

Supporting Information

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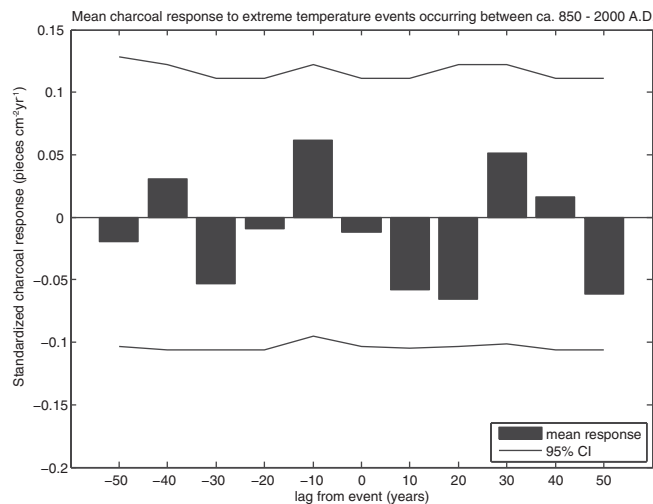


Fig. S1. Superposed epoch analysis (SEA) examining mean charcoal accumulation rates relative to extreme summer temperature events. Bars represent mean standardized charcoal accumulation rates (CHAR pieces $\text{cm}^{-2} \text{y}^{-1}$) in the composite record during decades with extreme summer temperature events (year 0, >95% C.I. of mean temperatures from circa A.D. 850–2000) and for five decades prior to and after extreme temperature events. Summer temperature reconstruction is derived from silver pine (*Lagarostrobos colensoi*) tree-ring chronologies and calibrated with instrumental data (1, 2). Mean CHAR levels did not exceed 95% C.I. Confidence intervals represent the 2.5th and 97.5th quartile when repeating the SEA 1,000 times using randomly shifted temperature event series.

- 1 Cook ER, Palmer JG, D'Arrigo RD (2002) Evidence for a "Medieval Warm Period" in a 1,100 year tree-ring reconstruction of past austral summer temperatures in New Zealand. *Geophys Res Lett*, 10.1029/2001GL014580.
- 2 Cook K, Vizy E (2006) South American climate during the last glacial maximum: Delayed onset of the South American monsoon. *J Geophys Res—Atm* 3:1–21.

Table S1. Site locations and climate data derived from 30 y (1950–1980) mean climate observations

Site	Elevation, m	Latitude, °south	Longitude, °east	Mean annual temperature, °C	Precipitation (mm/y)	Annual water deficit, mm
Diamond Lake	380	44.65	168.96	10.10	980	90
Glendhu Lagoon	280	44.66	169.05	10.10	896	114
Lake Kirkpatrick	570	45.03	168.57	8.00	1077	26
Lake Te Aroha	290	45.33	167.80	9.10	1311	0
Lake Thomas	490	45.47	167.95	8.30	1109	5
Lake Sarah	570	43.05	171.78	9.10	1154	26
Lake Letitia	600	43.05	171.95	8.70	1086	49
Blackwater Lake	680	43.12	171.92	8.60	1096	44
Lagoon Saddle	1170	43.05	171.60	5.80	2292	0
Horseshoe Lake	460	42.60	172.52	9.70	968	95
Lewis Pass	860	42.38	172.40	7.70	2599	0
Dingle Burn	370	44.44	169.38	10.00	1075	56
Duke's Tarn	830	44.96	168.49	6.70	1342	0
Lake Johnson	390	45.00	168.73	9.50	739	165
Travis Swamp	5	43.42	172.70	11.90	591	285
Pomahaka	845	45.51	169.25	6.40	1029	0

Climate data were derived from mathematical analysis of long-run average weather station data by Land Environments of New Zealand (1). Annual water deficit (mm) is the sum of monthly amounts in which evaporation exceeds rainfall (1).

1 Leathwick J, et al. (2003) *Land Environments of New Zealand* David Bateman Ltd., Auckland, NZ), p 183.

Table S2. AMS radiocarbon dating and pollen determined age information for each site

Site (year core collected)	Depth below surface, cm	Uncalibrated 14C age, 14C years B.P.	Calibrated age 95% confidence intervals, years B.P.	Calibrated 14C age, years B.P.	Years, B.C./A.D.	Material dated	Lab ID KCCAMS, CAMS*, NZ [†]
Blackwater Lake (2008)	51	2,595 ± 35	2,617 ± 135	2,625 ± 57	B.C. 675 ± 57	plant fragments, wood charcoal	55529
Blackwater Lake (2008)	135	8,220 ± 100	9,126 ± 319	9,049 ± 142	B.C. 7,099 ± 142	plant fragments, wood charcoal	55528
Lagoon Saddle (2008)	49	1,800 ± 60	1,655 ± 143	1,618 ± 74	332 ± 74	plant fragments	55531
Lagoon Saddle (2008)	119	3,425 ± 20	3,610 ± 93	3,802 ± 43	B.C. 1,852 ± 43	plant fragments	55530
Diamond Lake (2007)	20	—	—	—	1,970	inferred from pollen	—
Diamond Lake (2007)	64	640 ± 40	602 ± 33	519 ± 11	1,431 ± 11	plant fragments	39052
Diamond Lake (2007)	89	585 ± 25	543 ± 24	622 ± 7	1,328 ± 7	wood charcoal	39053
Diamond Lake (2007)	101	820 ± 20	702 ± 16	704 ± 15	1,246 ± 15	wood charcoal	42006
Diamond Lake (2009)	28	1,240 ± 15	1,111 ± 57	*	*	wood charcoal	71865
Diamond Lake (2009)	43	770 ± 15	668 ± 23	619 ± 18	1,331 ± 18	wood charcoal	71866
Diamond Lake (2009)	54	660 ± 15	606 ± 43	680 ± 13	1,270 ± 13	seed	71864
Diamond Lake (2009)	141	2,260 ± 15	2,234 ± 84	2,215 ± 43	B.C. 265 ± 43	leaf	71867
Dingle Burn (2008)	59	490 ± 20	504 ± 17	494 ± 9	1,456 ± 9	wood charcoal	55539
Dingle Burn (2008)	80	505 ± 40	510 ± 46	535 ± 9	1,415 ± 9	wood charcoal	55538
Dingle Burn (2008)	100	640 ± 20	607 ± 43	598 ± 12	1,352 ± 12	wood charcoal	55537
Dingle Burn (2008)	172	1,015 ± 20	854 ± 59	852 ± 34	1,098 ± 34	seed	55536
Dukes Tarn (2008)	33	210 ± 20	194 ± 105	74 ± 28	1,876 ± 28	leaf	55542
Dukes Tarn (2008)	119	390 ± 15	383 ± 77	435 ± 31	1,515 ± 31	leaf	55541
Dukes Tarn (2008)	139	670 ± 15	602 ± 44	664 ± 23	1,286 ± 23	leaf	55540
Dukes Tarn (2008)	165	905 ± 20	1,190 ± 72	1,066 ± 16	884 ± 16	leaf	71876
Glendhu Lagoon (1998)	80	540 ± 25	524 ± 11	548 ± 18	1,402 ± 18	wood charcoal	42012
Horseshoe Lake (2008)	20	195 ± 15	207 ± 133	148 ± 14	1,802 ± 14	plant fragments	55546
Horseshoe Lake (2008)	44	390 ± 20	392 ± 79	396 ± 22	1,554 ± 22	wood charcoal	55545
Horseshoe Lake (2008)	64	675 ± 20	601 ± 46	551 ± 22	1,399 ± 22	wood charcoal	55544
Horseshoe Lake (2008)	143	1,500 ± 20	1,332 ± 40	1,306 ± 24	644 ± 24	woody material	55543
Horseshoe Lake (2009)	28	190 ± 15	211 ± 136	177 ± 18	1,773 ± 18	woody material	71868
Horseshoe Lake (2009)	30	150 ± 20	97 ± 129	194 ± 19	1,756 ± 19	leaf	71869
Horseshoe Lake (2009)	46	375 ± 15	383 ± 71	334 ± 22	1,616 ± 22	woody material	71870
Horseshoe Lake (2009)	111	995 ± 15	849 ± 57	850 ± 21	1,100 ± 21	woody material	71871
Lake Johnson (2009)	15	145 ± 15	94 ± 126	94 ± 77	1,856 ± 77	woody material	71872
Lake Johnson (2009)	23	155 ± 15	98 ± 129	93 ± 74	1,857 ± 74	woody material	71873
Lake Johnson (2009)	47	1,505 ± 15	1,335 ± 39	1,299 ± 26	651 ± 26	woody material	71874
Lake Kirkpatrick (2007)	8	—	—	—	1,970	inferred from pollen	—
Lake Kirkpatrick (2007)	95	690 ± 20	599 ± 31	569 ± 8	1,381 ± 8	wood charcoal	42007
Lake Kirkpatrick (2007)	117	705 ± 15	595 ± 33	651 ± 8	1,299 ± 8	wood charcoal	42008
Lake Kirkpatrick (2009)	108	710 ± 15	596 ± 46	655 ± 14	1,295 ± 14	leaf, woody material	71875
Lake Kirkpatrick (2009)	119	645 ± 15	609 ± 41	735 ± 15	1,215 ± 15	woody material	71877
Lake Kirkpatrick (2009)	191	1,625 ± 15	1,466 ± 59	1,307 ± 24	643 ± 24	leaf	71878
Lake Letitia (2008)	32	355 ± 15	392 ± 64	427 ± 25	1,523 ± 25	wood charcoal	55555
Lake Letitia (2008)	80	2,245 ± 45	2,214 ± 137	2,153 ± 54	B.C. 203 ± 54	plant fragments	55535
Lake Sarah (2008)	33	520 ± 30	516 ± 23	500 ± 14	1,450 ± 14	wood charcoal	55534
Lake Sarah (2008)	53	620 ± 40	590 ± 60	627 ± 24	1,323 ± 24	wood charcoal	55533
Lake Sarah (2008)	136	1185 ± 20	1,018 ± 69	1,017 ± 33	933 ± 33	leaf	55554
Lake Sarah (2008)	164	1,245 ± 30	1,113 ± 107	1,117 ± 32	833 ± 32	plant fragments	55532
Lake Te Aroha (2007)	33	535 ± 20	522 ± 10	502 ± 8	1,448 ± 8	leaf	42011
Lake Te Aroha (2007)	47	510 ± 15	512 ± 7	534 ± 6	1,416 ± 6	woody material	39055
Lake Thomas (2007)	22	—	—	—	1,970	inferred from pollen	—
Lake Thomas (2007)	95	590 ± 140	589 ± 118	320 ± 21	1,630 ± 21	wood charcoal	42009
Lake Thomas (2007)	138	410 ± 30	482 ± 53	503 ± 14	1,447 ± 14	wood charcoal	42010
Lake Thomas (2007)	154	2,500 ± 45	2,579 ± 93	2,361 ± 86	B.C. 411 ± 86	woody material	133155*
Lewis Pass (2008)	88	4,020 ± 20	4,433 ± 106	4,466 ± 40	BC 2,516 ± 40	leaf	55548
Lewis Pass (2008)	132	8,250 ± 25	9,141 ± 119	9,027 ± 63	B.C. 7,077 ± 63	plant fragments	55547
Travis Swamp (1995)	37	722 ± 65	629 ± 133	634 ± 86	1,316 ± 86	peat	NZA 6649 [†]
Travis Swamp (1995)	113	1,341 ± 70	1,204 ± 146	1,205 ± 109	745 ± 109	peat	NZA 6335 [†]
Pomahaka Bog (2001)	38	378 ± 74	393 ± 160	516 ± 132	1,434 ± 132	plant fragments	NZA 7902 [†]
Pomahaka Bog (2001)	40	807 ± 41	696 ± 173	583 ± 155	1,367 ± 155	peat	NZA 19668 [†]
Pomahaka Bog (2001)	42	775 ± 40	673 ± 187	653 ± 178	1,297 ± 178	plant fragments	NZA 19951 [†]
Pomahaka Bog (2001)	82	4,038 ± 42	4,456 ± 200	2,380 ± 201	B.C. 430 ± 201	plant fragments	NZA 19952 [†]

Diamond Lake sample 71865 was not used in age-depth determination because of suspected contamination. Samples dated at three AMS laboratories:

W. M. Keck Carbon Cycle Accelerator Mass Spectrometry Laboratory (KCCAMS),

*Lawrence Livermore National Laboratory's Center for Accelerator Mass Spectrometry (CAMS, Livermore, CA), and

[†]Waikato Radiocarbon Dating Laboratory (University of Waikato, Hamilton, NZ).