**S1. Approach of isolating individual contributions to PET (Fu and Feng, 2014)**

We define  and . The subscripts “0” and “1” represent the mean values for the preindustrial period and the mid-Holocene, respectively. The change in a variable x from the preindustrial period to the mid-Holocene is denoted by . Then the change in PET using equation (1) can be written in the form:



From this equation (note that the change in wind speed is small), we can isolate the effect of temperature change as the PET using *T*mean in the mid-Holocene but RH, *U*, and AE from the preindustrial period minus the PET using all the inputs from the preindustrial period. The effects of the changes in RH, AE or *U* are estimated by subtracting PET calculated using RH, AE or *U* in the preindustrial period but other inputs for the mid-Holocene from that using the inputs from the mid-Holocene.

Table S1. Records documenting aridity changes between the mid-Holocene and the present day for South Asia, South America, Australia and southern Africa. Latitude and longitude are expressed by the standard convention, with + for °N or °E, and − for °S or °W, respectively. N/A denotes not available.

Methods: A = sediment; B = pollen or plant microfossil; C = speleothem; D = organic matter; E = diatom; F = loess and palaeosol; G = dune; H = plant leaf wax.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sites | Locality | Latitude (°) | Longitude (°) | Elevation (m ASL) | Methods | Record length (14C ka) | Number of dates (14C) | Changes | References |
| **Asia (mainly South Asia)** | | | | | | | | | |
| Didwana | N India | 27.33 | 74.58 | N/A | B | ca. 19 | 7 | Wetter | Singh et al. (1990) |
| Didwana | N India | 27.33 | 74.58 | N/A | A | 12.8 | 7 | Wetter | Wasson et al. (1984) |
| Gujjar Hut | N India | 30.83~30.87 | 78.78~78.85 | ca. 3500 | B | 6.9 cal | 3 | Wetter | Phadtare (2000) |
| Lake Sanai | N India | 26.12 | 81.02 | N/A | A; B | 14.8 | 7 | Wetter | Sharma et al. (2006) |
| Lunkaransar | N India | 28.39 | 73.78 | N/A | A | 10.9 cal | 15 | Wetter | Enzel et al. (1999) |
| Tso Kar | N India | 33.17 | 78.00 | 4527 | B | 15.2 cal | 32 | Wetter | Demske et al. (2009) |
| Tso Kar | N India | 33.30 | 78.00 | 4527 | A; B | 36.9 | 41 | Wetter | Wünnemann et al. (2010) |
| Deosila | NE India | 25.97 | 90.95 | N/A | B | 6.3 | 4 | Wetter | Dixit and Bera (2011) |
| Sandynallah | S India | 11.00~11.50 | 76.00~77.33 | 2200 | A | >40 | 39 | Wetter | Rajagopalan et al. (1997) |
| Sandynallah | S India | 11.44 | 76.63 | ca. 2200 | B | 30 | 4 | Drier | Vasanthy (1988) |
| Nal Sarovar | W India | 22.80 | 72.00 | N/A | A | 6.8 | 8 | Drier | Prasad et al. (1997) |
| Wadhwana Lake | W India | 22.18 | 73.48 | N/A | A; B | ca. 7.5 cal | 8 | Wetter | Prasad et al. (2014) |
| Qunf Cave Q5 | Oman | 17.17 | 54.30 | 650 | C | 10.3~2.7; 1.4~0.4 | 18 (Th-U) | Wetter | Fleitmann et al. (2003) |
| **South America** | | | | | | | | | |
| Arroyo Sauce Chico | Argentina | −38.08 | −62.27 | N/A | B | >7 | 1; 1 (TL) | Wetter | Prieto (1996) |
| Chasico | Argentina | −38.40 | −62.85 | 88 | F | 17.7 cal | 5; 3 (OSL) | Drier | Zech et al. (2009) |
| Misiones D4 | Argentina | −27.39 | −55.53 | 330 | F | 34.5 | 13 | Drier | Zech et al. (2009) |
| Mallin Book | Argentina | −41.33 | −71.58 | 800 | B | 12.9 | 9 | Drier | Markgraf (1983) |
| Vaca Lauquen | Argentina | −36.83 | −71.08 | 1450 | B; E | 10.1 | 3 | Drier | Markgraf (1987) |
| Upper Parana River Basin | Argentina and Brazil | −23.72 | −53.17 | 250~320 | A; B | 42.5 | 9; 4 (TL) | Unclear | Stevaux (2000) |
| Laguna Bella Vista | Bolivia | −13.62 | −61.55 | 200~900 | B | >50.8 | 15 | Drier | Mayle et al. (2000) |
| Laguna Chaplin | Bolivia | −14.47 | −61.06 | 200~900 | B | 38.1 | 14 | Drier | Mayle et al. (2000) |
| Laguna Sucuara (L1) | Bolivia | −16.83 | −62.04 | 255 | F | 9.5 cal | 4 | Drier | Zech et al. (2009) |
| Agua Preta de Baixo | Brazil | −18.42 | −41.83 | 470 | D | 10.8 cal | 6 | Drier | Turcq et al. (2002) |
| Aguas Emendadas | Brazil | −15.57 | −47.58 | 1040~1170 | B; D | 30.5 | 8 | Drier | Barberi et al. (2000) |
| Cambara do Sul | Brazil | −29.05 | −50.10 | 1040 | B; D | 42.7 | 7 | Drier | (Behling et al., 2004) |
| Caracarana | Brazil | 3.84 | −59.78 | 104 | D | 11.3 cal | 10 | Drier | Turcq et al. (2002) |
| Carajas N3 | Brazil | −6.14 | −50.19 | 680 | D | 10.6 cal | 8 | Drier | Turcq et al. (2002) |
| Crominia | Brazil | −17.25~−17.33 | −49.33~−49.47 | 710 | A; B | 32.1 | 5 | Drier | Salgado-Labouriau et al. (1997) |
| Comprido Lake | Brazil | −2.21 | −53.90 | N/A | A; D | 9 | 14 | Drier | Moreira et al. (2013) |
| Dom Helvecio | Brazil | −19.68 | −42.58 | 280 | D | 9.4 cal | 4 | Drier | Turcq et al. (2002) |
| Lago do Pires | Brazil | −17.95 | −42.22 | 390 | B | 9.5 | 6 | Drier | Behling (1995a) |
| Lagoa Feia | Brazil | −15.57 | −47.31 | 855 | D | 11 cal | 13 | Drier | Turcq et al. (2002) |
| Lagoa Nova | Brazil | −17.97 | −42.20 | 390 | B; D | 10.2 | 4 | Drier | Behling (2003) |
| Lagoa Santa | Brazil | −19.63 | −43.90 | 740 | B | >5.4 | 2 | Drier | Parizzi et al. (1998) |
| Morro de Itapeva | Brazil | −22.78 | −45.53 | 1850 | B; D | 35 | 9 | Drier | Behling (1997a) |
| Pantano da Mauritia | Brazil | −6.35 | −50.39 | 740 | A; B; D | 25 cal | 7 | Drier | Hermanowski et al. (2012) |
| Salitre de Minas | Brazil | −19.00 | −46.77 | 1050 | B | 32 | 14 | Drier | Ledru (1993) |
| Samambaia Lake | Brazil | −22.60 | −53.38 | N/A | A | 32.7 TL | 7 (TL) | Unclear | Parolin et al. (2008) |
| Saquinho | Brazil | −10.40 | −43.22 | 480 | B | 11 | 6 | Wetter | De Oliveira et al. (1999) |
| Serra Campos Gerais | Brazil | −24.67 | −50.22 | 1200 | B; D | 12.5 | 4 | Drier | Behling (1997b) |
| Serra da Bocaina 2 | Brazil | −22.71 | −44.57 | ca. 1650 | B; D | 10 cal | 3 | Drier | Behling et al. (2007) |
| Serra da Boa Vista | Brazil | −27.70 | −49.15 | 1160 | B | 13.9 | 4 | Drier | Behling (1995b) |
| Serra do Rio Rastro | Brazil | −28.38 | −49.55 | 1420 | B | 11.2~1 | 3 | Drier | Behling (1995b) |
| Serra dos Carajas | Brazil | −6.58 | −49.50 | 600–800 | A | 33.2 | 18 | Drier | Sifeddine et al. (2001) |
| Serra Norte de Carajas (N 4) | Brazil | −5.83~−6.58 | −49.50~−52.00 | 800 | D | 11.8 cal | 8 | Drier | Cordeiro et al. (2008) |
| Volta Velha | Brazil | −26.07 | −48.63 | 5 | B | 37.6 | 9 (1 is false) | Drier | Behling and Negrelle (2001) |
| GIK 17748-2 | Chile | −32.75 | −72.03 | Water depth 2545 | A | ca. 15.6 cal | 6 | Drier | Lamy et al. (1999) |
| Laguna Aculeo | Chile | −33.83 | −70.92 | 350 | B | 9.6 cal | 14; 15 (210Pb) | Drier | Villa-Martínez et al. (2003) |
| Laguna Aculeo | Chile | −33.83 | −70.90 | 350 | A; B; E | 9.6 cal | 17 | Drier | Jenny et al. (2002) |
| Laguna Miscanti | Chile | −23.73 | −67.77 | 4140 | B | 22 | 17 | Drier | Grosjean et al. (2001) |
| Laguna Miscanti | Chile | −23.73 | −67.77 | 4140 | A | 15.5 | 6 | Drier | Valero-Garcés et al. (1996) |
| Palo Colorado | Chile | −32.08 | −71.48 | N/A | B | 9.4 cal | 11 | Drier | Maldonado and Villagrán (2006) |
| Quebrada Puripica | Chile | −22.72 | −68.09 | ca. 3200~3600 | A | 7.9 cal | 35 | Wetter | Rech et al. (2003) |
| Quebrada Puripica | Chile | −22.80 | −68.06 | 3250 | A | 6.2 | 15 | Drier | Grosjean et al. (1997) |
| Quereo | Chile | −31.83 | −71.50 | ca. 25 | B | 11.6 | 8 | Drier | Villagrán and Varela (1990) |
| Laguna Lome Linda | Colombia | 3.30 | −73.38 | 310 | B | 8.7 | 8 (1 is poor) | Drier | Behling and Hooghiemstra (2000) |
| El Junco | Ecuador | 0.00 | −91.05 | ca. 650 | A; B | 10.3 | 6 | Drier | Colinvaux (1972) |
| Lago Lagunillas | Peru | −15.44 | −70.44 | ca. 4200 | E | 8.0 cal | 14 | Drier | Ekdahl et al. (2008) |
| Lake Aricota | Peru | −17.37 | −70.28 | 2800 | A | 7.1 cal | 29 | Wetter | Placzek et al. (2001) |
| Pumacocha | Peru | −10.70 | −76.06 | 4300 | A | 11.2 cal | 18 | Drier | Bird et al. (2011) |
| Lake Titicaca | Peru and Bolivia | −16.00~−17.50 | −68.50~−70.00 | 3810 | A; E | ca. 27.5 cal | 25 | Drier | Baker et al. (2001) |
| Los Ajos | Uruguay | −33.70 | −53.95 | 200 | B | 14.8 | 6 | Drier | Iriarte (2006) |
| Lake Valencia | Venezuela | 10.27 | −67.75 | 402 | A; B | 12.9 | 9 | Wetter | Bradbury et al. (1981) |
| Lake Valencia | Venezuela | 10.17 | −67.75 | 400 | A | ca. 12.6 | 13 | Wetter | Curtis et al. (1999) |
| Cariaco Basin | Venezuela | 10.71 | −65.17 | Water depth 893 | A | 14 | 10 | Wetter | Haug et al. (2001) |
| **Australia** | | | | | | | | | |
| Whitehaven Swamp | E Australia | −20.30 | 149.06 | 45 | A; B | ca. 7 | 1 | Wetter | Genever et al. (2003) |
| Lake Euramoo | NE Australia | −17.17 | 146.63 | 718 | A; B | 23 cal | 22 (3 are excluded); 14 (210Pb) | Wetter | Haberle (2005) |
| Nelly Bay | NE Australia | −19.00 | 147.00 | N/A | Coral | 6.223–5.918 cal | N/A | Drier | Lough et al. (2014) |
| Black Springs | NW Australia | −15.63 | 126.39 | N/A | A; B | 9.1 cal | 11 | Wetter | Field et al. (2017) |
| Middens, Flinders Ranges | SC Australia | −31.30 | 139.00 | N/A | B | 7.7 | 34 | Wetter | McCarthy and Head (2001) |
| Yudnamutana | SC Australia | −30.19 | 139.42 | ca. 8 | C | 11.6 U-Th | 10 (U-Th) | Wetter | Quigley et al. (2010) |
| Bega Swamp | SE Australia | −36.04 | 149.75 | N/A | B | 13.9 cal | 39 | Wetter | Hope et al. (2004)  Donders et al. (2007) |
| Club Lake | SE Australia | −36.42 | 148.29 | 1955 | B | 9.7 | 13 | Wetter | Martin (1986) |
| Lake Gnotuk | SE Australia | −38.22 | 143.10 | N/A | A | 21.8 OSL | 15; 15(OSL) | Wetter | Wilkins et al. (2013) |
| Lake Keilambete | SE Australia | −38.21 | 142.88 | N/A | A | 9.4 OSL | 13; 14(OSL) | Wetter | Wilkins et al. (2013) |
| Sperm Whale Head | SE Australia | −37.74 | 148.08 | N/A | B | 7.2 | 4 | Wetter | Hooley et al. (1980) |
| **Southern Africa** | | | | | | | | | |
| 1078 Hole C | Angola | −11.91 | 13.4 | >1000 | B | 44.9 | 8 | Wetter | Dupont et al. (2008) |
| Lake Challa | Kenya and Tanzania | −3.32 | 37.7 | 880 | H | 25 cal | 19 | Drier | Tierney et al. (2011) |
| River Mouth | Congo | −5.94 | 11.47 | N/A | H | 35.8 | 15 | Wetter | Schefuß et al. (2005) |
| Lake Rukwa | Tanzania | −8.42 | 32.72 | 793 | B | 16.8 | 9 | Wetter | Vincens et al. (2005) |
| Lake Malawi | Tanzania | −9.97 | 34.22 | N/A | H | 24.3 cal | 14 | Wetter | Castañeda et al. (2007) |
| Lake Ngami | Botswana | −20.5 | 22.4 | 922 | A | ca. 40.5 | 6 | Drier | Huntsman-Mapila et al. (2006) |
| Stampriet Aquifer | Namibia | −24 | 19.5 | 1125~1250 | Noble gas | 30 | N/A | Wetter | Stute et al. (1998) |
| Wonderwerk Cave | South Africa | −27.8 | 23.6 | 1680 | C | 35 | 16 | Drier | Brook et al. (2010) |
| Lake Eteza | South Africa | −28.5 | 32.2 | 14 | B | 10.2 cal | 19 | Wetter | Neumann et al. (2010) |
| Rietvlei wetland | South Africa | −34.4 | 21.5 | 17 | B | 16 cal | 9 | Drier | Quick et al. (2015) |
| Katbakkies Pass | South Africa | −32.9 | 19.6 | 1170 | B | 7 cal | 8 | Wetter | Chase et al. (2015) |

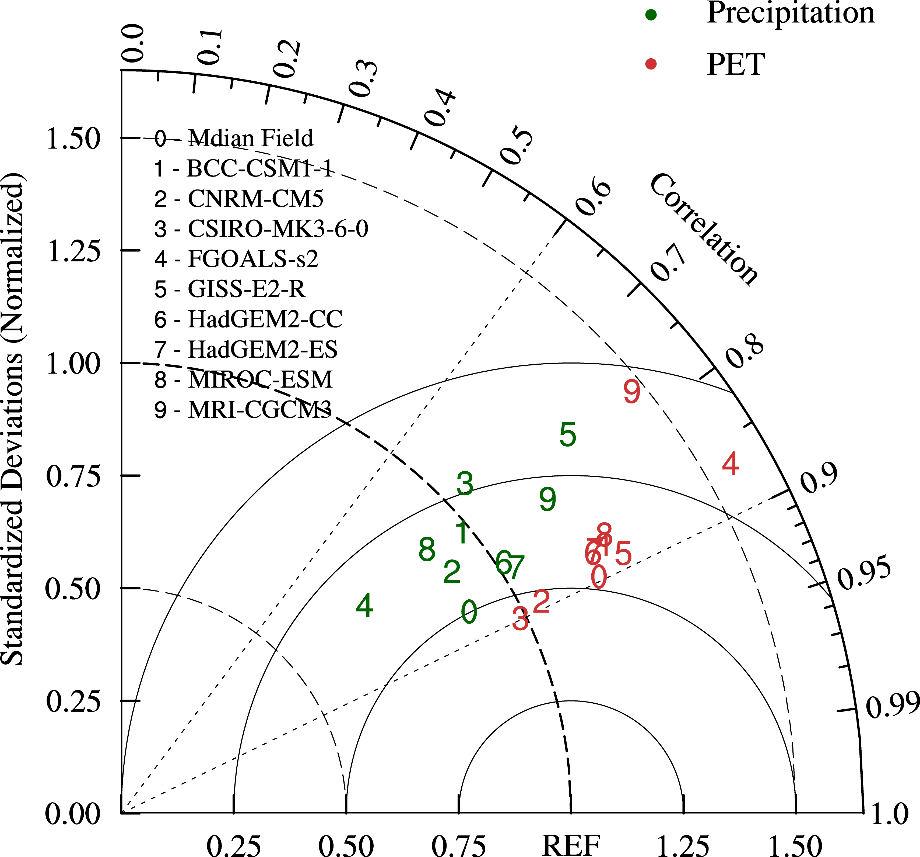


Fig. S1. Taylor diagram (Taylor, 2001) for displaying normalized pattern statistics of climatological annual precipitation and PET from 60°S to 60°N between PMIP3 models for the preindustrial period and observations for the period 1981–2010. Green number represents precipitation comparisons between models and PREC/L; red number represents PET comparison between models and NCEP-2; observations are regarded as the reference values (REF). The radial distance from the origin is the normalized standard deviation of a model; the spatial correlation coefficient between a model and the reference is expressed by the azimuthal position of the model; and the normalized centred root-mean-square difference between a model and the reference is their distance apart. The standard deviation and the centred root-mean-square difference are normalized by the observed standard deviation.

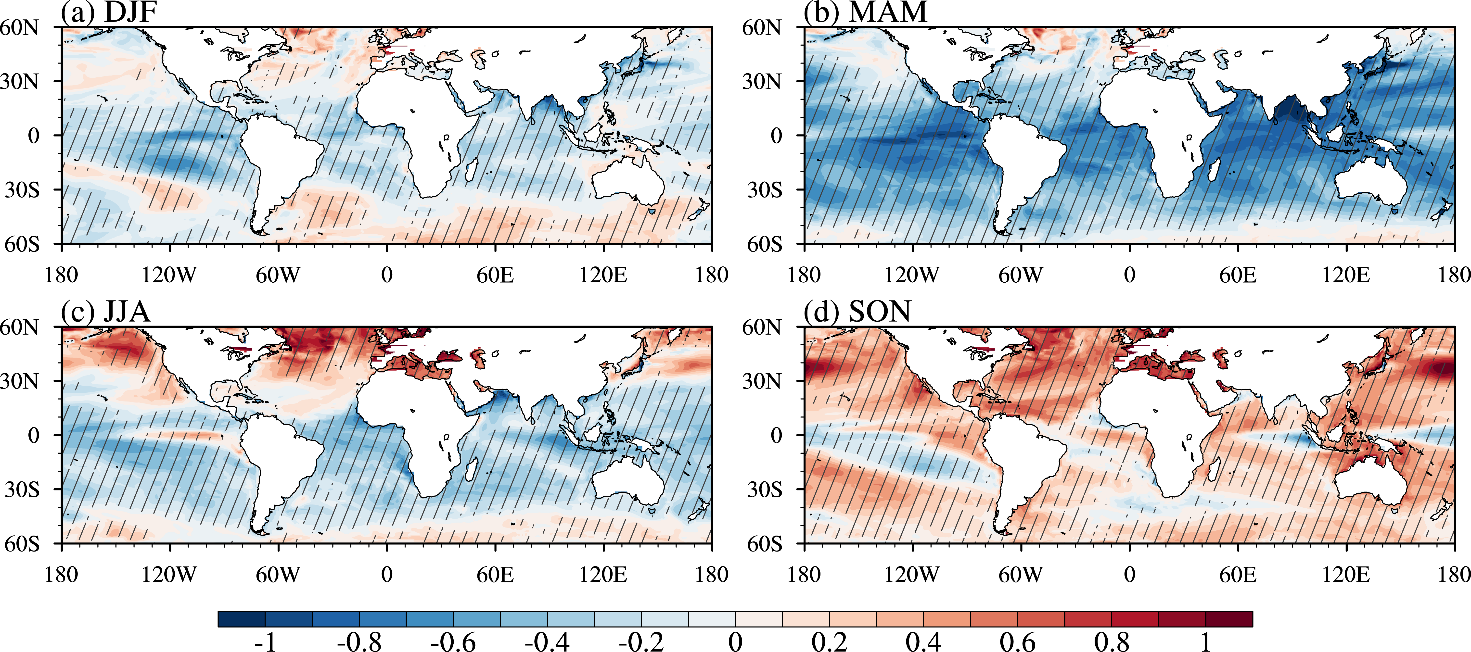


Fig. S2. The mid-Holocene change in sea surface temperature (°C) for (a) December–February, (b) March–May, (c) June–August, and (d) September–November. Diagonal lines denote that at least 6 of 9 models agree on the sign of the change.

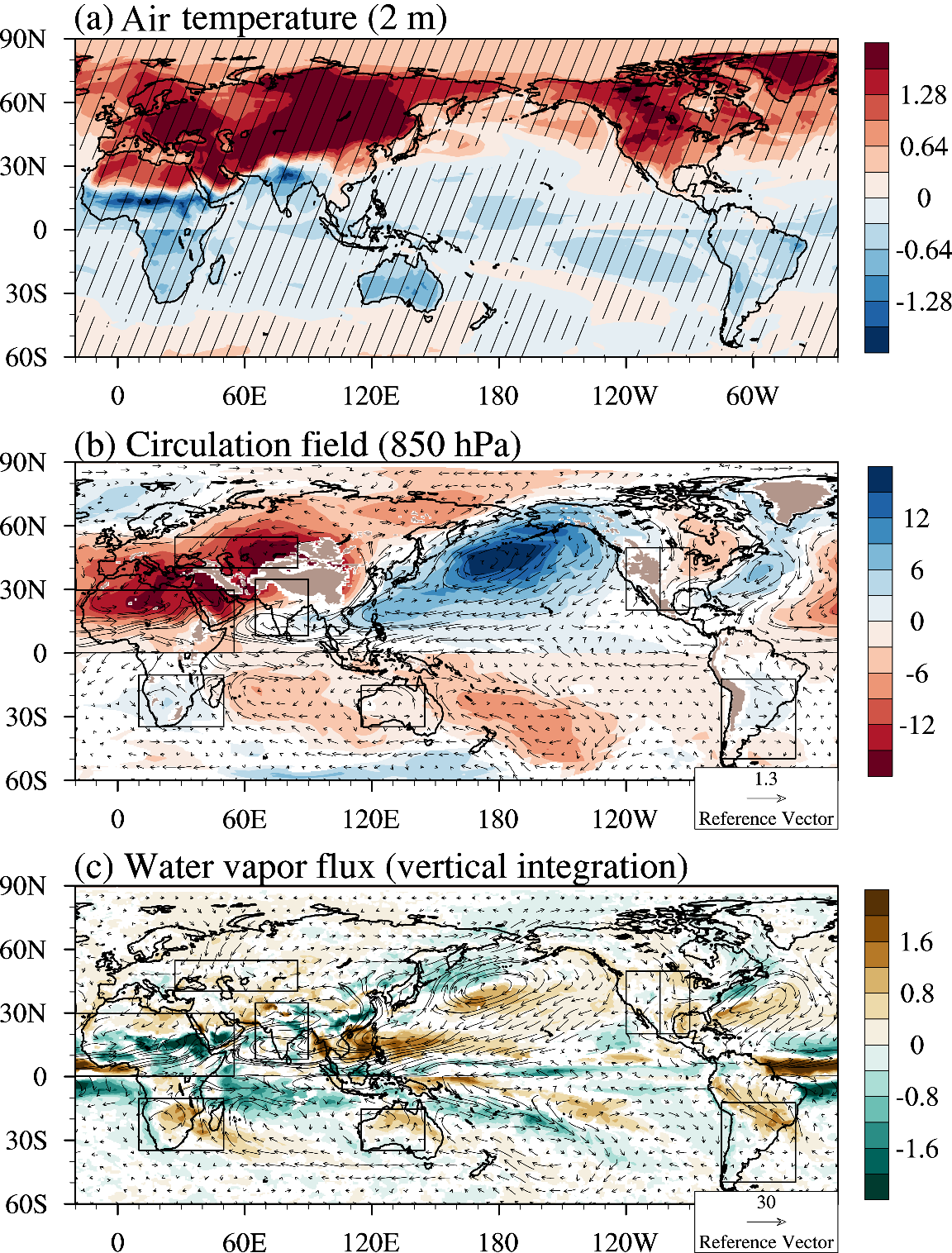


Fig. S3. Relative to the preindustrial period, the mid-Holocene change during summertime (June–August for the northern hemisphere and December–February for the southern hemisphere) in (a) near-surface air temperature at 2 m (°C), (b) the geopotential height (m) and wind filed (m·s−1) at 850 hPa, and (c) the water vapor flux (g·cm−1·s−1) and its divergence (10−3 g·m−2·s−1) integrated from the surface to 200 hPa. Diagonal lines in (a) denote that at least 6 out of 9 models agree on the sign of the change. Divergence in (b–c) is plotted only where at least 6 out of 9 models agree on the sign.

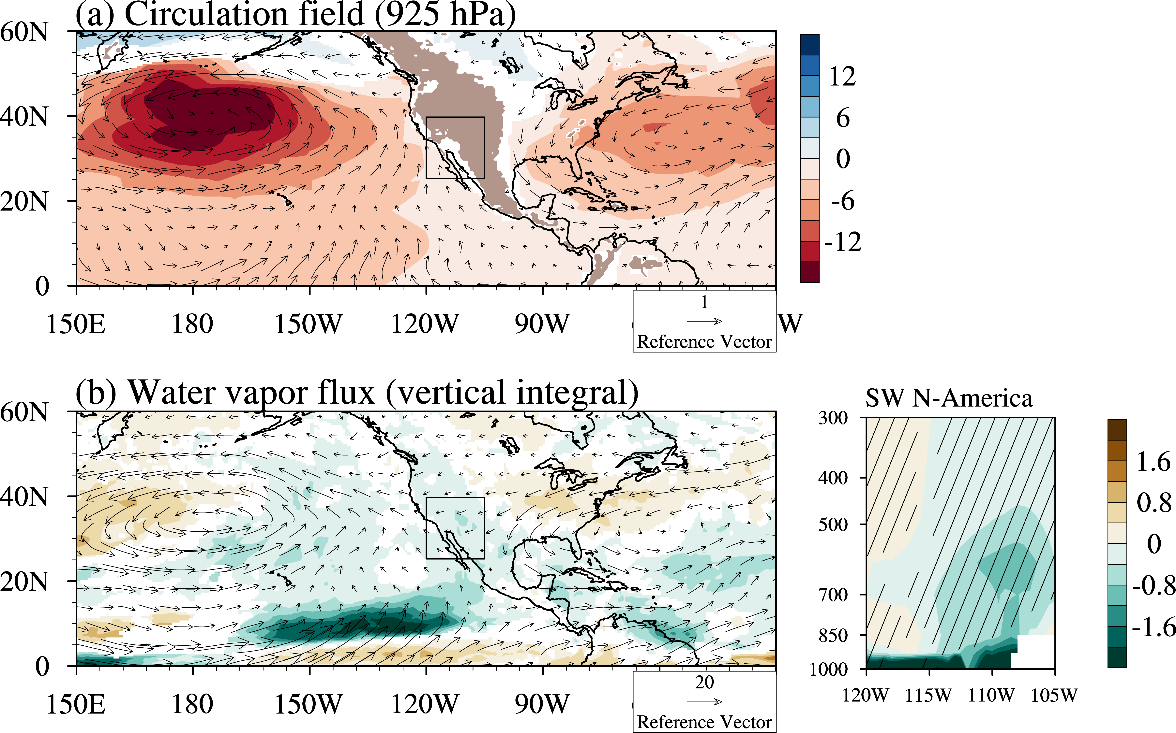


Fig. S4. The left-hand parts are same as Figs. S3b–c but in boreal spring (March–May) and for 925 hPa in (a). The right-hand figure in (b) shows the meridional-mean (25–40°N) change of the water vapor divergence for southwestern North America. Diagonal lines denote that at least 6 out of 9 models agree on the sign of the change.

**References**

Baker PA, Seltzer GO, Fritz SC et al. (2001) The history of South American tropical precipitation for the past 25,000 years. *Science* 291: 640–643.

Barberi M, Salgado-Labouriau ML and Suguio K (2000) Paleovegetation and paleoclimate of “Vereda de Águas Emendadas”, central Brazil. *Journal of South American Earth Sciences* 13: 241–254.

Behling H (1995a) A high resolution Holocene pollen record from Lago do Pires, SE Brazil: vegetation, climate and fire history. *Journal of Paleolimnology* 14: 253–268.

Behling H (1995b) Investigations into the Late Pleistocene and Holocene history of vegetation and climate in Santa Catarina (S Brazil). *Vegetation History and Archaeobotany* 4: 127–152.

Behling H (1997a) Late Quaternary vegetation, climate and fire history from the tropical mountain region of Morro de Itapeva, SE Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology* 129: 407–422.

Behling H (1997b) Late Quaternary vegetation, climate and fire history of the Araucaria forest and campos region from Serra Campos Gerais, Paraná State (South Brazil). *Review of Palaeobotany and Palynology* 97: 109–121.

Behling H (2003) Late glacial and Holocene vegetation, climate and fire history inferred from Lagoa Nova in the southeastern Brazilian lowland. *Vegetation History and Archaeobotany* 12: 263–270.

Behling H, Dupont L, DeForest Safford H et al. (2007) Late Quaternary vegetation and climate dynamics in the Serra da Bocaina, southeastern Brazil. *Quaternary International* 161: 22–31.

Behling H and Hooghiemstra H (2000) Holocene Amazon rainforest–savanna dynamics and climatic implications: high-resolution pollen record from Laguna Loma Linda in eastern Colombia. *Journal of Quaternary Science* 15: 687–695.

Behling H and Negrelle RRB (2001) Tropical rain forest and climate dynamics of the Atlantic lowland, southern Brazil, during the Late Quaternary. *Quaternary Research* 56: 383–389.

Behling H, Pillar VD, Orlóci L et al. (2004) Late Quaternary Araucaria forest, grassland (Campos), fire and climate dynamics, studied by high-resolution pollen, charcoal and multivariate analysis of the Cambará do Sul core in southern Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology* 203: 277–297.

Bird BW, Abbott MB, Rodbell DT et al. (2011) Holocene tropical South American hydroclimate revealed from a decadally resolved lake sediment δ18O record. *Earth and Planetary Science Letters* 310: 192–202.

Bradbury JP, Leyden B, Salgado-Labouriau M et al. (1981) Late Quaternary environmental history of Lake Valencia, Venezuela. *Science* 214: 1299–1305.

Brook GA, Scott L, Railsback LB et al. (2010) A 35 ka pollen and isotope record of environmental change along the southern margin of the Kalahari from a stalagmite and animal dung deposits in Wonderwerk Cave, South Africa. *Journal of Arid Environments* 74: 870–884.

Castañeda IS, Werne JP and Johnson TC (2007) Wet and arid phases in the southeast African tropics since the last glacial maximum. *Geology* 35: 823–826.

Chase BM, Lim S, Chevalier M et al. (2015) Influence of tropical easterlies in southern Africa's winter rainfall zone during the Holocene. *Quaternary Science Reviews* 107: 138–148.

Colinvaux PA (1972) Climate and the Galapagos islands. *Nature* 240: 17–20.

Cordeiro RC, Turcq B, Suguio K et al. (2008) Holocene fires in East Amazonia (Carajás), new evidences, chronology and relation with paleoclimate. *Global and Planetary Change* 61: 49–62.

Curtis JH, Brenner M and Hodell DA (1999) Climate change in the Lake Valencia Basin, Venezuela, ~12600 yr BP to present. *The Holocene* 9: 609–619.

De Oliveira PE, Barreto AMF and Suguio K (1999) Late Pleistocene/Holocene climatic and vegetational history of the Brazilian caatinga: the fossil dunes of the middle São Francisco River. *Palaeogeography, Palaeoclimatology, Palaeoecology* 152: 319–337.

Demske D, Tarasov PE, Wünnemann B et al. (2009) Late glacial and Holocene vegetation, Indian monsoon and westerly circulation in the Trans-Himalaya recorded in the lacustrine pollen sequence from Tso Kar, Ladakh, NW India. *Palaeogeography, Palaeoclimatology, Palaeoecology* 279: 172–185.

Dixit S and Bera S (2011) Mid-Holocene vegetation and climatic variability in tropical deciduous sal (Shorea robusta) forest of lower Brahmaputra valley, Assam. *Journal of the Geological Society of India* 77: 419–432.

Donders TH, Haberle SG, Hope G et al. (2007) Pollen evidence for the transition of the eastern Australian climate system from the post-glacial to the present-day ENSO mode. *Quaternary Science Reviews* 26: 1621–1637.

Dupont LM, Behling H and Kim JH (2008) Thirty thousand years of vegetation development and climate change in Angola (Ocean Drilling Program Site 1078). *Climate of the Past* 4: 107–124.

Ekdahl EJ, Fritz SC, Baker PA et al. (2008) Holocene multidecadal- to millennial-scale hydrologic variability on the South American Altiplano. *The Holocene* 18: 867–876.

Enzel Y, Ely LL, Mishra S et al. (1999) High-resolution Holocene environmental changes in the Thar Desert, northwestern India. *Science* 284: 125–128.

Field E, McGowan HA, Moss PT et al. (2017) A late Quaternary record of monsoon variability in the northwest Kimberley, Australia. *Quaternary International* 449: 119–135.

Fleitmann D, Burns SJ, Mudelsee M et al. (2003) Holocene forcing of the Indian monsoon recorded in a stalagmite from southern Oman. *Science* 300: 1737–1739.

Fu Q and Feng S (2014) Responses of terrestrial aridity to global warming. *Journal of Geophysical Research: Atmospheres* 119: 7863–7875.

Genever M, Grindrod J and Barker B (2003) Holocene palynology of Whitehaven Swamp, Whitsunday Island, Queensland, and implications for the regional archaeological record. *Palaeogeography, Palaeoclimatology, Palaeoecology* 201: 141–156.

Grosjean M, Núñez L, Cartajena I et al. (1997) Mid-Holocene climate and culture change in the Atacama Desert, northern Chile. *Quaternary Research* 48: 239–246.

Grosjean M, van Leeuwen JFN, van der Knaap WO et al. (2001) A 22,000 14C year BP sediment and pollen record of climate change from Laguna Miscanti (23°S), northern Chile. *Global and Planetary Change* 28: 35–51.

Haberle SG (2005) A 23,000-yr pollen record from Lake Euramoo, wet tropics of NE Queensland, Australia. *Quaternary Research* 64: 343–356.

Haug GH, Hughen KA, Sigman DM et al. (2001) Southward migration of the intertropical convergence zone through the Holocene. *Science* 293: 1304–1308.

Hermanowski B, da Costa ML and Behling H (2012) Environmental changes in southeastern Amazonia during the last 25,000 yr revealed from a paleoecological record. *Quaternary Research* 77: 138–148.

Hooley AD, Southern W and Kershaw AP (1980) Holocene vegetation and environments of sperm whale head, Victoria, Australia. *Journal of Biogeography* 7: 349–362.

Hope G, Kershaw AP, van der Kaars S et al. (2004) History of vegetation and habitat change in the Austral–Asian region. *Quaternary International* 118–119: 103–126.

Huntsman-Mapila P, Ringrose S, Mackay AW et al. (2006) Use of the geochemical and biological sedimentary record in establishing palaeo-environments and climate change in the Lake Ngami basin, NW Botswana. *Quaternary International* 148: 51–64.

Iriarte J (2006) Vegetation and climate change since 14,810 14C yr B.P. in southeastern Uruguay and implications for the rise of early Formative societies. *Quaternary Research* 65: 20–32.

Jenny B, Valero-Garcés BL, Villa-Martínez R et al. (2002) Early to mid-Holocene aridity in central Chile and the southern westerlies: the Laguna Aculeo record (34°S). *Quaternary Research* 58: 160–170.

Lamy F, Hebbeln D and Wefer G (1999) High-resolution marine record of climatic change in mid-latitude Chile during the last 28,000 years based on terrigenous sediment parameters. *Quaternary Research* 51: 83–93.

Ledru M-P (1993) Late Quaternary environmental and climatic changes in central Brazil. *Quaternary Research* 39: 90–98.

Lough JM, Llewellyn LE, Lewis SE et al. (2014) Evidence for suppressed mid-Holocene northeastern Australian monsoon variability from coral luminescence. *Paleoceanography* 29: 581–594.

Maldonado A and Villagrán C (2006) Climate variability over the last 9900 cal yr BP from a swamp forest pollen record along the semiarid coast of Chile. *Quaternary Research* 66: 246–258.

Markgraf V (1983) Late and postglacial vegetational and paleoclimatic changes in subantarctic, temperate, and arid environments in Argentina. *Palynology* 7: 43–70.

Markgraf V (1987) Paleoenvironmental changes at the northern limit of the subantarctic Nothofagus forest, lat 37°S, Argentina. *Quaternary Research* 28: 119–129.

Martin ARH (1986) Late glacial and Holocene alpine pollen diagrams from the Kosciusko National Park, New South Wales, Australia. *Review of Palaeobotany and Palynology* 47: 367–409.

Mayle FE, Burbridge R and Killeen TJ (2000) Millennial-scale dynamics of southern Amazonian rain forests. *Science* 290: 2291–2294.

McCarthy L and Head L (2001) Holocene variability in semi-arid vegetation: new evidence from Leporillus middens from the Flinders Ranges, South Australia. *The Holocene* 11: 681–689.

Moreira LS, Moreira-Turcq P, Cordeiro RC et al. (2013) Holocene paleoenvironmental reconstruction in the eastern Amazonian basin: Comprido lake. *Journal of South American Earth Sciences* 44: 55–62.

Neumann FH, Scott L, Bousman CB et al. (2010) A Holocene sequence of vegetation change at Lake Eteza, coastal KwaZulu-Natal, South Africa. *Review of Palaeobotany and Palynology* 162: 39–53.

Parizzi MG, Salgado-Labouriau ML and Kohler HC (1998) Genesis and environmental history of Lagoa Santa, southeastern Brazil. *The Holocene* 8: 311–321.

Parolin M, Volkmer-Ribeiro C and Stevaux JC (2008) Use of spongofacies as a proxy for river-lake paleohydrology in Quaternary deposits of central-western Brazil. *Revista Brasileira de Paleontologia* 11: 187–198.

Phadtare NR (2000) Sharp decrease in summer monsoon strength 4000–3500 cal yr B.P. in the Central Higher Himalaya of India based on pollen evidence from alpine peat. *Quaternary Research* 53: 122–129.

Placzek C, Quade J and Betancourt JL (2001) Holocene lake-level fluctuations of lake Aricota, southern Peru. *Quaternary Research* 56: 181–190.

Prasad S, Kusumgar S and Gupta SK (1997) A mid to late Holocene record of palaeoclimatic changes from Nal Sarovar: a palaeodesert margin lake in western India. *Journal of Quaternary Science* 12: 153–159.

Prasad V, Farooqui A, Sharma A et al. (2014) Mid–late Holocene monsoonal variations from mainland Gujarat, India: A multi-proxy study for evaluating climate culture relationship. *Palaeogeography, Palaeoclimatology, Palaeoecology* 397: 38–51.

Prieto AR (1996) Late Quaternary vegetational and climatic changes in the Pampa grassland of Argentina. *Quaternary Research* 45: 73–88.

Quick LJ, Carr AS, Meadows ME et al. (2015) A late Pleistocene–Holocene multi-proxy record of palaeoenvironmental change from Still Bay, southern Cape Coast, South Africa. *Journal of Quaternary Science* 30: 870–885.

Quigley MC, Horton T, Hellstrom JC et al. (2010) Holocene climate change in arid Australia from speleothem and alluvial records. *The Holocene* 20: 1093–1104.

Rajagopalan G, Sukumar R, Ramesh R et al. (1997) Late Quaternary vegetational and climatic changes from tropical peats in southern India – An extended record up to 40,000 years BP. *Current Science*: 60–63.

Rech JA, Pigati JS, Quade J et al. (2003) Re-evaluation of mid-Holocene deposits at Quebrada Puripica, northern Chile. *Palaeogeography, Palaeoclimatology, Palaeoecology* 194: 207–222.

Salgado-Labouriau ML, Casseti V, Ferraz-Vicentini KR et al. (1997) Late Quaternary vegetational and climatic changes in cerrado and palm swamp from Central Brazil. *Palaeogeography, Palaeoclimatology, Palaeoecology* 128: 215–226.

Schefuß E, Schouten S and Schneider RR (2005) Climatic controls on central African hydrology during the past 20,000 years. *Nature* 437: 1003–1006.

Sharma S, Joachimski MM, Tobschall HJ et al. (2006) Correlative evidences of monsoon variability, vegetation change and human inhabitation in Sanai lake deposit: Ganga Plain, India. *Current Science* 90: 973–978.

Sifeddine A, Martin L, Turcq B et al. (2001) Variations of the Amazonian rainforest environment: a sedimentological record covering 30,000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology* 168: 221–235.

Singh G, Wasson RJ and Agrawal DP (1990) Vegetational and seasonal climatic changes since the last full glacial in the Thar Desert, northwestern India. *Review of Palaeobotany and Palynology* 64: 351–358.

Stevaux JC (2000) Climatic events during the late Pleistocene and Holocene in the Upper Parana River: Correlation with NE Argentina and South-Central Brazil. *Quaternary International* 72: 73–85.

Stute, M, Talma, AS., 1998. Glacial temperatures and moisture transport regimes reconstructed from noble gas and δ18O, Stampriet aquifer, Namibia. In: *Isotope Techniques in the Study of Environmental Change*. Vienna: IAEA Vienna Symposium 1997, pp. 307–328.

Taylor KE (2001) Summarizing multiple aspects of model performance in a single diagram. *Journal of Geophysical Research: Atmospheres* 106: 7183–7192.

Tierney JE, Russell JM, Damste JSS et al. (2011) Late Quaternary behavior of the East African monsoon and the importance of the Congo Air Boundary. *Quaternary Science Reviews* 30: 798–807.

Turcq B, Albuquerque ALS, Cordeiro RC et al. (2002) Accumulation of organic carbon in five Brazilian lakes during the Holocene. *Sedimentary Geology* 148: 319–342.

Valero-Garcés BL, Grosjean M, Schwalb A et al. (1996) Limnogeology of Laguna Miscanti: evidence for mid to late Holocene moisture changes in the Atacama Altiplano (Northern Chile). *Journal of Paleolimnology* 16: 1–21.

Vasanthy G (1988) Pollen analysis of Late Quaternary sediments: evolution of upland savanna in Sandynallah (Nilgiris, South India). *Review of Palaeobotany and Palynology* 55: 175–192.

Villa-Martínez R, Villagrán C and Jenny B (2003) The last 7500 cal yr B.P. of westerly rainfall in Central Chile inferred from a high-resolution pollen record from Laguna Aculeo (34°S). *Quaternary Research* 60: 284–293.

Villagrán C and Varela J (1990) Palynological evidence for increased aridity on the central Chilean coast during the Holocene. *Quaternary Research* 34: 198–207.

Vincens A, Buchet G, Williamson D et al. (2005) A 23,000 yr pollen record from Lake Rukwa (8°S, SW Tanzania): New data on vegetation dynamics and climate in Central Eastern Africa. *Review of Palaeobotany and Palynology* 137: 147–162.

Wasson RJ, Smith GI and Agrawal DP (1984) Late Quaternary sediments, minerals, and inferred geochemical history of Didwana Lake, Thar Desert, India. *Palaeogeography, Palaeoclimatology, Palaeoecology* 46: 345–372.

Wilkins D, Gouramanis C, De Deckker P et al. (2013) Holocene lake-level fluctuations in Lakes Keilambete and Gnotuk, southwestern Victoria, Australia. *The Holocene* 23: 784–795.

Wünnemann B, Demske D, Tarasov P et al. (2010) Hydrological evolution during the last 15 kyr in the Tso Kar lake basin (Ladakh, India), derived from geomorphological, sedimentological and palynological records. *Quaternary Science Reviews* 29: 1138–1155.

Zech W, Zech M, Zech R et al. (2009) Late Quaternary palaeosol records from subtropical (38°S) to tropical (16°S) South America and palaeoclimatic implications. *Quaternary International* 196: 107–120.