.12	36.04	600	19.9	OLS (1989)	Butzer (1972)
Manyara	OLS_Rrt4iAcWTIK	-3.62	35.82	945	21	OLS (1989)	White et al. (1982)
Mexico	OLS_RTsihKwmPMu	19.5	-99	2240	21	OLS (1989)	Bradbury (1971)
Nabta	OLS_Rrtm3chd7C5	23	31	250	21	OLS (1989)	Wendorf (1980)
Naivasha	OLS_RFUFyYZUb0P	-0.68	36.33	1890	21	OLS (1989)	Butzer et al. (1972)
NakuruElmenteita	OLS_RjwvXKkI618	-0.42	36.17	1750	21	OLS (1989)	Butzer et al. (1972)
Patzcuaro	OLS_ROkPLG6ezuC	19.58	-101.58	2044	21	OLS (1989)	Pollard (1982)
Quexil	OLS_RSQIFjVgiso	16.93	-90.12	110	13.4	OLS (1989)	Deevey (1978)
Selima	OLS_R1vmDg2WuOy	21.32	29.34	200	12.3	OLS (1989)	Haynes et al. (1979)
Tanganyika	OLS_RvTeu3ziD24	-6.03	28.53	773	19.9	OLS (1989)	Hecky et al. (1973)
TermitOuestKandelBouzou	OLS_RmpO87FXnN9	16.08	11.25	300	13.4	OLS (1989)	Faure (1963)
Turkana	OLS_RDo2ZhhzvEJ	5	36	375	21	OLS (1989)	Butzer et al. (1972)
Lake Turkana	WEB-9119d-899e-4084-82c1-1fac9	3.79	35.93	430	13	Original Pub	Garcin et al. (2012)
Walker	OLS_RzqaAnmlHbH	35.5	-111.67	2700	21	OLS (1989)	Long (1981)
Wanum	OLS_Roe2Ri2GOD9	-6.63	146.78	35	12.3	OLS (1989)	Garrett-Jones (1979)
ZhangzangChaka	OLS_RAPLKNVwmJW	32.5	82.33	6000	19.9	OLS (1989)	Fu-Bao et al. (1987)
ZiwayShala	OLS_RRO1Ic9Qv3B	7.75	38.67	1558	21	OLS (1989)	Geze (1975)

Table S2: List of pollen proxy records calibrated to mean annual precipitation. These data were used to independently validate data assimilation. The TSid is a unique identifier for the appropriate time series in the LiPD file. Duration represents the difference between the maximum and minimum age of the record. Any records spanning more than 21,000 years were assigned a duration of 21 kyr. Records are compiled by Hancock et al. (2023) for the Holocene Hydroclimate (HH) dataset. LC indicates those from the Legacy Climate dataset (Herzschuh et al., 2023).

site	TSid	lat	lon	duration (kyr)	source	original publication
Achit Nuur	lcRHKtvc1HMQRltXv6E	51.58	104.85	20.6	LC	Sun (2013)
Aegelsee	lcRiO79S9Ix3TwY9hPY	46.65	7.54	13.7	LC	Lotter (1991)
Agerods Mosse	lcRxfTrPDKVUtCFt7rs	55.93	13.43	10.2	LC	Nilsson (1964)
Albany River Bog	lcRzlW3oGuXnInc3Msu	51.44	-83.62	5.9	LC	Glaser et al. (2004)
Alp Lusga Belalp 1	lcR2SXIdl9wohfxxdbD	46.23	7.59	7.7	LC	van der Knaap (1997)
Alut Lake	lcRDoKSlINMOkI1PqMf	60.14	152.31	21	LC	Anderson (2002)
Andy	PYTCPIAO06Y	64.65	-128.08	13.2	HH	Szeicz et al. (1995)
Avstjonna	lcR9GEASzqUKcowM16T	61.65	9.88	13	LC	Birks (2012)
Ayoo de Vidriales	lcRXz9wnygIFdmBJCJe	42.13	-6.07	16.7	LC	Morales-Molino (2014)
Baahar Nuur Lake	lcRDlSFQ3FGujgZJ3LN	39.32	109.27	5.8	LC	Huang (2009)
Bakaly	lcRKi1dhBq6WuciB6US	41.87	71.96	6.9	LC	Beer (2008)
Battle Ground Lake	lcRM5YQeikjGgODpYRD	45.8	-122.49	21	LC	Barnosky (1983)
Bayanchagan Lake BY	lcRrnLoUTd7IMmW7hE5	41.65	115.21	11.5	LC	Jiang (2006)
Beaverhouse Lake	lcROtMDEQsOa6CKzEBo	46.15	-85.49	6.2	LC	Ritchie (1976)
Beaver Lake	lcRhapwgU8yMeacBLgK	44.92	-88.16	5.8	LC	Calcote (2003)
Bebrukas Lake	lcRuTlqjPrHd2xH329d	54.09	24.12	14.5	LC	Kabailiene (1986)
Bebrukas Lake	lcRYFM1oW2BMerncgWT	54.09	24.12	17.2	LC	Kabailiene (1986)
Bebrukas Lake	lcR7JrQa2JW0MEcIlwG	54.09	24.12	17.2	LC	Kabailiene (1986)
Begbie Lake	lcRfmVxd7PePxotBtxX	48.59	-123.68	14	LC	Brown et al. (2019)
Bell's Lake	lcRCIhUix5QOaVYiSJ3	65.02	-127.48	12.2	LC	Szeicz et al. (1995)
Benson Pond	lcRyuLsI0devWnXL9UK	42.38	-73.09	14.7	LC	Oswald et al. (2018)
Berry Pond	lcRmoUYX9CAfAdUW9Re	42.62	-71.09	14.9	LC	Whitehead (1979)
Berry Pond	lcRFk9bWYJHqyCtFNx8	42.5	-73.32	14.2	LC	Whitehead (1979)
Bibersee	lcRux6T4mIrY0kwQeJs	47.21	8.47	14.2	LC	van der Knaap (2001)
Bitsch-Naters	lcRoCXWDdV0uxUvztLb	46.34	7.99	11.1	LC	van der Knaap (1997)
Biviere di Gela	lcRvxK7zhrGHqqmmSr5	37.02	14.34	7.5	LC	Colombaroli (2009)
Black Gum Swamp	lcRLcJzCjoqgEKwHqBs	42.54	-72.18	14.5	LC	Foster et al. (1993)
Blood Pond	lcRFOyuRIeyddE3MuQ9	42.08	-71.96	15.2	LC	Oswald et al. (2018)
Boomerang Lake	WEB31e807ae	49.18	-124.16	11.8	HH	Brown et al. (2006)
Brede Bridge	lcRraSSIL4ehrOMpeyc	50.91	0.68	5.9	LC	Waller (1994)
Breitnau-Neuhof	lcRWWzCPyjezteZo74a	47.93	8.07	12.7	LC	Rosch (1989)
Bruckmisse	lcR4iehaNeTVyPOO2np	48.73	8.64	4.9	LC	Rosch (2009)
Bruckmisse	lcRseG41EyZPFn7vBuL	48.73	8.64	7.7	LC	Rosch (2009)
Brurskardtjorni	lcRLALDzbV8deV0FSpS	61.42	8.67	12.1	LC	Bjune (2005)

Buck Lake	lcRlOmh5hio8SI6zqLN	46.52	-86.35	7.7	LC	no pub on record
Bugristoe	lcRQoeD5swxv5zB9KeA	58.25	85.17	7	LC	Blyakharchuk (1989)
Bulgarian Black Sea	lcRUewusWiI9G28ut2a	42.47	28.41	12.4	LC	Filipova-Marinova (2014)
Burden Lake	lcRi9rpgU3KNzoGhTeP	42.6	-73.56	9.7	LC	Gaudreau (1986)
Caddo Creek (Core 3)	lcRPzK3bolAUBI4YPWm	32.05	-95.51	7	LC	Albert (2011)
Cahaba Pond	lcRVRnl9YOspeS2qWJq	33.5	-86.53	14.1	LC	Delcourt et al. (1983)
Camp 11 Lake	lcRYUf2GzuKWaJw7Cls	46.67	-88.02	11.7	LC	Brubaker (1975)
Cangumiao	lcRJ9bcRX8zajMu6bEY	38.97	118.6	5.3	LC	Xu (2004)
Canyon Lake	lcRPBnamW5NHR8VPMKn	46.83	-87.92	11.7	LC	Davis et al. (1991)
Cape Shpindler	lcRaeEm3p5q0v5R3dkJ	69.72	62.8	14.6	LC	Andreev (2001)
Capitola Lake	lcRH47ExCxsXc3fhZVO	45.52	-89.56	10	LC	Calcote (2003)
Carquefou	lcRI8sX3Od0JpEYzLbI	47.31	-1.48	4.6	LC	Cyprien (2001)
Chadianpo	lcRxjdbi8n5mfOcteLV	36.1	114.4	4.2	LC	Zhang (2007)
Chantemerle	lcRKr2FoiqFt9fd0w2J	45.92	0.02	4.6	LC	Fauquette (1999)
Chaohu Lake CH1	lcRRQAEsiOSvKg2mTq7	31.56	117.39	11.3	LC	Wu (2008)
Charco da Candieira	lcRz2jklJHwfxKMvv1z	40.34	-7.58	14.7	LC	Van der Knaap (1994)
Chesapeake Bay (MD99-2209)	lcR8NsSZHAiFlBflvWP	38.89	-76.39	7.2	LC	Willard et al. (2005)
Chifeng-Qiguo Mt.	lcR03YZlwKcvi9NBBso	42.28	118.97	8.7	LC	Xu (2002)
Chuna Lake	PYTI39I3N0G	67.95	32.48	8.8	HH	Solovieva et al. (2005)
Cinq-Mars-la-Pile	lcReM30B315r999fKee	47.34	0.45	9.2	LC	Carcaud (2002)
Clear Lake	lcRm2HAyL9Ow8Vn9ldV	41.64	-86.54	16	LC	Baker et al. (1992)
Clear Lake	lcRKzoswtatgqh9p86e	43.13	-93.43	13.8	LC	Baker et al. (1992)
Col des Lauzes	lcRScfMGWPopcFlEwve	44.77	6.54	13.9	LC	de Beaulieu (1977)
Compass Pond	lcRRxSlrTN8OVtHnbmp	50.03	-56.2	15.3	LC	Blake Jr (1986)
Cooley Lake	lcRUbe6c1j2j2brmI3y	49.49	-117.65	7.5	LC	Gavin et al. (2006)
Coppermine Saddleback	lcRE5QbPJ0FLNw7ktuv	67.83	-115.32	4.2	LC	no pub on record
Crater Lake	lcRQgznauTtY1MfGgdK	49.19	-120.1	12.7	LC	Heinrichs et al. (2002)
Crowfoot Lake	lcRlsbmXFmyXRKKhM7a	51.65	-116.42	13.6	LC	no pub on record
Csogle	lcRtQQC74Cocv8dlqiq	47.22	17.25	7.1	LC	Juhasz (2002)
Dags Mosse	lcRBfIzOEaoKY4OpCu0	58.32	14.71	8.8	LC	Goransson (1989)
Dailey Lake	lcRWXs1OS7FPp0sIlOC	45.26	-110.82	14.1	LC	Krause et al. (2015)
Dallican Water	lcRYN4y5FCQn0BuDu6s	60.39	-1.1	11.1	LC	Bennett (1992)
Darko	lcRPtpeHk3QmKrusMf8	49.64	15.87	14.2	LC	Rolecek (2020)
Deep Lake	NAm2kHydro215	41.62	-70.58	11	HH	Marsicek et al. (2013)
Deep-Falmouth Pond	lcRlZG93oUnsBEDKSaM	41.56	-70.64	15.6	LC	Oswald et al. (2018)
Deep-Taunton Pond	lcRgG0nqmKpMbG6TnGY	41.88	-71.01	16.1	LC	Oswald et al. (2018)
Delorme 2	lcRICjQTzvniz5Xlx4q	54.42	-69.93	7	LC	Richard et al. (1982)
Devil's Bathtub	lcRDYi20GlO0AonbO2J	43.02	-77.57	11.6	LC	Clark et al. (1996)
Divers Lake	lcRkBG2IjDkwtqKcx6y	43.04	-78.4	15.4	LC	Miller (2003)
Doel	lcRf6K3Ujfi8s5aGQ2k	51.32	4.25	6.3	LC	Deforce (2011)
Dolgoe Lake	PYTISXSSSBC	71.87	127.07	14.1	HH	Wolfe et al. (2000)

Domsvatnet	lcRnIxD1N0tJmJywI9G	70.33	31.03	11	LC	Hyvarinen (1976)
Donggi Cona	WEBbf48ea2b	35.22	98.33	12.1	HH	Chen et al. (2020); (2014)
Donvold	lcRnH3jf8tH4ClLnO43	68.13	13.58	8.9	LC	Nilssen (1983)
Dossaccio Bormio	lcR9AhAppvA2OXgJvAi	46.47	10.34	12.8	LC	van der Knaap (1997)
Dragonfly Lake	lcRZoZg8mFwmuOuhnO7	60.81	-135.34	10.8	LC	Edwards et al. (2015)
Dune Lake	lcRXeYKFhQZcl9FryEQ	64.42	-149.9	12.6	LC	Bigelow (1997)
Dvur Ansov	lcR1bQbrAuTWjAjkdSV	48.78	16.42	8.9	LC	no pub on record
Eggen ob Blatten	lcRouwX4QfecNxAemPx	46.37	7.99	8.3	LC	van der Knaap (1997)
El Maillo mire	lcRYHQZme5i2N0fBzz0	40.55	-6.21	10.7	LC	Morales-Molino (2013)
Embouchac	lcRhScBDOfWzXEnwp1A	43.57	3.92	8.1	LC	Puertas (1997)
Enos Lake	WEB10ea8a20	49.28	-124.15	10.5	HH	Brown et al. (2006)
Etang d'y Cor Montana	lcRR7x41VDYDCPUJV8T	46.31	7.48	15.5	LC	van der Knaap (1997)
Felchowsee	lcRRBl4D2Fg9Zb4tvGP	53.06	14.13	5.4	LC	Jahns (2000)
Felchowsee	lcRpbhIeSqLqRxKnBNF	53.06	14.13	7.3	LC	Jahns (2000)
Found Lake	lcRSMVjlC246WXbuLnK	45.55	-78.64	12	LC	McAndrews (1981)
Frechencourt	lcRKKBJ6j334zCND9v4	49.95	2.43	4.7	LC	van Zeist (1980)
Gallanech Beg	lcRQz7vdye6CXMQO3SI	56.38	-5.5	14.5	LC	Davies (1997)
Gerry Lake	lcRg0FX7kDsVlxAdcdh	53.65	-121.51	11.1	LC	Gavin et al. (2009)
Gitanga (Gi-2)	WEB1392075b	-3.7	29.77	12.9	HH	Bonnefille (2000)
Gladkoye Bog	lcRTqdPXHtWaFMq3hMc	55	83.33	11	LC	Anderson (2002)
Goat Lake	lcRQ9mDBHfr9XBLQbUd	60.26	-149.91	9.2	LC	Anderson et al. (2017)
Gomishan	lcRfkhpLwl5zDhzsObe	37.15	54.06	10.8	LC	Leroy (2013)
Lake Gonghai	WEBbc36fb7b	38.54	112.14	14.7	HH	Ding et al. (2017)
Goose Bay Marsh	lcRlao41kuFDZ74153k	44.35	-75.87	8.2	LC	Rippke et al. (2010)
Gould Pond	lcRpmbA744mctx0iYnT	44.98	-69.32	15.8	LC	Jacobson Jr (1987)
Grachen See	lcRQNnJ7W7IKng8MaOe	46.2	7.84	9.3	LC	Welten (1982)
Graham Lake	lcRCyUpvGwoKyOEvQkq	45.18	-77.35	13.9	LC	Fuller (1995)
Grande Briere	lcRmOmrZ1GmmblFM6W3	47.37	-2.25	6.1	LC	Visset (1979)
Grant's Bog	lcR811cfIlc7gPTWct5	49.79	-125.13	14.1	LC	Lacourse et al. (2019)
Grasvatn	lcRaZI95pzisAqfMKRi	63.7	8.69	12.4	LC	Moe (1996)
Grays Lake	lcR89DqINtE3c8u2oBa	43.07	-111.44	21	LC	Beiswenger (1987)
Grey Islands	lcRquihWeSVoCRQXYyT	50.77	-55.52	11.4	LC	Evans (2002)
Grosser Krebssee	lcRCOiuJmrTNYijSm8z	52.85	14.1	6.9	LC	Jahns (1999)
Grosser Krebssee	lcRabb4phk9C2IJ0xj0	52.85	14.1	4.5	LC	Jahns (1999)
Gunnarsfjorden	WEB09437cc2	71.04	28.17	9.2	HH	Allen et al. (2007)
Gur	lcRGzeoFV49AbtHJxKb	53.03	51.84	21	LC	Mokhova (2009)
Gytgykai Lake	lcRy7IhuBaQ6uF11NxS	63.17	175	17.2	LC	Anderson (2002)
Hail Lake	lcRzxniarU5TTRDhKkh	60.03	-129.02	11.8	LC	Cwynar et al. (1995)
Haircut Lake	lcRjEweSTJryZAYGb1l	60.52	-133.21	7.4	LC	Edwards et al. (2015)
Halos I	lcR9Wrg5WflyKPDn0gq	39.16	22.84	7.8	LC	Bottema (1988)
Hams Lake	lcREzhF3Ls6YkH3b9dK	43.24	-80.41	12.9	LC	Bennett (1987)

Heal Lake	WEB7ec5f35f	48.54	-123.46	11.7	HH	Brown et al. (2006)
Heart Lake	lcRQfIlOAnlXiGk0QCz	44.18	-73.97	12.5	LC	Whitehead (1990)
Hermit Lake	lcRXLkyFOBBg5jAZeV9	38.09	-105.63	13.8	LC	Anderson et al. (2021)
Lake Hidden	WEBe3940424	29.81	92.54	12.1	HH	Chen et al. (2020); (1999)
High Lake	lcRS0efHRT1BJR9ikbT	44.52	-76.6	12.1	LC	Fuller (1995)
Hopschensee	lcRP11grEDTPmBg8KEk	46.25	8.02	16	LC	van der Knaap (2000)
Hulun Lake	LPDc4757948	49.13	117.5	11	HH	Wen et al. (2010)
Humber Pond 3	lcR3bIWhA552iIKLT1e	43.64	-79.48	4.4	LC	Weninger et al. (1989)
Hurecka slat	lcR1ZBXuVhPXDI89DZT	49.15	13.33	12.8	LC	Svobodova (2002)
Iffigsee	lcRNGsv0Rdc2JExg4ck	46.39	7.41	11.3	LC	Schworer (2015)
Irvin Lake	lcRu5pCMYC2GUPBBzzd	47.14	-93.64	14.7	LC	Alwin (1982)
Jaslo	lcRRsJBLTTrGwZpaako	49.78	21.47	10.4	LC	Harmata (1995)
Jaunay	lcR7lkJf5CzFuBWMTZH	46.66	-1.89	9.3	LC	Joly (2006)
Jay Lake	lcRJKbOXTRs7gaPoBqC	46.23	-89.28	10.4	LC	Ewing (2000)
Jiji (Ji-2)	WEB1392075b-dup	-3.92	29.67	10.9	HH	Bonnefille (2000)
Jingbo Lake	lcRS3drKNxjECOBHubn	39.5	109.5	9.6	LC	Li (2011)
Jones Lake	lcRCHngCXxJyC7boD1V	49.45	-99.29	11.3	LC	Teed et al. (2009)
Karas'e Lake	lcREJxJv4v4Xe4w8NHU	49.37	75.4	6.3	LC	Tarasov (1995)
Karasye Lake	lcR8mj67gLS492AwE9G	53.03	70.22	6.2	LC	Tarasov (1994)
Kayakskoye Zaimitschye	lcRJSh0UMEWySvvTehJ	55	81	6.9	LC	Anderson (2002)
Kendegelukol Lake	lcRKnkmvI3WSopJhUG5	50	137.05	16.3	LC	Blyakharchuk (2004)
Kinnshaugen	lcRuxGlk7M2jIBZRVX9	61.11	10.36	10.8	LC	Birks (2012)
Knob Hill Pond	lcR7PMjhhOCIJBCqpWw	44.36	-72.37	14.1	LC	Oswald et al. (2018)
Komaritsa Peat Exposure	lcR2i3W5G42BwI55d4z	57.5	69	10.4	LC	Anderson (2002)
Kotyrkol' Peat Bog	lcR24ksEG9b6zeB53ZK	52.96	70.38	4.8	LC	Tarasov (1992)
Koycegiz Golu	lcRY9JluMsRhPsnGrPq	36.88	28.64	5.2	LC	van Zeist (1975)
KR02	PYT4D9VTHOK	71.34	-113.78	10.2	HH	Peros et al. (2008)
Kuruyange (Ku-1 and Ku-2)	WEBb6841ae1	-3.58	29.68	21	HH	Bonnefille (2000)
Kuruyange (Ku-1 and Ku-2)	WEB4fba7605	-3.58	29.68	12.8	HH	Bonnefille (2000)
Labsky dul	lcRiW7mrxVo28FuA6iC	50.76	15.55	21	LC	Engel (2010)
Lac a Leonard	lcRn8pfW2aOkGuGkhHo	49.21	-65.81	10.7	LC	Labelle et al. (1984)
Lac a Sam	lcRxEJjleCcL9BE7yhk	46.65	-72.98	11.2	LC	no pub on record
Lac aux Quenouilles	lcRqZ63xorXscRkaQkU	46.17	-74.4	13	LC	Savoie et al. (1979)
Lac Bastien	lcRZEIQ110W378d9TOj	46.4	-78.92	10.7	LC	Bennett (1987)
Lac Caribou	lcRdtSl7jfYKWCM0SIH	48.2	-64.94	13.2	LC	Jette et al. (1992)
Lac Colin	lcR3VLvepAl8jPQ0Jap	46.72	-70.3	13.2	LC	Mott (1977)
Lac de Bretaye	lcRTAPYumbvCzcHXAOG	46.33	7.07	11.7	LC	Thole (2016)
Lac de Praver	lcRUGwWEexWpwOLUlSO	45.07	5.86	8.1	LC	Nakagawa (1998)
Lac des Grenouilles	lcRKSi9CEIDrCS6N9y5	44.1	7.48	8.2	LC	Finsinger (2020)
Lac des Roches Moutonnees	lcRxypeAN6trKSWT7tq	56.77	-64.82	4.9	LC	McAndrews et al. (1977)
Lac du Lauzon	lcROpAQxk5Ao0bN7OYy	44.68	5.79	7.2	LC	Argant (2000)

Lac Faribault	lcRbxTYXmaIHDE2ZQHZ	58.87	-71.72	6.6	LC	Richard (1981)
Lac Petel	lcR4Qzw6lCy4TeiU8MG	50.55	-66.27	8.7	LC	King (1986)
Lac Superieur de Fully	lcRb4cZaToq9bd0pTUO	46.18	7.09	11	LC	Finsinger (2007)
Lai Nair Schuls-Tarasp	lcRMHuDYr4ooGY4YFQN	46.78	10.28	15.7	LC	Welten (1982)
Lake 31	lcR8K3KbvN8GOh5iSkH	67.05	-50.47	5.2	LC	Eisner et al. (1995)
Lake Bayanchagan	lcRclYIyYQ8Kq5SvVWo	41.63	115.23	11.5	LC	Jiang (2010)
Lake BI2	lcRU9Wv8xbnApq52K5R	57.12	-76.38	8.1	LC	Gajewski et al. (1992)
Lake CH2	lcRvWx7hzKylZOr6Ue9	49.68	-74.58	8.7	LC	Garralla (1991)
Lake Grinnell	lcRTFzF9IdSdplxVIsK	41.1	-74.64	16.8	LC	Zhao et al. (2010)
Lake Jake	lcRq6t1IHrB7zTbN9av	63.67	-65.15	9.7	LC	Miller et al. (2005)
Lake LB1	lcRJebEqyeZJeTWr9gD	57.92	-75.62	7.4	LC	Gajewski et al. (1993)
Lake Solso	lcR6XGIZJJ6sUMOSpGg	56.13	8.61	11.2	LC	Odgaard (1988)
Lake Solso	lcRonkgxC2OuZ5Khx0O	56.13	8.61	6.8	LC	Odgaard (1988)
Lake Tianchi	lcRLUGwe6u9sNwCWBA0	25.87	99.28	18.5	LC	Jiang (2019)
Lake Varna	lcR1swPAuEHYu5rmwNE	43.2	27.83	8	LC	Bozilova (1994)
Lake Voulkaria	lcR92SM1LEHTVnz3T6Q	38.87	20.83	10.2	LC	Jahns (2005)
Lake WA01	lcRBEvaydIFwOnSZuma	61.24	-136.93	10.5	LC	Ravindra (2009)
Larix laricina Site 5	lcRz3iMAf5YXkq554az	57.72	-75.81	4.4	LC	Peñalba et al. (1997)
Lavau	lcRQLFkYUzyqFavzbXI	47.34	-1.93	6.5	LC	Voeltzel (1987)
Le Fourneau	lcRO66HhB9HOPSTtGWS	48.44	-0.19	21	LC	Barbier (2000)
Le Gesvres	lcRzquIL84dpfJdywy3	47.27	-1.6	9.8	LC	Ouguerram (2002)
Lej da Champfer	lcRU88QgoMtobQ78a50	46.47	9.81	12.2	LC	Gobet (2005)
Le Marais de la Perge (South)	lcRiPXC1QOIC1ugFpbT	45.38	-1.11	6.9	LC	Diot (1995)
Lembolovskoye lake	lcRuBI86L2fbLUHGeuU	60.36	30.31	12.9	LC	Arslanov (2001)
Lille Kjelavatn	lcRyQRzcwKdCEM16Z9h	59.8	7.25	8.9	LC	Birks (2007)
Lily Lake	lcRPCIzys1FJAv11nWi	59.2	-135.4	12.6	LC	Cwynar (1990)
Lily Lake	lcRjUN7lrKnYMS1DSr3	47.91	-89.09	9.6	LC	Cwynar (1990)
Lily Lake	lcROBIER3oUzr1eINaV	41.98	-120.21	11.7	LC	Cwynar (1990)
Litlvatnet	lcRukEb6BnbJCwvGQcS	68.53	14.93	12.6	LC	Bjune (2009)
Little Cheyne Court Walland marsh	lcRyc8tsEYpBLQv53H9	50.96	0.83	4.6	LC	Waller (1999)
Little Swift Lake	lcRUFhLpJJEIgFJy1fm	60.22	-159.77	12.8	LC	Axford et al. (2004)
Little Willey Pond	lcRMPkP0JPngepqKt5J	43.29	-71.18	13.2	LC	Oswald et al. (2018)
Loch a'Chroisg	lcR1zcvlTpHe7Gu2Ozc	57.57	-5.14	4.3	LC	Pennington (1973)
Loch Cleat	lcRJ5gQAZ1C6slQ2wzM	57.62	-6.28	12.1	LC	Birks (1983)
Logne	lcRsKj7HRaEa8Csoe9n	47.33	-1.5	4.8	LC	Barbier (1997)
Lone Fox Lake	lcRGoh2qGUcOrSspCnQ	56.72	-119.72	12.3	LC	MacDonald (1984)
Long Breach	lcR2gzCRtzbPXSErk7O	51.07	-3.69	6.6	LC	Fyfe (2003)
Long Lake	lcRZkWC1fAUMWFcopmS	41.5	-106.37	13.3	LC	Carter et al. (2017)
Longquan Lake LC2	lcRCI2bFYEi8iJDZ3pT	31.08	112.24	21	LC	Liu (1991)
Loon Pond	lcRtljGbgEMRcxcyRwF	45.03	-68.2	14.7	LC	no pub on record
Lorraine Lake	lcRi9DLyVIp1ptYxuLt	46.14	-86.48	9.8	LC	Calcote (2003)

Lough Mullaghlahan	lcRShwFkjy6CGJ3eBei	54.78	-8.47	14.6	LC	Fossitt (1994)
Luganskoe	lcRCHeP7xkq0keh2M2L	43.72	40.7	6	LC	Efremov (1995)
Lukaschin Yar Peat Exposure	lcR6zfg40KfwrtKMP1E	61	78.5	11.7	LC	Anderson (2002)
Mallard Pond	lcRtxJO058HFi2LTtPf	51.29	-101.32	8.6	LC	Teed et al. (2009)
Mansell Pond	lcRsGKE1HtShd5fiLfc	45.04	-68.73	10	LC	Almquist-Jacobson et al. (1995)
Marais de Keswick	lcR05uuYvKoZnUNKOyb	44.2	-79.51	4.4	LC	Dinel et al. (1986)
Marais de Lisle	lcRws8UtuiI7583vk4v	47.43	-1.49	6.2	LC	Ouguerram (2002)
Marcella Lake	lcRTMSt7gELRNTyCnb3	60.07	-133.81	9.1	LC	Edwards et al. (2015)
Masatjornet	lcR8fc8B2pDMdMUjVUf	61.56	10.27	13	LC	Birks (2012)
Miancheng M1	lcRXvbC4hazRnHK1FGt	30.18	113.22	11.4	LC	Yang (1998)
Mica Lake	lcR51PFKlQqno4VsZWI	60.69	-148.14	10.2	LC	Anderson et al. (2017)
Mission Cross Bog	lcRrhdt8mGJgTgCwIu9	41.78	-115.48	9.8	LC	Thompson (1984)
Mohawk Pond	lcRgMVsDdQMDFsI82dW	41.81	-73.29	18.7	LC	Gaudreau (1986)
Mono Lake	lcRf9gq05AeCrcXDAIG	38.01	-119.03	13.2	LC	Davis (1999)
Mont Carre Heremence	lcRI110DdZhuZLCfO81	46.15	7.37	8.2	LC	Welten (1982)
Moon Lake	lcR3ODiGVrOdeMTGOjO	46.86	-98.16	13.8	LC	Laird (1996)
Morttjern	lcR9d3tUR71Zym2GxwZ	59.06	11.62	11.5	LC	Birks (2012)
Motta Naluns	lcRgDGHB8seTJysUnfr	46.81	10.26	11	LC	van der Knaap (1997)
Mrtvy luh	lcRQwutEsOeqKYYHxvG	48.87	13.88	6.4	LC	Svobodova (2001)
Mshinskoye raised bog	lcRURPnnXHhtNCJhPrL	59.01	29.98	11.6	LC	Arslanov (2001)
Myshetskoe-Dolgoe	lcR85IhuFYet9fVBJm1	56.07	37.33	14.8	LC	Kremenetski (2000)
Natla Bog	lcRQaFKDkPHIf6Ldubv	63.02	-128.8	10.1	LC	MacDonald (1983)
Nelson Lake	lcR2ADpVvLUJQ0bZHQZ	46.23	-85.38	7.8	LC	Delcourt et al. (2002)
Newark Valley Pond	lcRFg61loqbAXRktuir	39.67	-115.77	21	LC	Mensing et al. (2008)
Nizhnevartovsk	lcRHrOMi2BPU2oeX6XI	62	76.67	12.4	LC	no pub on record
No Bottom Lake	GH8d2bed43	41.28	-70.11	11	HH	Marsicek et al. (2013); Dunwiddie (2013)
Northeast Shark River Slough	lcR6YXnNeDv2fjyHQ0H	25.75	-80.58	5.1	LC	Glaser et al. (2013)
Novoalex peatland	lcRM94MG6etHseLCjV6	55.12	41.04	8.1	LC	Novenko (2016)
Novo-Uspenka	lcRLulYb48KtEkGIREq	56.62	84.17	6	LC	Blyakharchuk (1989)
Nutt Lake	lcRD3uw2NlnVEYyVEDB	45.22	-79.45	11.1	LC	Bennett (1987)
Old Field	lcReP7TW9LscM4pX9SP	37.12	-89.83	5.6	LC	King (1981)
Ospitale	lcR3bsuKx5tY1eHYdiF	44.16	10.78	5.9	LC	Watson (1996)
Over Gunnarsfjorden	lcRPMFnjpsyrThm2wUI	71.04	28.17	13.2	LC	Allen (2007)
Oygardstjonn	lcRNCuYpM1BbEmsE2Jo	59.63	7.99	11.8	LC	Birks (2007)
Ozerki	lcR6LYfIIRUIVSNa84H	50.42	80.47	14.3	LC	Tarasov (1994)
Padul Lake	WEB-c8f6e-2665-4cfa-846a-481f4	37.01	-3.6	21	HH	Camuera et al. (2022)
Padul Lake	WEB-9a7cd-c928-4876-9177-0f783	37.01	-3.6	21	HH	Camuera et al. (2022)
Padul Lake	WEB-a01b8-a050-4ceb-b3c1-e41a3	37.01	-3.6	21	HH	Camuera et al. (2022)
Paidre	lcRo2OfFrT0Gm5uCDb8	58.28	25.5	7.3	LC	Saarse (1995)

Pannel Bridge	lcRvvlSZxS9bXTLaFfY	50.91	0.68	11.4	LC	Waller (1987)
Pashennoe	lcR9TrdUideka9MU4fK	49.37	75.4	10.8	LC	Tarasov (1994)
Pavullo nel Frignano	lcRDPE8R2Ll9LGh8P0b	44.32	10.84	15.3	LC	Vescovi (2010)
Penegor Lake	lcRKSAUVxPgaePuZst2	46.62	-88.86	9.7	LC	Calcote (2003)
Perch Lake	lcRyOxxsKid1XcvzymT	51.65	-100.9	6.1	LC	no pub on record
Pillon Gsteig-Diablerets	lcRAwlfFkCrGR9UHhR0	46.36	7.2	11.8	LC	van der Knaap (1997)
Pixie Lake	WEB69d58fa4	48.6	-124.2	12	HH	Brown et al. (2006)
Point Escuminac	lcRLarbP2pT7p0Kh393	47.08	-64.8	12.8	LC	Warner et al. (1991)
Poland Spring Pond	lcRuSyi5hCNJTteCp9X	44.03	-70.35	15.1	LC	no pub on record
Pos'yet Bay	lcRSIAYzn1UZ8xPJ3S8	42.63	130.8	9.5	LC	Anderson (2002)
Pretty Lake	lcRPJLdE7kvEsaM11zp	41.58	-85.25	15.3	LC	Williams (1974)
Pur-Taz Peatland	lcRhVCufSo9bBzCcMnH	66.7	79.73	5.6	LC	Peteet (1998)
Pye Lake	lcR5p1vTbyYhjbhn154	44.98	-62.09	14.1	LC	Mott et al. (2009)
Qindeli	lcRidlzjKtSWUMlPMg0	47.88	133.67	13.6	LC	Xia (1988)
Qinghai Lake	WEB6d14587e	36.67	100.58	12.1	HH	Chen et al. (2020); (2002)
Qongjiamong Lake	WEBa860e0be	29.81	92.37	12.1	HH	Chen et al. (2020); (2003)
Ranger Lake	PYTCYF0YQTU	67.15	-153.65	21	HH	Brubaker et al. (1983)
Ratasjoen	lcRJaPYXhPFpzwSAIk6	62.27	9.83	11.5	LC	Velle (2005)
Redrock Lake	lcRqNrP3cF8Okd3KGC3	40.08	-105.54	11.4	LC	Maher Jr (1973)
Regetovka	lcRXldXWx5IunOLzL9u	49.42	21.28	9.9	LC	Wacnik (1995)
Reidel Lake	lcR6BJJfRZckOtBFbZP	46.21	-95.28	13.1	LC	Almquist-Jacobson et al. (1992)
Reiersdalvann	lcRIvs0Q0rvv2CWcbWs	58.33	7.79	10.9	LC	Birks (2007)
Rhamnus Lake	WEB4581c605	48.63	-123.72	11.1	HH	Brown et al. (2006)
Rice Lake	lcRSsAIzeDWcvyVipb6	48.01	-101.54	10.6	LC	no pub on record
Rice Lake	lcRaqtkYUpcVFmXJnVU	44.2	-78.14	5.7	LC	McAndrews (1969)
Ridge and Slough (02-05-21-5)	lcRtm2nqesiKFqeqhXe	25.83	-80.77	4.2	LC	Bernhardt et al. (2009)
Riviere-aux-Feuilles 2	lcRfnxvvCGEBTBvKcZk	58.22	-71.95	6.1	LC	no pub on record
Rogers Lake	GH6d568132	41.21	-72.17	11	HH	Marsicek et al. (2013)
Rogers Lake	lcRqQrMGXooyrseV4cP	41.35	-72.3	17.8	LC	Davis (1967)
Ruppert Lake	lcRLjFgm2COLZCD5g59	67.07	-154.23	15	LC	Brubaker et al. (1983)
Ruppert Lake	lcRITy31dNFpYMrrFH7	67.07	-154.24	14.2	LC	Brubaker et al. (1983)
Rusaka (Ru-1 and Ru-3)	WEBa1c23512	-3.43	29.62	9.2	HH	Bonnefille (2000)
Rusaka (Ru-1 and Ru-3)	WEB8ffcaee7	-3.43	29.62	21	HH	Bonnefille (2000)
Rutz Lake	lcRWHzMmVYYcDf6K32p	44.87	-93.86	13.1	LC	Stuiver (1975)
Ryerse Lake	lcRiq1prtqFDpKinLF2	46.13	-85.18	10	LC	no pub on record
Sa Curcurica	lcRoGFzRew9WTAEknaI	40.46	9.79	8.3	LC	Beffa (2016)
Saksunarvatn	lcREQ7puIGiJ4dGVajz	62.24	-7.16	8.9	LC	Johansen (1982)
Salada Pequena	lcRNeTKafVV1Glibo2e	41.03	-0.22	4.8	LC	no pub on record
Salmo Lake	lcRti96IuQQTbmLrU3C	60.45	-133.56	11.5	LC	Edwards et al. (2015)
Sandvikvatn	lcRUiZGHarjNxAiW1nX	59.28	5.49	9.6	LC	Paus (1982)
San Joaquin Marsh	lcR3h58B1xMNHkPYwiY	33.66	-117.86	8.8	LC	Davis (1992)

Schoodic Peninsula Hollow	lcRKhWUhucbIA6KVzZ9	44.37	-68.07	8	LC	Schauffler (1998)
Secret Valley Marsh	lcRVjgMr8niCWzlOTrs	40.57	-120.27	11.1	LC	West (2002)
Selin Lake	WEBdd4fa361	31.65	89.14	12.1	HH	Chen et al. (1993); (2020)
Selitkan-1 Exposure	lcRKWdAzk5gaaCCDOMh	53.22	135.05	7.9	LC	Anderson (2002)
Seven Lakes	lcRlQnhC5noD5c3isF7	40.9	-106.68	4.2	LC	Calder (2016)
Sharkey Lake	lcR5SRLpHOGiAs4Q4SW	44.59	-93.41	11.4	LC	Camill et al. (2003)
Sihailongwan Maar	LPD6fdee25b	42.28	126.6	11.8	HH	Stebich et al. (2015)
Simplon/Gampisch-Alter Spittel	lcRnhx0TV2RqvrweSW7	46.23	8.01	11.6	LC	van der Knaap (1997)
South Rhody peatland	lcRwZudUZlMj01vQXF2	46.57	-86.08	10.5	LC	Booth et al. (2004)
Spicer Lake	lcRwnVuzjxKgcJQwS8I	41.76	-86.52	15.2	LC	Wang et al. (2016)
Spirit Lake	lcR1KT6GyUTH14Ybu8w	46.47	-86.96	14.1	LC	Woods et al. (1989)
Spruce Pond	lcRgKkHN0CyyYoGbYOA	41.24	-74.18	17.1	LC	Maenza-Gmelch (1997)
Stages Pond	lcRzbcPN2Y2gyo9iwZ9	39.67	-82.94	4.2	LC	Snyder (1991)
Staroselsky Moch	lcRaesu0dd88X29ftJX	56.29	32.03	13.5	LC	Novenko (2009)
Steerenmoos	lcR6T9nRWTcVYluBUZX	47.81	8.2	8.9	LC	Rosch (2000)
Stewart Bog	lcR5PWLII1WSTWJrKGG	35.83	-105.72	14.2	LC	Jimenez-Moreno et al. (2008)
Storsandvatnet	lcRsxQJCal75WkUpl5m	63.46	8.45	14.3	LC	Birks (2012)
Straldzha mire	lcR0aDYyLrxCMKEkXI7	42.63	26.78	21	LC	Tonkov (2009)
Straldzha mire	lcRyf5ECfdUuscy1RT4	42.63	26.78	4.5	LC	Tonkov (2009)
Styggtjarnen	lcR4l0L8xuHdTs39hQR	62.32	13.56	9.3	LC	Giesecke (2005)
Sudoble Lake	lcRYR1SVCS4M1mdG6Hg	54.03	28.1	13.5	LC	Elovicheva (1985)
Svartvatnet	lcRKJqcToTVwvmD59ym	63.35	8.88	14	LC	Birks (2012)
Svatoborice-Mistrin	lcRyY8us0XnFvl0iGrN	48.94	17.07	8.3	LC	Svobodova (1989)
Svencele Bog	lcRaRjP3JKMmyWbjhW3	55.5	21.29	7.4	LC	no pub on record
Swampbuggy Lake	lcRRMCoTqUxIBPKGqtp	63.05	-147.42	8.2	LC	Rohr (2001)
Tangle Lakes	lcR4bKnn7hrqLKgZGr3	63.03	-146.06	5.4	LC	Ager et al. (1981)
Taul Zanogutii	lcRLTwUkmqSqLkVpHAA	45.33	22.8	15.4	LC	Farcas (1999)
Taylor Lake	lcRdS5DDFcpoNkFmck3	46.1	-123.91	4.8	LC	Long et al. (2002)
Tianchi Lake	lcRdGds9oOLVuJWyouN	35.26	106.31	6	LC	Sun (2011)
Tiavatnet	lcR5yi0K8vaJ1pDMGjM	63.06	9.42	12.6	LC	Birks (2012)
Tioga Pass Pond	lcR87uwkt1JVsPUAXqa	37.91	-119.26	10.5	LC	Anderson (1987)
Tlsta hora	lcRtqapfWlGeedhj31W	48.89	17.89	4.6	LC	Rybnickova (2005)
Tom' River Peat	lcRWjXOvOXsBSuCZKoz	56.17	84	10.2	LC	Anderson (2002)
Tourbiere Caribou	lcRK61Zqovd5AsakNEX	47.64	-71.24	4.3	LC	Richard (1977)
Tourbiere de la Lande	lcRZgqRfwDWqi1fNgxF	43.57	2.97	5.2	LC	Pulido (2006)
Tourbiere de Lanoraie COTEAU JAUNE	lcR1A1e4eCK8RCZbrM1	45.96	-73.34	8.2	LC	Comtois (1982)
Tourbiere de Lanoraie STJEAN	lcROauZ0E6EMlpLEs8f	46	-73.22	6	LC	Comtois (1979)
Tourbiere de Parcay-sur-Vienne	lcRcR80wTm1A4RAUIRb	47.09	0.48	12.3	LC	Cyprien (2006)
Tourbiere du Peschio	lcRw42ai03YAwD4En3b	44.45	3.6	5.8	LC	Pulido (2006)
Trettetjorn	lcR5MPWfK6sspyzNqi4	60.72	7	13.2	LC	Bjune (2005)

Troarn Saint-Samson	lcRu4yXp3wwLjp0Lsnb	49.18	-0.17	5	LC	Lespez (2010)
Troarn Saint-Samson	lcR7lnczhhWSUhBzFx9	49.18	-0.17	4.2	LC	Lespez (2010)
Tschokljovo Marsh	lcRscdnEDYcOz51Mjsk	42.37	22.83	8	LC	Bozilova (1985)
TsoMoriri	GH2b8af51c	32.93	78.32	12	HH	Leipe et al. (2014)
Tsuolbmajavri	PYTJINRZ45D	68.41	22.05	9	HH	Korhola et al. (2002)
Uncle Seth's Pond	lcRNlfrkkQn5Ce0M7QR	41.43	-70.66	13.3	LC	Oswald et al. (2018)
Vallon de Provence	lcRwuwEJUSPd5BtSkfF	44.39	6.4	8.9	LC	de Beaulieu (1977)
Vallon de Provence	lcRtoAUZCUcuHH7pJF4	44.39	6.4	9	LC	de Beaulieu (1977)
Vechernii River	lcR4HXbcw98F8bYyA5X	63.28	147.75	7.2	LC	Anderson (2002)
Velky Ded	lcR3Q9kRsZeRDvtgrkj	50.08	17.22	5.4	LC	Rybnicek (2004)
Vestre Oykjamyrtjorn	lcRr3eI7cqYBPpIQz54	59.82	6	13.3	LC	Bjune (2005)
Vishnevskoe Lake	lcR8NnFIKkEryjVtdoJ	60.5	29.52	14.7	LC	Arslanov (1999)
Wallbach Lenk	lcRiJpSfk6qHogZUTSv	46.43	7.4	13.4	LC	van der Knaap (1997)
Wangjiadian profile	lcRpkrKA2Q4Uru9VFwq	36.16	114.67	15	LC	Cao (2010)
Waschhorn	lcRLZA5oyAihPeZFLb7	53.62	8.74	7.9	LC	Kuhl (1998)
Water Conservation Area 3B, Gumbo Limbo Far Tail	lcRCCeOBvoY6ibTb3Lr	25.77	-80.51	5	LC	Willard et al. (2001)
Watten	lcRgSd7F3XOo7P6g0F0	50.83	2.21	4.3	LC	Gandouin (2002)
Wenquan wetland	lcR13jshNz5dqXWSsRh	44.97	81.03	10.3	LC	Li (2020)
West Okoboji Lake	lcRbTXcI79CR4gJxaFC	43.33	-95.2	17.6	LC	Van Zant (1979)
West Olaf Lake	lcRDRHpPMtQHS2p3qME	46.6	-96.19	8.8	LC	Nelson et al. (2008)
West Side Pond	lcRT2tIa25Tm8EVwMwr	41.85	-73.26	13	LC	Lacourse et al. (2005)
Wiggenhall St. Germans	lcRbLUSpdmvr6eTifaD	52.69	0.34	5.2	LC	Waller (1994)
Windmill Lake	lcRw0soaBrKg4z1ACYN	63.66	-148.81	16.4	LC	Bigelow (1997)
Winneconnet Pond	lcRqcv7HT215BsuiBp5	41.97	-71.12	16.6	LC	Suter (1985)
Wolsfeld Lake	lcRopIDpnZtAWYZM2E4	45.01	-93.57	13.4	LC	Grimm (1981)
Woryty	lcR1N0S6oyvXMQEpB94	53.75	20.21	13.4	LC	Ciesla (1977)
Woryty	lcRgNEo7t886ISDFpMs	53.75	20.21	11.7	LC	Ciesla (1977)
Yabitsuyachi	lcRnpyqRGt7A1AQgJZl	40.62	140.9	8.2	LC	Morita (1987)
Yakumo	LPD72217804	42.28	140.26	5.5	HH	Leipe et al. (2013)
Zalozhtsy	lcRx8TPoWqgtzHDb9wM	49.75	25.45	9.7	LC	Artyushenko (1982)
Zaruckoe	lcRWLf959HwYAt7u0lE	63.9	36.25	9.4	LC	Elina (1981)
Zigetang Lake	WEB94c7839d	32	90.9	12.1	HH	Herzschuh et al. (2006); Chen et al. (2020)

Table S3: R and w_{loc} sensitivity experiments. Mean reconstruction correlation coefficients are listed for experiments which use a variety of combinations of the w_{loc} (localization) and R uncertainty parameters. Values are similar to the skill metrics shown in Fig. 5 and Fig. S4 which use an R of 10 and w_{loc} of 8,000. For this table, the assimilation was performed with only 5 iterations for computational efficiency.

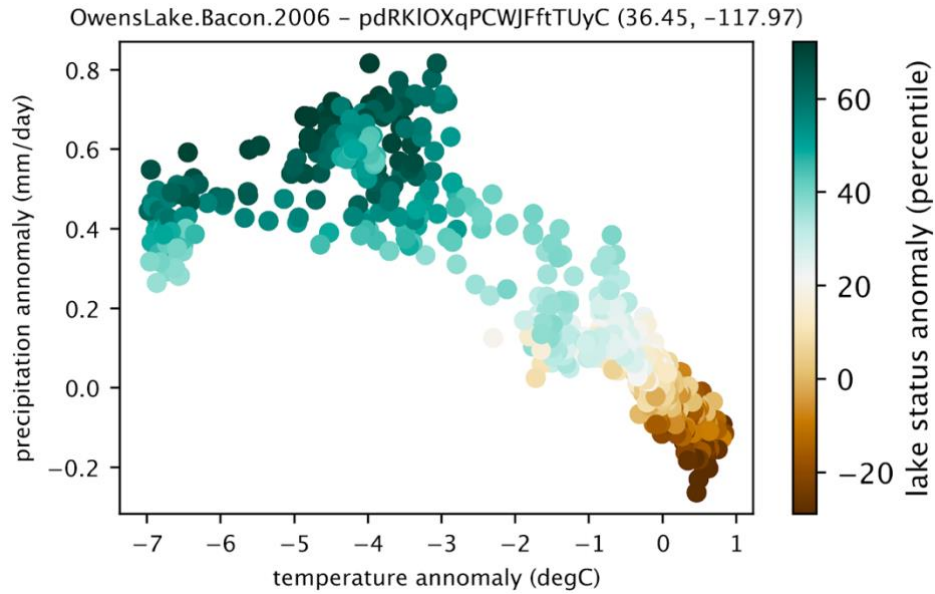
		lake status (global mean correlation coefficient)		
		assigned uncertainty (percentile)		
		10	30	50
localization radius (km)	10,000	0.37	0.37	0.37
	8,000	0.33	0.33	0.33
	6,000	0.26	0.26	0.26
		precipitation (global mean correlation coefficient)		
		assigned uncertainty (percentile)		
		10	30	50
localization radius (km)	10,000	0.34	0.34	0.34
	8,000	0.39	0.39	0.39
	6,000	0.41	0.41	0.41
		precipitation (North America mean correlation coefficient)		
		assigned uncertainty (percentile)		
		10	30	50
localization radius (km)	10,000	0.42	0.42	0.42
	8,000	0.47	0.47	0.47
	6,000	0.46	0.46	0.46

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Figure S1: Representative relationship between temperature, precipitation, and lake status. Temperature (x axis) and precipitation (y axis) values are plotted from the model prior grid cell nearest to the Owens Lake proxy record located in the US Southwest. Colors indicated the calculated lake status value corresponding to each climate state. Dark green colors in the top left indicate high lake status values when temperature is colder and precipitation is higher. All values are plotted as anomalies relative
60 **to the 11.7–0 mean.**
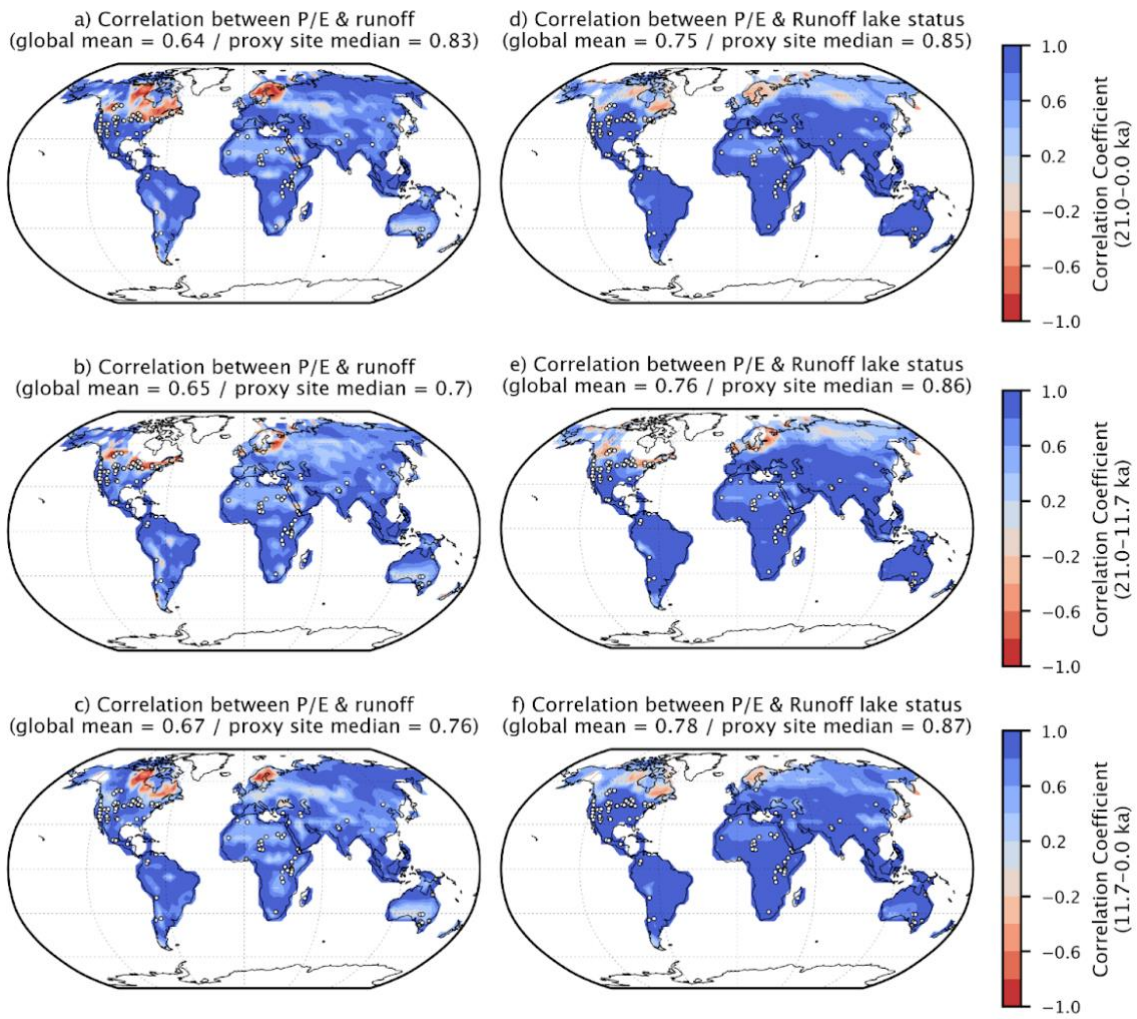
Figure S2: Correlation between runoff and P/E values in TraCE. (a-c) Pearson's correlation coefficients between the two variables are plotted for each grid cell. (d-f) Lake status values were also calculated using P/E and runoff as the numerator of the lake status equation to evaluate the impact of this substitution on the PSM. Correlations were calculated for the entire time series (a,d) as well the deglacial (b,e) and Holocene (c,f).

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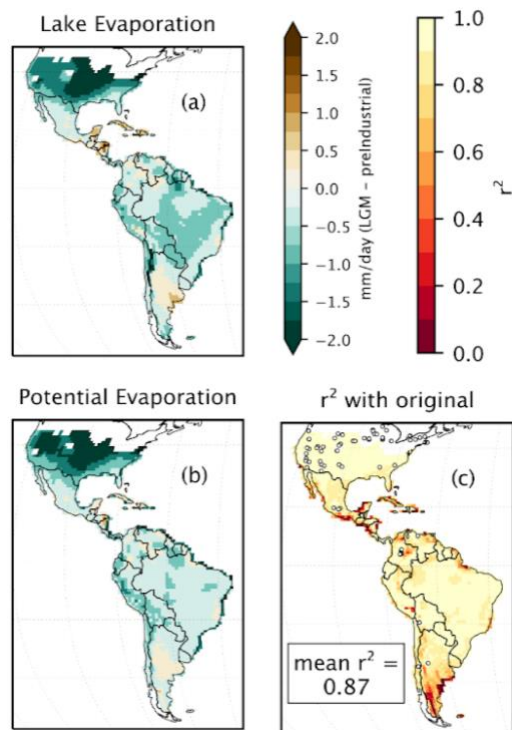
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Figure S3: Comparison of lake evaporation methods. Similar to Fig. 4 except that a comparison between lake evaporation and potential evaporation is shown rather than lake status. (a) lake evaporation values calculated by Lowry and Morrill (2019). (b) is the potential evaporation values calculated for this study. Both panels a and b show the mean LGM value subtracted by the mean preindustrial value. (c) r2 value for each grid cell using the combined 200 year time series.

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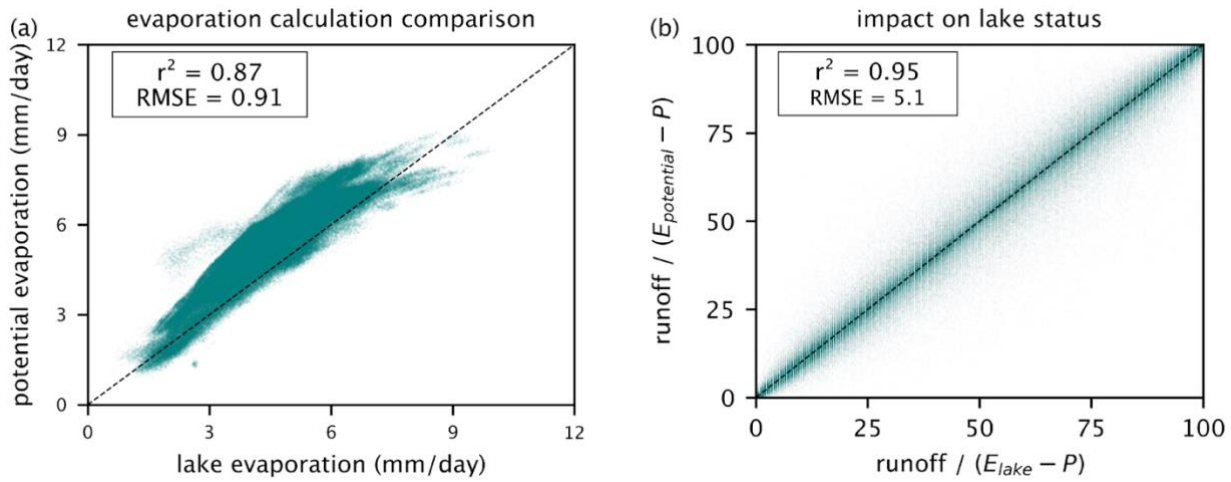
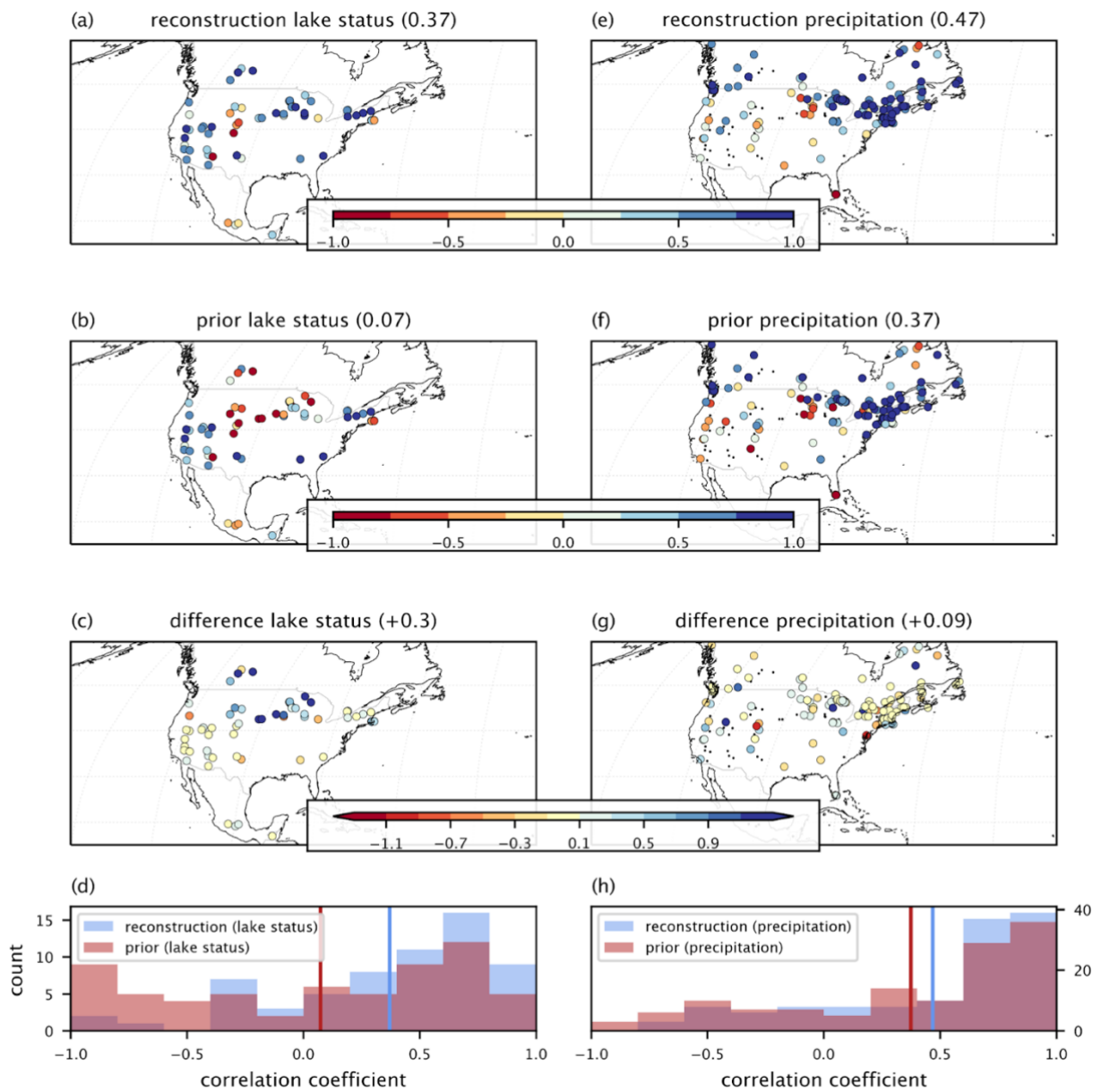


Figure S4: Scatter plot comparing the similarity of lake status PSM calculations. (a) Evaporation values used to create Fig. S3c. (b) impact of modifications to the lake status equation (y axis) relative to the use of runoff and lake evaporation calculated by Lowry and Morrill (2019; x axis). These values are also plotted spatially in Fig. 4. The dashed 1:1 line indicates hypothetical perfect agreement for comparison.

85   **Figure S5: Validation statistics for North America. Similar to Fig. 5 but only Pearson's correlation coefficients for the North America region are shown. This is the one region with numerous proxy records for both lake status and calibrated precipitation.**

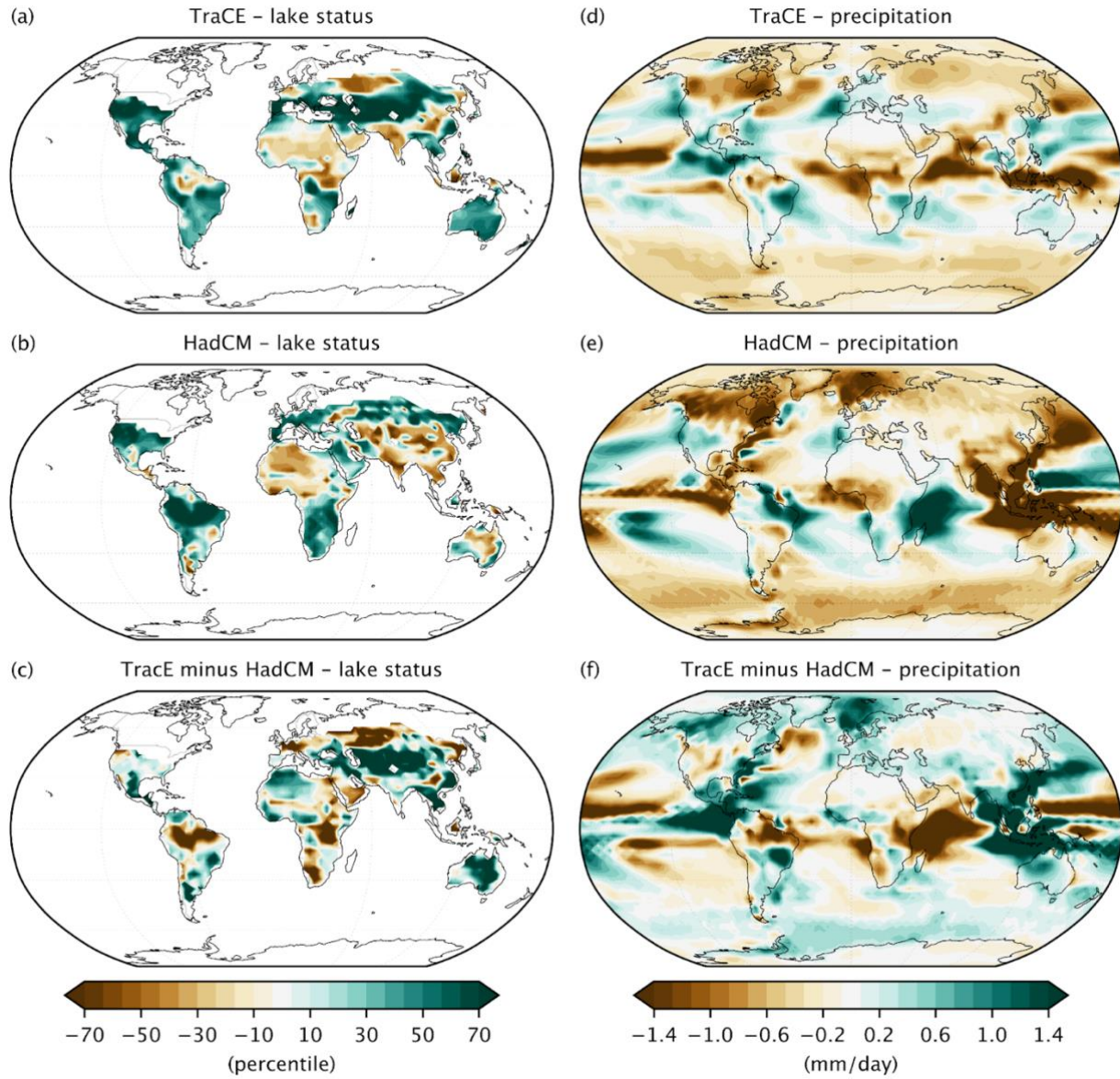



Figure S6: Simulated Last Glacial Maximum anomalies. Same as figure 6 except that the values of TraCE (a,d), and HadCM (c,f) and their differences (b,e) are shown rather than the model prior and DAMP-21ka reconstruction.

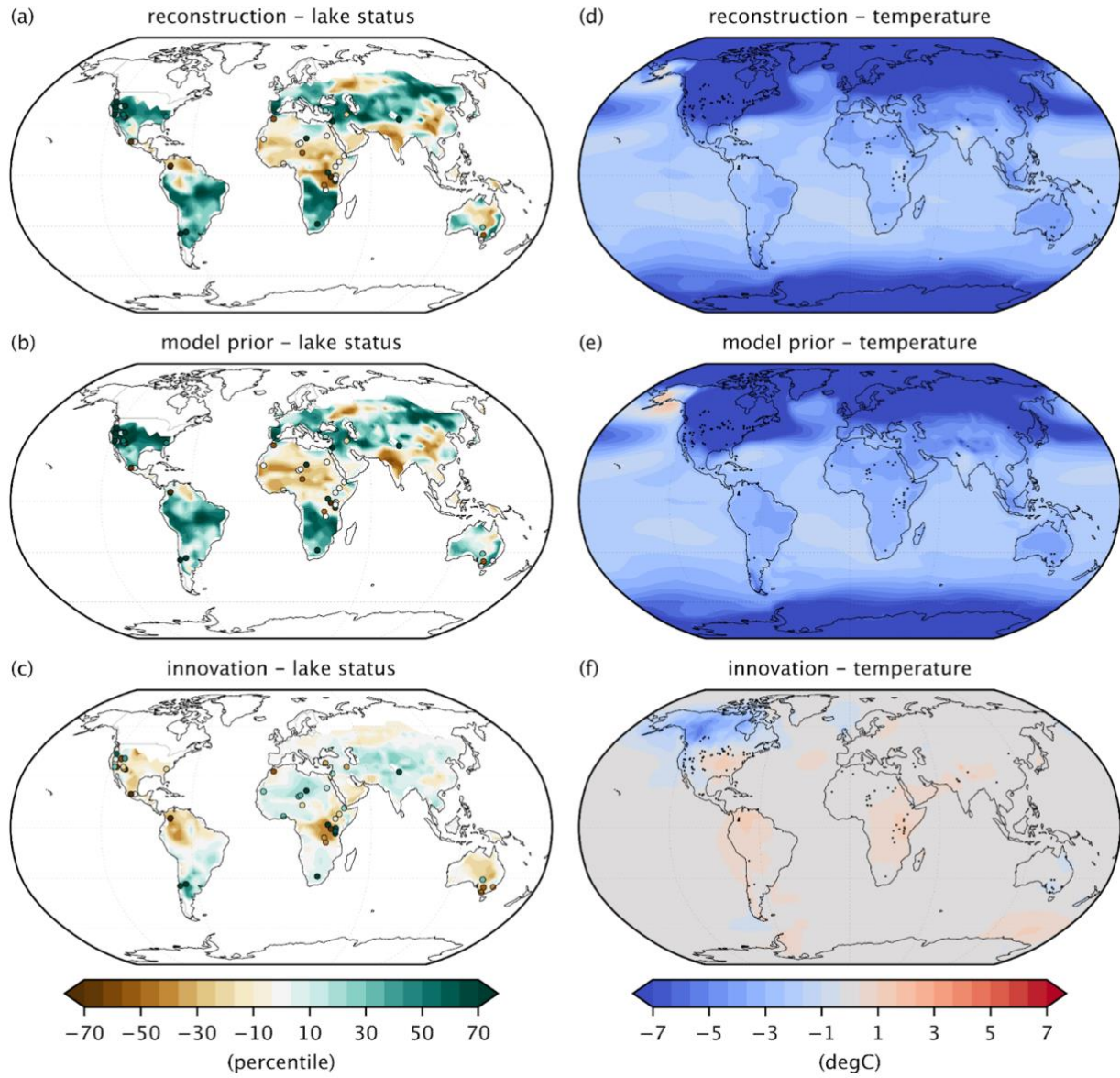



Figure S7: Last Glacial Maximum lake status and temperature anomalies. Similar to figure 6 except that temperature anomalies are shown in the right-hand column (d-f).

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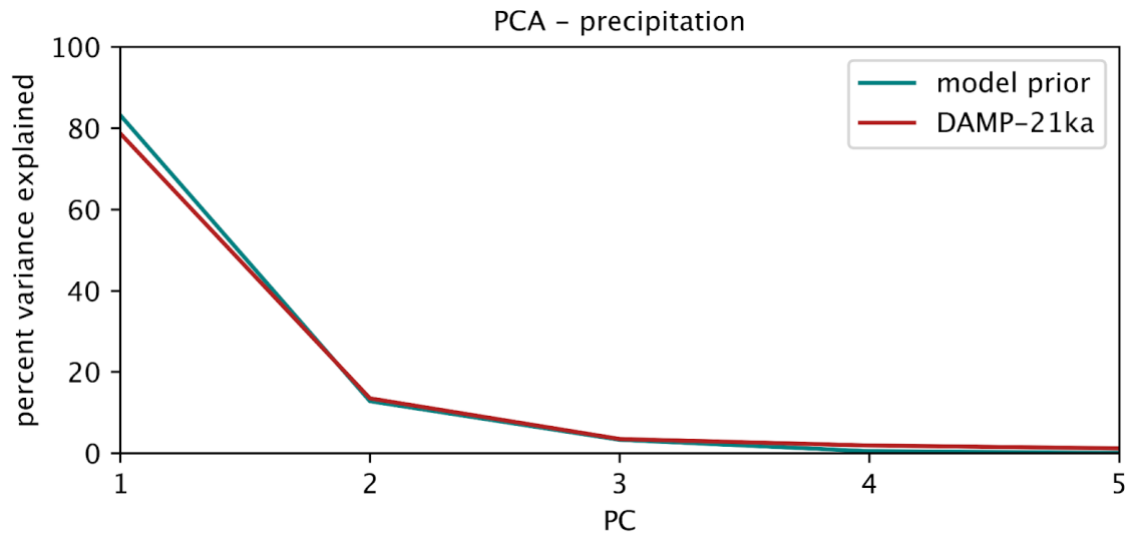
Figure S8: Scree plot for mean annual precipitation PCA. The percent variance explained for the first 4 PCs for the model prior (green) and the DAMP-21ka reanalysis (red). PC1 and PC2 explain most of the variance for both datasets and are both shown in Fig. 9 (reconstruction) and Fig. S8 (prior).

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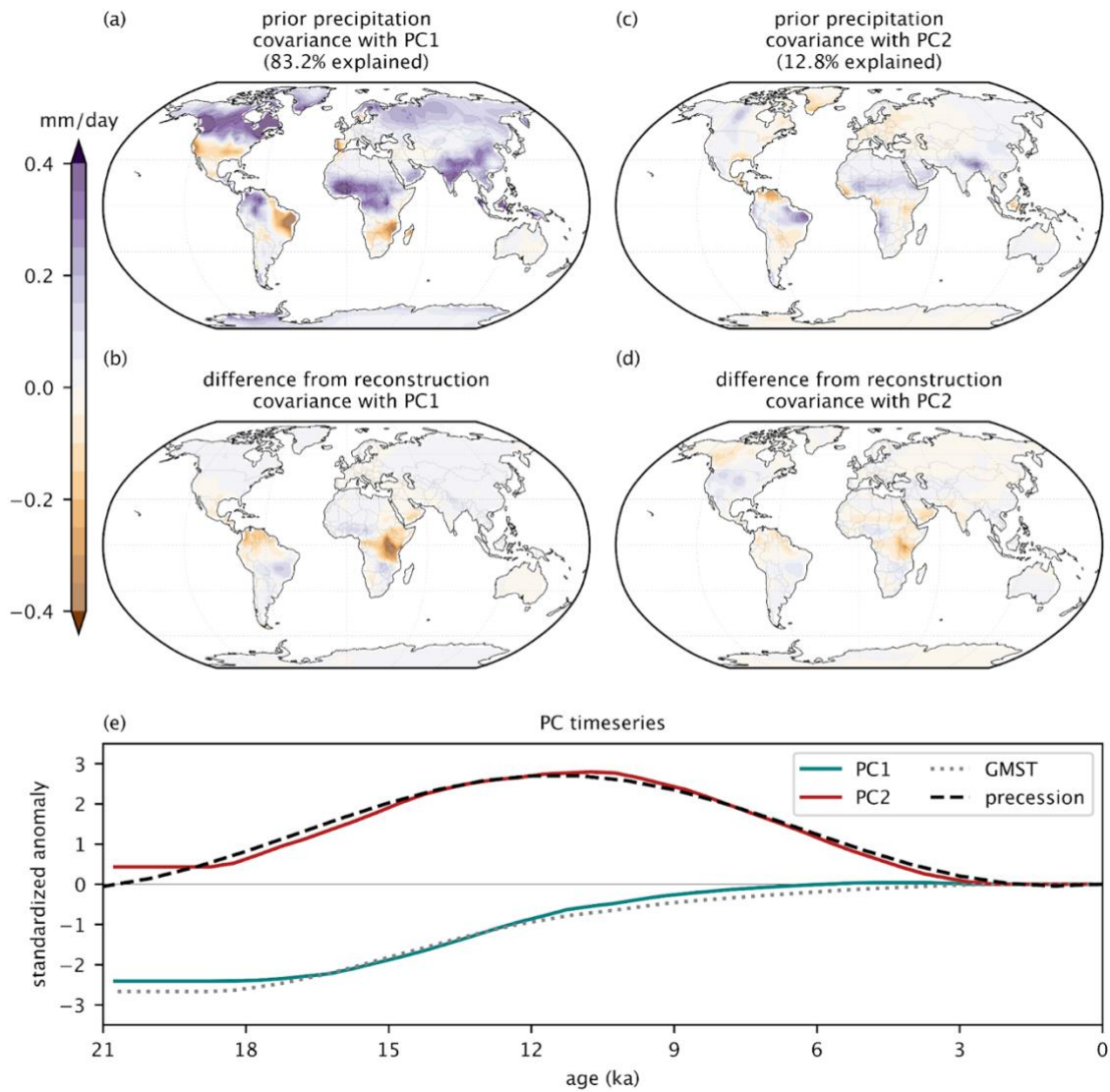
Figure S9: PCA of terrestrial annual precipitation using the model prior (21–0 ka). (a,c)The covariance between each grid cell and PC1 and PC2 is shown for the prior. (b,d) The difference between panels a and c compared to the covariance calculated from the reconstruction (Fig. 9). (e) The PC time series are plotted (solid lines) along with the global mean surface temperature (GMST) of the reconstruction (black) and the precessional forcing (grey; Berger and Loutre, 1991). The time series values are standardized (z-scores) to allow for plotting on a common y axis.
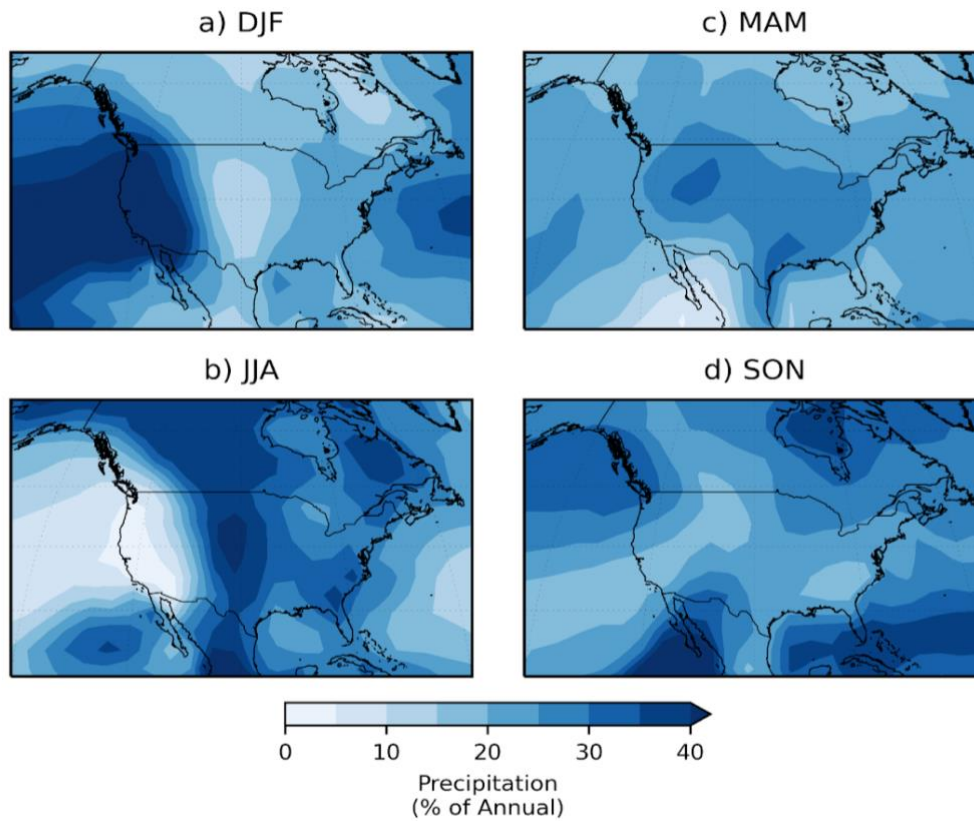
Figure S10: Percentage of annual precipitation by season. Values represent the mean seasonal percentage during decades within the last millennium (1 to 0 ka) for the mean of TraCE and HadCM.

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