

Ecography

ECOG-01998

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Supplementary material

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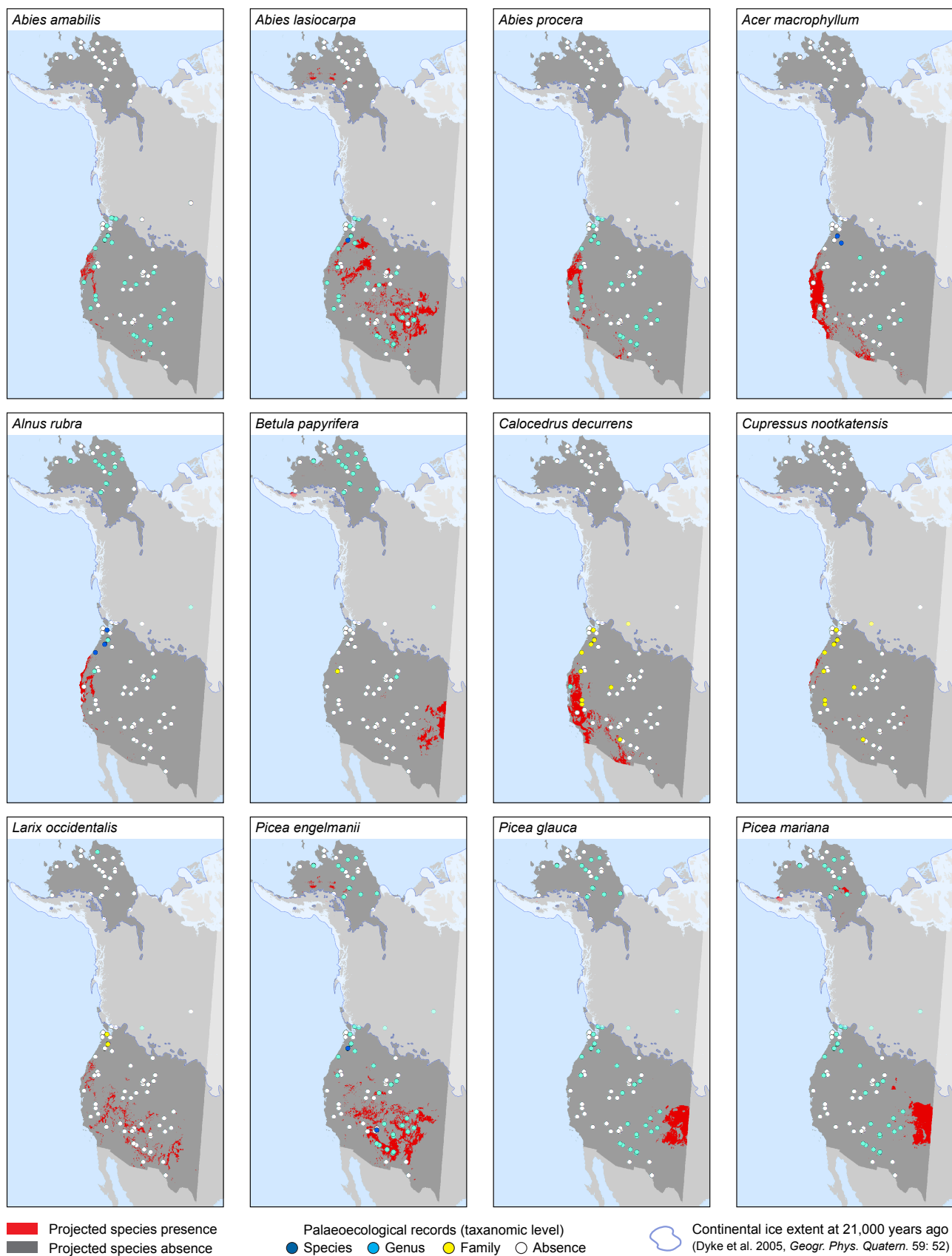


Figure A1: Maps of species ranges at 21,000 years ago, as projected by the ensemble species distribution model. Palaeoecological data from fossil pollen and neotoma records are shown, as is the number of presence records for each species (n). A complete list of site information and references for each record is provided in Supplementary material Appendix 2, Table A3. **(Continued on next page)**

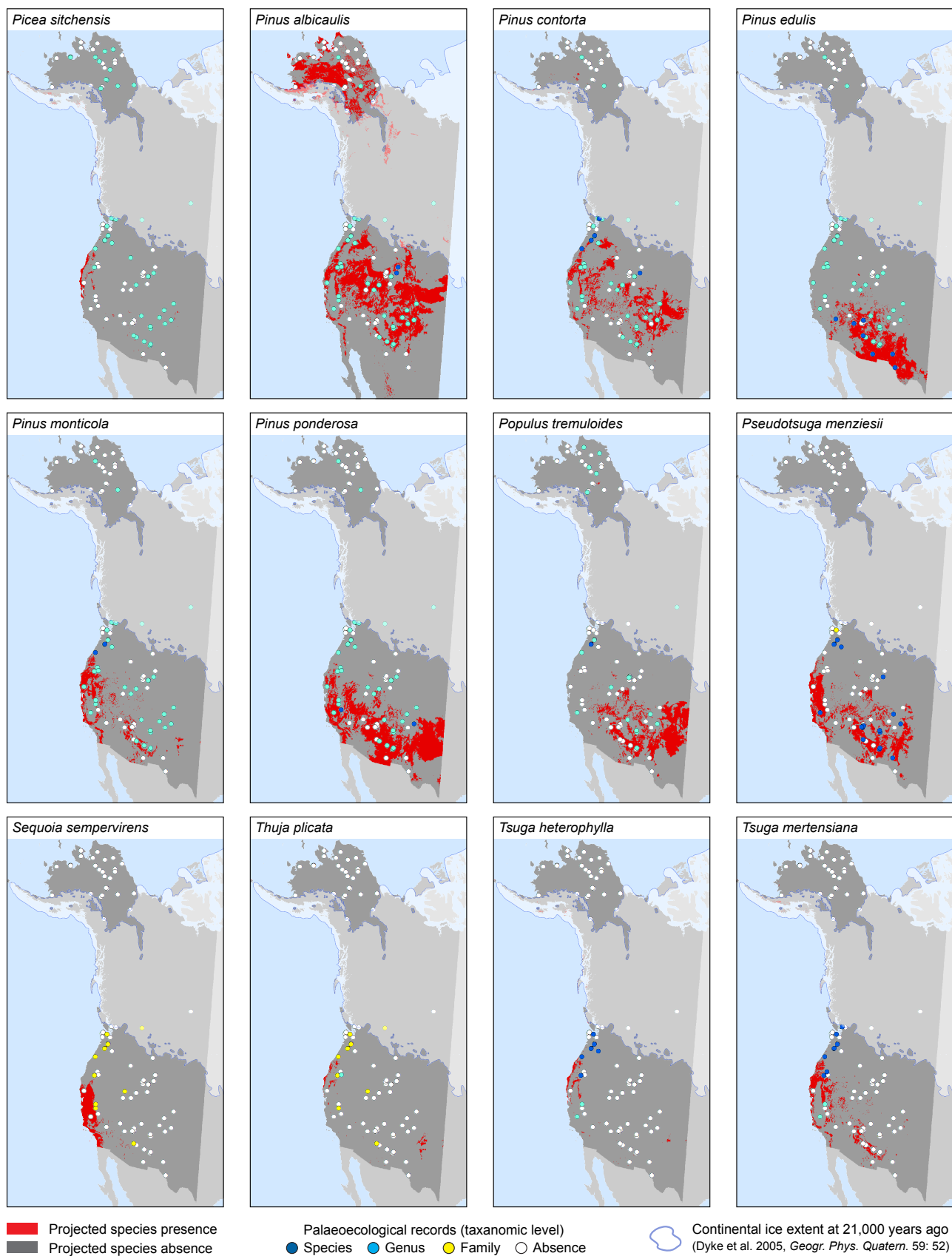


Figure A1: (Continued) Maps of species ranges at 21,000 years ago, as projected by the ensemble species distribution model. Palaeoecological data from fossil pollen and neotoma records are shown, as is the number of presence records for each species (n). A complete list of site information and references for each record is provided in Supplementary material Appendix 2, Table A3.

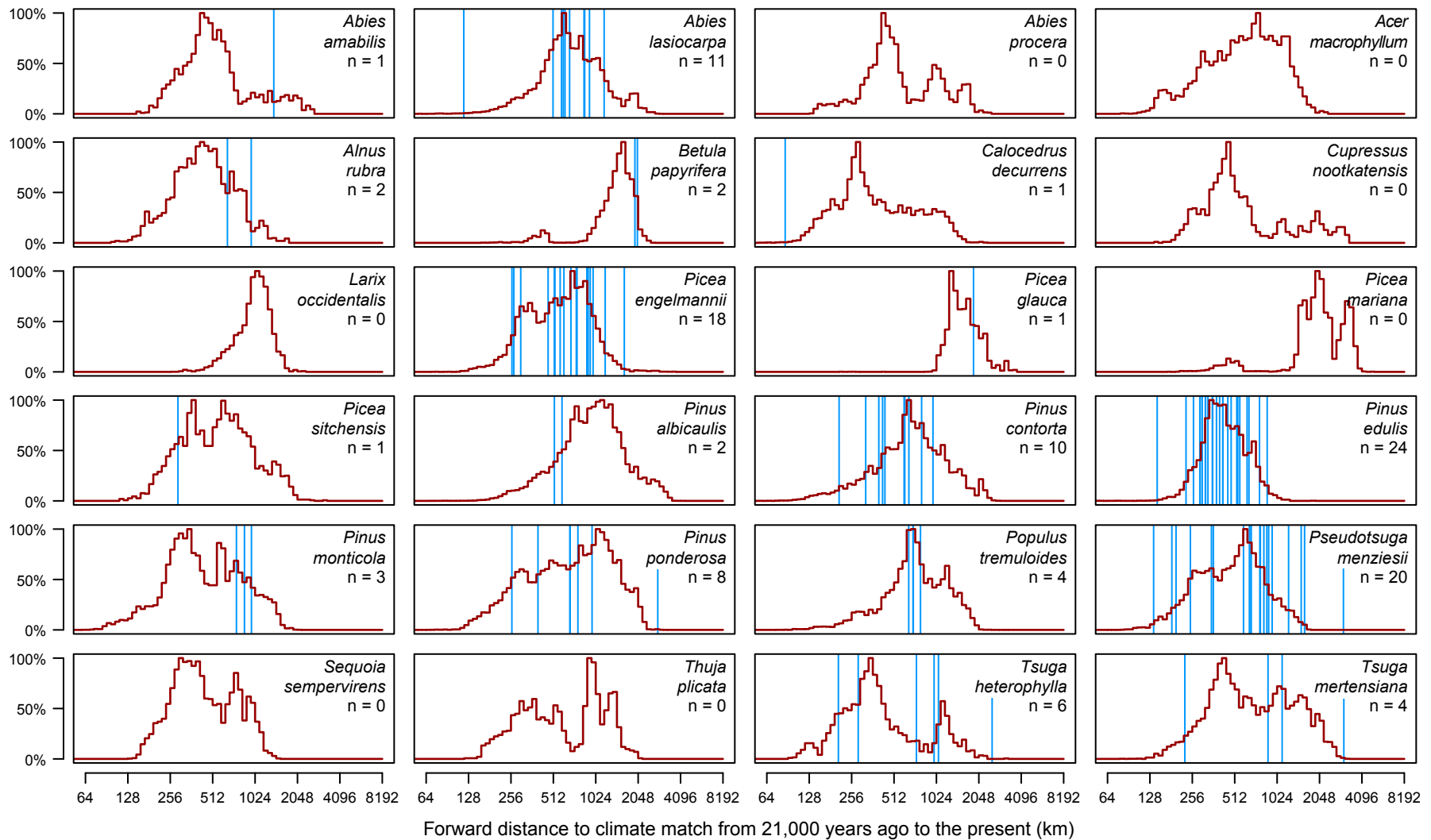


Figure A2: Distributions of the forward postglacial distance for each species, calculated from modelled ranges at the last glacial maximum 21,000 years ago to the nearest matching climates in the present day ranges (shown in red). Overlaid on these distributions are the forward postglacial distances from sites in the fossil record (as mapped in Figure A1) showing species presences at the last glacial maximum to the nearest matching climate in the present day ranges are shown as blue lines. The number of presences in the fossil record at the last glacial maximum is noted for each species (n).

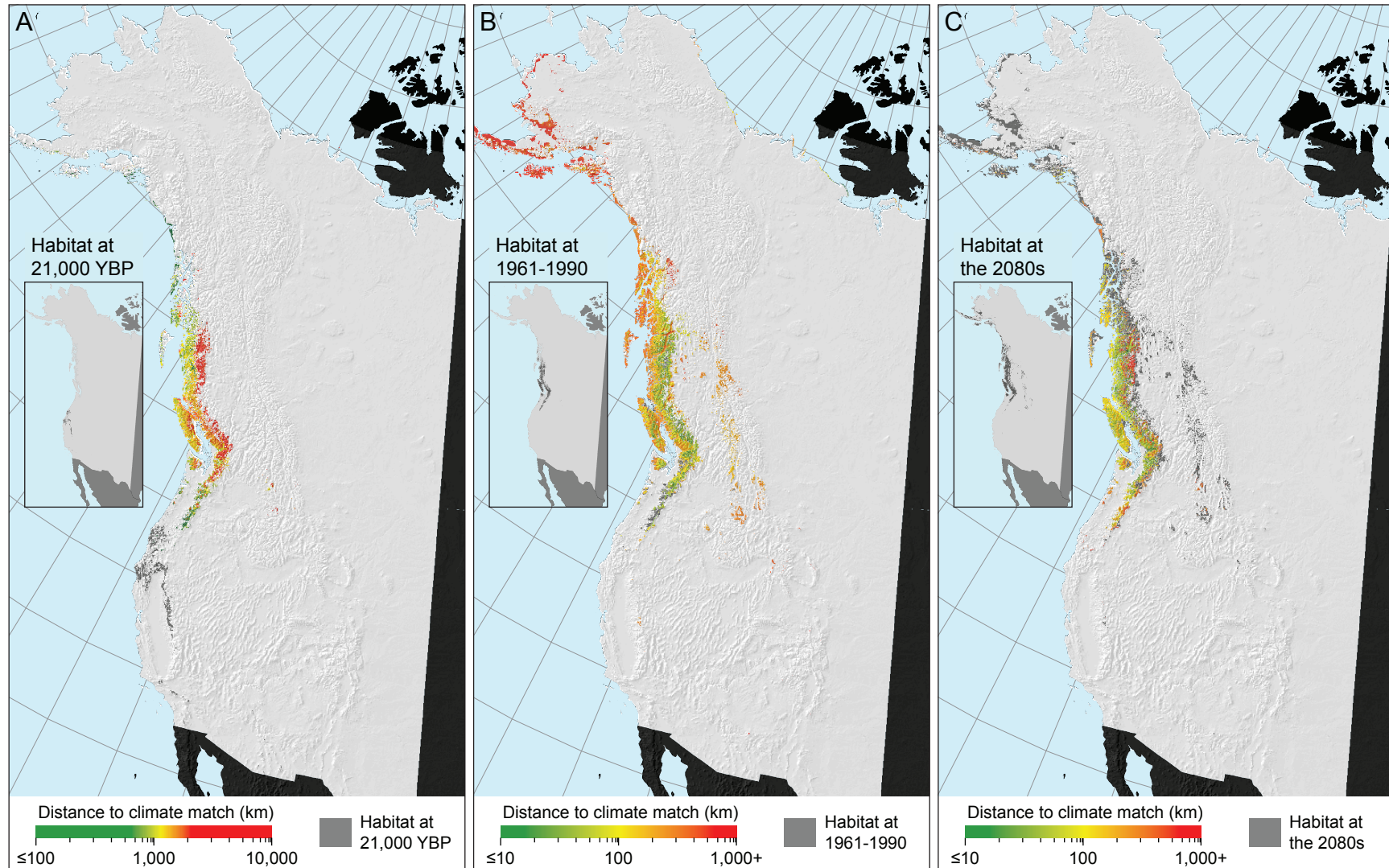


Figure A3: *Abies amabilis* (Pacific silver fir) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

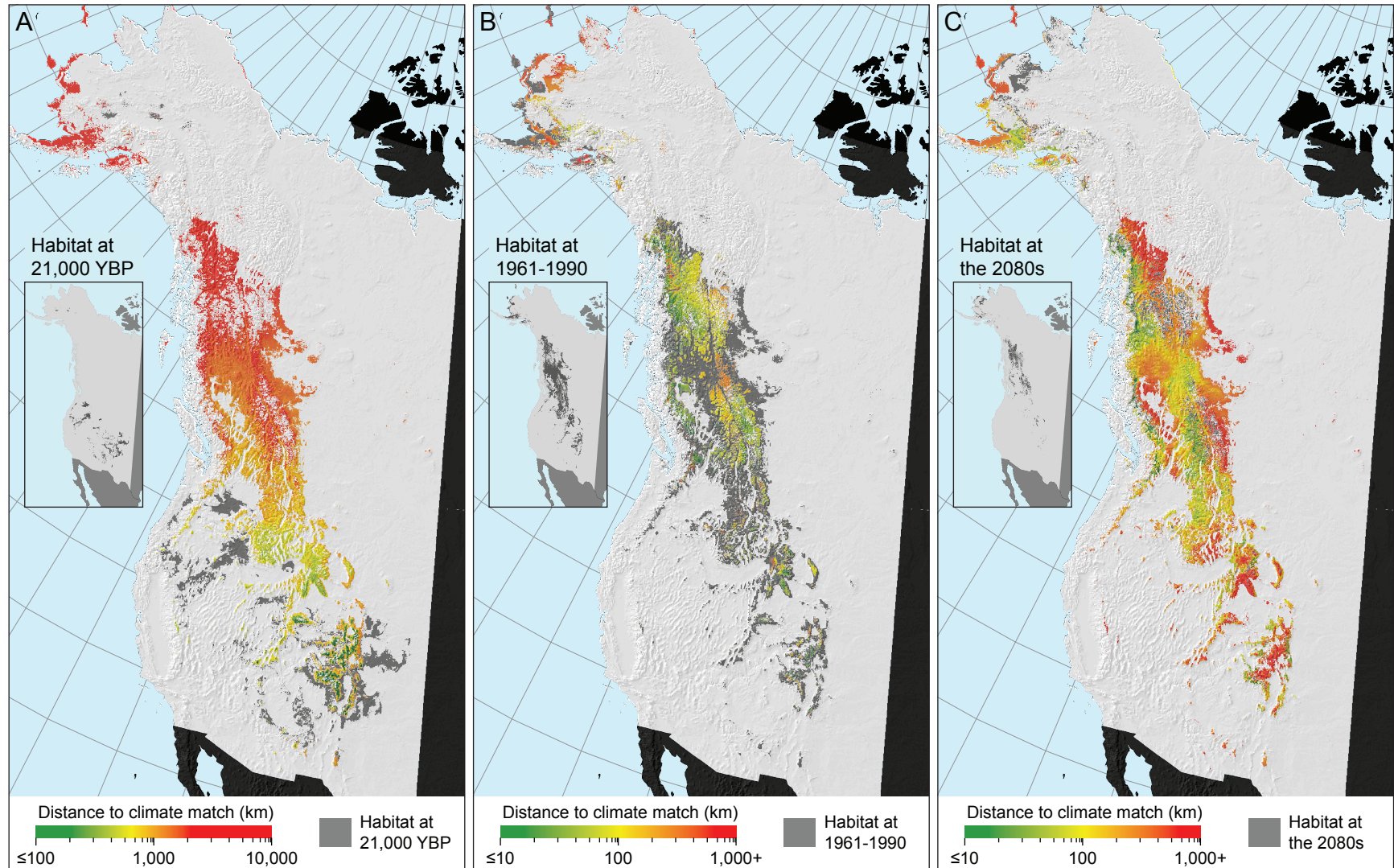


Figure A4: *Abies lasiocarpa* (subalpine fir) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

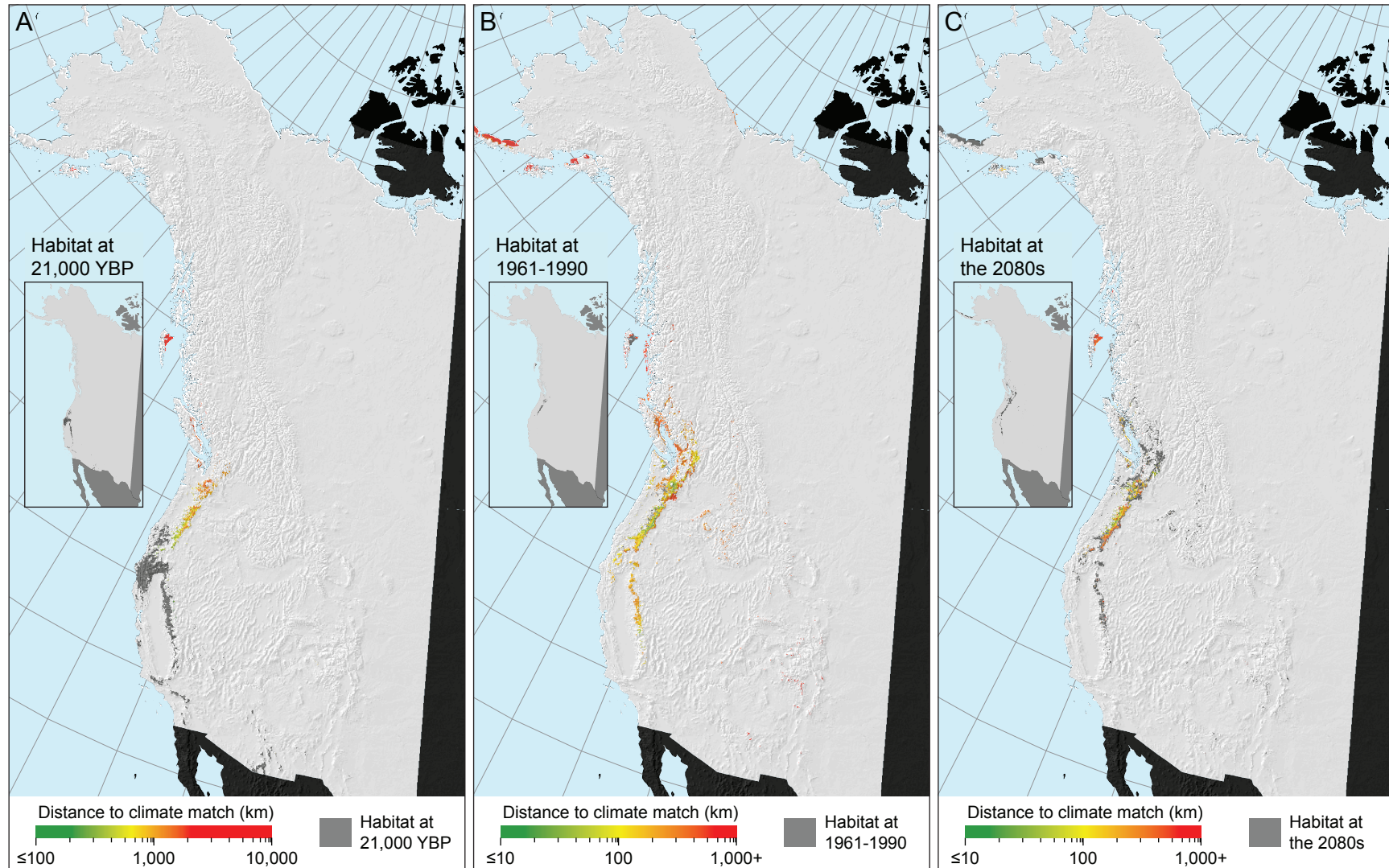


Figure A5: *Abies procera* (noble fir) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

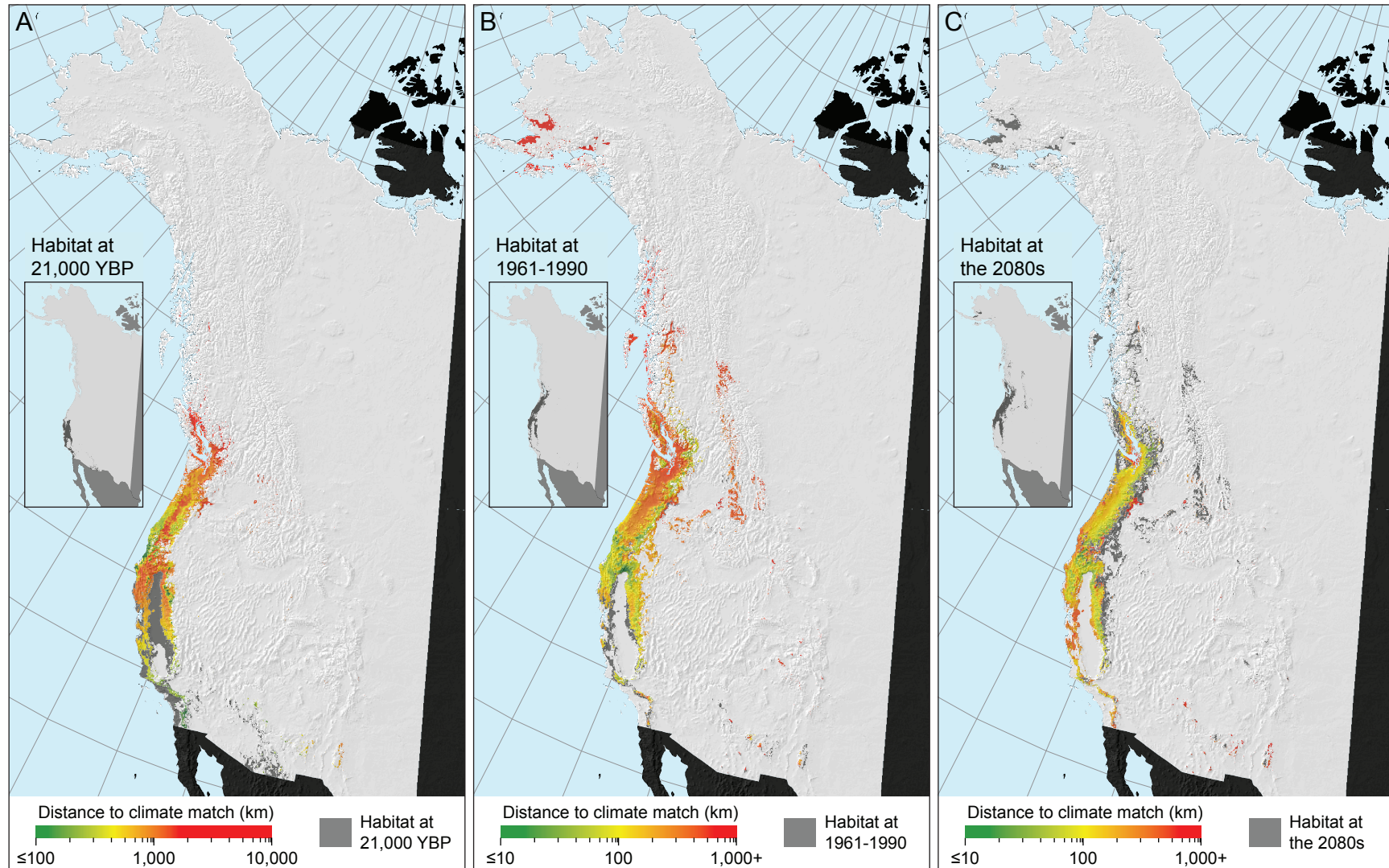


Figure A6: *Acer macrophyllum* (bigleaf maple) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

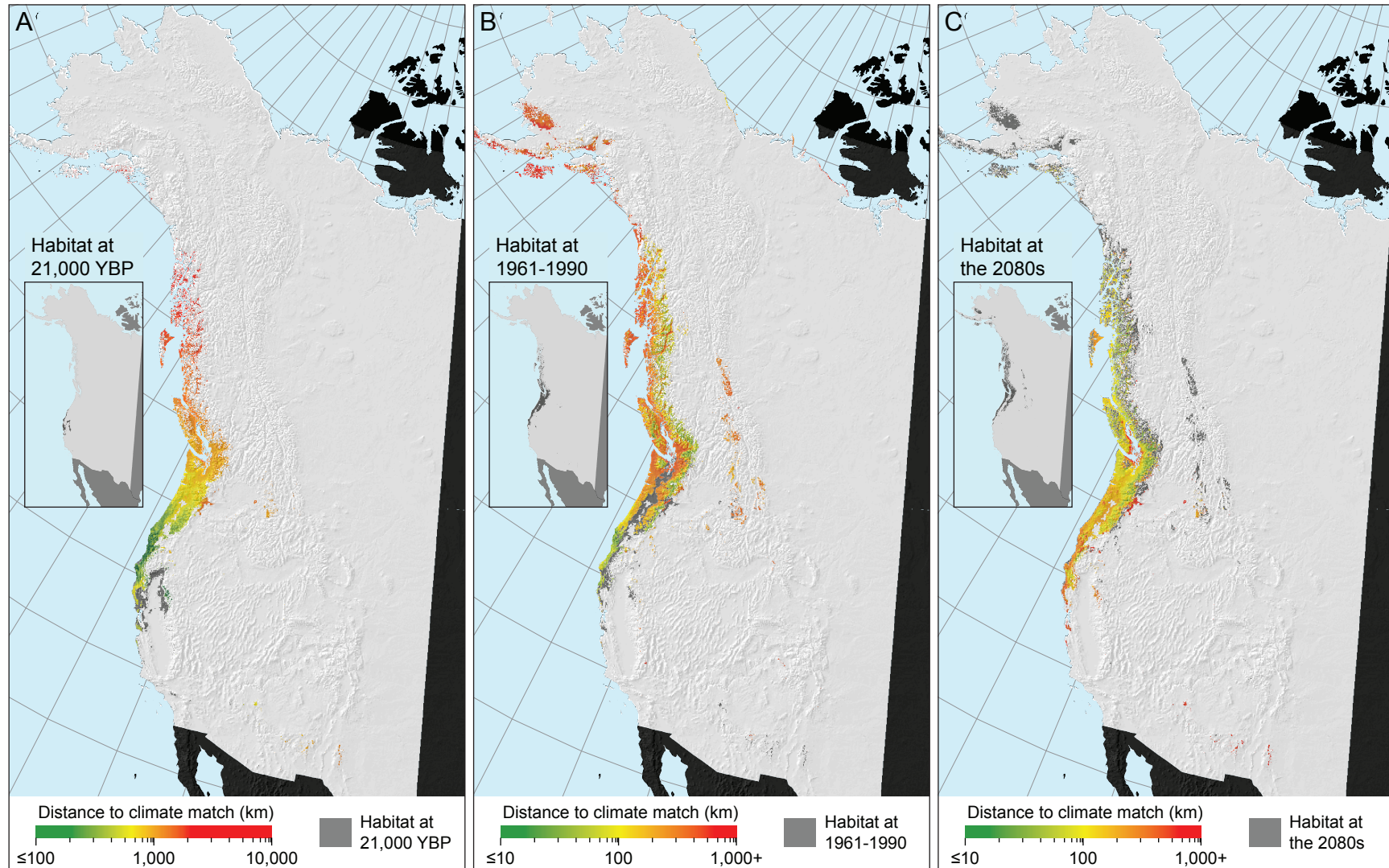


Figure A7: *Alnus rubra* (red alder) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

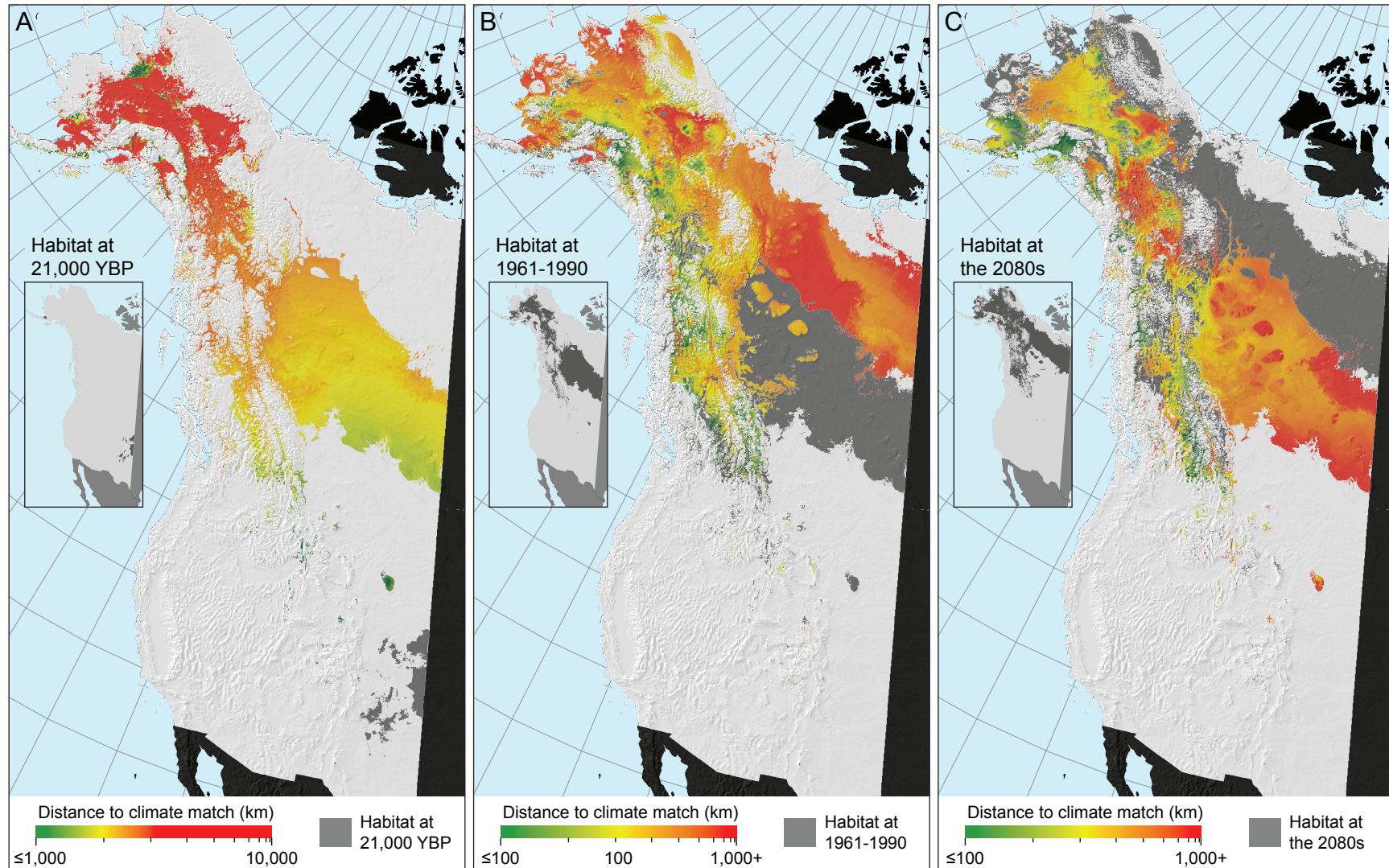


Figure A8: *Betula papyrifera* (paper birch) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

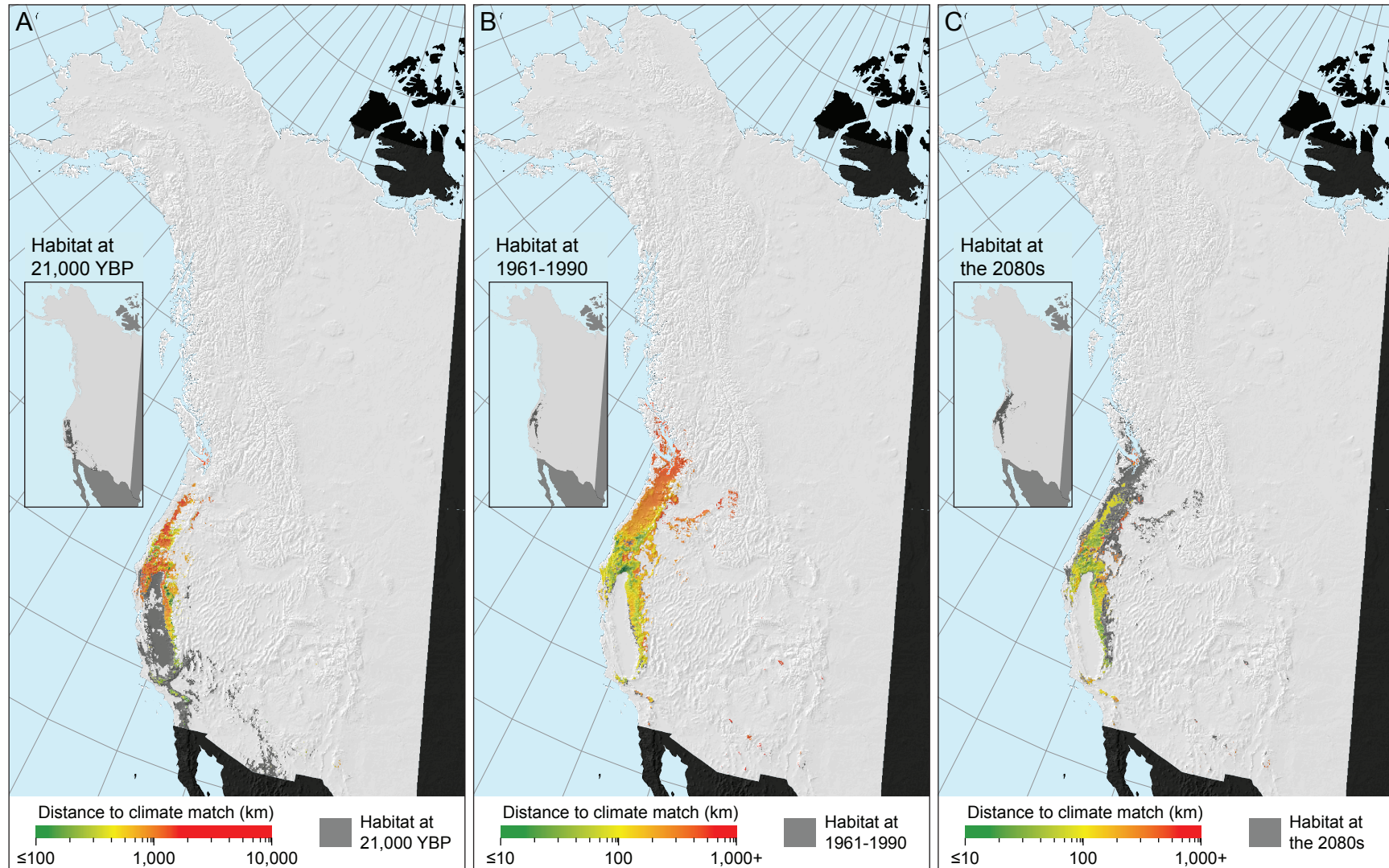


Figure A9: *Calocedrus decurrens* (incense cedar) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

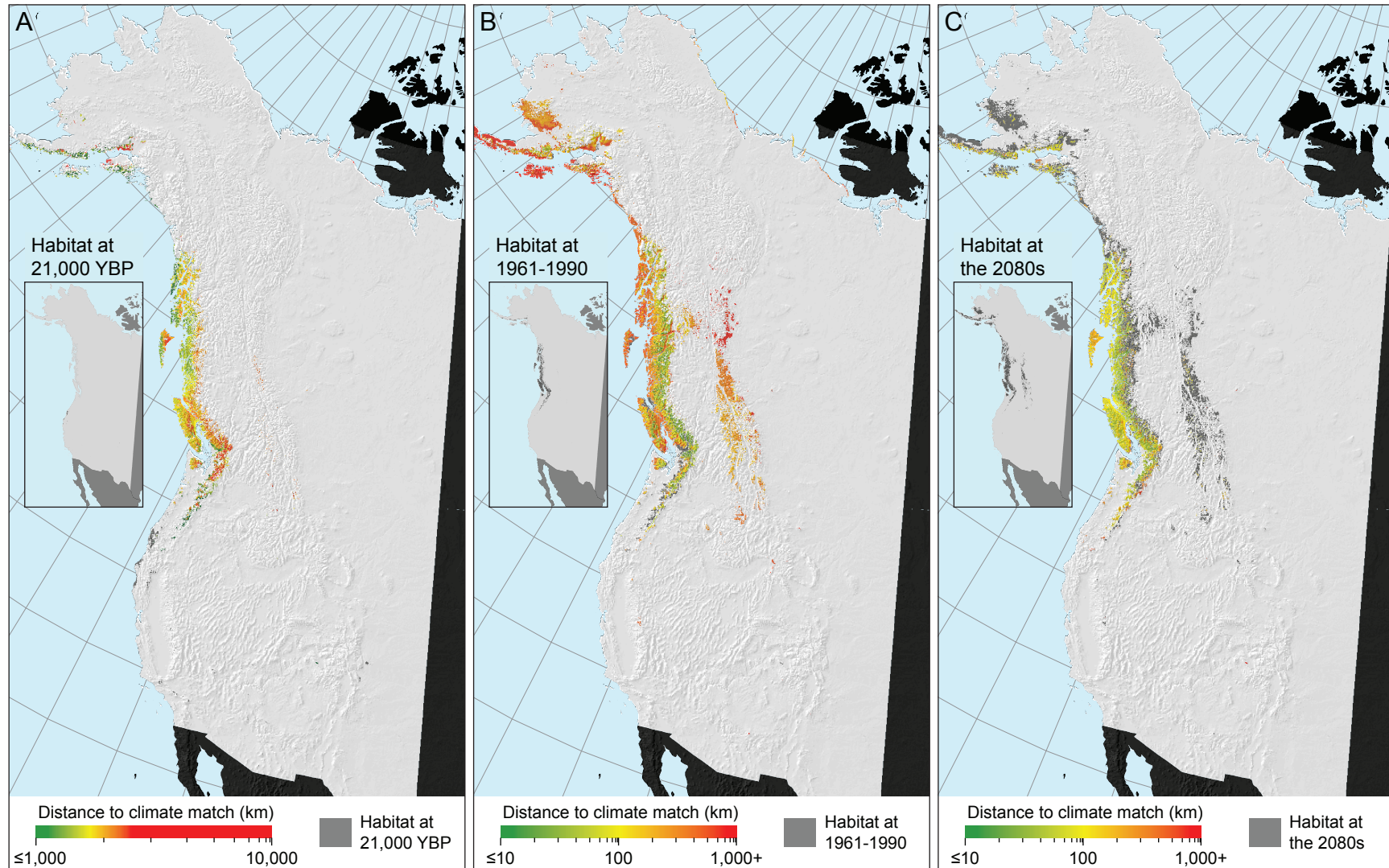


Figure A10: *Cupressus nootkatensis* (yellow cedar) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

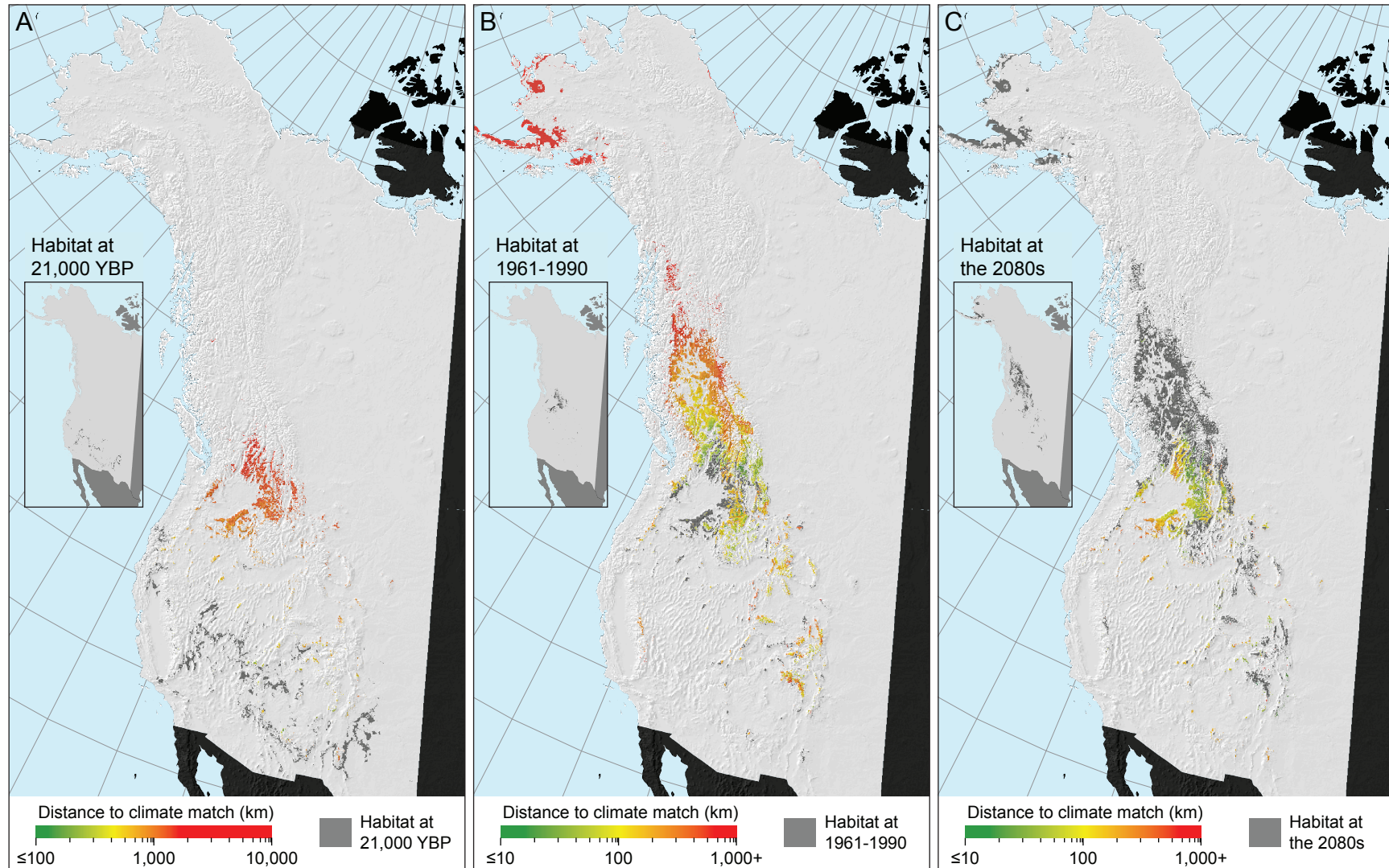


Figure A11: *Larix occidentalis* (western larch) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

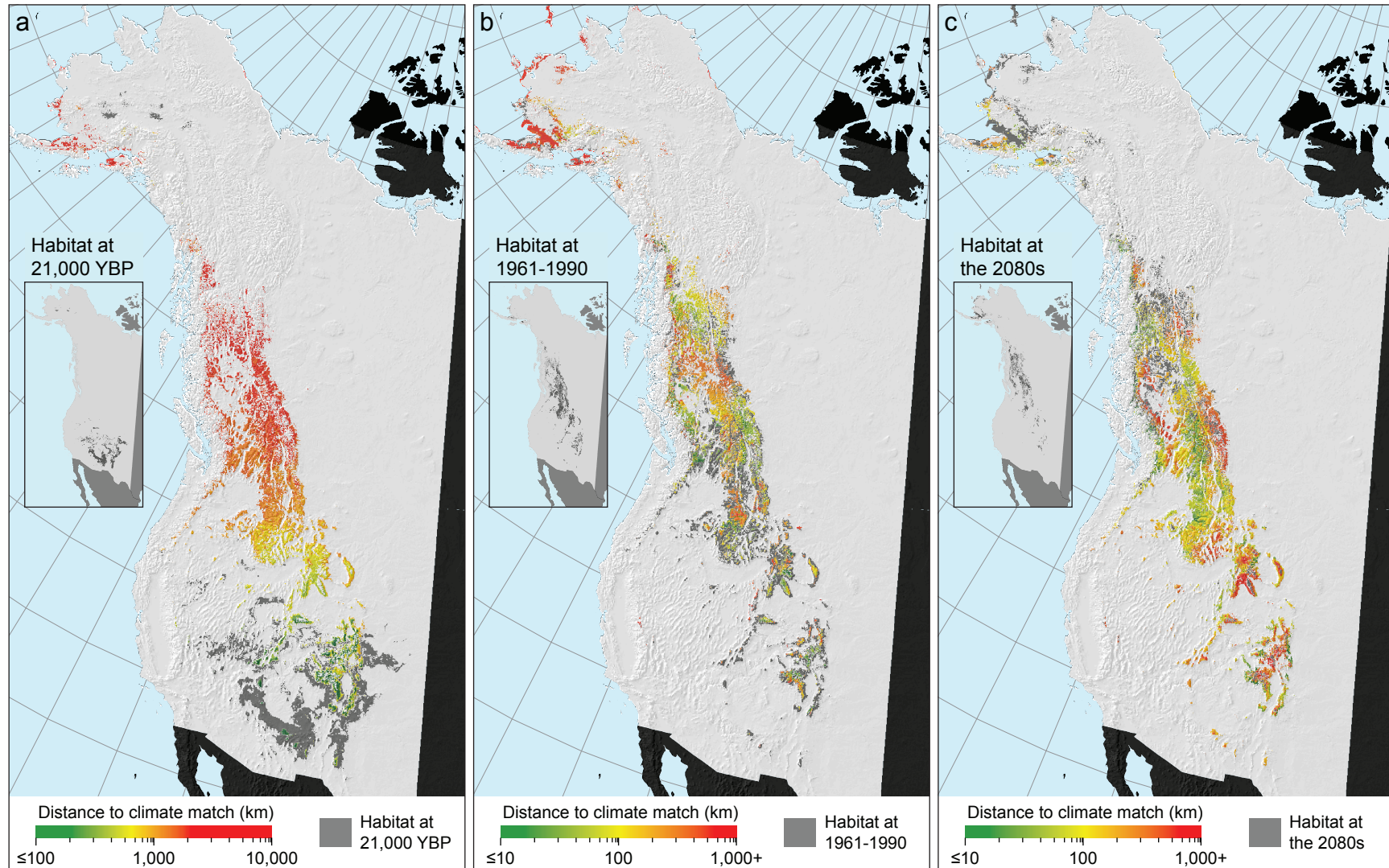


Figure A12: *Picea engelmannii* (Engelmann spruce) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

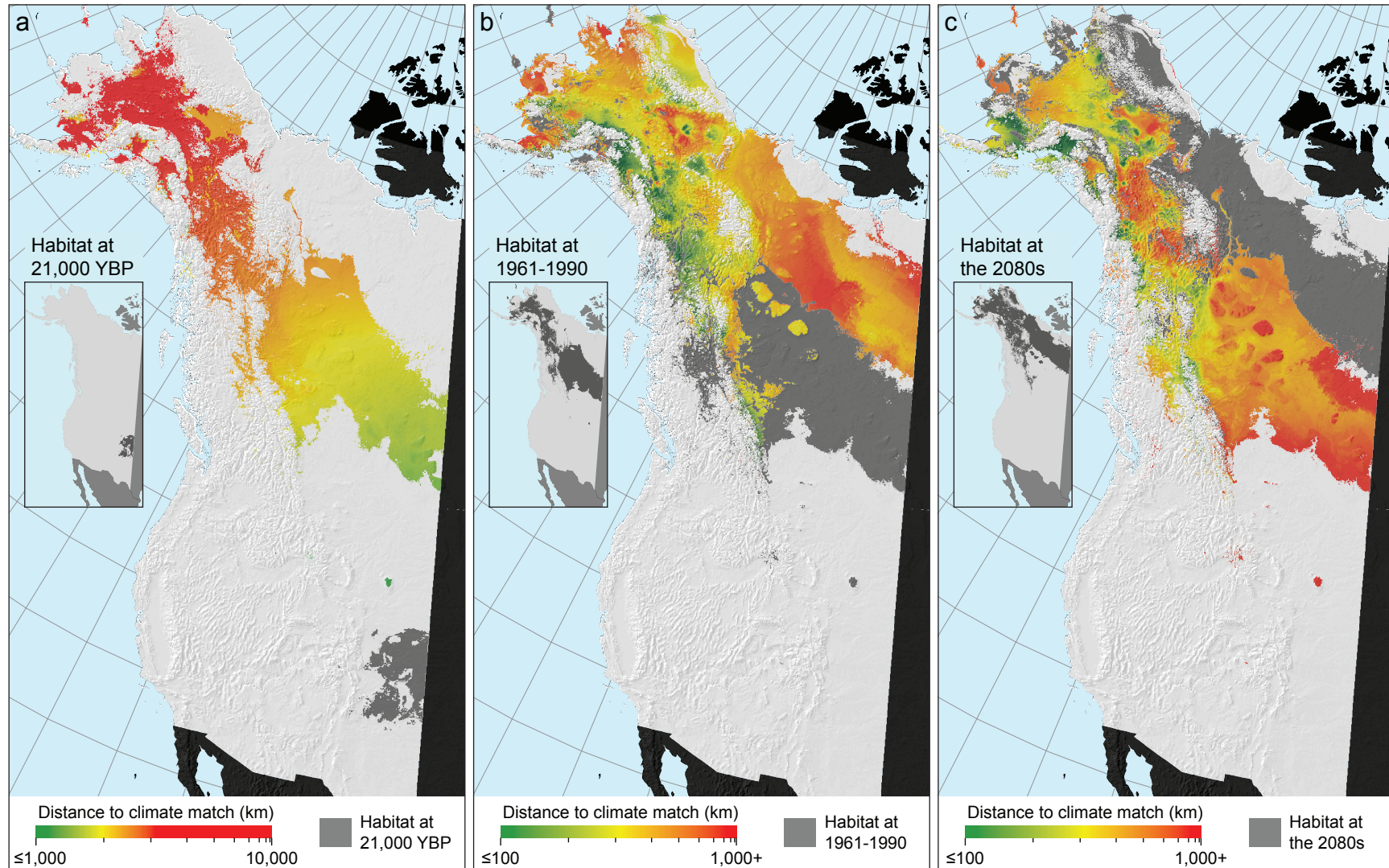


Figure A13: *Picea glauca* (white spruce) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

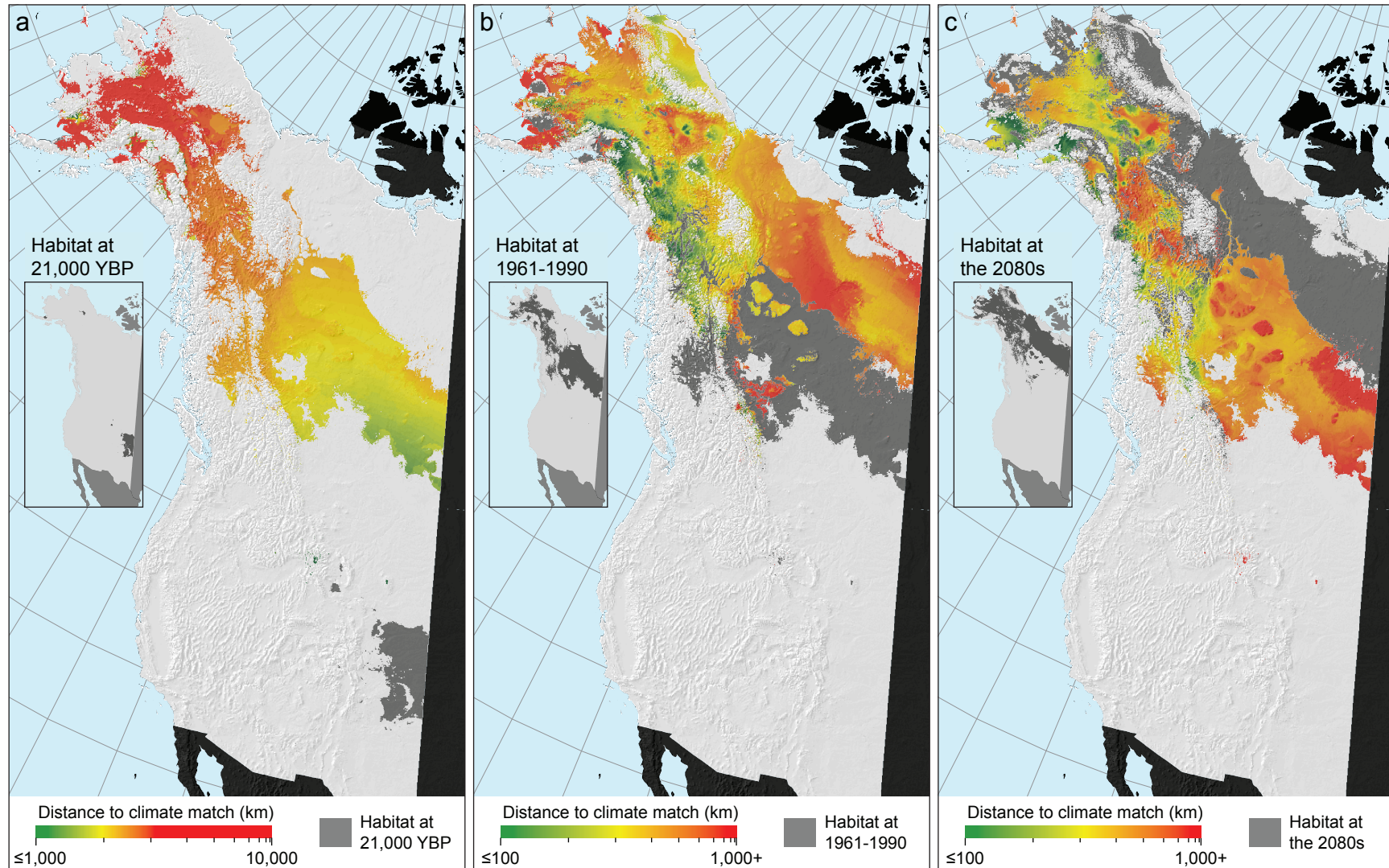


Figure A14: *Picea mariana* (black spruce) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

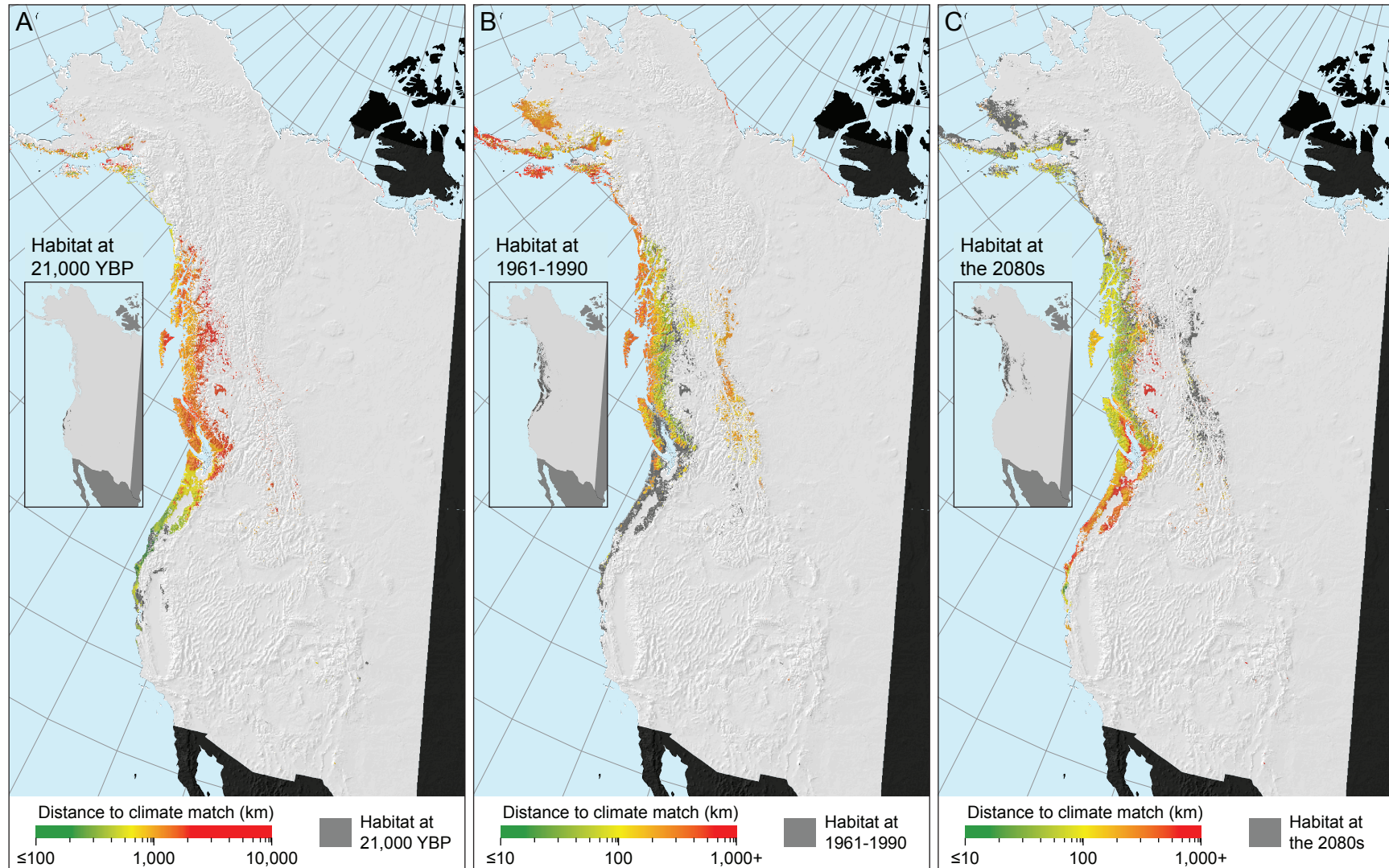


Figure A15: *Picea sitchensis* (sitka spruce) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

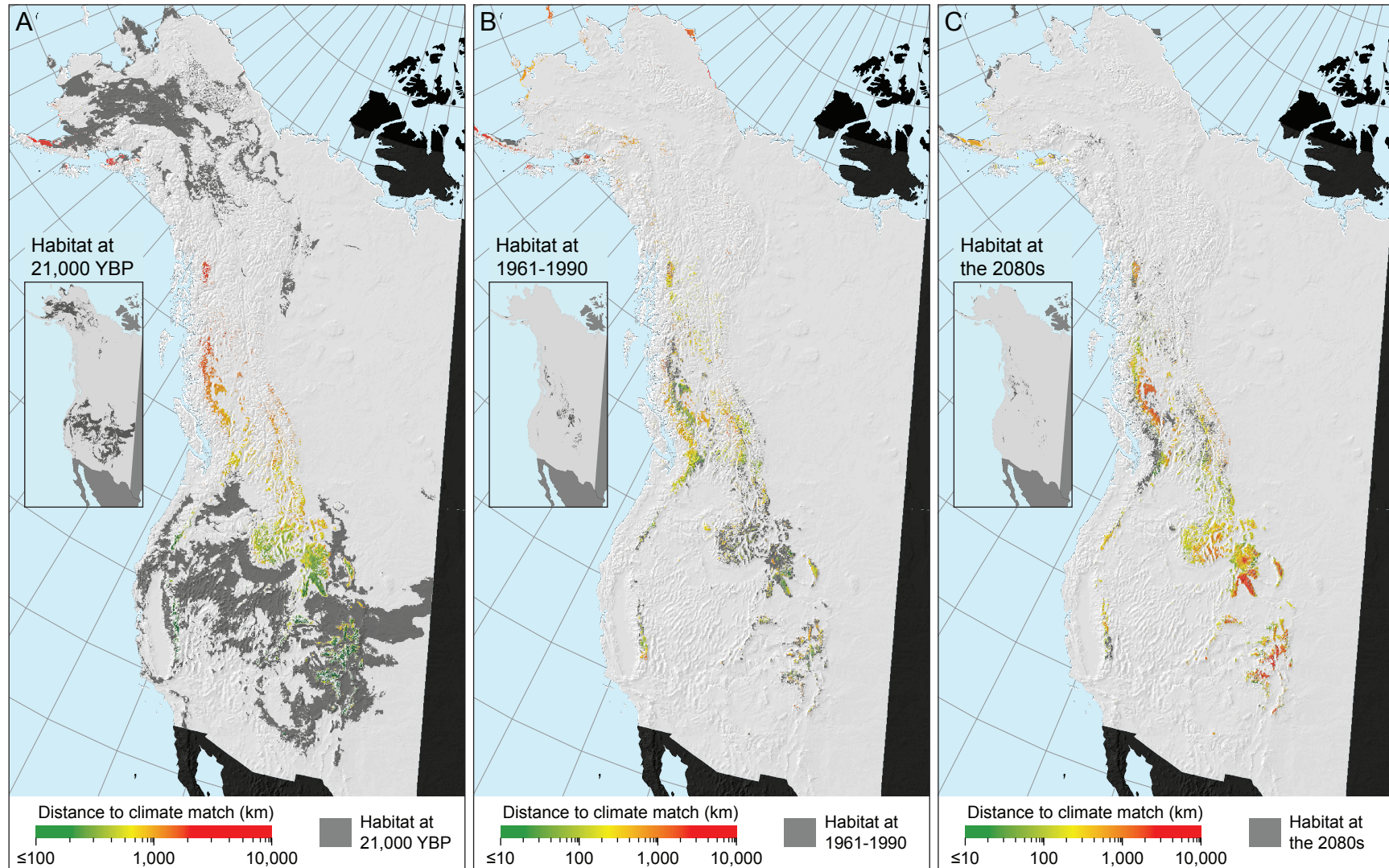


Figure A16: *Pinus albicaulis* (whitebark pine) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing post-glacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

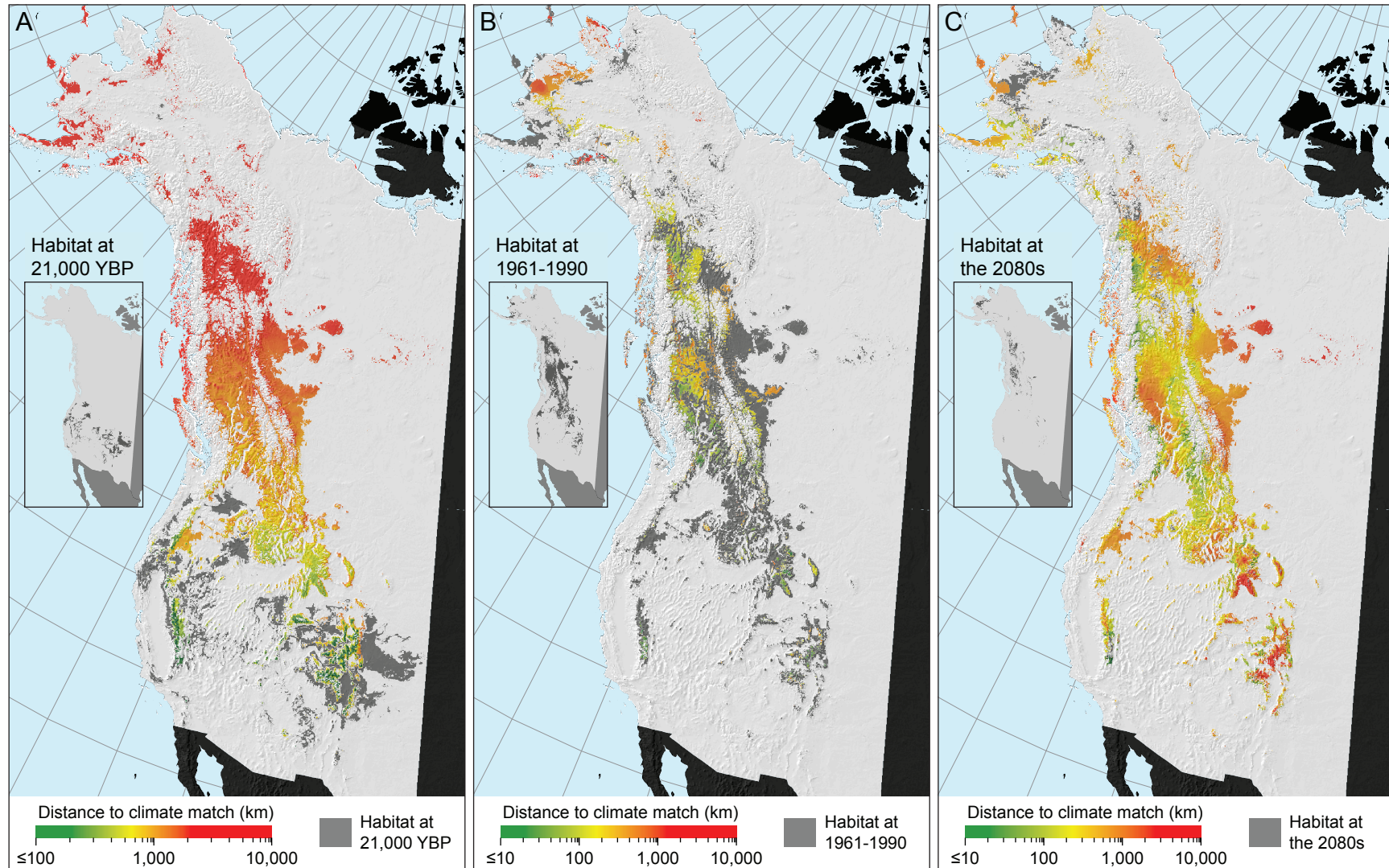


Figure A17: *Pinus contorta* (lodgepole pine) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

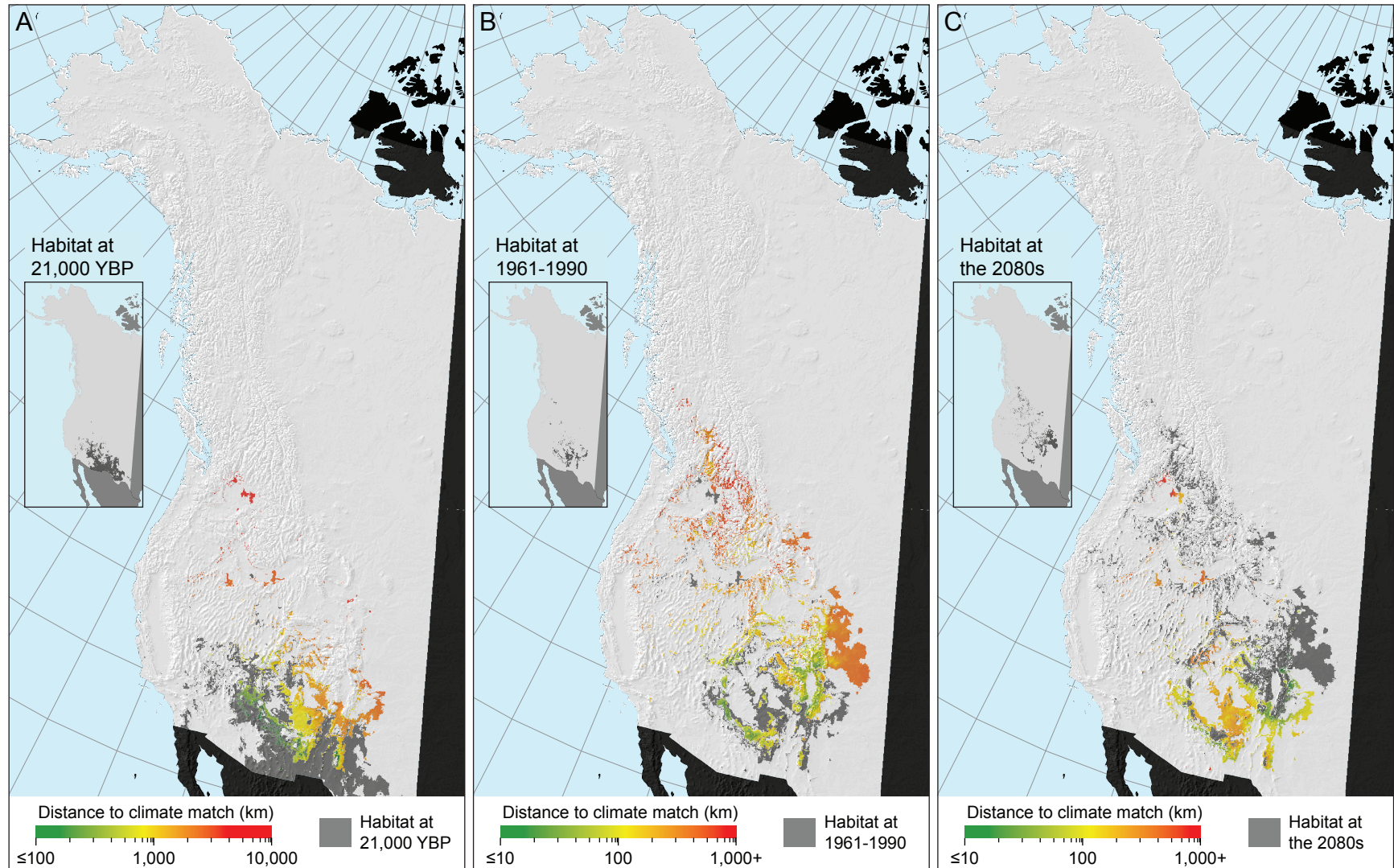


Figure A18: *Pinus edulis* (pinyon pine) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

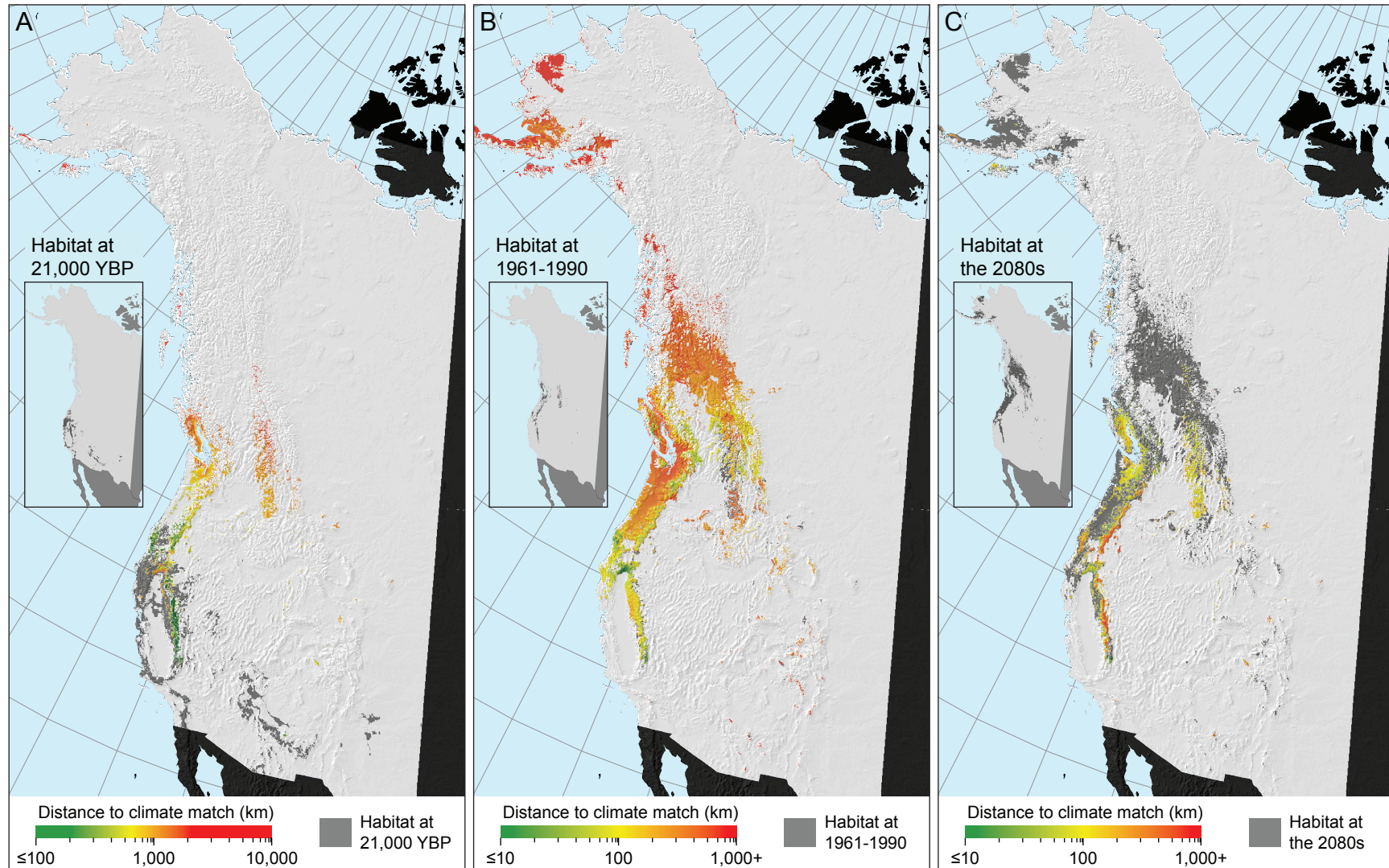


Figure A19: *Pinus monticola* (western white pine) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

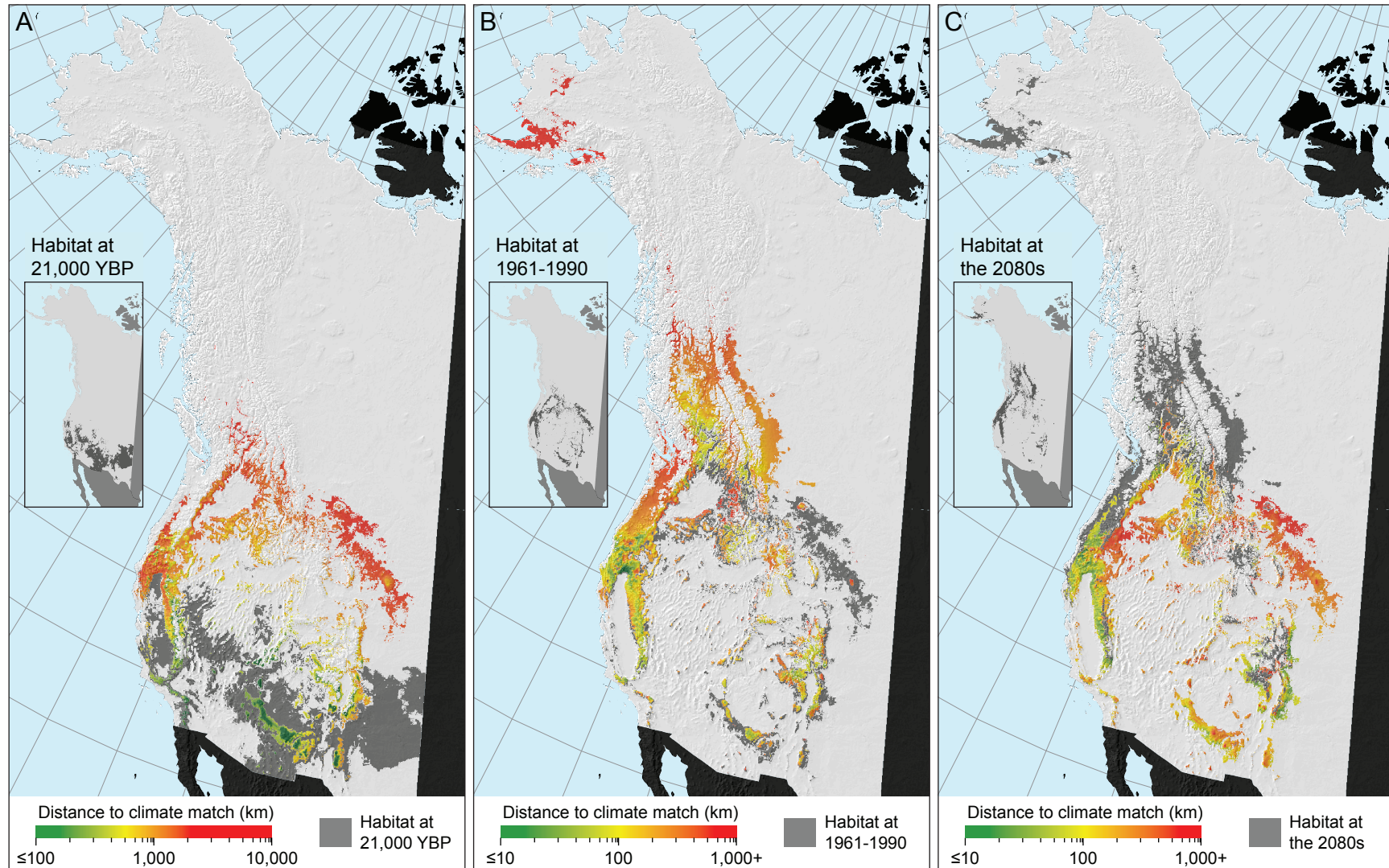


Figure A20: *Pinus ponderosa* (ponderosa pine) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

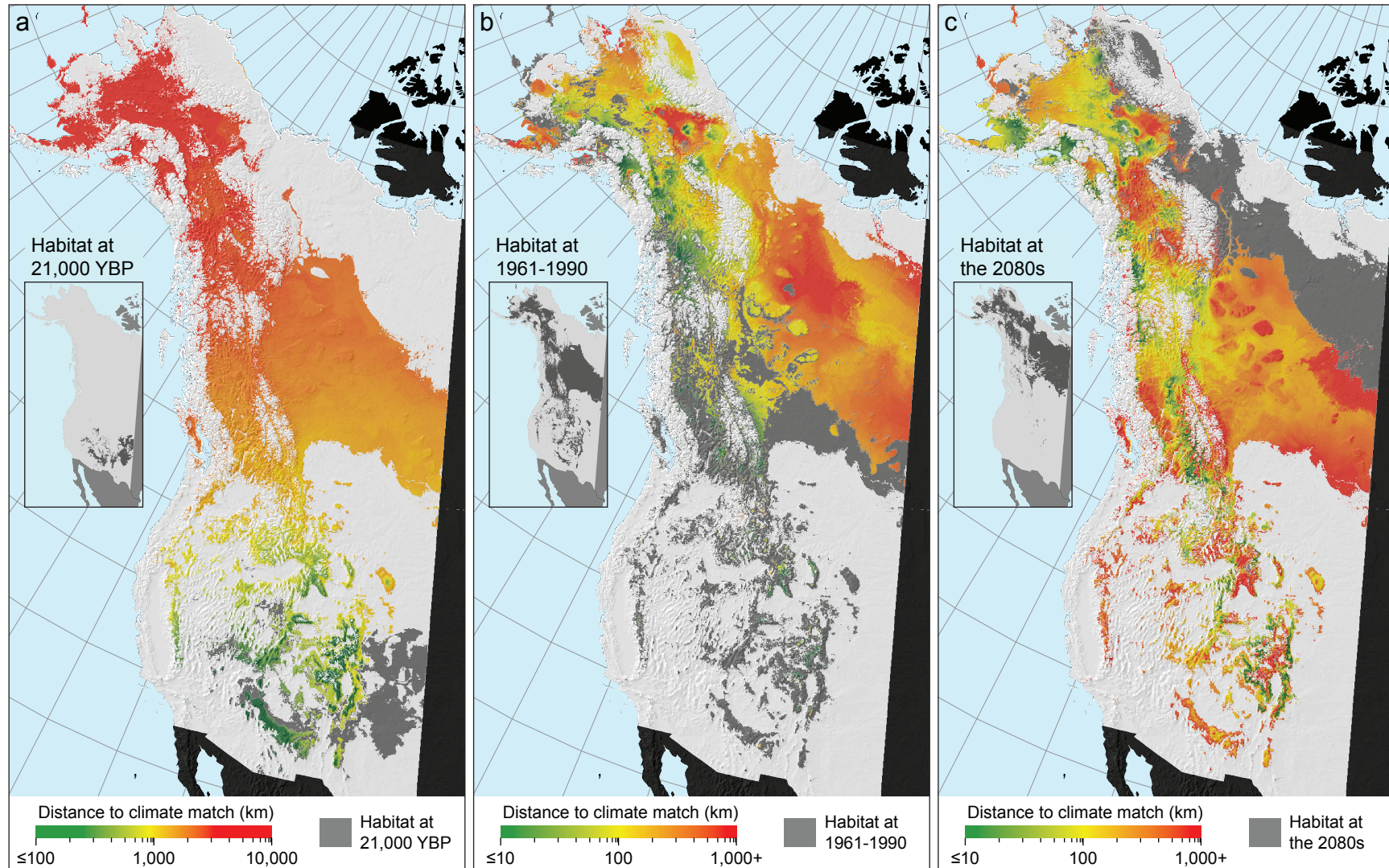


Figure A21: *Populus tremuloides* (trembling aspen) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

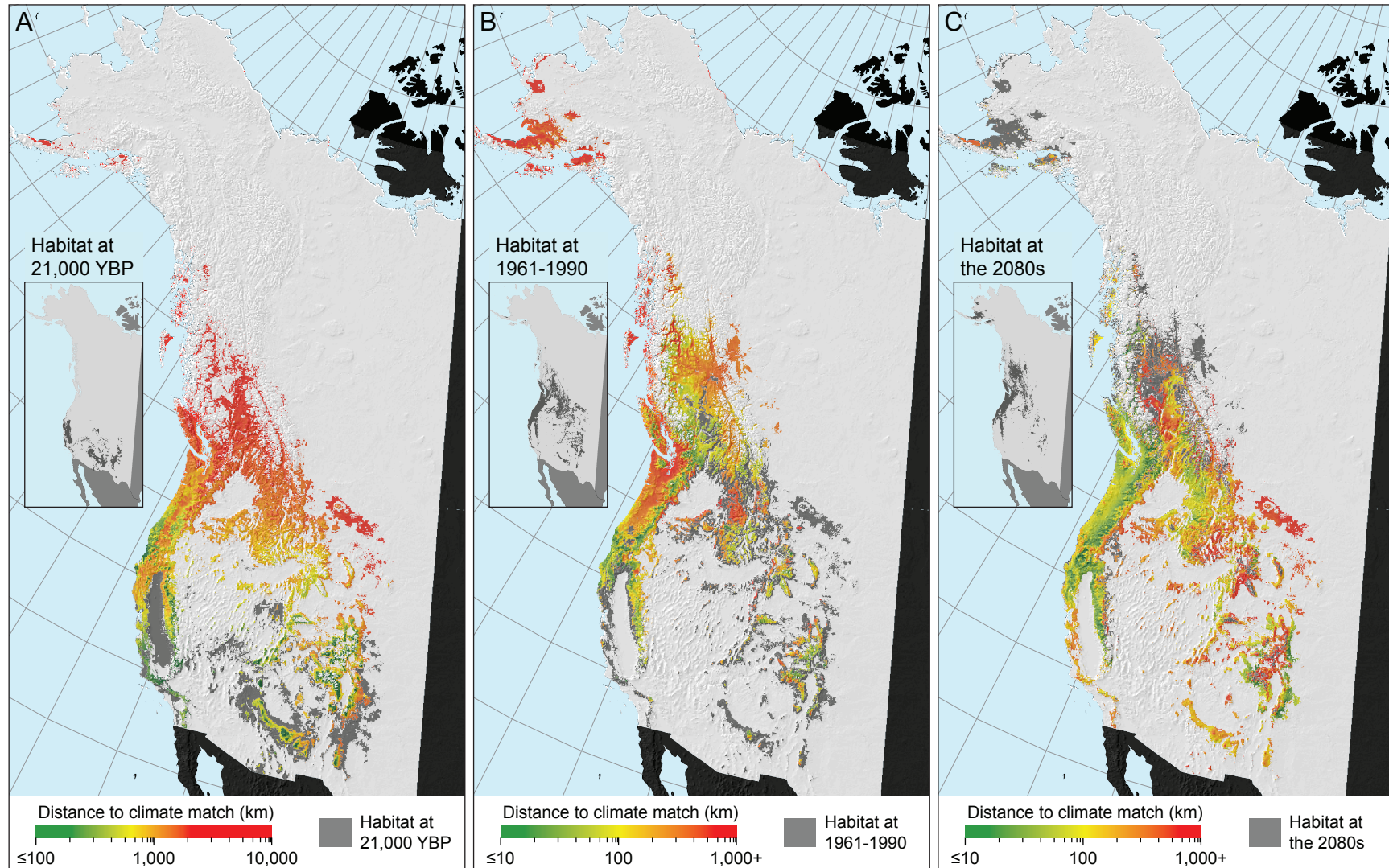


Figure A22: *Pseudotsuga menziesii* (Douglas-fir) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

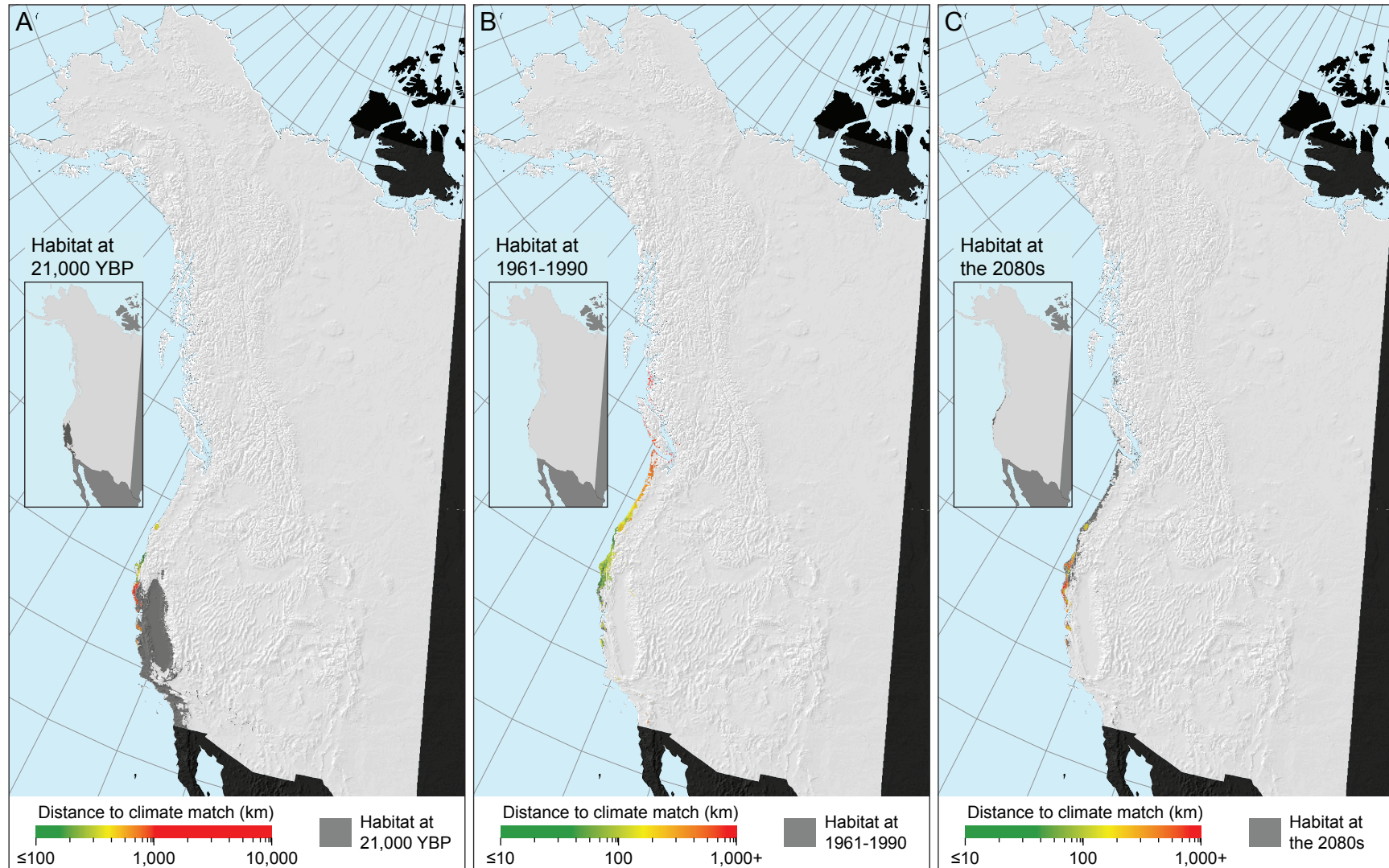


Figure A23: *Sequoia sempervirens* (coast redwood) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

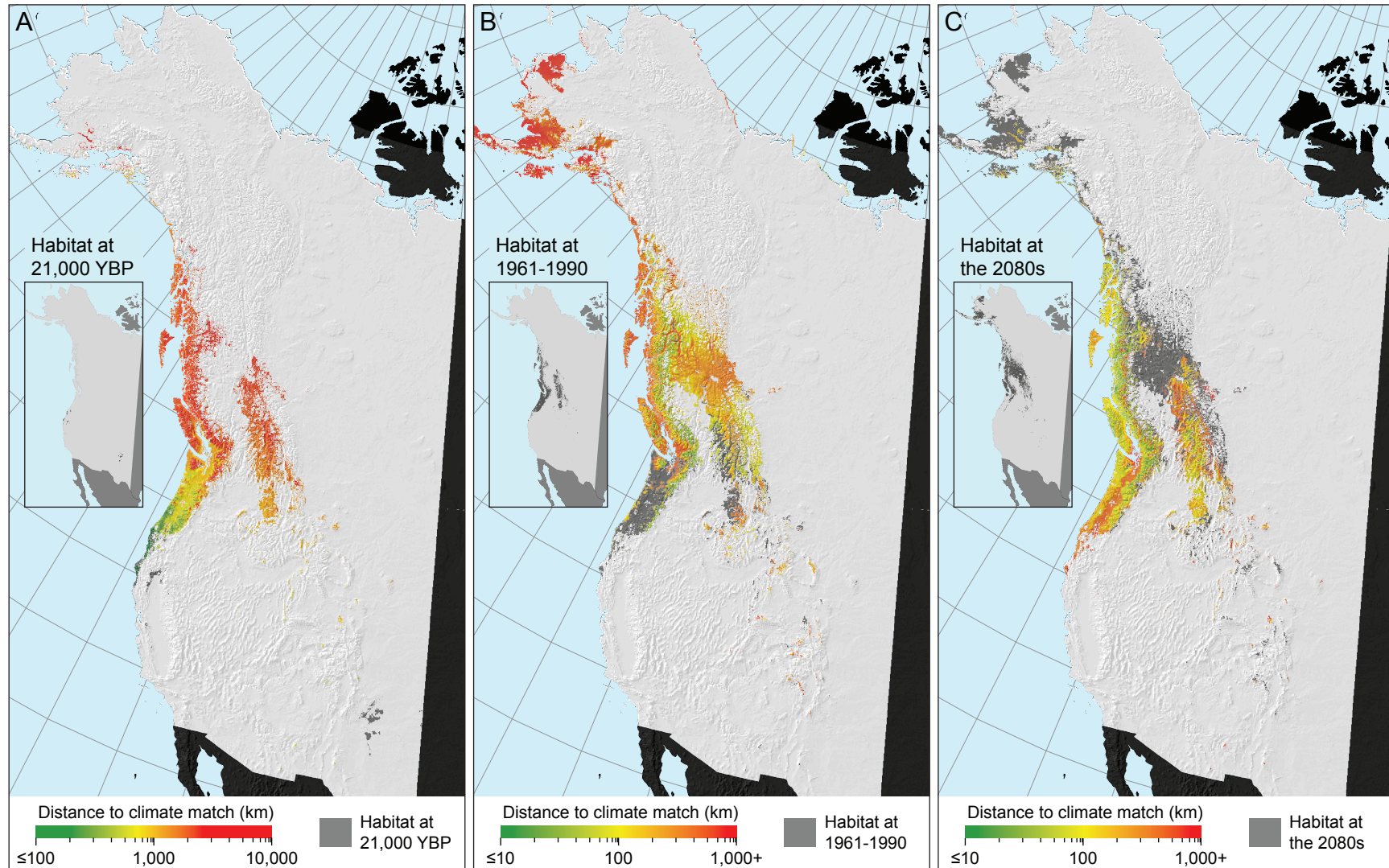


Figure A24: *Thuja plicata* (western redcedar) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

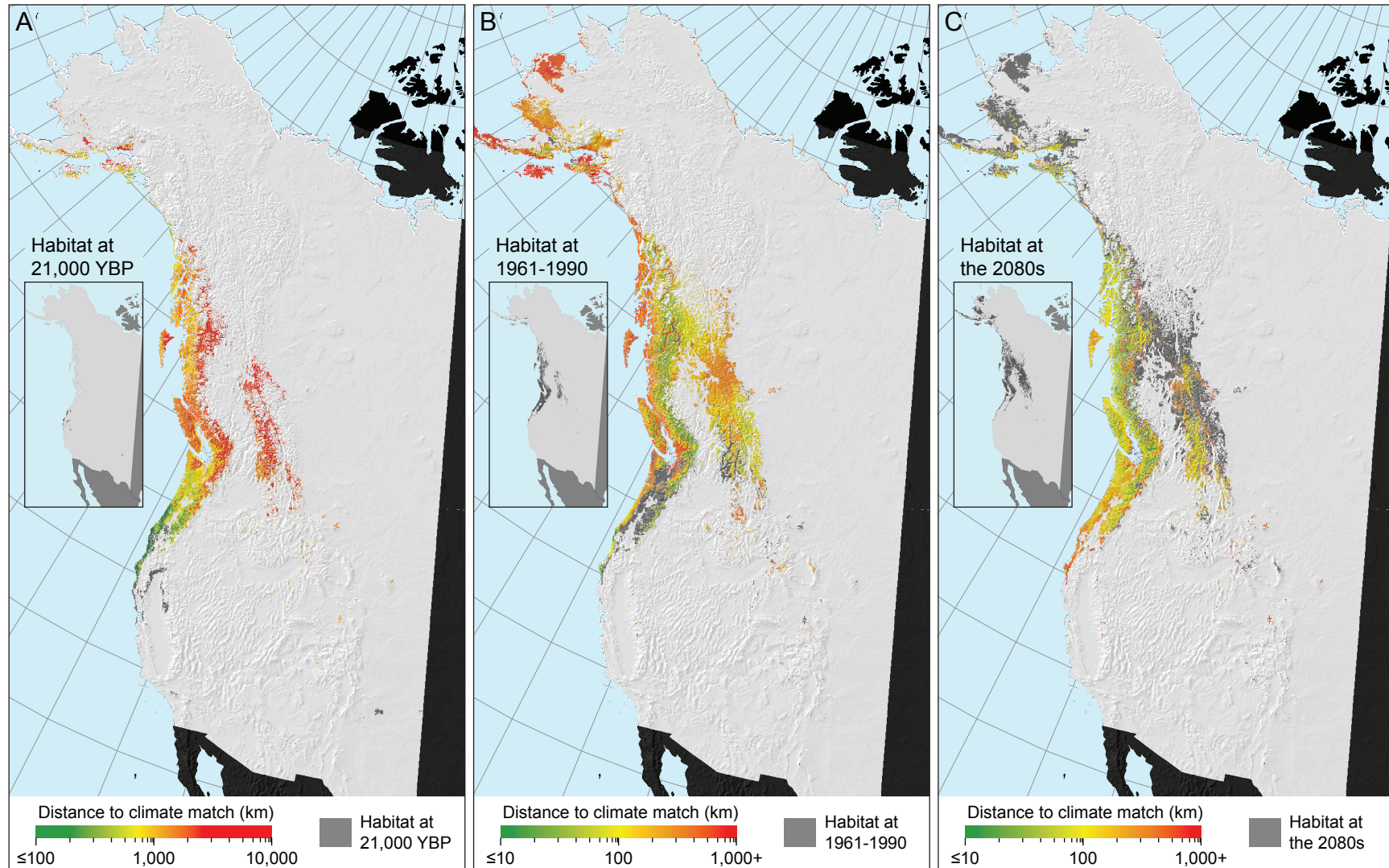


Figure A25: *Tsuga heterophylla* (western hemlock) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

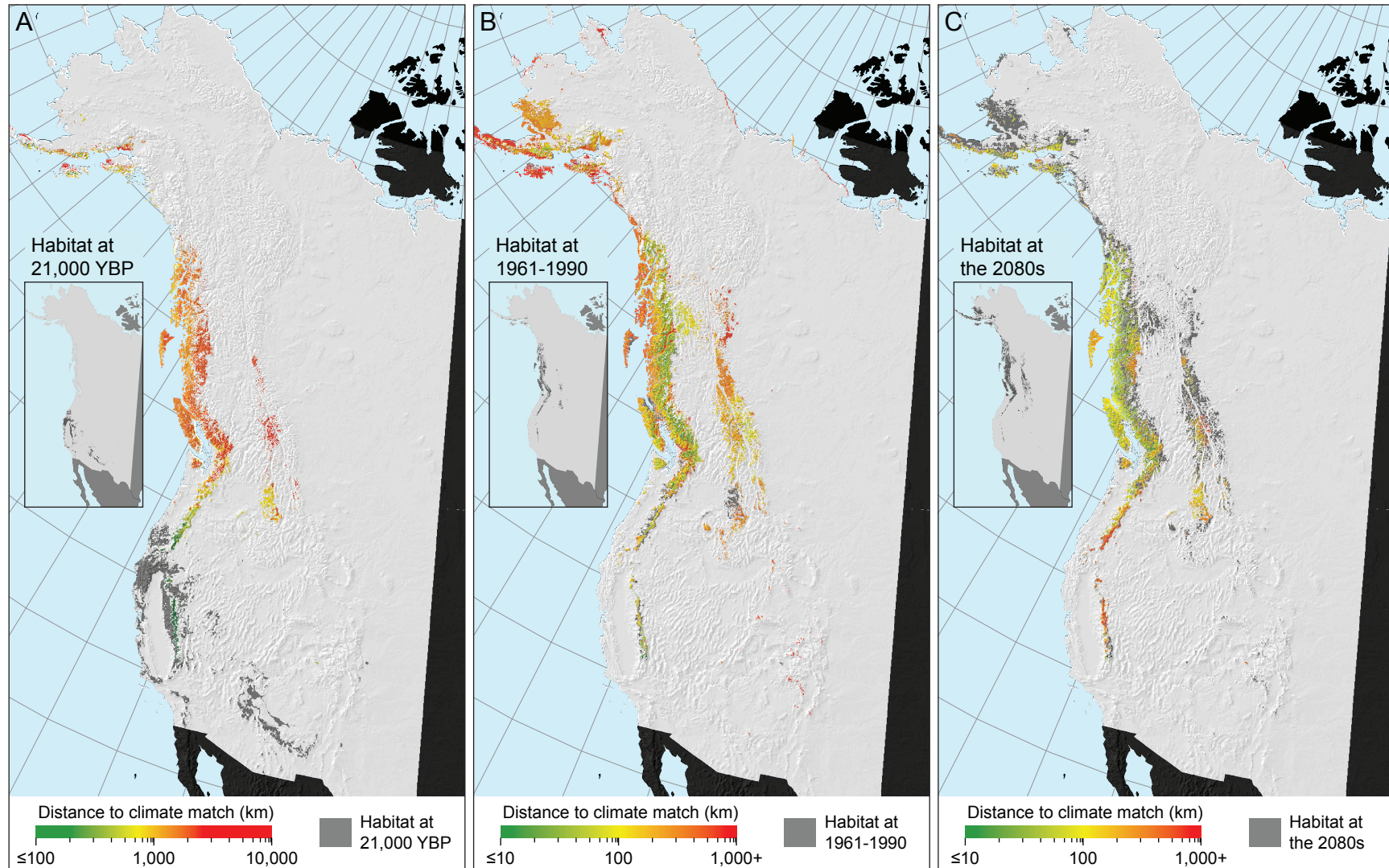


Figure A26: *Tsuga mertensiana* (mountain hemlock) distance maps for the past and future showing the distance to the nearest climate match, (A) as a backward calculation from the 1961-1990 climate normal period the last glacial maximum 21,000 years ago, representing postglacial migration rates, (B) from projected climate for the 2080s period to the 1961-1990 normal period, representing the future migration requirement to fill available habitat, and (C) as a forward calculation from the 1961-1990 normal period to the 2080s, representing the distance to future climate equivalents for current populations.

Appendix 2 - Supplementary Tables

A1	Required migration distances for 24 North American tree species	2
A2	Required migration rates for 24 North American tree species	3
A3	Palaeoecological sites and references	4

Table A1: Required migration distances for 24 North American tree species, listed by biogeographic zone. For each species, the 5th percentile (p05), median (p50), and 95th percentile (p95) distances (in kilometres) are given. The forward calculations measure how far individual populations must travel to find suitable habitat in a subsequent time period: from the last glacial maximum (LGM) to the present day (Pres) or from the present day to the 2080s. The reverse calculations measure from how far populations must have travelled for climate habitat in subsequent time periods to be occupied by suitable adapted genotypes: from the present to the last glacial maximum and from the 2080s to the present.

Species name	Forward calculations						Reverse calculations					
	LGM to Pres			Pres to 2080s			Pres to LGM			2080s to Pres		
	p05	p50	p95	p05	p50	p95	p05	p50	p95	p05	p50	p95
<u>Mesic: coastal only</u>												
1. <i>Abies amabilis</i> (Pacific silver fir)	227	453	1632	32	101	626	764	1398	2379	48	388	1701
2. <i>Abies procera</i> (noble fir)	199	459	1524	43	251	958	409	1013	2463	90	476	2356
3. <i>Acer macrophyllum</i> (big leaf maple)	166	578	1273	40	118	474	278	839	1474	49	303	1674
4. <i>Alnus rubra</i> (red alder)	174	410	891	40	122	539	309	978	2154	48	359	1170
5. <i>Calocedrus decurrens</i> (incense cedar)	138	312	1105	37	100	543	264	798	1306	49	270	709
6. <i>Cupressus nootkatensis</i> (yellow cedar)	227	442	2211	34	98	357	899	1647	2537	52	351	1302
7. <i>Picea sitchensis</i> (Sitka spruce)	204	525	1406	43	191	1356	454	1478	2654	50	302	1187
8. <i>Sequoia sempervirens</i> (coast redwood)	188	384	946	115	407	986	214	578	1009	66	199	1043
Group Average	190	445	1374	48	174	730	449	1091	1997	57	331	1393
<u>Mesic: coastal & interior</u>												
9. <i>Pinus monticola</i> (western white pine)	144	382	1147	43	132	548	219	957	1891	76	423	1406
10. <i>Pseudotsuga menziesii</i> (Douglas-fir)	175	469	1050	52	265	1212	285	1004	2066	53	254	758
11. <i>Thuja plicata</i> (western redcedar)	187	531	1349	42	156	617	589	1792	2616	58	305	1177
12. <i>Tsuga heterophylla</i> (western hemlock)	151	335	1271	39	128	493	502	1576	2849	52	266	924
13. <i>Tsuga mertensiana</i> (mountain hemlock)	219	601	1882	34	110	494	365	1602	2566	50	293	1166
Group Average	175	464	1340	42	158	673	392	1386	2398	58	308	1086
<u>Boreal & sub-boreal</u>												
14. <i>Betula papyrifera</i> (paper birch)	411	1406	1859	140	521	1130	1473	2024	3522	137	428	938
15. <i>Picea glauca</i> (White spruce)	1062	1451	2227	174	531	1150	1453	2163	3723	162	451	912
16. <i>Picea mariana</i> (black spruce)	449	1908	3226	179	527	1076	1451	2058	3524	169	476	1014
17. <i>Pinus contorta</i> (lodgepole pine)	205	626	1530	122	484	1420	397	1410	3366	67	216	744
18. <i>Populus tremuloides</i> (trembling aspen)	250	666	1444	170	546	1316	541	1909	3952	157	492	968
Group Average	475	1211	2057	157	522	1218	1063	1913	3617	138	413	915
<u>Sub-alpine</u>												
19. <i>Abies lasiocarpa</i> (subalpine fir)	261	613	1574	94	416	1286	490	1373	3326	57	179	672
20. <i>Picea engelmannii</i> (Engelmann spruce)	224	534	1056	78	327	1210	304	1309	2545	68	244	792
21. <i>Pinus albicaulis</i> (whitebark pine)	326	906	2175	110	466	2072	155	712	1731	86	411	1968
Group Average	270	684	1602	94	403	1523	316	1131	2534	70	278	1144
<u>Xeric & sub-xeric</u>												
22. <i>Larix occidentalis</i> (western larch)	542	964	1357	73	210	599	578	1123	1493	120	429	2426
23. <i>Pinus edulis</i> (pinyon pine)	228	392	707	56	184	504	262	656	1152	100	612	1503
24. <i>Pinus ponderosa</i> (ponderosa pine)	184	660	1666	49	258	817	262	929	1482	63	286	1944
Group Average	318	672	1243	59	217	640	367	903	1376	94	442	1958
Overall Average	273	667	1521	77	277	908	538	1305	2408	80	351	1269

Table A2: Required migration rates for 24 North American tree species, listed by biogeographic zone. For each species, the 5th percentile (p05), median (p50), and 95th percentile (p95) rates (in metres per year) are given. The forward calculations measure how fast individual populations must travel to find suitable habitat in a subsequent time period: from the last glacial maximum (LGM) to the present day (Pres) or from the present day to the 2080s. The reverse calculations measure how fast populations must have travelled for climate habitat in subsequent time periods to be occupied by suitable adapted genotypes: from the present to the last glacial maximum or from the 2080s to the present. Post-glacial and future rates are calculated as distances (Table A1) divided by 21,000 years or 110 years, respectively.

Species name	Forward calculations						Reverse calculations					
	LGM to Pres			Pres to 2080s			Pres to LGM			2080s to Pres		
	p05	p50	p95	p05	p50	p95	p05	p50	p95	p05	p50	p95
<u>Mesic: coastal only</u>												
1. <i>Abies amabilis</i> (Pacific silver fir)	11	22	78	291	918	5691	36	67	113	436	3527	15464
2. <i>Abies procera</i> (noble fir)	9	22	73	391	2282	8709	19	48	117	818	4327	21418
3. <i>Acer macrophyllum</i> (big leaf maple)	8	28	61	364	1073	4309	13	40	70	445	2755	15218
4. <i>Alnus rubra</i> (red alder)	8	20	42	364	1109	4900	15	47	103	436	3264	10636
5. <i>Calocedrus decurrens</i> (incense cedar)	7	15	53	336	909	4936	13	38	62	445	2455	6445
6. <i>Cupressus nootkatensis</i> (yellow cedar)	11	21	105	309	891	3245	43	78	121	473	3191	11836
7. <i>Picea sitchensis</i> (Sitka spruce)	10	25	67	391	1736	12327	22	70	126	455	2745	10791
8. <i>Sequoia sempervirens</i> (coast redwood)	9	18	45	1045	3700	8964	10	28	48	600	1809	9482
Group Average	9	21	65	436	1577	6635	21	52	95	514	3009	12661
<u>Mesic: coastal & interior</u>												
9. <i>Pinus monticola</i> (western white pine)	7	18	55	391	1200	4982	10	46	90	691	3845	12782
10. <i>Pseudotsuga menziesii</i> (Douglas-fir)	8	22	50	473	2409	11018	14	48	98	482	2309	6891
11. <i>Thuja plicata</i> (western redcedar)	9	25	64	382	1418	5609	28	85	125	527	2773	10700
12. <i>Tsuga heterophylla</i> (western hemlock)	7	16	61	355	1164	4482	24	75	136	473	2418	8400
13. <i>Tsuga mertensiana</i> (mountain hemlock)	10	29	90	309	1000	4491	17	76	122	455	2664	10600
Group Average	8	22	64	382	1438	6116	19	66	114	525	2802	9875
<u>Boreal & sub-boreal</u>												
14. <i>Betula papyrifera</i> (paper birch)	20	67	89	1273	4736	10273	70	96	168	1245	3891	8527
15. <i>Picea glauca</i> (White spruce)	51	69	106	1582	4827	10455	69	103	177	1473	4100	8291
16. <i>Picea mariana</i> (black spruce)	21	91	154	1627	4791	9782	69	98	168	1536	4327	9218
17. <i>Pinus contorta</i> (lodgepole pine)	10	30	73	1109	4400	12909	19	67	160	609	1964	6764
18. <i>Populus tremuloides</i> (trembling aspen)	12	32	69	1545	4964	11964	26	91	188	1427	4473	8800
Group Average	23	58	98	1427	4744	11076	51	91	172	1258	3751	8320
<u>Sub-alpine</u>												
19. <i>Abies lasiocarpa</i> (subalpine fir)	12	29	75	855	3782	11691	23	65	158	518	1627	6109
20. <i>Picea engelmannii</i> (Engelmann spruce)	11	25	50	709	2973	11000	14	62	121	618	2218	7200
21. <i>Pinus albicaulis</i> (whitebark pine)	16	43	104	1000	4236	18836	7	34	82	782	3736	17891
Group Average	13	33	76	855	3664	13842	15	54	121	639	2527	10400
<u>Xeric & sub-xeric</u>												
22. <i>Larix occidentalis</i> (western larch)	26	46	65	664	1909	5445	28	53	71	1091	3900	22055
23. <i>Pinus edulis</i> (pinyon pine)	11	19	34	509	1673	4582	12	31	55	909	5564	13664
24. <i>Pinus ponderosa</i> (ponderosa pine)	9	31	79	445	2345	7427	12	44	71	573	2600	17673
Group Average	15	32	59	539	1976	5818	17	43	66	858	4021	17797
Overall Average	13	32	72	697	2519	8251	26	62	115	730	3187	11536

Table A3: Site information for the fossil pollen and macrofossil records used for comparison with modelled species ranges from the last glacial maximum (Supplementary material Appendix 1, Figure A1 and A2). For each site, the site name, latitude (Lat, in decimal degrees), longitude (Long, in decimal degrees), elevation above sea level (Elev, in metres), and associated reference are provided. Sites were drawn from the North American Pollen Database (www.ncdc.noaa.gov/paleo/napd.html), the Neotoma Paleoecology Database (www.neotomadb.org), or directly from the literature.

Site Name	Lat	Long	Elev	Reference
Ahaliorak Lake	68.90	-151.35	178	Eisner & Colinvaux (1990)
Alamo Canyon	32.12	-112.70	915	Van Devender (1982)
American Falls	42.90	-112.50	1351	Bright (1982)
Antifreeze Pond	62.35	-140.83	188	Rampton (1971)
Arch Cave	39.28	-114.08	1980	Thompson (1984)
Artillery Mountains	34.37	-113.62	723	King & Van Devender (1977)
Artillery Peak	34.33	-113.58	725	Wells (1983)
Basin Canyon	36.70	-115.27	1630	Spaulding (1981)
Battle Ground Lake	45.80	-122.49	155	Anderson (1985)
Bechan Cave	37.37	-110.87	1280	Gennett & Baker (1986)
Bennett Ranch	30.62	-104.98	1035	Van Devender & Spaulding (1979)
Big Boy Canyon	32.83	-105.92	1555	Van Devender <i>et al.</i> (1984)
Bogachiel Bog	47.88	-124.33	156	Heusser (1978)
Burro Mesa	29.27	-103.38	1200	Wells (1966)
Caledonia Marsh	42.30	-121.90	1259	Hakala & Adam (2004)
Cape Deceit	66.00	-165.00	172	Matthews (1974)
Carp Lake	45.92	-120.88	714	Whitlock (1993)
Cave of the Early Morning Light	35.71	-113.39	1300	Van Devender & Spaulding (1979)
Chemehuevi Mountain	34.70	-114.50	258	Van Devender (1990)
Chuar Valley	36.17	-111.92	1770	Cole (1981)
Clark Mountain	35.55	-115.62	2140	Spaulding (1981)
Clear Creek - Luka Cave	36.13	-112.00	1600	Cole (1981)
Clear Lake	39.00	-122.75	408	Adam <i>et al.</i> (1981)
Copley Lake	38.87	-107.08	3250	Fall <i>et al.</i> (1995)
Cordova Bay	48.50	-123.33	0	Alley & Chatwin (1979)
Cottonwood Canyon	36.05	-112.00	1100	Cole (1981)
Crescendo Cave	36.31	-111.86	1155	Coats (1996)
Crescent Spring	41.42	-113.33	1293	Mehring (1977)
Dagger Mountain	29.53	-103.10	880	Wells (1966)
Davis Lake	46.59	-122.25	282	Valastro & Davis (1970)
Dead Man Lake	36.24	-108.95	2759	Ritchie (1977)
Deadman	36.63	-115.30	1970	Spaulding (1981)
Deadtrees Cave	36.31	-111.86	1140	Coats (1996)
Death Valley	36.58	-117.33	425	Woodcock (1986)

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Table A3 – continued from previous page

Site Name	Lat	Long	Elev	Reference
Devilins Park	40.00	-105.55	2946	Madole (1986)
Doll Creek	66.05	-135.65	221	Ritchie (1982)
Dutch John Mountain - Jarvies Draw	40.95	-109.42	2100	Jackson <i>et al.</i> (2005)
Eagle Eye Mountain	33.88	-113.17	812	McAuliffe & Van Devender (1998)
Eleana Range	37.12	-116.23	1810	Spaulding (1985)
Ernst Tinaja	29.27	-103.02	760	Van Devender & Spaulding (1979)
Etna Station	37.55	-114.62	1350	Madsen (1973)
Eureka View	37.33	-117.78	1430	Spaulding (1980)
Eyrie	36.64	-115.28	1855	Spaulding (1981)
Fargher	45.88	-122.52	236	Grigg & Whitlock (2002)
Flaherty Mesa	36.48	-115.25	1720	Spaulding (1981)
Forty Mile Canyon	36.95	-116.38	1240	Spaulding (1994)
Frenchman Flat	36.78	-115.87	1100	Wells (1983)
Grass Lake	41.65	-122.17	1538	Hakala & Adam (2004)
Grays Lake	43.08	-111.50	1973	Beiswenger (1991)
Hall Canyon	37.62	-110.89	1390	Cole & Murray (1999)
Hance Canyon	36.03	-111.97	1100	Cole (1981)
Hanging Lake	68.38	-138.38	500	Bartley (1962)
Harding Lake	64.44	-146.91	218	Baruch & Bottema (1991)
Hay Lake	34.00	-109.43	2780	Berglund & Rapp (1988)
Haystack Mountain	36.60	-118.08	1155	Koehler & Anderson (1994)
Head Lake	37.70	-105.50	2300	Peman (1981)
Hedrick Pond	43.75	-110.60	2073	Birks & Williams (1983)
Hollyburn Creek	49.29	-122.88	35	Lian <i>et al.</i> (2001)
Holter Lake	46.99	-112.01	1087	Huber & Hill (2002)
Horseshoe Mesa	36.03	-111.98	1450	Cole (1981)
Humptulips Bog	47.23	-124.00	89	Heusser (1985)
Imuruk Lake	65.57	-163.20	177	Livingstone (1955)
Isabella Creek	64.75	-147.00	210	Heusser (1983)
Jacob Lake	34.33	-110.83	2285	Jóhansen (1982)
January Cave	50.19	-114.52	2040	Burns (1991)
Joe Lake	66.77	-157.22	183	Yakushko & Makhnach (1973)
Kaiyak Lake	68.15	-161.42	190	Birks & Koc (2002)
Kalaloch	47.63	-124.38	47	Heusser (1972)
Kings Canyon	36.80	-118.80	1275	Cole (1981)
Koyukuk-4	66.95	-151.74	159	Hamilton (1982)
Kvichak Pen	58.64	-157.29	180	Ager & Brubaker (1985)
Ladder Cave	39.35	-114.08	2060	Thompson (1984)
Little Lake	44.17	-123.58	217	Ray <i>et al.</i> (1981)

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Table A3 – continued from previous page

Site Name	Lat	Long	Elev	Reference
Little Nankoweap	36.32	-111.87	1155	Coats <i>et al.</i> (2008)
Long Lake	36.01	-108.83	2727	Adovasio <i>et al.</i> (1990)
Maravillas Canyon	29.56	-102.78	600	Wells (1966)
Mayberry Well	33.70	-108.30	2080	Bagg (1909)
Middle Butte Cave	43.25	-112.75	1420	Mehring (1985)
Mineral Lake	46.70	-122.25	627	Tsukada & Sugita (1982)
Molas Lake	37.75	-107.68	3200	Benn & Army Corps of Engineers (1984)
Montezuma's Head	32.12	-112.70	975	Van Devender (1982)
Nankoweap	36.25	-111.95	2020	Cole (1981)
Natural Bridges	37.50	-110.00	1830	Mead <i>et al.</i> (1987)
North Muddy Mountain	36.58	-114.53	530	Wells (1983)
Oil Lake	63.62	-150.12	366	Eisner & Colinvaux (1992)
Owl Canyon	36.41	-116.24	790	Spaulding (1985)
Painted Hills	39.88	-119.66	1380	Wigand (1992)
Penthouse	36.47	-115.25	1600	Spaulding (1981)
Point Grenville	47.25	-124.10	109	Heusser (1973)
Point of Rocks	36.57	-116.08	910	Spaulding (1985)
Port Moody	68.67	-150.48	201	Heusser (1983)
Potato Lake	34.46	-111.35	2205	Wilshusen (1986)
Rainbow Canyon	37.55	-114.57	1350	Wells (1983)
Rampart Cave	36.03	-113.86	530	Van Devender <i>et al.</i> (1977)
Ranger Lake	67.15	-153.65	820	Davis (1969)
Ranger Mountains	36.77	-115.85	1100	Wells & Berger (1967)
Rattlesnake Cave	43.52	-112.62	1635	Bright & Davis (1982)
Rebel Lake	67.42	-149.80	914	Ager & Brubaker (1985)
Rough Canyon	32.38	-105.88	1490	Betancourt <i>et al.</i> (2001)
Ruby Marshes	40.13	-115.48	1824	Thompson (1992)
Sacatone Wash	35.25	-114.62	730	Wells (1983)
Salt Creek	38.23	-110.25	1490	Coats <i>et al.</i> (2008)
San Agustin Plains	33.87	-108.25	2069	Guilday (1982)
Sands of Time Lake	66.00	-148.00	180	Edwards & Barker Jr. (1994)
Shafter	29.78	-104.37	1280	Van Devender <i>et al.</i> (1978)
Shrine, Stevens Cave	36.31	-111.86	1170	Coats (1996)
Sisters Creek	49.29	-122.88	35	Lian <i>et al.</i> (2001)
Skutz Falls	48.78	-123.95	144	Alley & Chatwin (1979)
Snake Range	39.33	-114.12	2290	Wells (1983)
Specter Range	36.67	-116.21	1190	Spaulding (1985)
Spires	36.57	-115.30	2040	Spaulding (1981)
Squirrel Lake	67.10	-160.38	188	Anderson <i>et al.</i> (1985)

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Table A3 – continued from previous page

Site Name	Lat	Long	Elev	Reference
Stanton's Cave	36.50	-111.96	900	Dryer (1994)
Streamview Rockshelter	39.33	-114.10	1860	Thompson (1984)
Streeruwitz Hills	31.12	-105.15	1430	Van Devender & Spaulding (1979)
Tank Trap Wash	31.90	-106.15	1340	Van Devender & Spaulding (1979)
Tiinkdhul Lake	66.58	-143.15	189	Lee & Quitmyer (1984)
Toklat High Bluffs	66.58	-143.15	176	Elias <i>et al.</i> (1996)
Tse'an Kaetan Cave	36.07	-112.13	1460	Mead (1983)
Tukuto Lake	68.50	-157.05	166	Oswald <i>et al.</i> (1999)
Tulelake	41.95	-121.48	1230	Hakala & Adam (2004)
Tungak Lake	61.50	-164.10	180	Ager (1982)
Turtle Mountains	34.29	-114.85	850	Wells & Berger (1967)
Turtle Mountains	34.40	-114.82	850	Wells & Berger (1967)
Two Goblin	36.63	-118.13	1460	Koehler & Anderson (1995)
Utricularia Lake	35.97	-108.81	2753	Montgomery (1986)
Volcanic Tableland	37.47	-118.42	1341	Jennings (1996)
Vulture Cave	36.10	-113.93	645	Mead & Phillips III (1981)
W Grand Canyon	35.72	-113.38	1300	Wells (1983)
Waterman Mountains	32.35	-111.46	795	Anderson & Van Devender (1991)
Wells #8	39.33	-114.12	1992	Wells (1983)
West Doubtful Canyon	32.32	-109.10	1370	Holmgren <i>et al.</i> (2006)
Whiskey Lake	35.98	-108.81	2712	Nelson & Madsen Jr. (1980)
White Rim	38.42	-110.46	1390	Coats <i>et al.</i> (2008)
Willow Wash	36.47	-115.25	1585	Spaulding (1981)
Zagoskin Lake	63.45	-162.11	1	Ager (1984)

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