**Table 1. List of data sets used in reconstruction.**

| Site/Core Name | Source | Proxy | Latitude (°) | Longitude (°) | elevation (m) | Reference |
|---|---|---|---|---|---|---|
| lapland | tree | width | 69.00 | 25.00 | | Helama et al. 2010 |
| Torneträsk | tree | width | 68.00 | 20.00 | 400 | Grudd et al. 2002 |
| Cave of the Bells | speleothem | $\delta^{18}O$ | 31.75 | -110.75 | 1647 | Wagner et al.,2010 |
| Botuver Cave | speleothem | $\delta^{18}O$ | -27.22 | -49.16 | 104 | Cruz et al.,2005;Wang et al.,2007 |
| Buca della Renella | speleothem | $\delta^{18}O$ | 44 | 0 | 152 | Drysdale et al.,2006 |
| Buckeye Creek Cave | speleothem | $\delta^{18}O$ | 37.976 | -80.4 | 590 | Springer et al.;2008;Hardt,B.et al.;2010 |
| Cold Air Cave | speleothem | $\delta^{18}O$ | -24.02 | 29.11 | 1340 | Holmgren et al.,1999,2003 |
| Cold Water Cave | speleothem | $\delta^{18}O$ | 43.47 | -91.97 | 362 | Denniston et al.,1999 |
| Dongge Cave | speleothem | $\delta^{18}O$ | 25.28 | 108.08 | 452 | Dykoski et al.,2005;Yuan et al.,2004;Wang et al.,2005 |
| Fort Stanton | speleothem | $\delta^{18}O$ | 33.3 | -105.3 | 1860 | Asmerom et al.,2010 |
| Gunung Buda National Park | speleothem | $\delta^{18}O$ | 4.03 | 114.8 | 31 | Partin et al.,2007; |
| Heshang Cave | speleothem | $\delta^{18}O$ | 30.45 | 110.416 | 248 | Hu et al.,2008 |
| Hoti Cave | speleothem | $\delta^{18}O$ | 23.08 | 57.35 | 688 | Neff et al.,2001 |
| Hulu Cave | speleothem | $\delta^{18}O$ | 32.5 | 119.16 | 48 | Wang et al.,2001 |
| Jerusalem West Cave | speleothem | $\delta^{18}O$ | 31.783 | 35.15 | 733 | Frumkin et al.,1999 |
| Jiuxian Cave | speleothem | $\delta^{18}O$ | 33.5667 | 109.1 | 856 | Cai et al.,2010 |
| Katerloch Cave | speleothem | $\delta^{18}O$ | 47.0833 | 15.55 | 907 | Boch et al.,2009 |
| Liang Luar Cave | speleothem | $\delta^{18}O$ | -8.533 | 120.433 | 607 | Griffiths et al.,2009 |
| Lianhua Cave | speleothem | $\delta^{18}O$ | 29.483 | 109.533 | 607 | Cosford et al.,2009 |

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|---|---|---|---|---|---|---|
| Lynds Cave | speleothem | $\delta^{18}O$ | -41.58 | 146.25 | 648 | Xia et al.,2001 |
| Ma'ale Efrayim Cave | speleothem | $\delta^{18}O$ | 32.08 | 35.37 | 199 | Vaks et al.,2003 |
| Moomi Cave | speleothem | $\delta^{18}O$ | 12.5 | 54 | 695 | Shakun et al.,2007 |
| Mystery Cave | speleothem | $\delta^{18}O$ | 43.62 | -92.3 | 406 | Denniston et al.,1999 |
| NWSI north-west of the South Island | speleothem | $\delta^{18}O$ | -42 | 172 | 102 | Williams et al.,2010 |
| Peqiin Cave | speleothem | $\delta^{18}O$ | 32.58 | 35.19 | 109 | Bar-Matthews et al.,2003 |
| Pink Panther Cave | speleothem | $\delta^{18}O$ | 32.083 | -105.1667 | 1194 | Asmerom et al.,2007 |
| Poleva Cave | speleothem | $\delta^{18}O$ | 44.72 | 21.75 | 249 | Constantin et al.,2007 |
| Qunf Cave | speleothem | $\delta^{18}O$ | 17.17 | 54.3 | 488 | Fleitmann et al.,2007 |
| Sanbao Cave | speleothem | $\delta^{18}O$ | 31.667 | 110.433 | 1838 | Wang et al.,2008;Dong et al.,2010 |
| Sofular Cave | speleothem | $\delta^{18}O$ | 41.416 | 31.934 | 438 | Fleitmann et al.,2009 |
| Soreq Cave | speleothem | $\delta^{18}O$ | 31.45 | 35.03 | 433 | Bar-Matthews et al.,2003 |
| Spring Valley Caverns | speleothem | $\delta^{18}O$ | 43.75 | -92.41 | 332 | Denniston et al.,1999 |
| Terciopelo Cave | speleothem | $\delta^{18}O$ | 10.1667 | -85.3333 | 255 | Lachniet et al.,2009 |
| Cueva del Tigre Perdido | speleothem | $\delta^{18}O$ | -5.940556 | -77.308056 | 868 | Breukelen et al.,2008 |
| Venado Cave | speleothem | $\delta^{18}O$ | 10.6 | -84.8 | 251 | Lachniet et al.,2004 |
| Xiangshui Cave | speleothem | $\delta^{18}O$ | 25.25 | 110.916 | 491 | Cosford et al.,2008 |
| Yamen Cave | speleothem | $\delta^{18}O$ | 25.4833 | 107.9 | 631 | Yang et al.,2010 |
| Yaoba Don Cave | speleothem | $\delta^{18}O$ | 28.8 | 109.833 | 546 | Cosford et al.,2008 |
| Fauske | speleothem | d18O | 67.22 | 15.81 | 160 | Linge et al. 2009 |
| Søylegrotta | speleothem | d18O | 66.62 | 13.68 | 280 | Lauritzen & Lundberg 1999 |
| Kortlandamossen1 | peat | humification_index, humification_index | 59.85 | 12.29 | 112 | Borgmark & Wastegård 2008 |
| Rystad 1 | peat | humification_index | 68.24 | 13.78 | 40 | Vorren et al. 2012 |
| Sellevollmyra | peat | humification_index | 69.11 | 15.94 | 1 | Vorren et al. 2007 |

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|---|---|---|---|---|---|---|
| Stömyren | peat | humification_index | 60.21 | 13.47 | 250 | Borgmark & Wastegård 2008 |
| S52/S53 | peat | d13C, d13C | 59.89 | -104.21 | 395 | Tillman et al. 2010 |
| GGC-19 | marine | d18O.forams, dinocysts, dinocysts, dinocysts | 72.16 | -155.51 | -369 | Farmer et al. 2011 |
| HLY0501-05 | marine | dinocysts | 72.69 | -157.52 | -415 | de Vernal et al. 2013; McKay et al. 2008 |
| P1/B3 | marine | dinocysts, dinocysts | 73.68 | -162.66 | -201 | de Vernal et al. 2005 |
| ARC-3 | marine | IP25 | 74.27 | -91.11 | -347 | Vare 2009; Belt et al. 2010 |
| DA05 | marine | forams | 68.72 | -51.11 | -335 | Lloyd 2007 |
| HU84-030-021 | marine | dinocysts | 58.37 | -57.51 | -2853 | de Vernal et al. 2001. 2013 |
| HU90-013-017 | marine | dinocysts | 58.21 | -48.37 | -3380 | de Vernal et al. 2013 |
| HU91-039-008 PC | marine | dinocysts | 77.27 | -74.33 | -663 | Levac et al.. 2001;de Vernal et al. 2013 |
| 2004-804-009 | marine | dinocysts | 74.19 | -81.20 | -781 | Ledu et al. 2010; de Vernal et al. 2013 |
| MD99-2227 | marine | dinocysts | 58.21 | -48.37 | -3460 | de Vernal and Hillaire-Marcel 2006; de Vernal et al. 2013 |
| 2005-804-006 | marine | dinocysts | 68.99 | -106.57 | -118 | Ledu et al. 2010; de Vernal et al. 2013 |
| ARC-4 | marine | IP25 | 69.17 | -100.70 | -61 | Belt et al. 2010 |
| ARC-5 | marine | IP25 | 68.99 | -106.57 | -112 | Belt et al. 2010 |
| B997-321 | marine | d18O.foram | 66.53 | -21.50 | | Smith et al. 2005 |
| GIK23258-2/3 | marine | d18O.foram, forams.pl | 75.00 | 14.00 | -1768 | Sarnthein et al. 2003 |
| T88-2, JM01-1199 | marine | forams | 71.99 | 14.36 | | Hald et al. 2007 |
| JM96-1207 | marine | dinocysts | 68.10 | -29.35 | -404 | Solignac et al., 2006; de Vernal et al. 2013 |
| JR51-GC35 | marine | alkenones | 67.59 | -17.56 | | Bendle & Rosell-Melé 2007 |

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|---|---|---|---|---|---|---|
| LO09-14 | marine | diatoms | 58.94 | -30.41 | | Berner et al. 2008 |
| Malangenfjord | marine | d18O.foram | 69.50 | 18.39 | -213 | Husum & Hald 2004 |
| MD95-2011, JM997-948/2A BC | marine | alkenones, diatoms, forams, d18O.foram | 66.97 | 7.64 | -1048 | Berner et al. 2010; Calvo et al. 2002; Andersson et al. 2003; Risebrobakken et al. 2003 |
| MD95-2015 | marine | alkenones | 58.77 | -25.97 | | Giraudeau et al. 2000; Marchal et al. 2002 |
| MD99-2256 | marine | forams | 64.30 | -24.21 | 246 | Ólafsdóttir et al. 2010 |
| MD99-2264 | marine | forams | 66.68 | -24.20 | 235 | Ólafsdóttir et al. 2010 |
| MD99-2269 | marine | diatoms | 66.85 | -20.85 | | Justwan et al. 2008 |
| MD99-2317 | marine | d18O.foram, IRD | 68.10 | -27.86 | | Jennings et al. 2011 |
| MD99-2322 | marine | d18O.foram, IRD, carbonate | 67.14 | -30.83 | | Jennings et al. 2011 |
| MSM5/5-712-2 | marine | IP25, dinocysts | 78.92 | 6.77 | -1487 | Müller et al. 2012; de Vernal et al. 2013 |
| MSM5/5-723-2 | marine | IP25 | 79.16 | 5.34 | -1349 | Müller et al. 2012 |
| ODP 684 | marine | Mg/Ca, d18O.foram | 61.00 | -25.00 | -1648 | Came et al. 2007 |
| P1003 | marine | d18O.foram, d18O.foram | 63.76 | 5.26 | -875 | Sejrup et al. 2011 |
| PS2641-4 | marine | IP25 | 73.16 | 19.48 | -469 | Müller et al. 2012 |
| RAPID-12-1k | marine | d18O.foram, Mg/Ca | 62.09 | -17.82 | -1938 | Thournally et al. 2009 |
| Troll 28-03 | marine | forams, d18O.foram | 60.87 | 3.73 | -345 | Klitgaard-Kristensen et al. 2001; Sejrup et al. 2004 |
| PL-96-112 BC | marine | dinocysts | 71.74 | 42.61 | -286 | Voronina et al., 2001; de Vernal et al. 2013 |
| Lake WA01 | lake | pollen | 61.24 | -136.93 | 1000 | Rebecca A.,et al.2013 |
| Berry Pond | lake | hydrogen isotopic composition of sedimentary leaf wax (C28n-acid) and palmitic acid (C16n-acid) | 42.51 | -73.32 | 630 | Bryan Shuman , et al. 2006 |
| Bregne Ice Cap | lake | MS, LOI, grainsize, 14C dating, Biogenic silica | 70.91 | -25.60 | 800 | Laura B., et al 2013 |
| Last Chance Lake | lake | MS, LOI, grainsize, 14C dating, Biogenic silica | 70.91 | -25.59 | 690 | Laura B., et al 2013 |

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|---|---|---|---|---|---|---|
| Two Move Lake | lake | (MS, LOI, grainsize, 14C dating, Biogenic silica | 70.91 | -25.59 | 790 | Laura B., et al 2013 |
| Cascade Lake | lake | Sediment biomarker (Uk'37) and leaf wax hydrogen isotope (d2H) | 68.38 | -154.60 | 920 | D'Andrea, W.J et al. |
| Kurupa Lake | lake | Sediment biomarker (Uk'37) and leaf wax hydrogen isotope (d2H) | 68.35 | -154.61 | 920 | D'Andrea, W.J et al. |
| Burial Lake/Burial2015 | lake | Geochemical data from Burial Lake, Alaska for the last 37,000 cal yr BP. Data include dry bulk density, percent organic matter, percent biogenic silica, magnetic susceptibility, carbon to nitrogen (C/N) mass ratios, bulk sediment organic matter carbon (d13C) and nitrogen (d15N) isotopes, and elemental abundances from scanning XRF analysis. | 68.43 | -159.17 | 460 | M.S. Finkenbinder, et al.2015 |
| Crooked Pond | lake | Hydrogen isotope ratios of palmitic acid in lacustrine sediments | 47.30 | -53.25 | 152 | Shuman, B., et al. 2006. |
| Davis Pond | lake | Sediment loss-on-ignition (LOI) values | 42.14 | -73.41 | 213 | Paige E.,et al.2011 |
| Deep Pond | lake | Sediment loss-on-ignition (LOI) | 41.56 | −70.635 | 23 | Jeremiah P.,et al.2013 |
| Schalkenmehrener Maar | lake | dust record | 50.17 | 6.86 | 420 | Klemens Seelos et al.2009 |
| Holzmaar | lake | dust record | 50.12 | 6.88 | 425 | Klemens Seelos et al.2009 |
| Dehner Maar | lake | dust record | 50.29 | 6.51 | 565 | Klemens Seelos et al.2009 |
| Oberwinkler Maar | lake | dust record | 50.15 | 6.95 | 385 | Klemens Seelos et al.2009 |
| Schalkenmehrener Maar | lake | dust record | 50.17 | 6.86 | 420 | Frank Sirocko,et al.2013. |
| Holzmaar | lake | dust record | 50.12 | 6.88 | 425 | Frank Sirocko,et al.2013. |
| Dehner Maar | lake | dust record | 50.29 | 6.51 | 565 | Frank Sirocko,et al.2013. |
| Oberwinkler Maar | lake | dust record | 50.15 | 6.95 | 385 | Frank Sirocko,et al.2013. |
| Eifel | lake | Pleistocene laminated lake sediments from maar structures | 50.16 | 6.83 | 400 | H. Brunck, et al.2016. |
| Holzmaar | lake | pollen | 50.12 | 6.88 | 425 | F. Sirocko,et al.2016 |
| Dehner Maar | lake | pollen | 50.29 | 6.51 | 565 | F. Sirocko,et al.2016 |

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|---|---|---|---|---|---|---|
| Elk Lake, Minnesota Database. | lake | varve thickness, pollen, diatoms, geochemistry, isotopes, mineralogy, and physical properties. | 45.47 | -93.95 | 291 | |
| Foy Lake, Montana, USA | lake | Diatom | 48.16 | 114.36 | 1006 | Stone, J.R. and S.C. Fritz. 2008. |
| Harding Lake | lake | Geochemical data dry bulk density, percent organic matter, percent biogenic silica, magnetic susceptibility, carbon to nitrogen (C/N) mass ratios, bulk,sediment organic matter carbon isotopes (d13C), pollen, and elemental abundances. | 64.42 | -146.85 | 217 | Finkenbinder, M.S.,et al 2014. |
| Lake Jøkelvatnet/JØP-112 | lake | Titanium concentration data | 70.17 | 21.70 | 156 | Hella E. Wittmeier,et al.2015 |
| Lake Masoko, Tanzania | lake | Magnetic Susceptibility | -9.33 | 33.76 | 860 | Garcin, Y., et al. 2008. |
| Lake Petén Itzá, Guatemala/PI-6 | lake | Magnetic Susceptibility | 17.00 | -89.78 | 110 | Jaime Escobar,et al.2012 |
| Lake Victoria/V95-1P | lake | TEX86 and Leaf Wax dD and d13C Data | -1.23 | 33.20 | 1133 | Melissa A. Berke,et al.2012 |
| Bone Lake | lake | LOI | 70.89 | -22.27 | 442 | Thomas V. Lowell,et al.2013 |
| Lone Spruce Pond | lake | Diatom Census | 60.01 | -159.14 | 135 | Perren, B,2016. |
| Lower Bear Lake | lake | magnetic susceptibility, LOI 550C, LOI 950C,ostracod counts (# per 1g dry weight), gastrop counts (# per 1g dry weight), molar CN ratios | 34.25 | 116.91 | 2059 | Kirby, M.E., et al. 2012. |
| Yanacocha | lake | metals, LOI550, biogenic silica, and total Ti | -13.94 | -70.87 | 4910 | Beal, Samuel,et al.2014 |
| Nanerersarpik Lake | lake | Biogenic Silica Concentrations (%) from FTIRS, Elemental concentrations from Itrax core scanner, Magnetic suceptibility, %TOC, atomic C/N, and d13Corg. | 66.90 | -37.13 | 100 | de Wet, G.A.et al.2012 |
| Lake Hvítárvatn03-1 | lake | Biogenic silica,sediment,,%,,paleolimnology,,,N density(g/cm3)Density,sediment,,g/cm3,,paleolimnology,,,N Magnetic Susceptibility,sediment,,SI unit,,paleolimnology,,,NTotal Carbon,sediment,,percent,,paleolimnology,,,N Total Organic Carbon Flux,sediment,,g/cm2/yr,,paleolimnology,,,N delta 13C,sediment,,per mil VPDB,,paleolimnology,,,N Carbon/Nitrogen,sediment,,unitless,,paleolimnology,,,N Total | 64.64 | -19.84 | 422 | Larsen, D.J. et al 2012 |

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|---|---|---|---|---|---|---|
| | | Nitrogen,sediment,,unitless,,paleolimnology,,,N | | | | |
| Cleland Lake | lake | Lake sediment stable isotope (d18O and d13C) from 3 lakes in British Columbia and Washington. | 50.83 | -116.39 | 1126 | Byron A. Steinman,et al.2016 |
| Lime Lake | lake | Lake sediment stable isotope (d18O and d13C) | 48.87 | -117.34 | 781 | Byron A. Steinman,et al.2016 |
| Paradise Lake | lake | Lake sediment stable isotope (d18O and d13C) | 54.69 | -122.62 | 733 | Byron A. Steinman,et al.2016 |
| Path Lake | lake | High-resolution pollen and physcial properties data from Path Lake, Nova Scotia. Data include | 43.87 | -64.93 | 15 | Karen Neil,et al.2014 |
| Laguna Queshquecocha | lake | Bulk Density Clastic Sediment Si_cps Sr_cps Zr_cps | -9.80 | -77.30 | 4250 | Nathan D. Stansell,et al.2017 |
| Laguna Jahuacocha | lake | k_cps Ca cps Ti cps Clastic sediment flux Magnetic susceptibility | -10.23 | -76.93 | 4076 | Nathan D. Stansell,et al.2013 |
| Laguna Lutacocha | lake | Ca Ti Fe clastic-flux | -10.55 | -76.72 | 4320 | Nathan D. Stansell,et al.2013 |
| Laguna Lutacocha | lake | Magnetic susceptibility | -10.55 | -76.72 | 4320 | Nathan D. Stansell,et al.2013 |
| Laguna Lutacocha | lake | Wet Bulk Density | -10.55 | -76.72 | 4320 | Nathan D. Stansell,et al.2013 |
| Laguna Queshquecocha | lake | Ca Sr Zr clastic-flux Magnetic susceptibility Wet Bulk Density | -9.80 | -77.30 | 4260 | Nathan D. Stansell,et al.2013 |
| Bunny Lake/BNL11-1A2014 | lake | Loss-on-ignition data (550C burn) | 71.03 | -27.43 | 819 | Medford, A., Hall,et al 2014 |
| Raven Lake | lake | Loss-on-ignition data (550C burn) | 71.07 | -27.31 | 1054 | Medford, A., Hall,et al 2014 |
| Rapids Lake | lake | Loss-on-ignition data (550C burn) | 71.03 | -27.42 | 824 | Medford, A., Hall,et al 2014 |
| Shainin Lake | lake | Wet Bulk Density Magnetic Susceptibility Physical properties data | 68.34 | -151.07 | 879 | |
| Sikuiui Lake/13MCR-D3 | lake | Sediment physical properties (LOI, MS, ITRAX XRF) | 70.21 | -51.12 | 2502 | Avriel D. Schweinsberg, et al.2017 |

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|---|---|---|---|---|---|---|
| Silver Lake, California/SLPC11-1 | lake | Grain size, mineralogy, and geochemical data | 35.37 | -116.14 | 276.8 | Matthew E. Kirby, et al.2015 |
| Keyhole Lake | lake | Lake sediment data and tree-ring chronologies | 61.10 | -138.25 | 1261 | Gajewski, K.et al.2014 |
| Upper Fly Lake | lake | Lake sediment data and tree-ring chronologies | 61.04 | -138.09 | 1326 | Gajewski, K.et al.2014 |
| Laguna de Los Anteojos | lake | Biogenic Silica Dry Bulk Density Clastic flux Organic matter Magnetic susceptibility Titanium Iron percent | 8.54 | -71.07 | 3920 | |
| Laguna de Montos | lake | Dry Bulk Density Clastic flux Organic matter Magnetic susceptibility | 8.51 | -71.09 | 4050 | Nathan D. Stansell,et al.2014 |
| Laguna de Mucubají | lake | Biogenic Silica Titanium Iron Dry Bulk Density Organic matter Clastic flux Magnetic susceptibility | 8.80 | -70.83 | 3577 | |
| Wahoo Lake, Brooks Foothills, Alaska. | lake | Oxygen and carbon isotopes of Pisidium bivalves and lithological composition | 69.08 | -146.93 | 700 | Richard S. Vachula,et al. 2017 |
| Fishtote Lake | lake | LOI | 69.23 | -50.93 | 285 | Yarrow Axford, et al. 2012 |
| Iceboom Lake | lake | Loss-on-ignition at 550 degrees C (% by weight) Magnetic susceptibility | 69.24 | -50.02 | 185 | Yarrow Axford,et al.2012 |
| Loon Lake | lake | Loss-on-ignition at 550 degrees C (% by weight) Magnetic susceptibility (SI units) | 69.06 | -49.92 | 278 | Yarrow Axford,et al.2012 |
| North Lake | lake | Biogenic Silica Loss-on-ignition at 550 degrees C (% by weight) | 69.24 | -50.03 | 190 | Yarrow Axford,et al.2012 |
| Pluto Lake | lake | Loss-on-ignition at 550 degrees C Magnetic susceptibility (SI units) | 69.11 | -51.03 | 170 | Yarrow Axford,et al.2012 |
| Wilson Creek | lake | Stable Isotope and Trace Element Data | 39.50 | -79.32 | 1261 | Kent et al. (2002) |
| Lake of the Woods | lake | Sediment loss-on-ignition (LOI) or sand content data and moisture balance (lake-level and DeltaP-E, Precipitation minus Evaporation) reconstructions for Little Windy Hill Pond and Lake of the Woods, Wyoming. | 43.48 | -109.89 | 2816 | Paul Pribyl and Bryan N. Shuman,2014. |
| Little Windy Hill Pond | lake | Sediment loss-on-ignition (LOI) or sand content data and moisture balance (lake-level and DeltaP-E, Precipitation minus Evaporation) reconstructions for Little Windy Hill Pond and Lake of the Woods, Wyoming. | 41.43 | -106.33 | 2980 | Paul Pribyl and Bryan N. Shuman,2014. |
| Yanchi Lake | lake | Geochemical and physical properties data | 39.75 | 99.33 | 1200 | Yu Li,et al.2013 |

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|---|---|---|---|---|---|---|
| Zhuye Lake | lake | Pollen assemblages and grain-size data | 39.05 | 103.67 | 1309 | Yu Li,et al 2009. |
| Laguna Pumacocha, Peru | lake | Stable isotope and limnological data from Laguna Pumacocha, Peru, spanning the last 11,000 years. | -10.70 | -76.06 | 4300 | Bird, B., et al. 2011. |
| Lahontan Basin | lake | Benson et al. 1995 and 1996 Lahontan Basin, Nevada Carbon and Strontium Isotope Data | 39.80 | -118.50 | 1183 | Benson, L., et al., 2002. |
| Lake Bosumtwi | lake | Hydrogen (dD) and carbon (d13C) isotope data from leaf wa | 6.51 | -1.41 | 300 | Peck, J.A., et al. 2007. |
| Lake Bosumtwi | lake | Description: Lake Bosumtwi, Ghana sediment age models derived from 4 methods: Radiocarbon, U-series, | 6.5333 | -1.42 | 99 | Timothy M. Shanahan,et al. 2013. |
| Lake Bourget LDB01-I, France | lake | # This dataset presents the total terrigneous input in core LDB01-I taken in Lake Bourget. | 45.7475 | 5.85 | 231.5 | Fabien Arnaud, et al. 2012. |
| Lake Cadagno, Switzerland | lake | Lake sediment bacterial lipids data and MBT/CBT temperature reconstruction from Lake Cadagno, Switzerland, for the past 11,000 years. Mean annual air temperature (MAAT) reconstruction is based on the MBT/CBT paleothermometer, utilizing temperature dependent distribution of specific bacterial membrane lipids in soil organic matter. | 46.55 | 8.71 | 1921 | Niemann, H., et al. 2012. |
| Lake Challa，Tanzania | lake | # The 172 main-series BIT samples (branched and isoprenoid tetraether index of soil bacterial versus aquatic archaeal membrane lipids) (cf. Fig.2 of the source publication) are 4-cm core increments extracted at constant 12-cm composite-depth intervals, plus 7 additional samples (samples at composite depths 118, 774, 958, 966, 970, 1050, 1074, and 2014 cm) filling in sharp transitions in BIT values (mainly around the Younger Dryas period) and 1 sample replacing the missing sample at 122 cm. The high-resolution BIT time series for the last millennium (cf. Supplementary Fig.7 of the source publication) adds 21 samples (highlighted in blue) from the uppermost 126 cm, to produce a contiguously sampled record of 4-cm core increments. The 3-pt running mean BIT values are based on main-series samples only. 'Composite depth' refers to the continuous depth axis of the master core sequence, which is composed of 21 cross-correlated core sections before excision of 5 turbidites. 'Corrected depth' refers to the depth axis of the master sequence after excision of these turbidites (they occur below samples at composite depths of 482, 674, 1898, 1910, and 2018 cm), and represents a continuous time axis. | -3.32 | 37.7 | 880 | Dirk Verschuren,et al.2009 |

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|---|---|---|---|---|---|---|
| Lake Challa, Kenya/Tanzania: | lake | Deuterium/hydrogen ratio of higher plant leaf waxes (dDwax) from Lake Challa, Kenya, covering the last 25,000 years.The chronology for the Lake Challa composite sediment sequence is based on a combination of 210Pb and AMS 14C dating as previously described by Verschuren et al. (2009). | -3.32 | 37.70 | 878 | Tierney, J.E., et al. 2011. |
| Lake Holzmaar, Germany Holocene Carbon Isotope Data | lake | Holocene total organic carbon and organic carbon isotope data from varved sediment from Lake Holzmaar | 50.12 | 6.88 | 425 | Lücke, A., et al. 2008. |
| Pyramid Lake, Nevada and Owens Lake, California | lake | Magnetic Susceptibility, d18O, d13C, Total Organic and Inorganic Carbon, and sediment porosity data | 40.02 | -119.56 | 1155 | Benson et al. 2002 |
| Jenny Lake, Teton National Park, Wyoming | lake | sediment accumulation rate, bulk density, clastic sediment concentration and flux, organic matter (concentration, flux, d13C, d15N, and C/N ratios), and biogenic silica, track changes in environmental conditions and landscape development. | 43.75 | -110.73 | 2070 | Darren J.,et al.2016 |
| Laguna La Gaiba | lake | Leaf wax (C27-C33 n-alkane) carbon and hydrogen isotope data | -17.77 | -57.72 | 160 | Kyrstin L., et al. 2016 |
| Laguna Potrok Aike, Argentina | lake | Continuous decadal resolution of sedimentological, geochemical and XRFscanning data | 51.96 | 70.38 | 113 | Haberzettl, T., et al. 2008 |
| SS32 | lake | diatoms, organic content,spectrally inferred sediment chlorophyll-a | 66.18 | -48.91 | 470 | Perren, B.B., et al. 2012. |
| SS16 | lake | diatoms, organic content,spectrally inferred sediment chlorophyll-a | 66.25 | -45.99 | 477 | Perren, B.B., et al. 2012. |
| SS49 | lake | diatoms, organic content,spectrally inferred sediment chlorophyll-a | 66.15 | -52.42 | 330 | Perren, B.B., et al. 2012. |
| Baffin Island, Nunavut, Canada | lake | Midge Temperature, Diatom pH, and C/N Data | 70.09 | -68.95 | 195 | Axford, Y., et al. 2010. |
| AS92-5, AS93-1, and AS96-1 | lake | oxygen isotope | 47.10 | 11.02 | 533 | von Grafenstein, U., et al., 2003 |
| Bear Lake, Utah 蜂 daho (USA). | lake | Diatom | 41.95 | -111.43 | 1805 | Moser, K.A. and J.P. Kimball. 2009. |
| Bison Lake, Colorado Holocene Calcite Oxygen Isotope Data | lake | d18O | 39.77 | -107.35 | 3255 | Anderson, L. 2011. |

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|---|---|---|---|---|---|---|
| Burial Lake | lake | Sediment physical properties and summary pollen data | 68.43 | -159.17 | 460 | Abbott, M.B., et al. 2010. |
| Moon Lake, North Dakota, USA | lake | diatom-derived salinity record | 46.85 | -99.01 | 2463 | Laird, K.R., et al., 2003 |
| Cheeseman Lake | lake | oxygen isotopes, carbon isotopes, geochemistry | 49.35 | -57.60 | 180 | Matthew S. Finkenbinder,et al.2016 |
| Crawford Lake | lake | Stable isotope | 43.47 | -79.95 | 304 | Yu, Z.C., and U. Eicher, 1999 |
| Twiss Marl Pond | lake | Stable isotope | 43.45 | -79.91 | 200 | Yu, Z.C., and U. Eicher, 1999 |
| Lake Malawi/M98-1P | lake | Biogenic Silica and Mass Accumulation Rate | -11.96 | 34.59 | 403 | Johnson, T.C.,et al.2002 |
| M98-2P | lake | Biogenic Silica and Mass Accumulation Rate | -9.98 | 34.23,17 | 363 | Johnson, T.C.,et al.2002 |
| Lake Peten-Itza, Guatemala, | lake | Ostracod and Gastropod Stable Isotopic Data. | 16.92 | -89.83 | | Curtis, J., 2001 |
| Little Swift Lake, Alaska | lake | major-element geochemistry, grain size measurements, loss on ignition, magnetic susceptibility, and pollen counts. Core LS-A, | 60.21 | -159.77 | 572 | Axford, Y. and D.S. Kaufman. 2010. |
| Fiskebølvatnet | lake | magnetic susceptibility, organic-matter flux, C/N, d13Corg, Ti concentrations, and mass accumulation rates. | 68.41 | 14.80 | 23 | Balascio, N.L. and R.S. Bradley. 2012. |
| Vikjordavatnet | lake | magnetic susceptibility, organic-matter flux, C/N, d13Corg, Ti concentrations, and mass accumulation rates. | 68.23 | -14.06 | 23 | Balascio, N.L. and R.S. Bradley. 2012. |
| Lone Spruce Pond | lake | organic matter, biogenic silica, carbon and nitrogen content and isotopic ratios, magnetic susceptibility, grain-size distribution of bulk sediment, abundance of alder shrub (Alnus) pollen, and midge (Chironomidae and Chaoboridae) assemblages. | 60.01 | -159.14 | 135 | Kaufman, D.S., et al. 2012. |
| Marcella Lake, Yukon | lake | Carbon and oxygen isotope ratios (per mil VPDB) from Charophyte | 60.07 | -133.81 | 749 | Anderson, L., et al. 2008. |
| Mica Lake | lake | d18O diatom, biogenic silica, and organic matter | 60.95 | -148.15 | 3.1 | Schiff, C.J., et al. 2008. |
| Aspvatnet glacial lake, | lake | Dry Bulk Density (DBD) g/cm3 Loss-on-ignition (LOI) (the samples were | 69.73 | 19.98 | 35 | Bakke, J., et al. 2006. |

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|---|---|---|---|---|---|---|
| Lyngen Peninsula | | ignited for 1 h at 550C)Magnetic Susceptibility (MS) (SI 10E-5) | | | | |
| Okpilak Lake | lake | lithology, organic-matter content,magnetic susceptibility, and pollen taxa. | 69.41 | -144.05 | 593 | Oswald, W.W., et al. 2012. |
| Pilkington Bay, Lake Victoria, Uganda. | lake | Diatom series | 0.27 | 33.41 | 11 water depth | Stager, J.C., et al., 2003, |
| Qalluuraq Lake, Alaska | lake | Magnetics | 70.38 | -157.35 | 13 | Wooller, M.J., et al. 2012. |
| Quartz Lake | lake | Chironomid and stable isotope data from sediments recovered from | 64.21 | -145.82 | 293 | Wooller, M.J., et al. 2012. |
| Salar de Uyuni, Bolivia | lake | Salar de Uyuni Drill Hole Natural Gamma Radiation Data. sed as a proxy for sediment mud/salt content and therefore | -20.25 | -67.50 | 3653 | Fritz, S.C., et al. 2004. |
| Trout Lake, Yukon | lake | Fossil midge larval data and inferred mean July air temperature, | 68.83 | -138.75 | 150 | Irvine, F., et al. 2012. |
| Sandflugtdalen | lake | organic-matter | 67.09 | -50.29 | 247 | Willemse, N.W., 1999, |
| Naujagdlup nunaa | lake | minerogenic-matter | 66.67 | -51.97 | 300 | Willemse, N.W., 1999, |
| Lake Igaliku, South Greenland | lake | Multiproxy Holocene sediment data from Lake Igaliku, South Greenland. Paleoenvironmental proxies measured include magnetic susceptibility, grain size, total organic carbon, total nitrogen and sulphur, sedimentation rates, pollen, and diatom assemblages. | 61.00 | -45.43 | 30 | Massa, C., et al. 2012. |
| Hongyuan, northeastern Tibetan Plateau | lake | peat core | 32.11 | 102.02 | 3527 | Yu, X., et al. 2011 |
| Lake Tana, Ethiopia | lake | δD of the C28 n-alkanoic acid (δDwax) fromcore 03TL3 | 11.95 | 37.31 | 1830 | Costa, K.,et al.2014 |
| Kangerlussuaq lake | lake | Loss-on-Ignition (LOI), Mass Accumulation Rate (MAR), bulk density, plus Calcium and Titanium content | 67.01 | 51.17 | 196 | Anderson, N.J., et al. 2012. |
| Lago Grande di Monticchio | lake | sedimentation rate based chronology | 40.93 | 15.58 | 656 | Allen, J.R.M., et al., 2002 |
| Laguna Pallcacocha, Ecuador | lake | Ecuador Alluvial Sediment Gray Scale Data | 2.77 | -79.23 | 4060 | Rodbell, et al, 2000 |
| Laguna Pallcacocha, Southern Ecuadorian Andes, Ecuador | lake | Red color intensity time series and number of warm ENSO events in 100 yr non-overlapping windows | -2.77 | -79.23 | 4200 | Moy, C.M., et al., 2002 |

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|---|---|---|---|---|---|---|
| Aral sea | lake | | 59.69 | 44.98 | | Kvasov,et al.,1975 |
| Bear lake | lake | $\delta^{13}C$,$\delta^{18}O$,TC,TIC,OC, $CaCO_3$,Ca,Mg,B,Ba,Fe,K,Li,Mn,Na,P,Sr,Ti | -111.33 | 42.00 | | Engleman et al.,1985 |
| Chad Lake | lake | | 14.19 | 13.47 | | Bouchette et al.,2010 |
| Eyre Lake | lake | | 137.71 | -29.07 | | Magee et al.,2004 |
| Great Salt Lake/USGS 96,95 | lake | Bulk organics,Humic acid from organic materials,Charcoal | -112.52 | 41.20 | 200 | Charles et al.2015 |
| Huguangyan Maar lake | lake | Ti,Fe,Mn,Magn. susc. ,S,TOC,bio.-SiO2 | 110.28 | 21.15 | | Yancheva et al.,2007 |
| Laguna Yanacocha | lake | Si,S,K,Ca,Ti,Mn,Fe,Zn,Rb,Sr,Zr | -75.93 | -10.56 | 4 | Nathan et al.,2015 |
| Lake Chichancanab | lake | $\delta^{13}C$, $\delta^{18}O$,CaCO3,S | -88.82 | 19.87 | 22 | Hodell et al.,1995 |
| Lake Issyk-Kul/IK97 | lake | $\delta^{13}C$,$\delta^{18}O$,Sr/Ca | 77.25 | 42.46 | 194 | Ricketts et al.,2001 |
| Lake Malawi/M98-1P/M98-1P | lake | BSi,LSR,MAR, BSi MAR. | 33.84 | -13.52 | 19 | Johnson et al.,2002 |
| Lake Qinghai | lake | brightness,%redness | 100.30 | 37.06 | 32 | Ji et al.,2005 |
| Lake Tanganyika | lake | dD,$\delta^{13}C$,TEX86 | 29.83 | -6.08 | 185 | Tierney et al.,2008 |
| Lake Titicaca | lake | dD | -69.16 | -15.94 | 266 | Kyrstin et al.,2014 |
| Lake Towuti/TOW9 | lake | Al, Mg, K, Ti,Fe, Cr, Co, V, U | 121.52 | -2.73 | 624 | Costa et al.,2015 |
| Makgadikgadi Basin/Kal98 | lake | U,Th,K | 24.70 | -20.51 | | Shaw et al.2003 |
| Victoria lake/LV95-1P | lake | TEX86, Leaf Wax,dD ,$\delta^{13}C$ | 33.20 | -1.23 | 209 | Melissa et al.,2012 |
| Aral sea | lake | | 44.97806 | 59.69106 | 29 | Kvasov,et al.,1975 |
| Bear lake | lake | $\delta^{13}C$,$\delta^{18}O$,TC,TIC,OC, $CaCO_3$,Ca,Mg,B,Ba,Fe,K,Li,Mn,Na,P,Sr,Ti | 42 | -111.33333 | 1805 | Engleman et al.,1985 |
| Chad Lake | lake | | 13.46975 | 14.18955 | 280 | Bouchette et al.,2010 |
| Eyre Lake | lake | | -29.07128 | 137.70725 | -15 | Magee et al.,2004 |
| Great Salt Lake | lake | Bulk organics,Humic acid from organic materials,Charcoal | 41.1973 | -112.521 | 1281 | Charles et al.2015 |
| Huguangyan Maar lake | lake | Ti,Fe,Mn,Magn. susc. ,S,TOC,bio.-SiO2 | 21.15 | 110.28333 | 16 | Yancheva et al.,2007 |
| Laguna Yanacocha | lake | Si,S,K,Ca,Ti,Mn,Fe,Zn,Rb,Sr,Zr | -10.5598 | -75.9303 | 3993 | Nathan et al.,2015 |
| Lake Chichancanab | lake | $\delta^{13}C$, $\delta^{18}O$,CaCO3,S | 19.87337 | -88.81922 | 3 | Hodell et al.,1995 |
| Lake Issyk-Kul | lake | $\delta^{13}C$,$\delta^{18}O$,Sr/Ca | 42.46046 | 77.25327 | 1601 | Ricketts et al.,2001 |
| Lake Malawi | lake | BSi,LSR,MAR, BSi MAR. | -13.52358 | 33.83546 | 476 | Johnson et al.,2002 |
| Lake Qinghai | lake | brightness,%redness | 37.0579 | 100.3029 | 3194 | Ji et al.,2005 |

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|---|---|---|---|---|---|---|
| Lake Tanganyika | lake | dD,$\delta^{13}C$,TEX86 | -6.08037 | 29.83262 | 767 | Tierney et al.,2008 |
| Lake Titicaca | lake | dD | -15.9368 | -69.1601 | 3815 | Kyrstin et al.,2014 |
| Lake Towuti | lake | Al, Mg, K, Ti,Fe, Cr, Co, V, U | -2.73284 | 121.51596 | 319 | Costa et al.,2015 |
| Makgadikgadi Basin | lake | U,Th,K | -20.51031 | 24.69518 | 904 | Shaw et al.2003 |
| Victoria lake | lake | TEX86, Leaf Wax,dD ,$\delta^{13}C$ | -1.2317 | 33.1983 | 1134 | Melissa et al.,2012 |
| Andy Lake | lake | pollen | 64.65 | -128.08 | 1360 | Viau & Gajewski 2009; Szeicz et al. 1995 |
| Bell's Lake | lake | pollen | 65.02 | -127.48 | 580 | Viau & Gajewski 2009; Szeicz et al. 1995 |
| Candelabra Lake | lake | pollen | 61.68 | -130.65 | 1040 | Viau & Gajewski 2009; Cwynar & Spear 1995 |
| Dune Lake | lake | d13C.bulk | 64.42 | -149.90 | 134 | Finney et al. 2012 |
| Farewell Lake | lake | MgCa.ostracodes | 62.55 | -153.63 | 230 | Hu et al. 1998 |
| Greyling Lake | lake | OM | 61.40 | -145.70 | 1015 | McKay & Kaufman 2009 |
| Hail Lake | lake | pollen | 60.03 | -129.02 | 690 | Viau & Gajewski 2009; Cwynar and Spear 1995 |
| Hallet Lake | lake | OM, BSi | 61.50 | -146.20 | 1128 | McKay & Kaufman 2009 |
| Honeymoon Pond | lake | pollen | 64.63 | -138.40 | 1160 | Viau & Gajewski 2009; Cwynar & Spear 1991 |
| Hudson Lake | lake | chironomids | 61.90 | -145.67 | 657 | Clegg et al. 2011 |
| Jellybean Lake | lake | d18O.calcite | 60.35 | -134.80 | 730 | Anderson et al. 2005 |
| Kusawa Lake | lake | BSi | 60.28 | -136.18 | 671 | Chakraborty et al. 2010 |
| Lily Lake | lake | pollen | 59.20 | -135.40 | 230 | Cwynar 1990 |

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|---|---|---|---|---|---|---|
| Lone Spruce Pond | lake | BSi | 60.01 | -159.14 | 135 | Kaufman et al. 2012 |
| Lac Meleze | lake | pollen | 65.22 | -126.12 | 650 | Viau & Gajewski 2009; MacDonald 1987 |
| Mica Lake | lake | d18O.diatom | 60.95 | -148.15 | 3 | Schiff et al. 2009 |
| Moose Lake | lake | chironomids | 61.37 | -143.60 | 437 | Clegg et al. 2010 |
| Quartz Lake | lake | chironomids | 64.21 | -145.81 | 293 | Wooller et al. 2012 |
| Rainbow Lake | lake | chironomids | 60.72 | -150.80 | 63 | Clegg et al. 2011 |
| Ranger Lake | lake | pollen | 67.15 | -153.65 | 820 | Viau & Gajewski 2009; Brubaker et al. 1983 |
| Screaming Lynx Lake | lake | chironomids | 66.07 | -145.40 | 223 | Clegg et al. 2011 |
| Takahula Lake | lake | d18O.calcite | 67.35 | -153.67 | 275 | Clegg & Hu 2010 |
| Trout Lake - combined | lake | chironomids, chironomids | 68.83 | -138.75 | 150 | Irvine et al. 2012 |
| Upper Fly Lake | lake | pollen | 61.07 | -138.09 | 1326 | Bunbury & Gajewski 2009 |
| Waskey Lake | lake | DBD, OM | 59.88 | -159.21 | 150 | Levy et al. 2004 |
| Wolverine Lake - April Core | lake | MAR | 67.10 | -158.91 | | Mann et al. 2002 |
| Akvaqiak Lake | lake | pollen | 66.78 | -63.95 | 17 | Fréchette & de Vernal 2009 |
| BC01 | lake | OM, MS, BSi | 75.18 | -111.92 | | Peros et al. 2010 |
| Big Round Lake | lake | MS | 69.87 | -68.86 | | Thomas et al. 2010 |
| Braya Sø | lake | alkenones | 67.00 | -50.70 | 170 | D'andrea et al. 2011 |
| Flower Valley Lake | lake | dD | 65.61 | -37.69 | 73 | Balascio et al. 2013 |
| Hjort Lake | lake | chironomids | 76.43 | -18.77 | 114 | Schmidt et al. 2011 |
| Igaliku Lake | lake | pollen.flux | 61.00 | -45.43 | 30 | Massa et al. 2012 |
| Iglutalk Lake | lake | pollen | 66.14 | -66.08 | 90 | Kerwin et al. 2004; Davis 1980 |
| Jake Lake | lake | pollen | 63.67 | -65.15 | 300 | Kerwin et al. 2004; Miller et al. 2005 |

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|---|---|---|---|---|---|---|
| N14 | lake | BSi | 59.98 | -44.18 | 101 | Andresen et al. 2004 |
| NAUJG1-1 | lake | mineral.content | 66.67 | -51.97 | 300 | Willemse & Törnqvist 1999 |
| North Lake | lake | OM, BSi, chironomids | 69.24 | -50.03 | 190 | Axford et al. 2013 |
| Qipisarqo Lake | lake | pollen, BSi | 61.00 | -47.75 | 7 | Fréchette & de Vernal 2009; Kaplan et al. 2002 |
| SFL-1 | lake | OM | 67.08 | -50.28 | 247 | Willemse & Törnqvist 1999 |
| SP02 | lake | OM, MS | 68.55 | -83.29 | 220 | Adams & Finkelstein 2010 |
| SS1381 | lake | OM.flux, mineral.flux | 67.01 | -51.10 | 196 | Anderson et al. 2012 |
| SS16 | lake | diatoms | 66.91 | -50.46 | 477 | Perren et al. 2012 |
| SS49 | lake | diatoms | 66.86 | -52.64 | 330 | Perren et al. 2012 |
| SS8 | lake | mineral.flux, OM.flux | 67.01 | -51.07 | 188 | Anderson et al. 2012 |
| Arapisto | lake | pollen | 60.58 | 24.80 | 133 | Sarmaja-Korjonen & Seppä 2007 |
| Austerkjosen | lake | pollen | 68.53 | 17.27 | 135 | Seppä et al. 2009 |
| Berkut | lake | chironomids | 66.35 | 36.67 | 25 | Ilyashuk et al. 2005 |
| Bjørnfjelltjørn | lake | pollen | 68.43 | 18.07 | 510 | Seppä et al. 2009; Brooks 2006 |
| Brurskardstjørni | lake | chironomids | 61.42 | 8.67 | 1309 | Velle et al. 2005 |
| Chuna Lake | lake | d18O.diatoms, pollen | 67.95 | 32.48 | 475 | Jones et al. 2004; Solovieva et al. 2005 |
| Dalene | lake | pollen | 58.25 | 8.00 | 40 | Eide et al. 2006; Seppä et al. 2009 |
| Dalmutladdo | lake | pollen | 69.17 | 20.72 | 355 | Bjune et al. 2004 |
| Dravladalsvatn | lake | DBD | 60.03 | 6.07 | | Bakke et al. 2005 |
| Fiskebølvatnet | lake | mass.flux | 68.41 | 14.80 | 23 | Balascio & Bradley 2012 |
| Flarken | lake | pollen | 58.55 | 13.67 | 108 | Seppä et al. 2005 |

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|---|---|---|---|---|---|---|
| Flotatjønn | lake | pollen | 59.67 | 7.55 | 890 | Seppä et al. 2009 |
| Gammelheimvatnet | lake | pollen | 68.47 | 17.75 | 290 | Seppä et al. 2009 |
| Gilltjärnen | lake | chironomids, pollen | 60.08 | 15.83 | 172 | Antonsson et al. 2006 |
| Lilla Gloppsjön | lake | pollen | 59.83 | 16.53 | 198 | Seppä et al. 2009 |
| Grostjørna | lake | pollen | 58.53 | 7.73 | 180 | Eide et al. 2006; Seppä et al. 2009 |
| Over Gunnarsfjorden | lake | pollen | 71.04 | 28.17 | 78 | Allen et al. 2007 |
| Haugtjern | lake | pollen | 60.83 | 10.88 | 338 | Eide et al. 2006; Seppä et al. 2009 |
| Holebudalen | lake | pollen, chironomids | 59.83 | 6.98 | 1144 | Velle et al. 2005; Eide et al. 2006; Seppä et al. 2009 |
| Igelsjön | lake | d18O.calcite | 58.47 | 13.73 | 111 | Hammarlund et al. 2003 |
| Isbenttjønn | lake | pollen | 59.77 | 7.43 | 787 | Seppä et al. 2009 |
| Jarburvatnet | lake | OM,MS | 61.70 | 6.76 | 1001 | Nesje et al. 2001 |
| Kinnshaugen | lake | pollen | 62.02 | 10.37 | 591 | Seppä et al. 2009 |
| Austre Kjennsvatnet | lake | DBD | 66.00 | 14.26 | 527 | Bakke et al. 2010 |
| Klotjärnen | lake | pollen | 61.82 | 14.58 | 235 | Seppä et al. 2009 |
| KP-2 | lake | pollen | 68.80 | 35.32 | 131 | Seppä et al. 2008; Seppä et al. 2009 |
| Laihalampi | lake | pollen | 61.48 | 26.07 | 137 | Heikkilä & Seppä 2003 |
| 850 | lake | chironomids, diatoms, d18O.diatoms | 68.37 | 19.12 | 850 | Larouque & Bigler 2004; Shemesh et al. 2001 |
| Litlvatnet | lake | pollen | 68.52 | 14.87 | 106 | Seppä et al. 2009 |
| Myrvatnet | lake | pollen | 68.65 | 16.38 | 200 | Seppä et al. 2009 |
| Nattmålsvatn | lake | MS | 69.18 | 17.39 | 170 | Janbu et al. 2011 |
| Nautajärvi | lake | pollen | 61.80 | 24.70 | 104 | Ojala et al. 2008; Seppä et al. 2009 |

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|---|---|---|---|---|---|---|
| Nerfloen | lake | multi-proxy_PC_score | 61.93 | 6.87 | 938 | Vasskog et al. 2012 |
| Voulep Njakajaure | lake | diatoms | 68.33 | 18.78 | 409 | Bigler et al. 2006; Barnekow et al. 1998 |
| Njulla | lake | diatoms, chironomids | 68.37 | 18.70 | 999 | Bigler et al. 2003 |
| Vestre Økjamyrttjørn | lake | pollen, chironomids | 59.82 | 6.00 | 570 | Bjune et al. 2005; Velle et al. 2005 |
| Raigastvere | lake | pollen | 58.58 | 26.65 | 53 | Seppä & Poska 2004 |
| Råtasjøen | lake | chironomids | 62.27 | 9.83 | 1169 | Velle et al. 2005 |
| Reiarsdalvatnet | lake | pollen | 58.32 | 7.78 | 245 | Seppä et al. 2009 |
| Ruila | lake | pollen | 59.17 | 24.43 | 43 | Seppä & Poska 2004 |
| Saarikko | lake | d18O.cellulose | 62.25 | 27.67 | 98 | Heikkilä et al. 2010 |
| Sjuodjijaure | lake | pollen, chironomids, diatoms | 67.37 | 18.07 | 826 | Rosén et al. 2001 |
| Spåime | lake | chironomids, d18O.cellulose | 63.12 | 12.32 | 887 | Hammarlund et al. 2004; Velle et al. 2005 |
| Svanåvatnet | lake | pollen | 66.44 | 14.05 | 243 | Bjune & Birks 2008 |
| Svartkälstjärn | lake | d18O | 64.27 | 19.55 | 257 | St Amour et al. 2010 |
| Svartvatnet | lake | pollen | 63.35 | 9.55 | 183 | Seppä et al. 2009 |
| Tiåvatnet | lake | pollen | 63.05 | 9.42 | 464 | Seppä et al. 2009 |
| Tibetanus | lake | pollen, d18O | 68.33 | 18.70 | 560 | Hammarlund et al. 2002 |
| Toskaljavri | lake | pollen, chironomids | 69.20 | 21.47 | 704 | Seppä & Birks 2002; Seppä et al. 2002, 2009 |
| Trehörningen | lake | pollen | 58.55 | 11.60 | 112 | Antonsson & Seppä 2007 |
| Trettetjørn | lake | pollen | 60.72 | 7.00 | 810 | Bjune et al. 2005 |
| Tsuolbmajavri | lake | diatoms, chironomids, pollen | 68.41 | 22.05 | 526 | Korhola et al. 2000, 2002; Seppä & Birks 2001, Seppä et al. 2009 |
| Vikjordavatnet | lake | OM.flux | 68.23 | 14.06 | 23 | Balascio & Bradley |

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|---|---|---|---|---|---|---|
| | | | | | | 2012 |
| Vuoskkujavri | lake | chironomids, diatoms, pollen | 68.33 | 19.10 | 348 | Bigler et al. 2002 |
| Yarnishnoe | lake | pollen | 69.07 | 36.07 | 54 | Seppä et al. 2008 |
| Ennadai Lake | lake | pollen | 61.17 | -100.92 | 168 | Viau & Gajewski 2009; Bender et al. 1967 |
| JR01 | lake | pollen | 69.90 | -95.07 | 120 | Zabenskie & Gajewski 2007 |
| Lake K2 | lake | chironomids | 58.73 | -65.93 | 167 | Fallu et al. 2005 |
| KR02 | lake | BSi, pollen | 71.34 | -113.78 | 299 | Peros & Gajewski 2008 |
| LR01 | lake | pollen | 58.58 | -75.25 | 170 | Gajewski et al 1993 |
| Toronto Lake | lake | d18O.cellulose | 63.72 | -109.35 | 414 | Wolfe et al. 1996; MacDonald et al. 1993 |
| Unit Lake | lake | ARM/IRM | 59.40 | -97.49 | 294 | Camill et al. 2012 |
| Whatever Lake | lake | d18O.cellulose | 64.68 | -97.05 | | Wolfe et al. 1996; MacDonald et al. 1993 |
| Haukdalsvatn | lake | d13C.bulk, C/N, OM, MS, sed_flux | 65.03 | -21.37 | 32 | Geirsdottir et al. 2013; Larsen et al. 2012 |
| Hvitarvatn | lake | BSi, d13C.bulk, C/N, OM, DBD, sed_rate | 64.62 | -19.85 | 422 | Geirsdottir et al. 2013; Larsen et al. 2012 |
| Mjáuvötn | lake | XRF, d13C, TOC, N, C, S, MS | 62.12 | -7.00 | 200 | Olsen et al. 2010 |
| Starvatn | lake | flux_grains, BSi | 62.05 | -6.59 | 94 | Andresen et al. 2006 |
| Dolgoe Lake | lake | d18O.cellulose, pollen | 71.87 | 127.07 | | Wolfe et al. 2000 |
| Lake Kharinei | lake | pollen, chironomids | 67.36 | 62.75 | 108 | Jones et al. 2011; Salonen et al. 2011 |
| Lake Lyadhej-To | lake | chironomids | 68.25 | 65.79 | | Andreev et al. 2005 |
| Lake Sysy-Kyuele | lake | diatoms | 69.40 | 123.83 | 81 | Biskaborn et al. 2012 |
| Mt Logan | ice | d18O.ice | 60.58 | -140.50 | 5300 | Fisher et al. 2008 |

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|---|---|---|---|---|---|---|
| Agassiz | ice | d18O.ice, ice.melt | 80.70 | -73.10 | 1730 | Vinther et al. 2009 |
| Camp Century | ice | d18O.ice | 77.17 | -61.13 | 1890 | Vinther et al. 2009 |
| Devon Ice Cap | ice | d18O.ice | 75.32 | -82.50 | | Fisher et al. 1983 (updated by author) |
| Dye-3 | ice | d18O.ice | 65.18 | -43.82 | | Vinther et al. 2006 |
| GISP2 | ice | d18O.ice, d18O.ice | 72.58 | -38.46 | 3216 | Alley 2000 |
| GRIP | ice | d18O.ice | 72.01 | -37.63 | 3230 | Vinther et al. 2006 |
| NGRIP | ice | d18O.ice | 75.10 | -42.32 | 2917 | Vinther et al. 2006; NorthGRIP members 2004 |
| Penny Ice Cap | ice | d18O.ice, d18O.ice | 67.25 | -66.75 | 1900 | Fisher et al. 1998 |
| Renland | ice | d18O | 71.30 | -26.70 | 2350 | Vinther et al. 2009 |

## Dataset

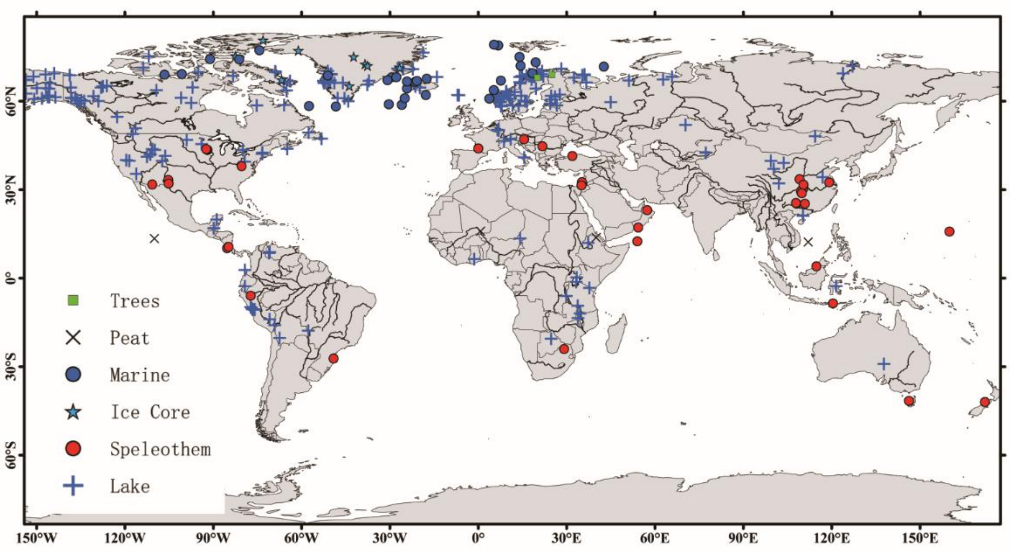



Fig 1. Location map of proxy precipitation datasets. Map of precipitation datasets from this study with precipitation proxy identified by color coding.

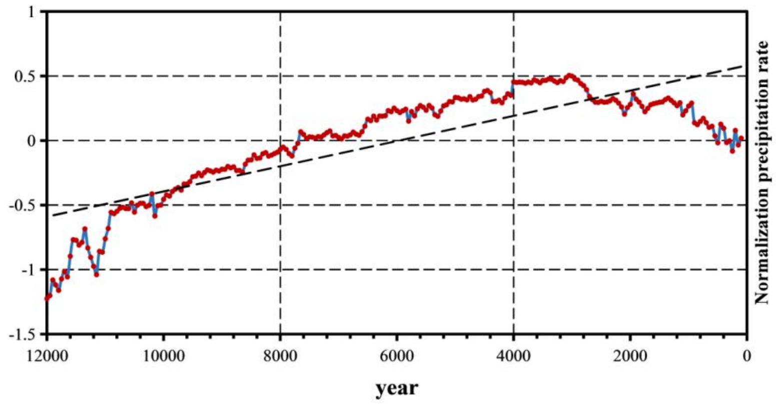



Fig 2. The blue line displays reconstructed precipitation by paleo-precipitation records, and the red solid point represents the precipitation that has been reconstructed after adding 100 white noises

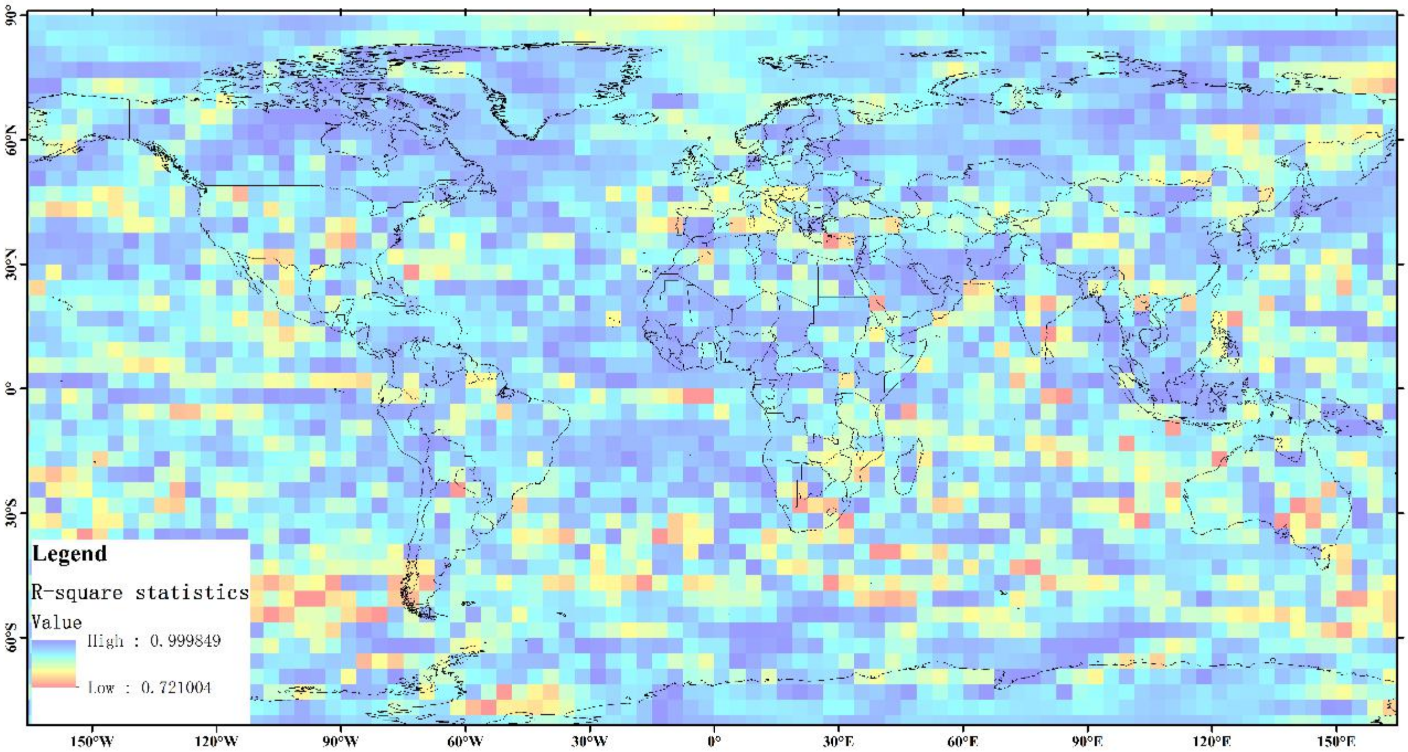
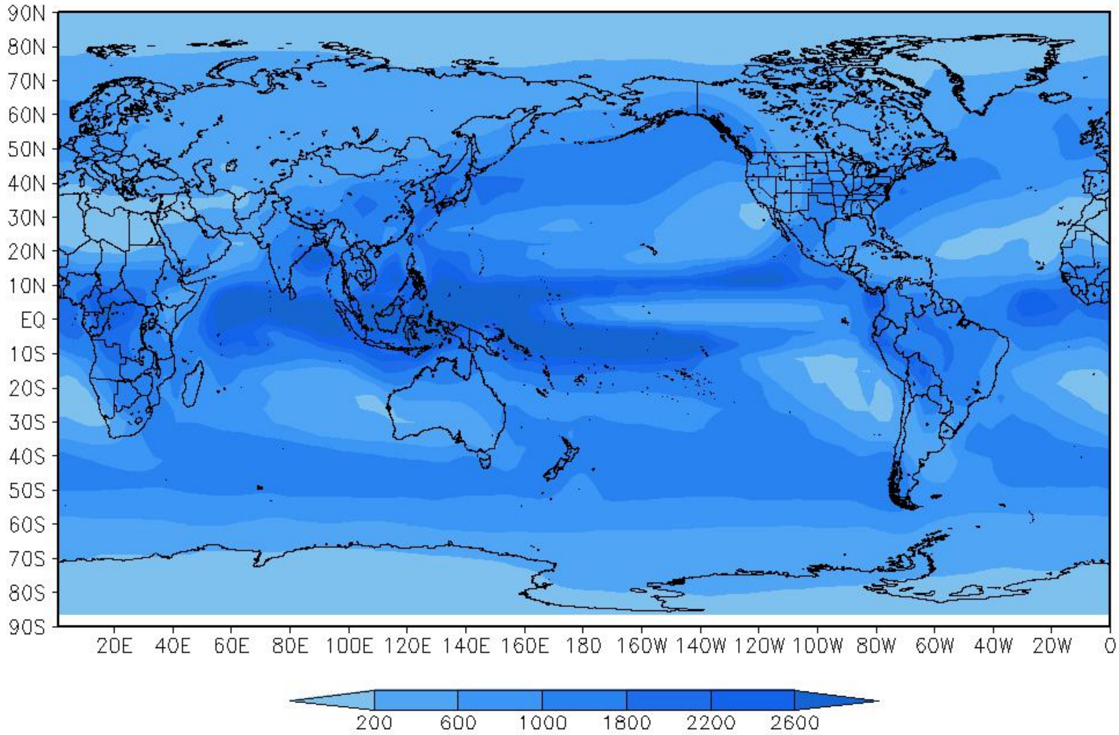



Fig 3. Spatial distribution of correlation coefficients between simulated precipitation and records over past 12000 years. For the purpose of exploring a systematic reconstruction of precipitation, deepening our understanding of the precipitation mechanism and grasping its role in the global hydrologic cycle, we collected 265 lake deposits, 38 cave sediments, 36 marine and 10 ice core data to reconstruct past precipitation, and the correlation coefficients for collection data and paleoclimate models (Trace) have distinctive signatures at 0.99 level.

Supplementary Information 1 List of data sets used in the global precipitation stack.

## Verification for data




Spatial distribution of paleo-precipitation reconstructions(TRACE models, mm per year)

To reconstruct relationships with simulated effects of known climatic forcing and records, we selected the TraCE-21ka transient climate-model simulations and records from the NOAA data center to establish regression equations. The TraCE-21ka transient climate-model simulation is a model derived from the full coupled oceanic atmospheric circulation model CCSM3. time-varying insolation, greenhouse gases, ice-sheet topography, land/ocean palaeogeography and meltwater fluxes to the ocean drive the TraCE-21ka transient climate-model simulations from 22, 000 yr BP to the present. (for more details, see http://www.cgd.ucar.edu/ccr/trace/). Model that establishes a global past-climate change framework for research community allows researchers insight into constraining climate sensitivity and understanding abrupt climate change, feather of the deglacial climate evolution in Greenland, Antarctica, the tropical Pacific, and the Southern and Deep Oceans (Supplementary Information 1). The TraCE simulation provides global $\delta^{18}O$ simulation data and precipitation simulation data, over the interval 22,000 yr BP to present. We use regression method to verify the good correlation between $\delta^{18}O$ simulation data and precipitation simulation data, and we prove that $\delta^{18}O$ value is a good indicator of precipitation variations. In the further research, we conduct the modified Multiple Regression Analyses to establish the equation between simulated precipitation data and records, and we bring records values into the equation to reconstruct Holocene precipitation.

The TraCE simulation spatial resolution is 3.75°×3.75°. In order to calculate the correlation between the record and The TraCE simulation, we need to interpolate each record. TraCE has a temporal resolution of 1000 yr BP. Thus, we interpolated the record data to a 1000 yr BP temporal precision that is good enough to reflect the temporal variability of the indicator values. The interpolation method uses the nearest interpolation method. The interpolation method first calculates the average value of the field of each interpolation point. We also attempt to use cubic spline interpolation and cubic polynomial interpolation to interpolate. The results show that the nearest point interpolation method reduces the deviation in climate - model simulations. The correlation coefficient and regression equation are calculated with the width of 1000 year data. The precipitation sequence is calculated the 3.75 °grid element for each climate reconstruction cell, including only land grid points. By taking the record with the highest correlation coefficient into the equation to fit the precipitation curve, the reconstructed results are interpolated to 50 yr BP temporal precision.

**Table 2. List of data sets used in the validation experiment.**

| Site Name | Core Name | Proxy | Latitude（°） | Longitude（°） | Resolution (yr) | Reference |
|---|---|---|---|---|---|---|
| Cave of the Bells | COB-01-02 | $\delta^{18}O$ | 31.75 | -110.75 | 50 | Wagner et al.,2010 |
| Botuver Cave | BT2 | $\delta^{18}O$ | -27.22 | -49.16 | 100 | Cruz et al.,2005;Wang et al.,2007 |
| Buca della Renella | RL4 | $\delta^{18}O$ | 44 | 0 | 56 | Drysdale et al.,2006 |
| Buckeye Creek Cave | BCC-002/BCC-004/BCC-006 | $\delta^{18}O$ | 37.976 | -80.4 | 15 | Springer et al.;2008;Hardt,B.et al.;2010 |
| Cold Air Cave | T7/T8 | $\delta^{18}O$ | -24.02 | 29.11 | 13 | Holmgren et al.,1999,2003 |
| Cold Water Cave | CWC-1s/CWC-2ss/CWC-3L | $\delta^{18}O$ | 43.47 | -91.97 | 17 | Denniston et al.,1999 |
| Dongge Cave | D4/DA | $\delta^{18}O$ | 25.28 | 108.08 | 5 | Dykoski et al.,2005;Yuan et al.,2004;Wang et al.,2005 |
| Fort Stanton | Fort Stanton | $\delta^{18}O$ | 33.3 | -105.3 | 33 | Asmerom et al.,2010 |
| Gunung Buda National Park | BA04/SCH02/SSC01 | $\delta^{18}O$ | 4.03 | 114.8 | 20 | Partin et al.,2007; |
| Heshang Cave | HS-4 | $\delta^{18}O$ | 30.45 | 110.416 | 8 | Hu et al.,2008 |
| Hoti Cave | H5 | $\delta^{18}O$ | 23.08 | 57.35 | 5 | Neff et al.,2001 |
| Hulu Cave | H82/MSD/PD/YT | $\delta^{18}O$ | 32.5 | 119.16 | 2 | Wang et al.,2001 |
| Jerusalem West Cave | AF12 | $\delta^{18}O$ | 31.783 | 35.15 | 517 | Frumkin et al.,1999 |
| Jiuxian Cave | C996-1/C996-2 | $\delta^{18}O$ | 33.5667 | 109.1 | 19 | Cai et al.,2010 |
| Katerloch Cave | K1/K3 | $\delta^{18}O$ | 47.0833 | 15.55 | 2 | Boch et al.,2009 |
| Liang Luar Cave | LR06-B1/LR06-B3 | $\delta^{18}O$ | -8.533 | 120.433 | 10 | Griffiths et al.,2009 |
| Lianhua Cave | A1 | $\delta^{18}O$ | 29.483 | 109.533 | 8 | Cosford et al.,2009 |
| Lynds Cave | Lynds Cave Core 001 | $\delta^{18}O$ | -41.58 | 146.25 | 73 | Xia et al.,2001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ma'ale Efrayim Cave | Ma'ale Efrayim Cave Core 001 | $\delta^{18}O$ | 32.08 | 35.37 | 371 | Vaks et al.,2003 |
| Moomi Cave | M1-5 | $\delta^{18}O$ | 12.5 | 54 | 22 | Shakun et al.,2007 |
| Mystery Cave | MC-28 | $\delta^{18}O$ | 43.62 | -92.3 | 70 | Denniston et al.,1999 |
| NWSI north-west of the South Island | nz-comp-001 | $\delta^{18}O$ | -42 | 172 | 36 | Williams et al.,2010 |
| Peqiin Cave | Peqiin Cave Core 001 | $\delta^{18}O$ | 32.58 | 35.19 | 469 | Bar-Matthews et al.,2003 |
| Pink Panther Cave | PP-1 | $\delta^{18}O$ | 32.083 | -105.1667 | 18 | Asmerom et al.,2007 |
| Poleva Cave | PP10 | $\delta^{18}O$ | 44.72 | 21.75 | 77 | Constantin et al.,2007 |
| Qunf Cave | Q5 | $\delta^{18}O$ | 17.17 | 54.3 | 7 | Fleitmann et al.,2007 |
| Sanbao Cave | SB10/SB26/SB27/SB3/SB43/SB44/SB49 | $\delta^{18}O$ | 31.667 | 110.433 | 13 | Wang et al.,2008;Dong et al.,2010 |
| Sofular Cave | So-1 | $\delta^{18}O$ | 41.416 | 31.934 | 7 | Fleitmann et al.,2009 |
| Soreq Cave | Soreq Cave Core 001 | $\delta^{18}O$ | 31.45 | 35.03 | 75 | Bar-Matthews et al.,2003 |
| Spring Valley Caverns | SVC-1/2 | $\delta^{18}O$ | 43.75 | -92.41 | 27 | Denniston et al.,1999 |
| Terciopelo Cave | CT-7 | $\delta^{18}O$ | 10.1667 | -85.3333 | 4 | Lachniet et al.,2009 |
| Cueva del Tigre Perdido | NC-A/B | $\delta^{18}O$ | -5.940556 | -77.308056 | 23 | Breukelen et al.,2008 |
| Venado Cave | Venado Cave Core 001 | $\delta^{18}O$ | 10.6 | -84.8 | 15 | Lachniet et al.,2004 |
| Xiangshui Cave | X3 | $\delta^{18}O$ | 25.25 | 110.916 | 69 | Cosford et al.,2008 |
| Yamen Cave | Y1 | $\delta^{18}O$ | 25.4833 | 107.9 | 9 | Yang et al.,2010 |
| Yaoba Don Cave | YB1 | $\delta^{18}O$ | 28.8 | 109.833 | 128 | Cosford et al.,2008 |
| Aral sea | | | 59.69106 | 44.97806 | | Kvasov,et al.,1975 |
| Bear lake | | $\delta^{13}C$,$\delta^{18}O$,TC,TIC,OC, $CaCO_3$,Ca,Mg,B,Ba,Fe, K,Li,Mn,Na,P,Sr,Ti | -111.33333 | 42.00000 | | Engleman et al.,1985 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Chad Lake | | | 14.18955 | 13.46975 | | Bouchette et al.,2010 |
| Eyre Lake | | | 137.70725 | -29.07128 | | Magee et al.,2004 |
| Great Salt Lake | USGS 96,95 | Bulk organics,Humic acid from organic materials,Charcoal | -112.52100 | 41.19730 | 200 | Charles et al.2015 |
| Huguangyan Maar lake | | Ti,Fe,Mn,Magn. susc. ,S,TOC,bio.-SiO2 | 110.28333 | 21.15000 | | Yancheva et al.,2007 |
| Laguna Yanacocha | | Si,S,K,Ca,Ti,Mn,Fe,Zn, Rb,Sr,Zr | -75.93030 | -10.55980 | 4 | Nathan et al.,2015 |
| Lake Chichancanab | | $\delta^{13}C$, $\delta^{18}O$,CaCO3,S | -88.81922 | 19.87337 | 22 | Hodell et al.,1995 |
| Lake Issyk-Kul | IK97 | $\delta^{13}C$,$\delta^{18}O$,Sr/Ca | 77.25327 | 42.46046 | 194 | Ricketts et al.,2001 |
| Lake Malawi | M98-1P/M98-1P | BSi,LSR,MAR, BSi MAR. | 33.83546 | -13.52358 | 19 | Johnson et al.,2002 |
| Lake Qinghai | | brightness,%redness | 100.30290 | 37.05790 | 32 | Ji et al.,2005 |
| Lake Tanganyika | | dD,$\delta^{13}C$,TEX86 | 29.83262 | -6.08037 | 185 | Tierney et al.,2008 |
| Lake Titicaca | Titicaca2014dD-LT01-2B | dD | -69.16010 | -15.93680 | 266 | Kyrstin et al.,2014 |
| Lake Towuti | TOW9 | Al, Mg, K, Ti,Fe, Cr, Co, V, U | 121.51596 | -2.73284 | 624 | Costa et al.,2015 |
| Makgadikgadi Basin | Kal98 | U,Th,K | 24.69518 | -20.51031 | | Shaw et al.2003 |
| Victoria lake | LV95-1P | TEX86, Leaf Wax,dD ,$\delta^{13}C$ | 33.19830 | -1.23170 | 209 | Melissa et al.,2012 |

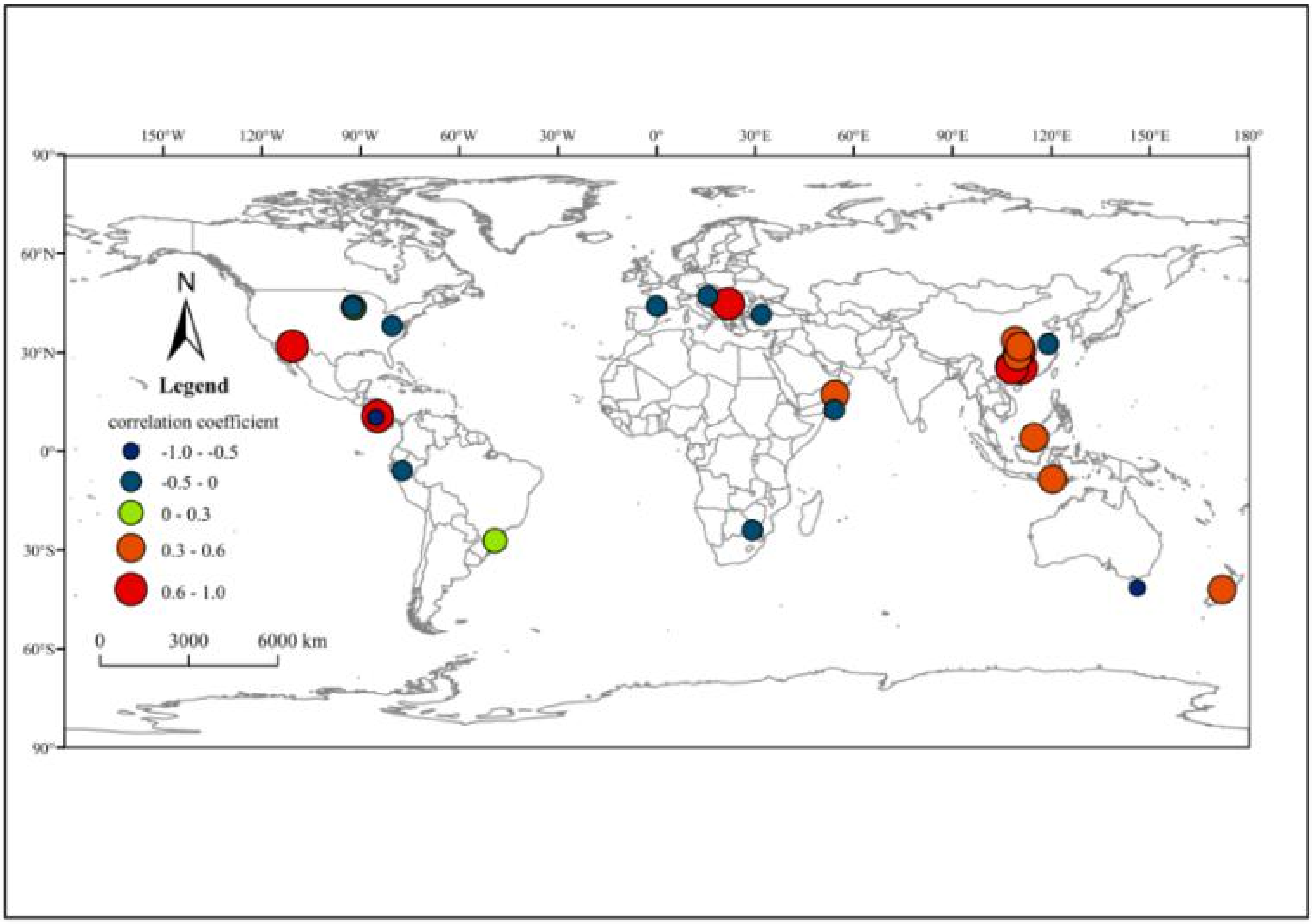



Fig 4. (**a**) Spatial distribution of regression coefficient of determination (R-square statistics) between speleothem records and paleoclimate simulated local precipitation, different color and the size of circle represent the change of R-square statistics. Although there are a lot of quantitative temperature reconstructions, these methods wasn't employed to reconstruct precipitation. Therefore, it is doubtful that the method can be used for precipitation reconstruction. Moreover, changes in lake level and $\delta^{18}O$ values in cave sediments are often used to reconstruct regional precipitation, but whether these indicators could be used to reconstruct precipitation

on a large scale remains unclear. In order to verify lake level changes in lake deposits and $\delta^{18}O$ values of cave sediments can be used to reconstruct precipitation and test the reliability of precipitation reconstruction methods. Based on the modified Point - to - Point Regression Method, we selected the lake sediments and cave sediment oxygen isotopes which represent typical climate characters of each continent to reconstruct the precipitation.

The oxygen isotope records, simulated oxygen isotopes, lake level changes records, simulated lake level changes, and simulated precipitation datasets were chosen to determine whether these indicators could be used to reconstruct precipitation, and the correlation coefficients among them have been detected.

Supplementary figure. 4(a) and 4(b) show that speleothem records strongly correlate with simulated local precipitation and $\delta^{18}O$ values, respectively. Areas with a correlation of more than 0.2 have basically passed the hypothesis test.

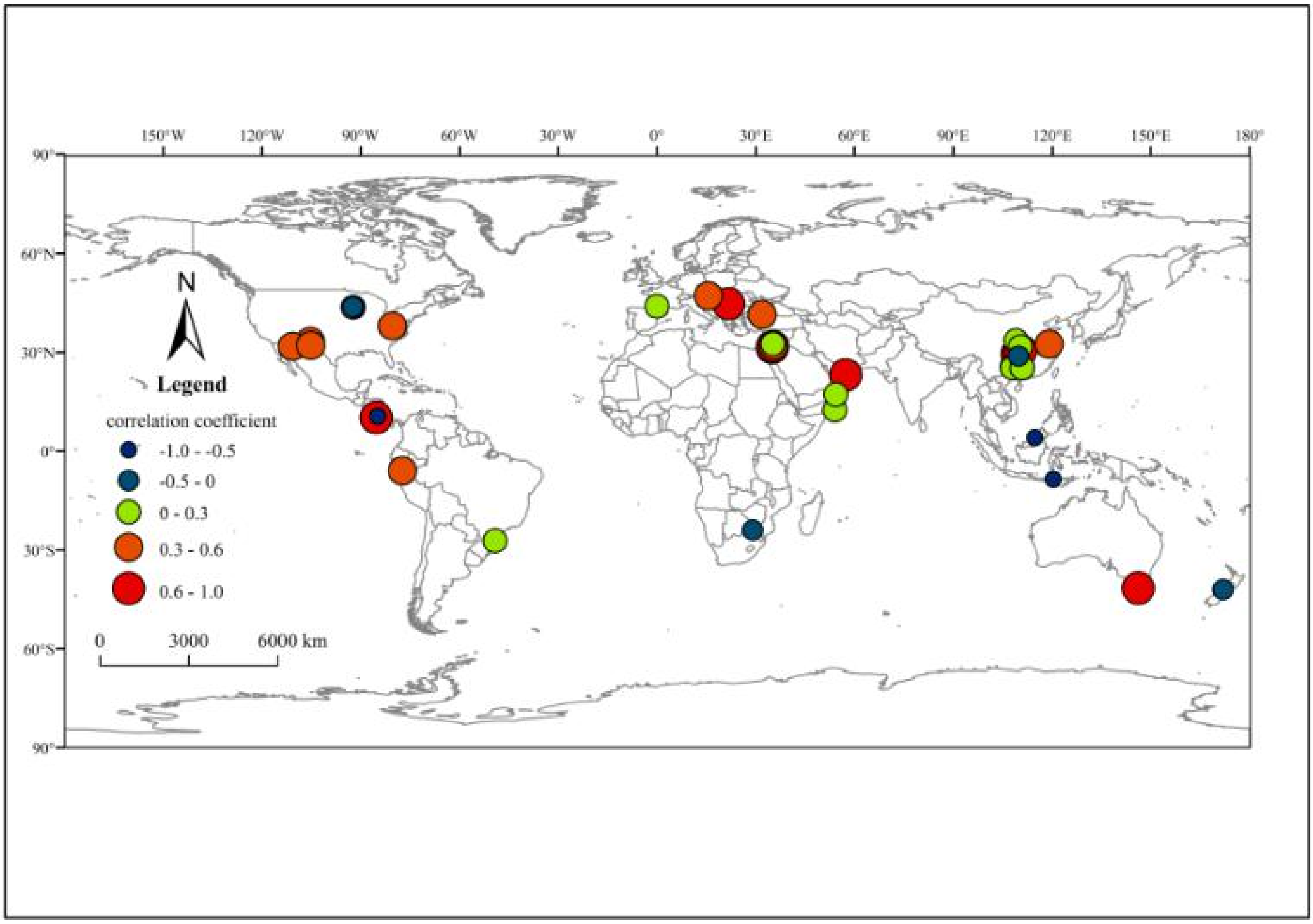



Fig 4. (**b**) Spatial distribution of regression coefficient of determination (R-square statistics) between speleothem records and simulation $\delta^{18}O$, different color and the size of circle represent the change of R-square statistics.

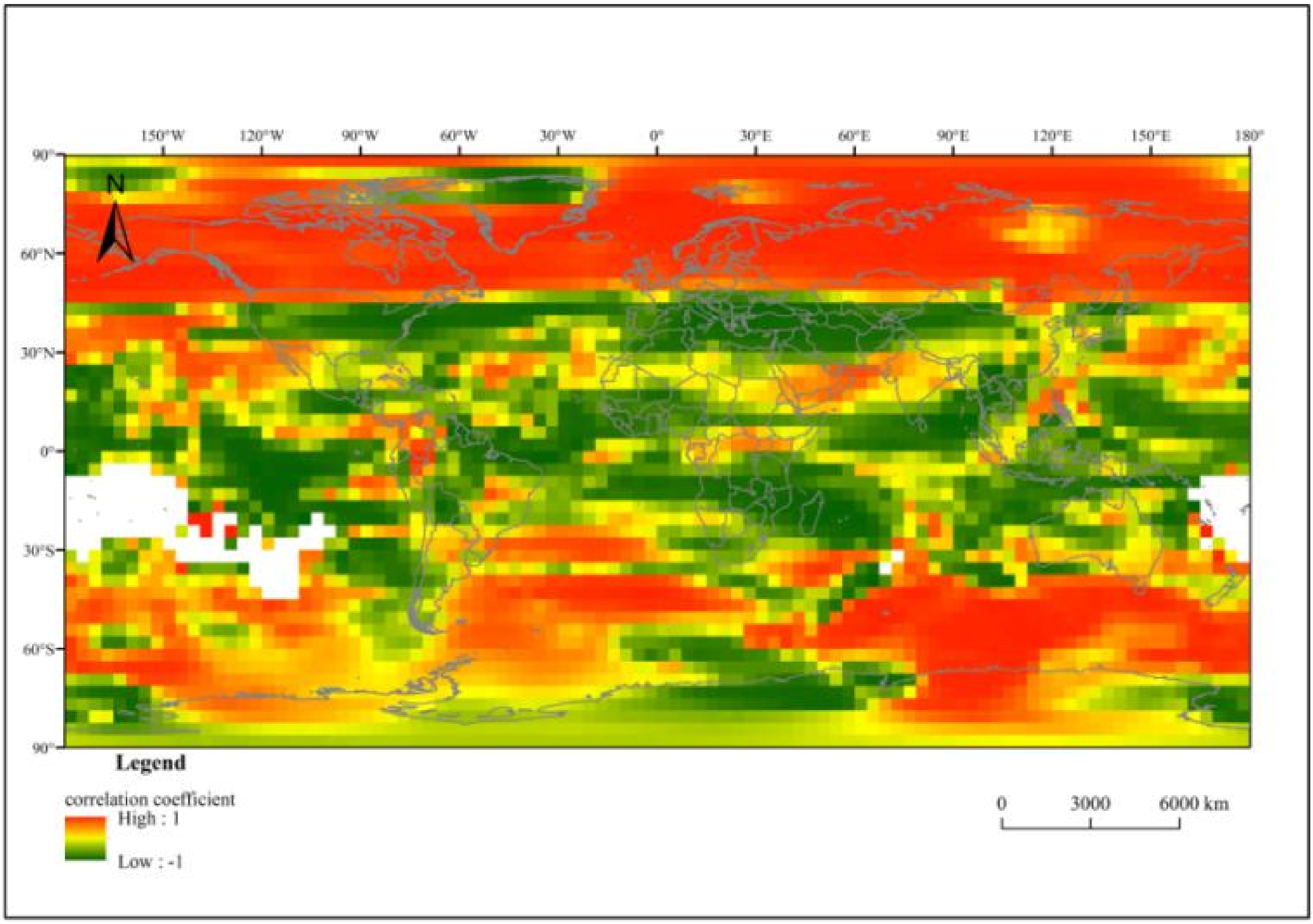



Fig 4. (**c**) Coefficient of Determination (R-square statistics) between simulated precipitation and simulated $\delta^{18}O$ on each grid. In the figure, the green denotes the region whose correlation coefficient is greater than 0.95, and red indicates the area with correlation coefficient less than -0.95. The result displays that most of the areas are highly correlated at ±0.95 level. The results of the correlation coefficient show that variations of $\delta^{18}O$ well indicate the precipitation in the global range. The same steps have been done using lake sediments, and the highly correlated results are shown in Supplementary figure 5.

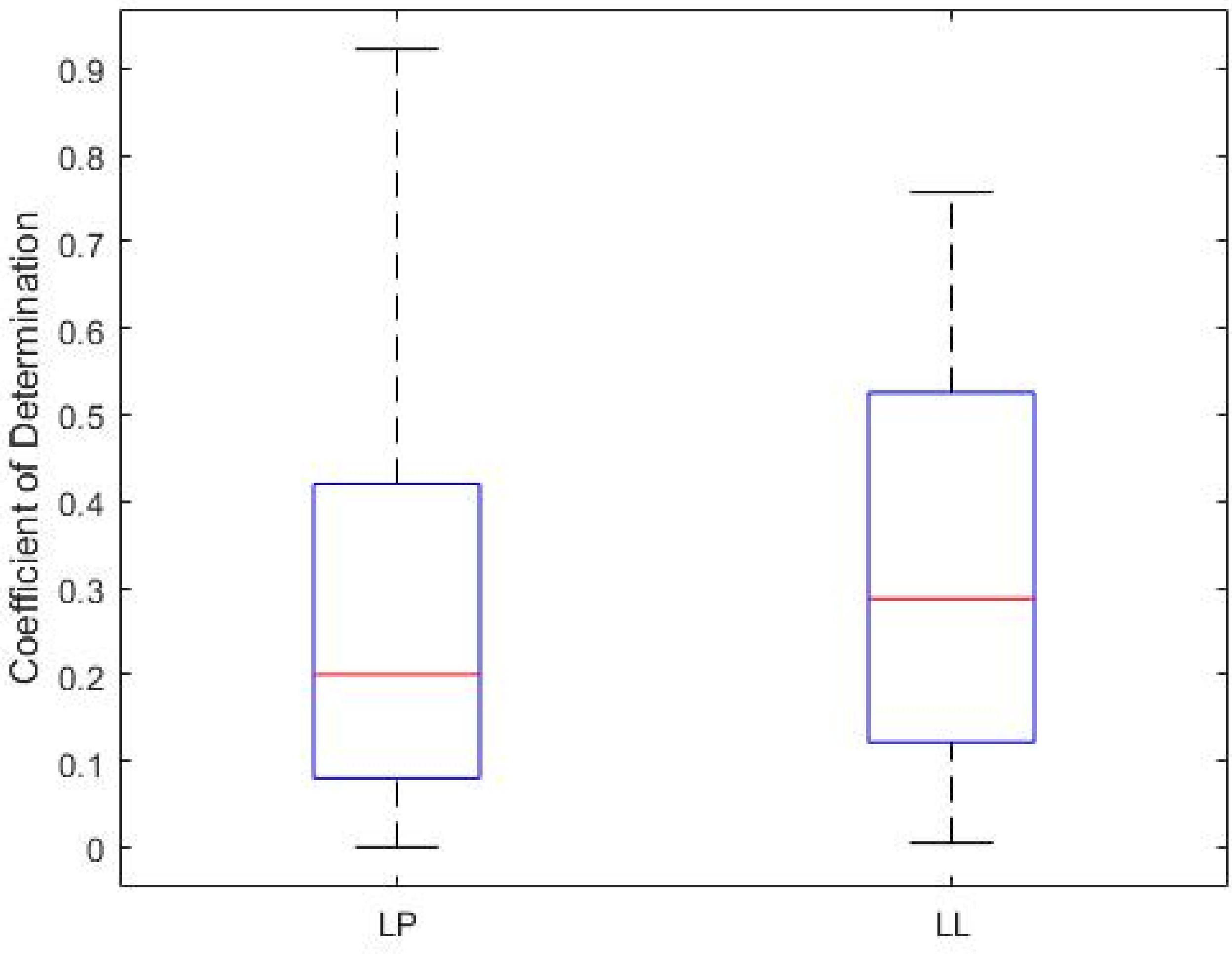



Fig 4. (**d**) Y axis represents the Coefficient of Determination (R-square statistics), X axis represents that the lake deposits regress with paleoclimate simulated local precipitation (LP) or simulated lake level variation (LL), respectively. Lake stable isotope, organic and inorganic indicators were interpolated to 1000-years resolution using cubic spline interpolation. The median $R^2$ value that lake deposits regress with simulated precipitation values is 0.20, and the mean value is 0.27. The median $R^2$ value that lake deposits regress with simulated lake level changes is 0.28, and the mean value is 0.32.

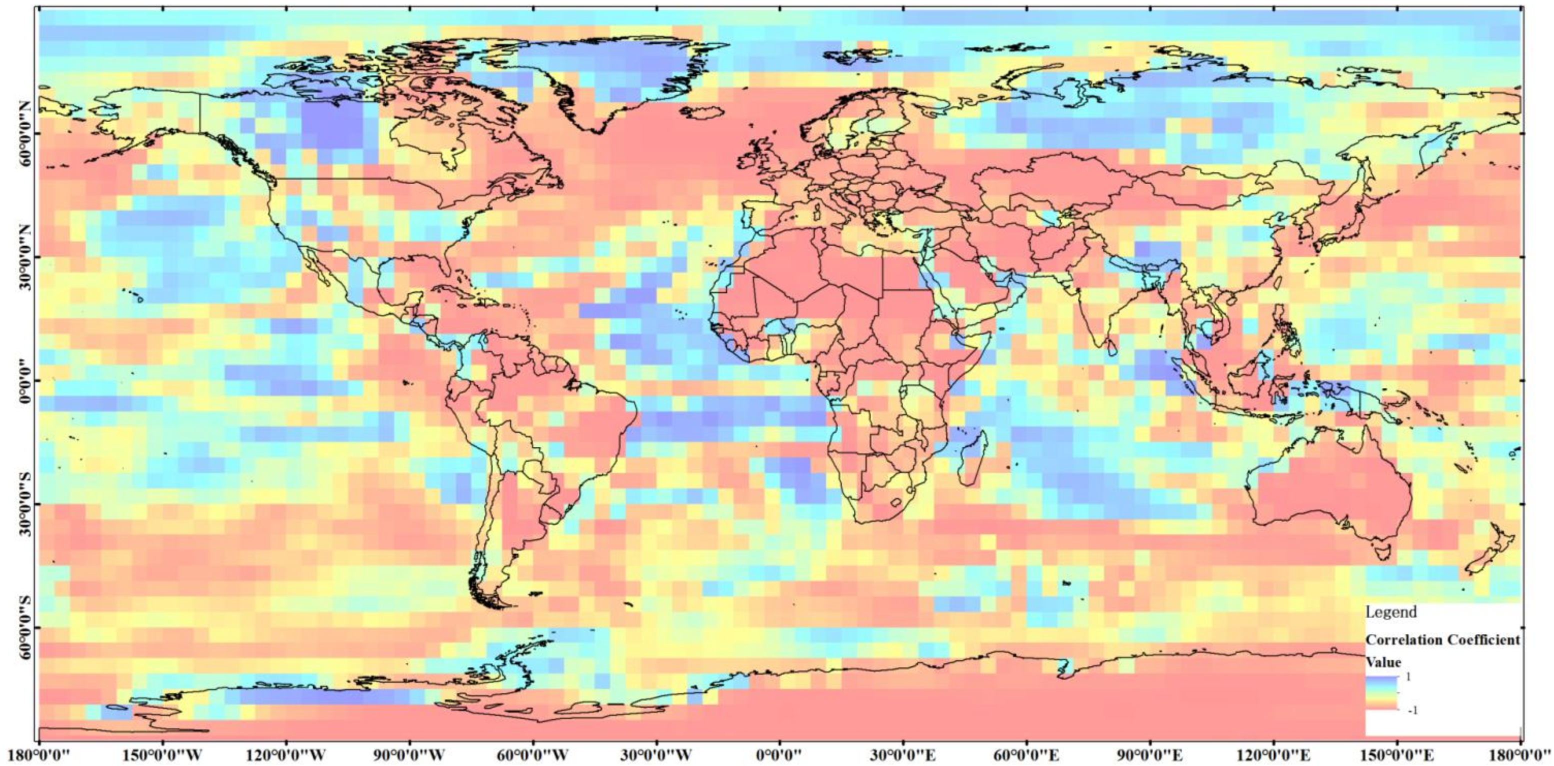



Fig 5. Spatial distribution of Correlation coefficients between simulated precipitation and simulated lake level change of past 12000 years. It is generally believed that precipitation, evaporation and water vapor transport can affect lake water level. In order to prove that lake water level changes can be used to reconstruct precipitation, we use the 1000-year-resolution simulated precipitation to regress with lake level changes (dataset) in the past 12000 years (available from http://www.ngdc.noaa.gov/paleo/lakelevel.html). Regression results show that there is an obvious relationship between the lake level change and precipitation. Africa, South America, Australia and Central Asia are highly negative related to precipitation, while Siberia and north polar regions are highly positive relevant. Our result illustrates that lake water level can be used to reconstruct precipitation.

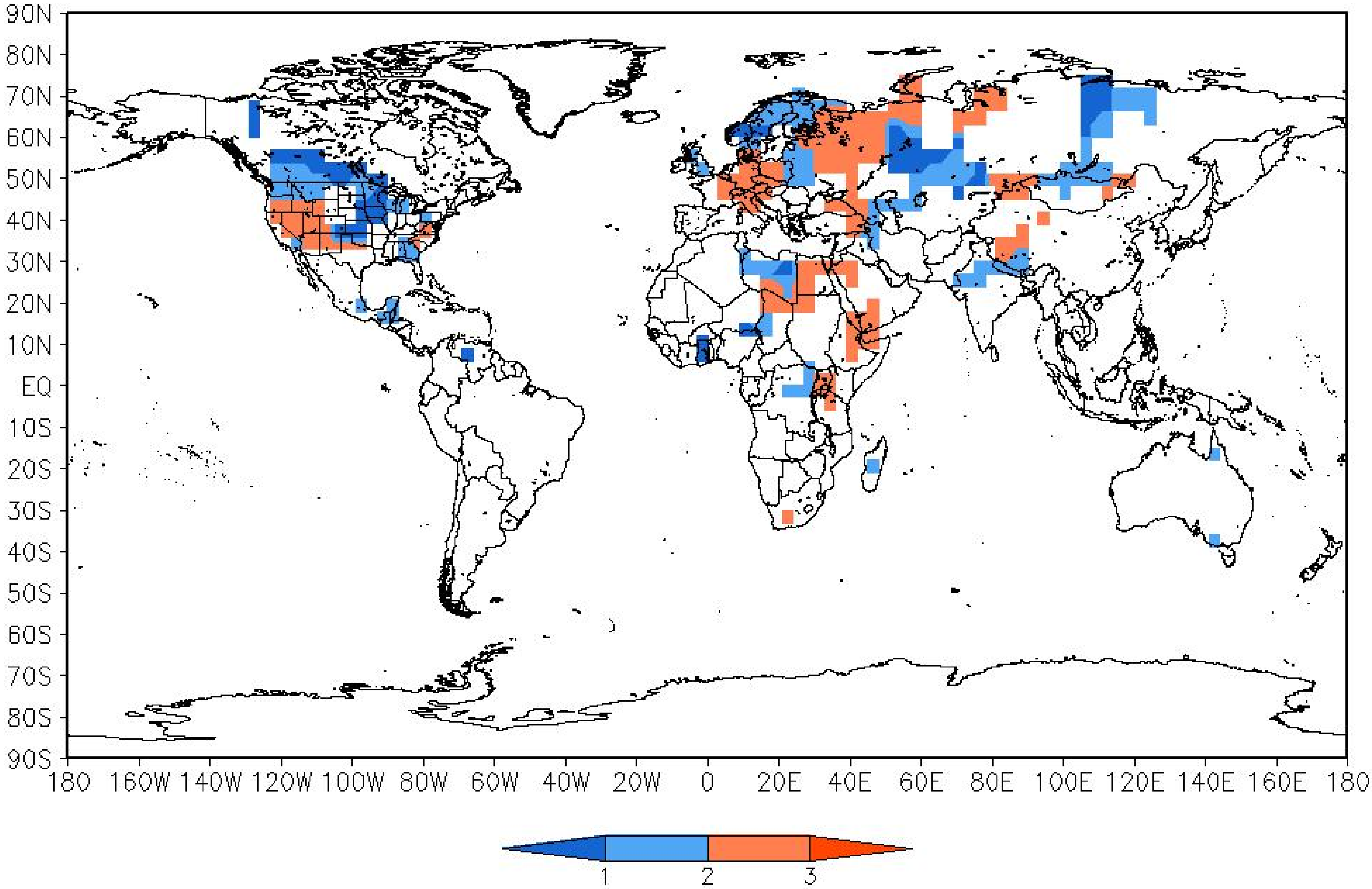



Fig 6. (**a**) The Holocene lake status estimates by indicator kriging method about 3 ka (available from http://www.ngdc.noaa.gov/paleo/lakelevel.html).

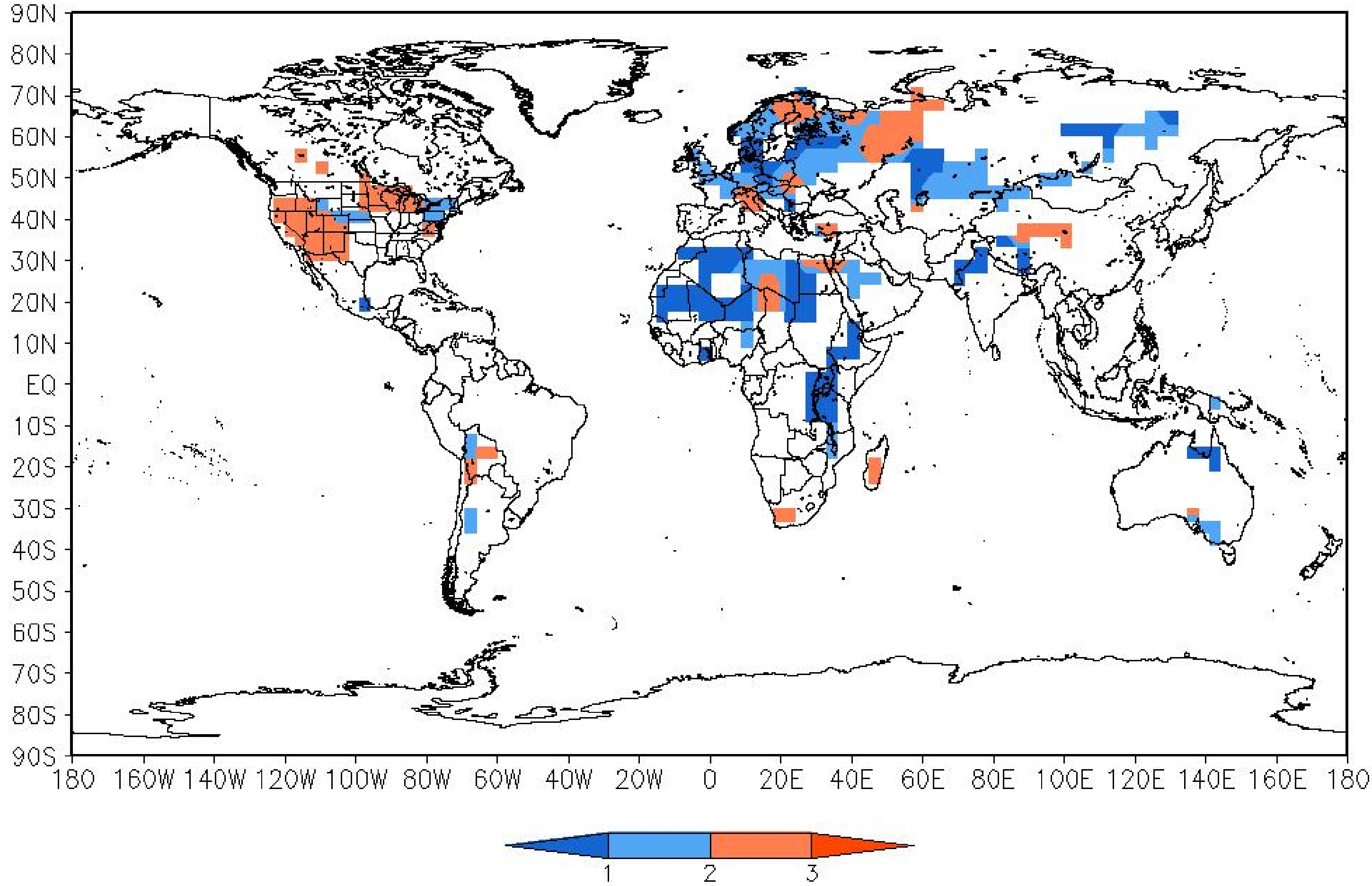



Fig 6. (**b**) The Holocene lake status estimates by indicator kriging method about 6 ka (available from http://www.ngdc.noaa.gov/paleo/lakelevel.html).

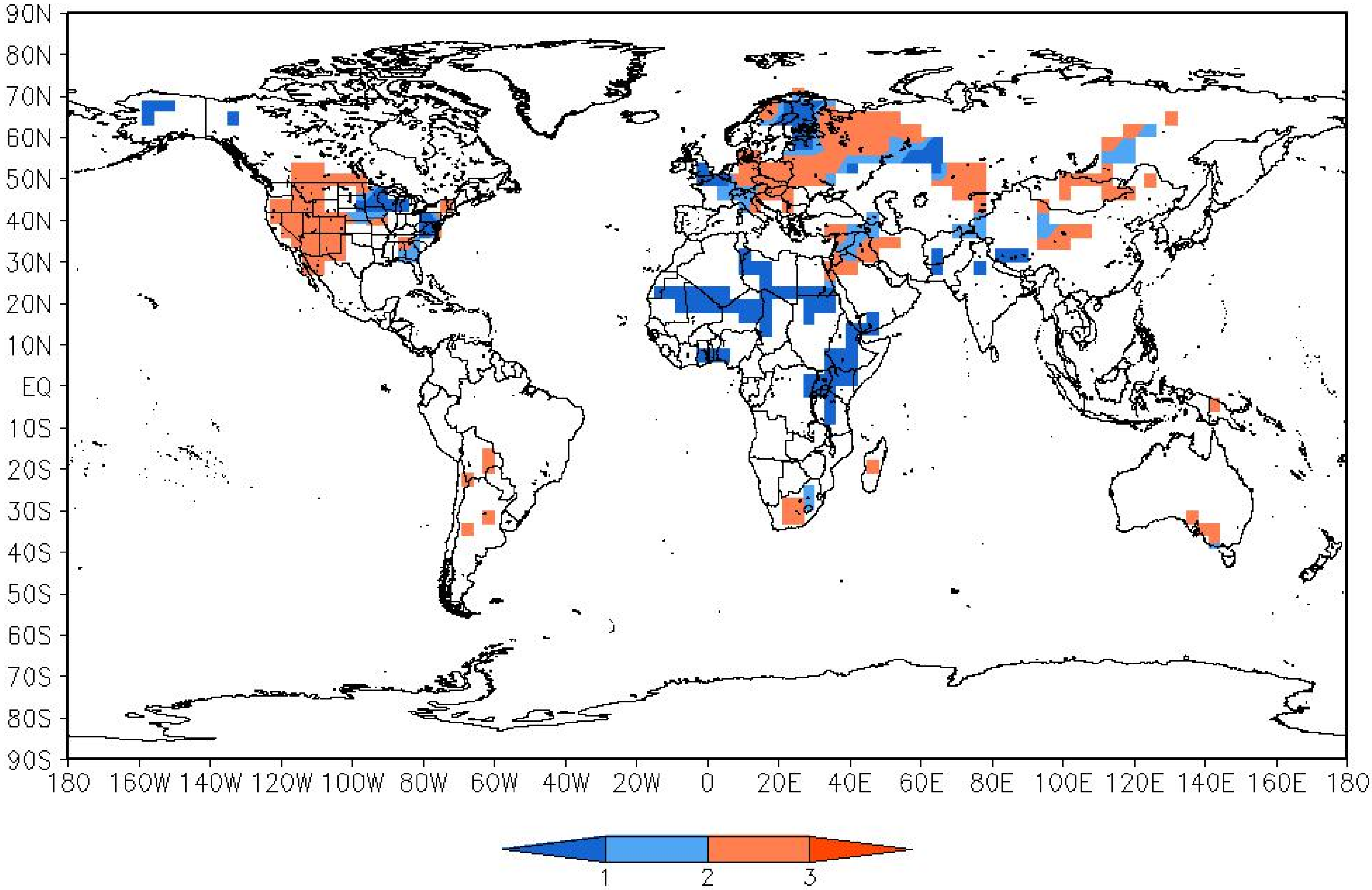



Fig 6. (**c**) The Holocene lake status estimates by indicator kriging method about 9 ka (available from http://www.ngdc.noaa.gov/paleo/lakelevel.html).

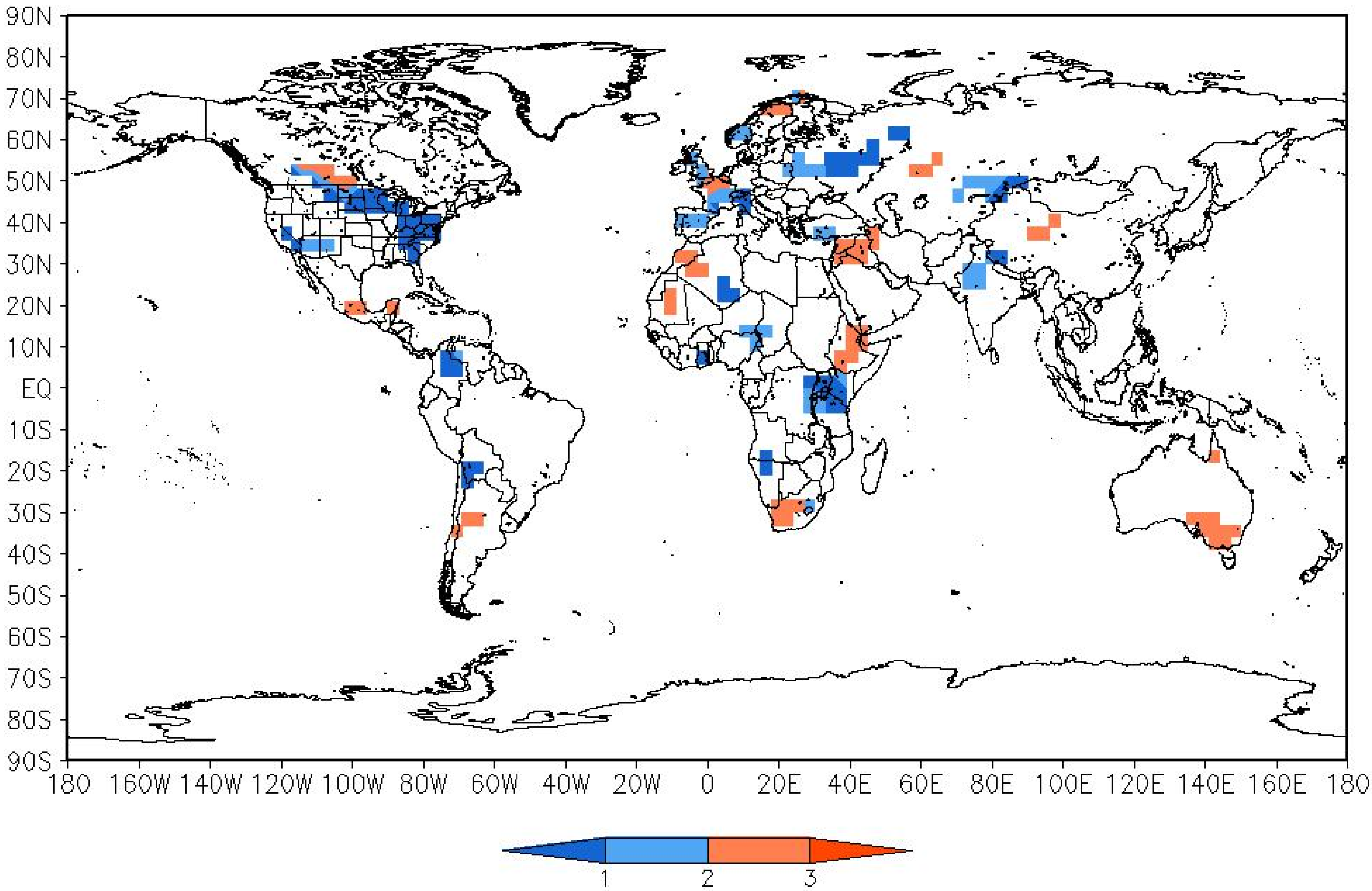



Fig 6. (**d**) The Holocene lake status estimates by indicator kriging method about 12 ka (available from http://www.ngdc.noaa.gov/paleo/lakelevel.html).

**The reconstruction results of 53 records**

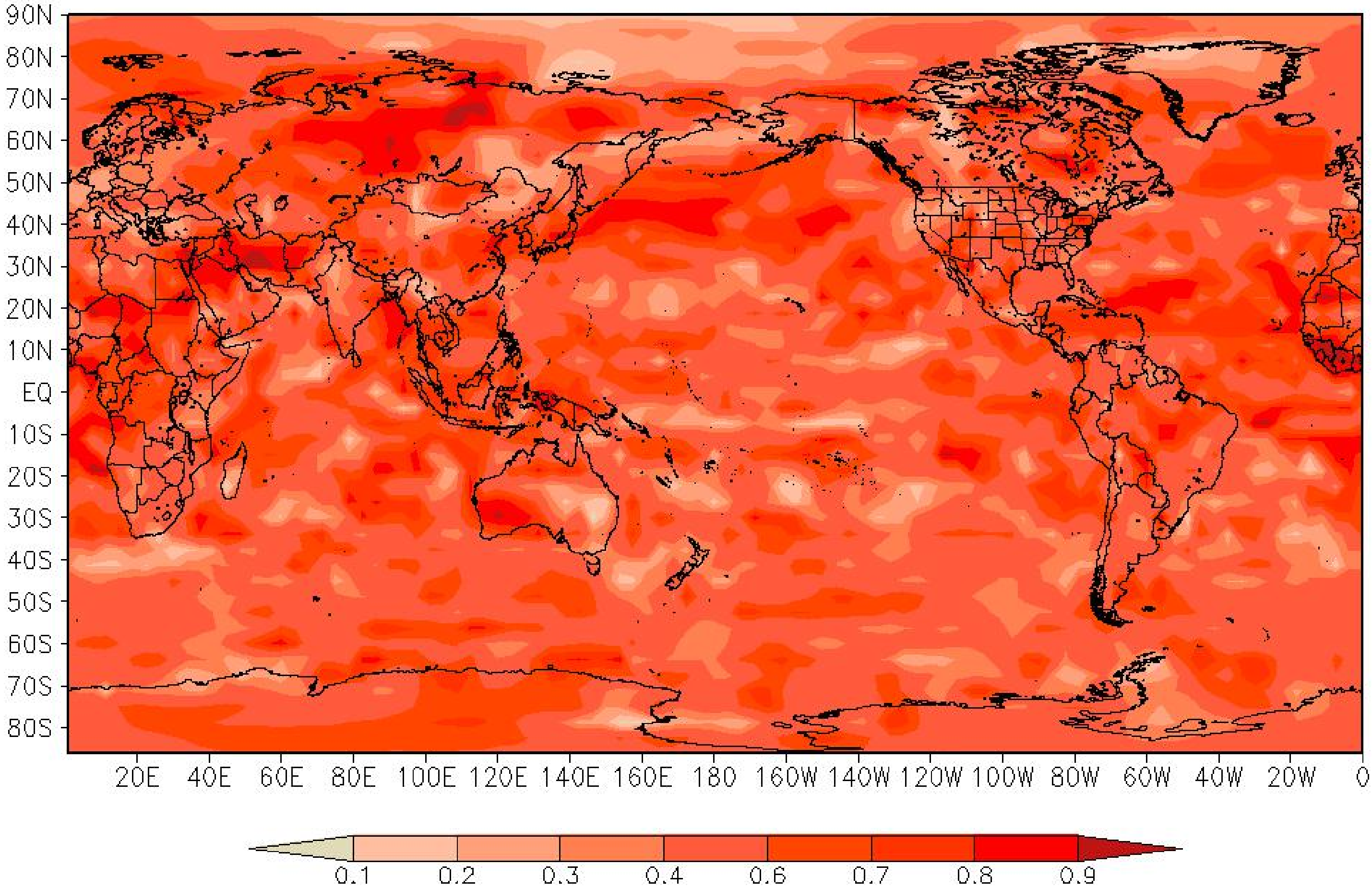



Fig 7. (**a**) Spatial distribution Coefficient of Determination (R-square statistics) of reconstruction results between lake deposits and simulated precipitation.

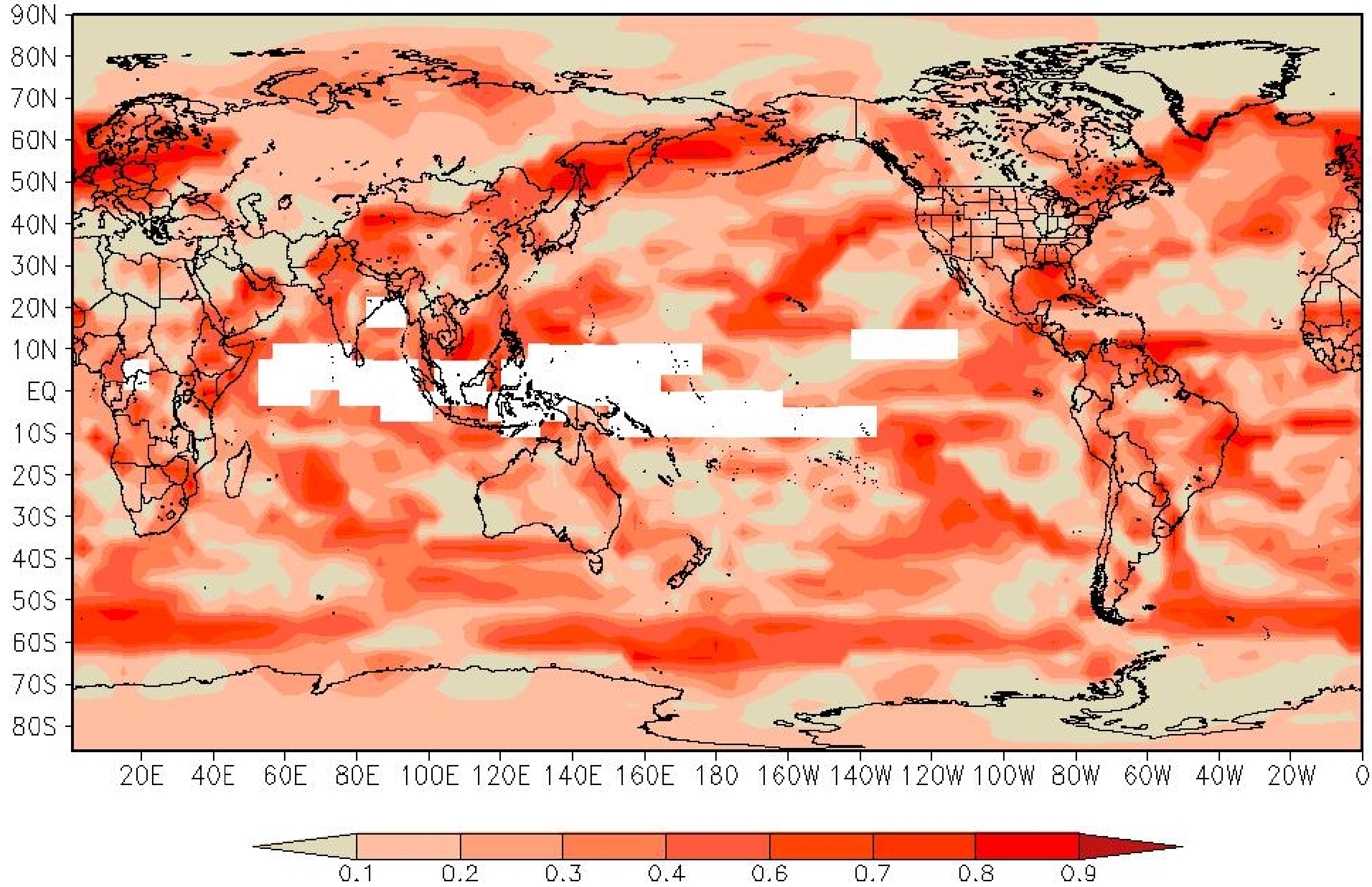



Fig 7. (**b**) Spatial distribution Coefficient of Determination (R-square statistics) of reconstruction result between cave records and simulated precipitation.

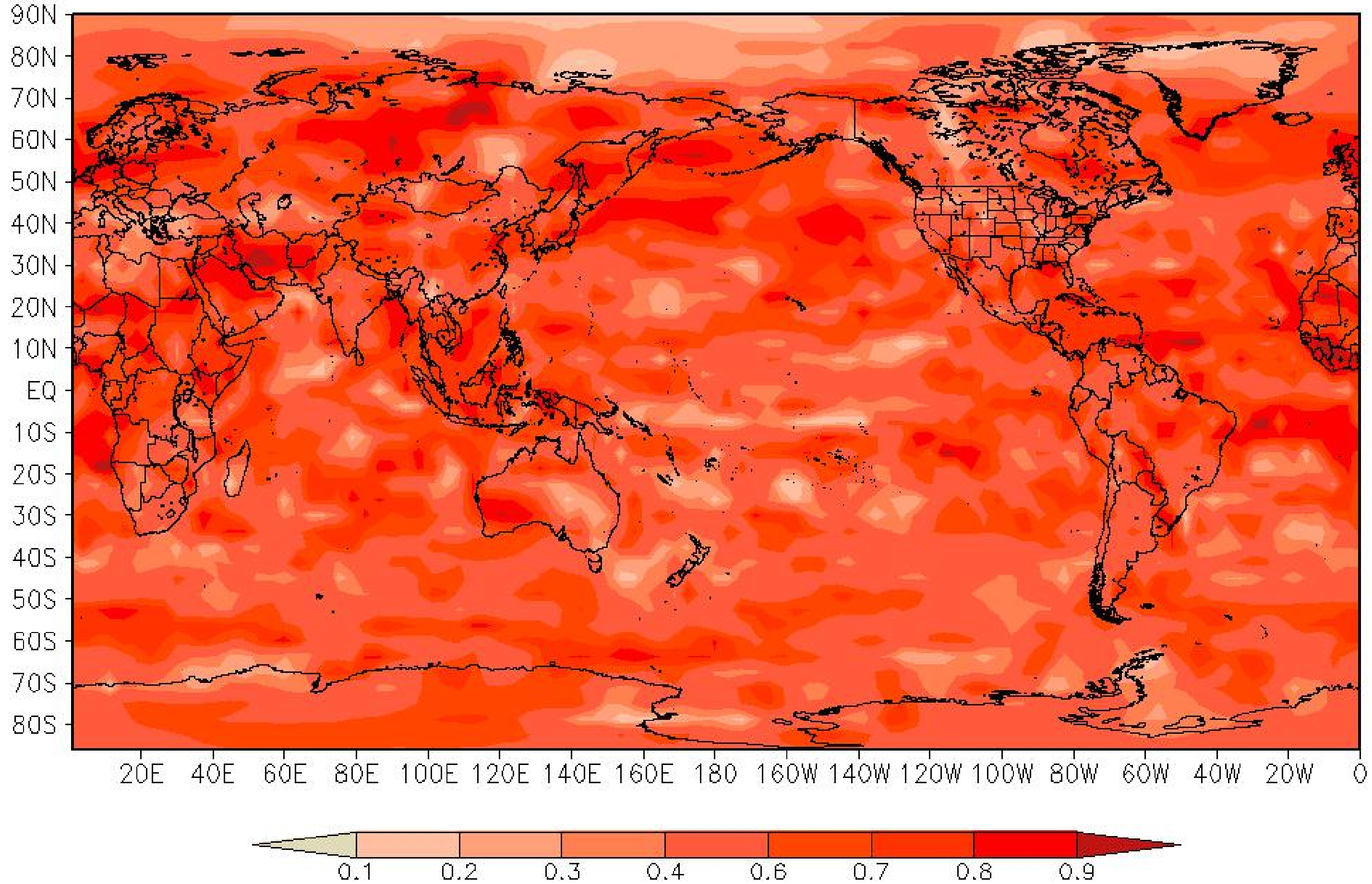



Fig 7. (**c**) Spatial distribution Coefficient of Determination (R-square statistics) of reconstruction result. Integrating lake and cave records regress with simulated precipitation to reconstruct the past precipitation. On one hand, these results suggest the reliability of precipitation reconstruction (Supplementary Information figure 7). For another, the results of the correlation coefficient show that variations of lake levels well indicate the precipitation on the global scale (Supplementary Information

figure 7 (a)), while the cave sediment has a good correlation with the precipitation in the monsoon region (Supplementary Information figure 7 (c)). These data are consistent with the hypothesis that $\delta\ ^{18}O$ values of monsoon region have a good correlation with monsoon precipitation. Thus, we have evidence that the geochemical indicators can be used to represent the past precipitation change.

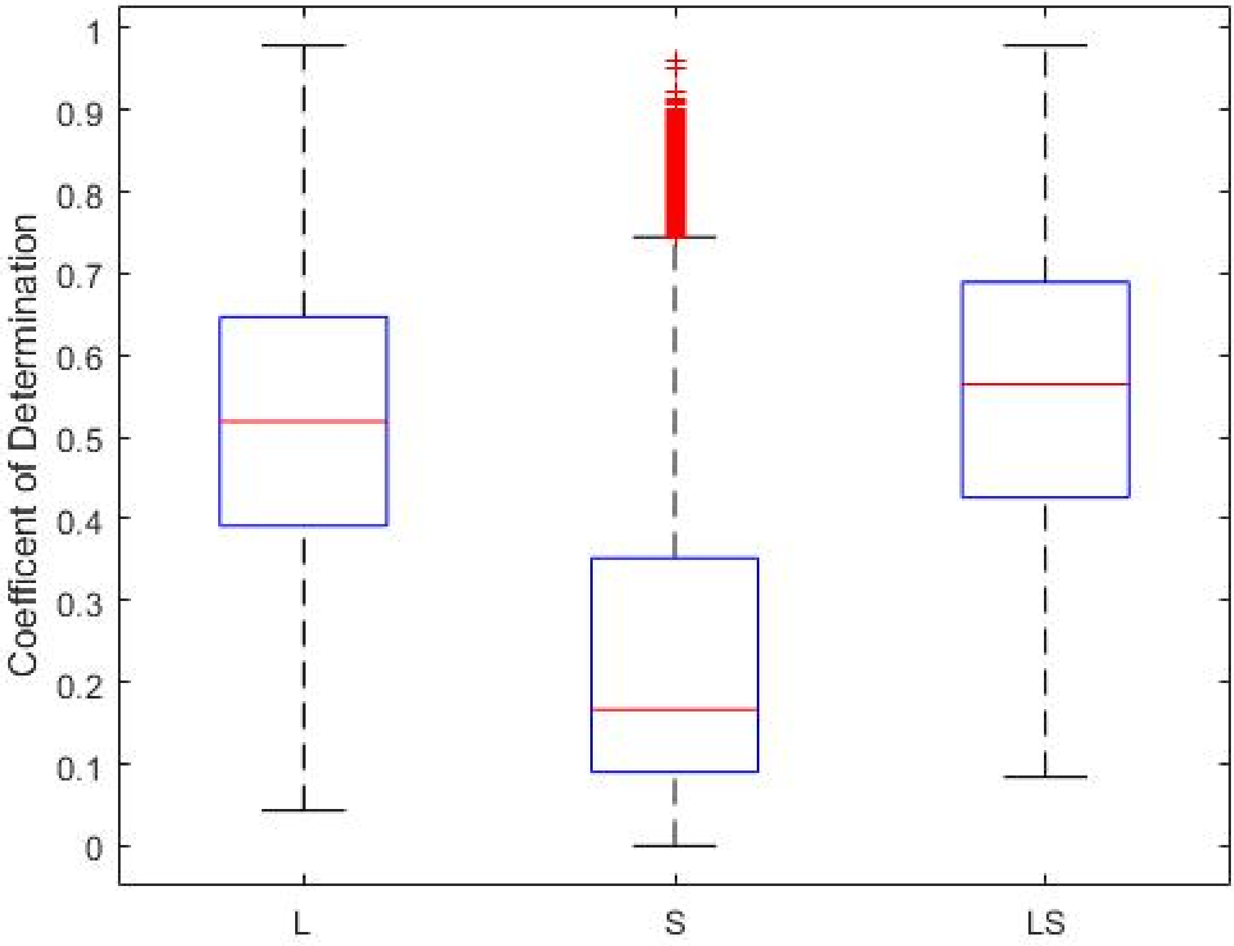



Fig 7. (**d**) boxplot indicates the correlation center of data distribution, X axis displays that indicator type regresses with paleoclimate simulated precipitation: L(lake), S (speleothem) and LS (integrating speleothem and lake record)