Supplementary Information

Table S1. Biome assignment rules in BIOME4 (ajusted from Dallmeyer et al., 2017)

NO.	BIOME	Domain PFT	Subpft	Additional Environment Limits	Mega-biomes
1	Tropical evergreen forest	Tropical evergreen trees	-	-	Tropical forest
		Tropical deciduous trees	-	number of green days>300	
2	Tropical semi-deciduous forest	Tropical deciduous trees	-	250<number of green days<300	
3	Tropical deciduous forest/woodland	Tropical deciduous trees	-	number of green days<250	
4	Temperate deciduous forest	Temperate deciduous trees	No temperate broadleaved or boreal evergreen tree present	-	Temperate Forest
		Temperate deciduous trees	Boreal evergreen trees present	Twm>21	
		Boreal evergreen trees	Temperate deciduous trees present	GDD5>900 and Tcm>-19, Twm>21	
		Boreal deciduous trees	Temperate deciduous trees	-	
5	Temperate conifer forest	Cool conifer	No temperate broadleaved trees present, no boreal deciduous trees subdominant	-	
		Cool conifer	Temperate deciduous trees with nearly similar NPP	-	
7	Cool mixed forest	Temperate deciduous trees	Boreal evergreen trees present	Twm<21 and Tcm>-15	
		Boreal evergreen trees	Temperate deciduous trees present	GDD5>900 and Tcm>-19, Twm<21	
8	Cool conifer forest	Boreal evergreen trees	No temperate deciduous trees present	GDD5>900 and Tcm>-19	
16	Temperate broadleaved savanna	Shrubs	Temperate deciduous trees present	-	
6	Warm mixed forest	Temperate broadleaved trees	-	-	Warm mixed forest
		Temperate deciduous trees	No boreal trees, but temperate broadleaved trees present	-	
		Temperate deciduous trees	No boreal trees, but cool conifer present	Tcm>3 and GDD5>3000	
		Cool conifer	Temperate broadleaved trees present	-	
9	Cold mixed forest	Temperate deciduous trees	Boreal evergreen trees present	Twm<21 and Tcm<-15	Boreal forest
		Cool conifer	Boreal deciduous trees	-	
		Boreal evergreen trees	Temperate deciduous trees present	GDD5<900 and Tcm<-19	
		Boreal deciduous trees	Cool conifer	-	
		Boreal deciduous trees	-	GDD5>900 and Tcm>-19	
10	Evergreen taiga/montane forest	Boreal evergreen trees	No temp deciduous trees present	GDD5<900 and Tcm<-19 and NPP>350	
		Boreal deciduous trees	Boreal evergreen trees	-	
11	Deciduous taiga/montane forest	Boreal deciduous trees	No temperate deciduous or cool conifer	GDD5<900 and Tcm<-19	
18	Boreal parkland	Boreal evergreen tress	-	GDD5<900 and Tcm<-19 and NPP<350	
		Shrubs	Boreal trees present	Twm<21	
		Boreal deciduous trees	-	-	
13	Tropical xerophytic shrubland	Woody desert	-	grass LAI>1 and Tmin>0	Grassland and
		Shrubs	Tropical trees present	woody LAI<4	
14	Temperate sclerophyll woodland	Shrubs	Temperate broadleaved trees present	-	

19	**Tropical grassland**	C4 tropical grass	-	-	*dry shrubland*
20	**Temperate grassland**	C3/C4 temperate grass	-	GDD0>800	
12	**Tropical savannah**	Shrubs	Tropical trees present	woody LAI>4	*Savanna and dry woodland*
15	**Temperate xerophytic shrubland**	Woody desert	-	grass LAI>1 and Tmin<0	
17	**Open conifer woodland**	Shrubs	Cool conifer present	-	
21	**Desert**	Woody desert	-	grass LAI<1	*Desert*
		Temperate or Tropical trees or conifer	-	NPP<100	
		C3/C4 temperate grass	No boreal trees present	-	
22	**Steppe–tundra**	C3/C4 temperate grass	-	GDD0<800	*Tundra*
		Cold herbaceous	-	-	
23	**Shrub tundra**	Tundra shrub	-	GDD0>500	
24	**Dwarf shrub tundra**	Tundra shrub	-	200<GDD0<500	
25	**Prostrate shrub tundra**	Tundra shrub	-	GDD0<200	
26	**Cushion forb lichen moss tundra**	Lichen/forb	-	-	

Table S2. Transfer matrix from BIOME4 typology to the pollen biome scores

BIOME4 type	Pollen biome type																
	CL DE	CL MX	CO CO	CO MX	DE SE	ST EP	TA IG	TE DE	TU ND	XE RO	HO DE	SA VA	TD FO	TR FO	TS FO	WA MX	TX WS
TrEgFo	0	0	0	0	0	0	0	0	0	0	0	0	5	15	10	0	0
TrSeDeFo	0	0	0	0	0	0	0	0	0	0	0	0	10	10	15	0	5
TrDeFo	0	0	0	0	0	0	0	0	0	0	0	5	15	5	10	0	0
TdDeFo	0	5	5	10	0	0	0	15	0	0	0	0	0	0	0	0	0
TeCoFo	0	0	15	10	0	0	0	5	0	0	0	0	0	0	0	0	0
WaMxFo	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0	15	0
CoMxFo	0	0	10	15	0	0	0	10	0	0	0	0	0	0	0	0	0
CoCoFo	0	0	15	10	0	0	5	0	0	0	0	0	0	0	0	0	0
ClMxFo	10	15	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
EgTaig	5	10	5	0	0	0	15	0	0	0	0	0	0	0	0	0	0
DeTaig	10	5	0	0	0	0	15	0	5	0	0	0	0	0	0	0	0
TrSav	0	0	0	0	0	5	0	0	0	0	0	15	5	0	0	0	10
TrXsSl	0	0	0	0	0	10	0	0	0	0	0	5	0	0	0	0	15
TeXsSl	0	0	0	0	0	5	0	0	0	15	0	0	0	0	0	5	0
TeScWo	0	0	0	0	0	5	0	0	0	15	0	5	0	0	0	10	0
TeBlSav	0	0	0	0	0	5	0	5	0	5	0	15	0	0	0	5	0
OpCoWo	0	0	10	0	0	5	0	0	0	0	0	0	0	0	0	0	0
BoprKl	0	0	5	0	0	10	10	0	0	5	0	0	0	0	0	0	0
TrGrl	0	0	0	0	0	15	0	0	0	0	5	5	0	0	0	0	0
TeGrlc	0	0	0	0	5	15	0	0	5	0	0	0	0	0	0	0	0
TeGrlw	0	0	0	0	5	15	0	0	0	5	0	5	0	0	0	0	0
HotDesert	0	0	0	0	0	10	0	0	0	0	15	0	0	0	0	0	0
Desert	0	0	0	0	15	10	0	0	0	0	0	0	0	0	0	0	0
ShTund	5	0	0	0	0	14	5	0	15	0	0	0	0	0	0	0	0
DShTund	0	0	0	0	0	5	0	0	15	0	0	0	0	0	0	0	0
PsShTund	0	0	0	0	0	5	0	0	15	0	0	0	0	0	0	0	0
FoLimoss	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Barren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

We divided temperate grassland into cool temperate grassland (TeGrlc) and warm temperate grassland (TeGrlw), and desert into cold desert (Desert) and hot desert (Hot Desert), based on the minimum temperature (22ºC) of the mean temperature of the warmest month (Prentice et al. 1992).

Pollen biome types: CLDE cold deciduous forest; CLMX cold mixed forest; COCO cool coniferous forest; COMX cool mixed forest; DESE desert; HODE hot desert; SAVA savanna; STEP steppe; TAIG taiga; TDFO tropical dry forest; TEDE temperate deciduous forest; TRFO tropical rain forest; TSFO tropical seasonal forest; TUND tundra; TXWS tropical xerophytic woods/scrub; WAMX broadleaved evergreen/warm mixed forest; XERO xerophytic woods/scrub.

BIOME4 types: Barren barren land; BoPrkl boreal parkland; ClMxFo cold mixed forest; CoCoFo cool evergreen needleleaf forest; CoMxFo cool mixed forest; Desert desert; DeTaig cold deciduous forest; DshTund erect dwarf-shrub tundra; EgTaig cold evergreen needleleaf forest; FoLiMoss cushion-forb lichen, and moss tundra; HotDesert hot desert; LIce land ice; OpCoWo temperate evergreen needleleaf open woodland; PsShTund prostrate dwarf-shrub tundra. ShTund low and high shrub tundra; TeBlSav temperate deciduous broadleaved savanna; TeCoFo temperate evergreen needleleaf forest; TeDeFo temperate deciduous broadleaf forest; TeGrlc cool temperate grassland, TeGrlw warm temperate grassland; TeScWo temperate sclerophyll woodland and shrubland; TeXsSl temperate xerophytic shrubland; TrDeFo tropical deciduous broadleaf forest and woodland; TrEgFo tropical evergreen broadleaf forest; TrGrl tropical grassland; TrSav tropical savanna; TrSeDeFo tropical semi-evergreen broadleaf forest; TrXsSl tropical xerophytic shrubland; WaMxFo warm-temperate evergreen broadleaf and mixed forest.

Table S3. The ranges of input parameters for simulation at modern, mid-Holocene periods

Parameter	Modern	Mid-Holocene
$\Delta Tjan$	[-10,10]℃	[-10,10]℃
$\Delta Tjul$	[-10,10]℃	[-10,10]℃
$\Delta Pjan$	[-90,100]%	[-90,100]%
$\Delta Pjul$	[-90,100]%	[-90,100]%
CO_2	340ppmv	270ppmv
Iterative number	2000	3000

Table S4. Climate change during mid-Holocene derived from IVM at each pollen site

Site	Lat	Lon	Alt	Biome	AnnT anomaly (K)	AnnP anomaly (mm)	MTCO anomaly (K)	MTWA anomaly (K)	Pjul anomaly (mm)
Sujiawan	35.54	104.52	1700	COMX	-3.6	151.8	-4	-3.4	36.3
Xiaogou	36.10	104.90	1750	COMX	-2.8	168.7	-1.4	-3.7	44.7
Dadiwan	35.01	105.91	1400	STEP	-0.5	210.2	4.6	-4	40.2
Sanjiaocheng	39.01	103.34	1320	DESE	-3	-99.3	0.1	-5.1	-98.6
Chadianpo	36.10	114.40	65	TEDE	-3.1	347.2	-0.8	-4.7	71.6
Qindeli	48.08	133.25	60	COMX	2.9	287.2	7.5	0.3	47.4
Fuyuanchuangye	47.35	133.03	56	TEDE	6	312.1	6.9	5.5	54.2
Jingbo Lake	43.83	128.50	350	TEDE	4.2	361.9	6	3.1	73.1
Hani Lake	42.22	126.52	900	TEDE	4.7	294.5	5.8	4	39.9
Jinchuan	42.37	126.43	662	TEDE	4.4	361.4	5.3	3.8	53.1
Maar Lake	42.30	126.37	724	TEDE	4.7	388	6.6	3.5	53.6
Maar Lake	42.30	126.37	724	TEDE	4.6	386.5	6.6	3.5	53.3
Xie Lake SO4	37.38	122.52	0	WAMX	-1	363.2	-1.6	-0.7	64.3
Nanhuiheming Core	31.05	121.58	7	WAMX	1.8	472.3	1.3	2.2	43.5
Toushe	23.82	120.88	650	WAMX	-2.1	962.9	-3.9	-1.1	13.7
Dongyuan Lake	22.17	120.83	415	WAMX	3.1	-158.6	4.1	2.5	-8.4
Yonglong CY	31.78	120.44	5	WAMX	1	353.3	2.3	0.2	38.4
Hangzhou HZ3	30.30	120.33	6	TEDE	-4.4	486.9	-7.7	-2.6	43.7

Xinhua XH1	32.93	119.83	2	WAMX	1.7	408.1	4.4	0	59.3
ZK01	31.77	119.80	6	WAMX	2.5	428.4	2.2	2.6	46.5
Chifeng	43.97	119.37	503	TEDE	1	-67	7.5	-2.8	-20.4
SZK1	26.08	119.31	9	WAMX	-2.3	395.9	-2.8	-2	32.9
Gucheng	31.28	118.90	6	WAMX	1.8	529.8	2.4	1.5	50.4
Lulong	39.87	118.87	23	TEDE	-1.3	361.3	1.1	-2.7	68.7
Hulun Lake	48.92	117.42	545	STEP	6.6	128.2	5.8	7.1	51.5
CH-1	31.56	117.39	5	WAMX	1.9	430.3	2.5	1.6	46.8
Sanyi profile	43.62	117.38	1598	STEP	5.5	184	1.9	7.6	64
Xiaoniuchang	42.62	116.82	1411	COMX	1.8	202.8	6.3	-0.9	56.3
Haoluku	42.87	116.76	1333	COMX	1.8	138.1	6.6	-1	39.6
Liuzhouwan	42.71	116.68	1410	COMX	2.5	194.8	5.7	0.7	53.9
Poyang Lake 103B	28.87	116.25	16	WAMX	1.9	303.1	0.8	2.5	20.9
Baiyangdian	38.92	115.84	8	TEDE	-2	261.7	0.4	-3.4	41.9
Bayanchagan	42.08	115.35	1355	TEDE	2.9	175.5	4.5	1.9	45.4
Huangjiapu	40.57	115.15	614	STEP	2.8	100.8	-0.7	4.8	21.2
Dingnan	24.68	115.00	250	TSFO	4.6	500.4	5.4	4.2	34
Guang1	36.02	114.53	56	STEP	2.5	126	1.9	2.8	27.3
Angulinao	41.33	114.35	1315	COMX	0.3	179.8	4	-1.9	54.6
Yangyuanxipu	40.12	114.22	921	STEP	1.6	131.9	-1.8	3.6	34.1
Shenzhen Sx07	22.75	113.78	2	WAMX	-2.6	549.8	-5.3	-1	29.5
GZ-2	22.71	113.51	1	TSFO	3	436.9	3.6	2.6	36.6

Daihai99a	40.55	112.66	1221	COMX	-0.7	212.3	3.9	-3.5	67
Daihai	40.55	112.66	1221	COMX	-1.1	161.4	3.9	-4.2	50.1
Sihenan profile	34.80	112.40	251	STEP	1.1	81.9	1.9	0.6	19.9
Diaojiaohaizi	41.30	112.35	2015	COMX	2.5	224.9	4.7	1.2	67.1
Ganhaizi	39.00	112.30	1854	TEDE	4.6	399.4	3.8	5.1	79.3
Jiangling profile	30.35	112.18	37	WAMX	1.1	412.9	3.8	-0.7	43.9
Helingeer	40.38	111.82	1162	DESE	-2.2	-219.5	-0.4	-3.2	-75.6
Shennongjia2	31.75	110.67	1700	WAMX	1.3	557.9	-2	3.1	31.3
Huguangyan Maar Lake B	21.15	110.28	59	TSFO	0.2	969.2	0.5	0.1	56.8
Yaoxian	35.93	110.17	1556	STEP	-0.1	-337.8	1.1	-1	-51.4
Jixian	36.00	110.06	1005	STEP	2.8	-37.5	0.3	4.2	-7
Shennongjia Dajiu Lake	31.49	110.00	1760	TEDE	1.2	364.7	0.2	1.7	18.8
Qigainur	39.50	109.85	1300	DESE	-1.5	-217	2.4	-4	-76.1
Beizhuangcun	34.35	109.53	519	STEP	1	-44	-1	2.1	-6.7
Lantian	34.15	109.33	523	STEP	3.2	-95.2	3.6	3	-17.2
Bahanniao	39.32	109.27	1278	COMX	-1.2	-10.1	3.1	-4	-4
Midiwan	37.65	108.62	1400	STEP	3	109.2	-0.5	5	28.8
Jinbian	37.50	108.33	1688	STEP	1	-140.8	1.3	0.8	-28.1
Xindian	34.38	107.80	608	STEP	1.9	58.8	-1.4	3.8	11.7
Nanguanzhuang	34.43	107.75	702	STEP	3.4	32.4	4	3	6.1
Xifeng	35.65	107.68	1400	TEDE	2.1	379.9	4.7	0.4	65.1
Jiyuan	37.13	107.40	1765	DESE	1.4	-444.5	2.4	0.8	-80.9

Jiacunyuan	34.27	106.97	1497	STEP	4.6	-251.5	3.8	5	-31.2
Dadiwan	35.01	105.91	1400	STEP	0.6	354.1	1.3	0.1	67.7
Maying	35.34	104.99	1800	COMX	-2.9	118.3	-2.9	-2.9	25.4
Huiningxiaogou	36.10	104.90	1750	COMX	-3.4	84.3	-2.2	-4.2	22.8
Sujiawan	35.54	104.52	1700	COMX	-3.6	178.4	-3.4	-3.8	44.5
QTH02	39.07	103.61	1302	STEP	-1.7	185.8	-1.9	-1.6	144.9
Laotanfang	26.10	103.20	3579	STEP	4.1	125	-1.1	7	123.3
Hongshui River2	38.17	102.76	1511	STEP	0.6	223.2	2	-0.2	138.1
Ruoergai	33.77	102.55	3480	STEP	4.7	106.1	1.9	6.3	26.1
Hongyuan	32.78	102.52	3500	TAIG	-3	-30.7	-2.6	-3.3	-8.9
Dahaizi	27.50	102.33	3660	TEDE	3.4	261.3	6.1	1.9	73.5
Shayema Lake	28.58	102.22	2453	TEDE	-0.5	330.7	1.5	-1.7	69
Luanhaizi	37.59	101.35	3200	COMX	2.8	275.9	4	2	131.7
Lugu Lake	27.68	100.80	2692	WAMX	1	380.2	1	0.9	67.9
Qinghai Lake	36.93	100.73	3200	STEP	5.6	206.8	3.6	6.7	102.9
Dalianhai	36.25	100.41	2850	STEP	3.3	98	3.2	3.3	44
Erhai ES Core	25.78	100.19	1974	WAMX	4	539.8	3.9	4	39.7
Xianmachi profile	25.97	99.87	3820	TEDE	4.8	349.8	5.6	4.4	70.4
TCK1	26.63	99.72	3898	COMX	1.9	226.2	-4.6	5.6	49
Yidun Lake	30.30	99.55	4470	COMX	3.6	213.8	0.5	5.4	53
Kuhai lake	35.30	99.20	4150	STEP	5.2	123.8	2.1	7.1	40.7
Koucha lake	34.00	97.20	4540	TUND	-3.2	77.2	-2.4	-3.6	19.6
Hurleg	37.28	96.90	2817	STEP	1.6	173.4	3.9	0.2	130.7
Basu	30.72	96.67	4450	COMX	3.6	20.6	0.1	5.6	5.8

Tuolekule	43.34	94.21	1890	STEP	2.6	168.6	4.1	1.7	138.2
Balikun	43.62	92.77	1575	STEP	1.3	167.1	2.7	0.4	131.8
Cuona	31.47	91.51	4515	TUND	-4.4	235.7	-3.5	-4.9	56.9
Dongdaohaizi2	44.64	87.58	402	DESE	-3.5	-67.2	0	-5.7	-81.6
Bositeng Lake	41.96	87.21	1050	STEP	0.5	175.5	5.2	-2.3	82.1
Cuoqin	31.00	85.00	4648	TUND	-3.9	1589	-1.3	-5.5	105.8
Yili	43.86	81.97	928	STEP	-0.9	152.2	3.5	-3.5	95.6
Bangong Lake	33.75	78.67	4241	STEP	3.1	471.7	-3	6.6	158.3
Shengli	47.53	133.87	52	TEDE	6.3	314.2	7.3	5.8	53
Qingdeli	48.05	133.17	52	WAMX	6.9	312.7	8.1	6.2	53.1
Changbaishan	42.22	126.00	500	TEDE	3.3	344.1	5	2.3	48.8
Liuhe	42.90	125.75	910	COMX	4.5	333.2	6.2	3.5	44.4
Shuangyang	43.27	125.75	215	TEDE	3.7	386.6	5.1	2.8	63.2
Xiaonan	43.33	125.33	209	WAMX	3.6	364.4	5.1	2.6	59.8
Tailai	46.40	123.43	146	STEP	2.8	161.9	-0.7	4.8	40.9
Sheli	45.23	123.31	150	STEP	2.6	132.5	-0.8	4.6	34.7
Tongtu	45.23	123.30	150	STEP	1.3	148.7	-1.2	2.8	37.8
Yueyawan	37.98	120.71	5	TEDE	-1.6	352	-0.2	-2.4	63.4
Beiwangxu	37.75	120.61	6	TEDE	-1.9	354.3	-1.3	-2.3	64.9
East Tai Lake1	31.30	120.60	3	WAMX	2.9	475.3	0.6	4.1	47.5
Suzhou	31.30	120.60	2	WAMX	-0.8	178	0.2	-1.4	15.8

Sun-Moon Lake	23.51	120.54	726	WAMX	-0.9	1007.6	-2.7	0.1	28.8
West Tai Lake	31.30	119.80	1	WAMX	2.7	603	1.2	3.6	57.9
Changzhou	31.43	119.41	5	WAMX	1.6	315.4	2	1.4	30.7
Dazeyin	39.50	119.17	50	TEDE	-0.6	369.6	1.4	-1.8	73.2
Hailaer	49.17	119.00	760	STEP	5.8	156.1	3.7	7	48.6
Cangumiao	39.97	118.60	70	TEDE	-0.3	383.5	2.6	-2	70.4
Qianhuzhuang	40.00	118.58	80	COMX	-3.5	296.4	2.3	-7	55.7
Reshuitang	43.75	117.65	1200	STEP	2.3	78.5	4.4	1.1	29.3
Yangerzhuang	38.20	117.30	5	TEDE	-1.8	381	0.8	-3.4	67.7
Mengcun	38.00	117.06	7	COMX	-2.9	282.5	-0.3	-4.5	53.1
Hanjiang-CH2	23.48	116.80	5	WAMX	-3.6	294	-4.9	-2.8	18.7
Hanjiang-SH6	23.42	116.68	3	TRFO	3.7	934	3.6	3.8	57.4
Hanjiang-SH5	23.45	116.67	8	WAMX	-4	346.2	-4.6	-3.6	20.9
Hulun Lake	48.90	116.50	650	STEP	4.9	266.3	1.6	6.9	115.2
Heitutang	40.38	113.74	1060	STEP	3.2	111.9	0.7	4.6	31.9
Zhujiang delta PK16	22.73	113.72	15	WAMX	-4	410	-5.4	-3.2	23.1
Angulitun	41.30	113.70	1400	TAIG	-5	116.3	-2	-6.9	36.1
Bataigou	40.92	113.63	1357	STEP	4.1	138.2	0	6.5	42.4
Dahewan	40.87	113.57	1298	STEP	3.3	139.2	-0.9	5.7	42.2
Yutubao	40.75	112.67	1254	STEP	3	172.6	0.3	4.6	54.5

Zhujiang delta K5	22.78	112.63	12	WAMX	-2.8	408.7	-5.4	-1.2	27.9
Da-7	40.52	112.62	1200	DESE	-0.8	-246.4	-0.8	-0.8	-78.3
Hahai-1	40.17	112.50	1200	STEP	3.3	182.8	1.4	4.4	57
Wajianggou	40.50	112.50	1476	STEP	1.7	84.5	1.9	1.6	25.9
Shuidong Core A1	21.75	111.07	-8	TRFO	1.6	783.8	0.9	2	41.5
Dajahu	31.50	110.33	1700	TEDE	1.2	536.4	0.1	1.8	29.1
Tianshuigou	34.87	109.73	360	STEP	2.3	81.6	1.2	2.9	17.2
Mengjiawan	38.60	109.67	1190	DESE	-1.3	-266.1	1.1	-2.8	-79.2
Fuping BK13	34.70	109.25	422	TEDE	-3	334.5	-3	-3	65
Yaocun	34.70	109.22	405	STEP	1.8	36.5	0.9	2.4	3.9
Jinbian	37.80	108.60	1400	STEP	-0.4	-50.8	1.3	-1.5	-12.4
Dishaogou	37.83	108.45	1200	DESE	-2.1	-305.1	1.1	-4.3	-79.8
Shuidonggou	38.20	106.57	1200	DESE	-2.7	-221.4	0	-4.5	-76.5
Jiuzhoutai	35.90	104.80	2136	TAIG	-5.1	105.3	-1	-7.8	26.5
Luojishan	27.50	102.40	3800	WAMX	3.7	268.3	6	2.4	77.9
RM-F	33.08	102.35	3400	COMX	1.3	192	-1.4	2.8	50.3
Hongyuan	33.25	101.57	3492	TUND	-5.8	7.7	-3.8	-7	2.1
Wasong	33.20	101.52	3490	COCO	-1	155.6	-4.7	1.1	35.8
Guhu Core 28	27.67	100.83	2780	COMX	-1	252.6	-5.8	1.8	46.5
Napahai Core 34	27.80	99.60	3260	COMX	0.8	311.4	-4	3.6	59.3
Lop Nur	40.50	90.25	780	DESE	-3	-162.2	1.6	-5.9	-117.2
Chaiwobao1	43.55	87.78	1100	DESE	-3.7	-210.4	-2.1	-4.8	-140.3
Chaiwobao2	43.33	87.47	1114	DESE	-3.2	-208.2	-1	-4.5	-143
Manasi	45.97	84.83	257	DESE	-1.4	-107.9	3	-4	-77

Wuqia	43.20	83.50	1000	DESE	-3.8	-108.9	0.3	-6.4	-146
Madagou	37.00	80.70	1370	STEP	-3.5	238.7	-1.2	-4.9	224.9
Tongyu	44.83	123.10	148	STEP	3.7	103.3	2.4	4.5	29.6
Nanjing	32.15	119.05	10	TEDE	-4.3	430.3	-5.7	-3.5	50
Banpo	34.27	109.03	395	COMX	-7.1	189.8	-5.1	-8.2	33.6
QL-1	34.00	107.58	2200	COMX	-1	559.4	-3	0.1	36.7
Dalainu	43.20	116.60	1290	TAIG	-5.4	65.7	-4	-6.2	22
Qinghai	36.55	99.60	3196	TAIG	-3	191.6	-1.6	-4	90
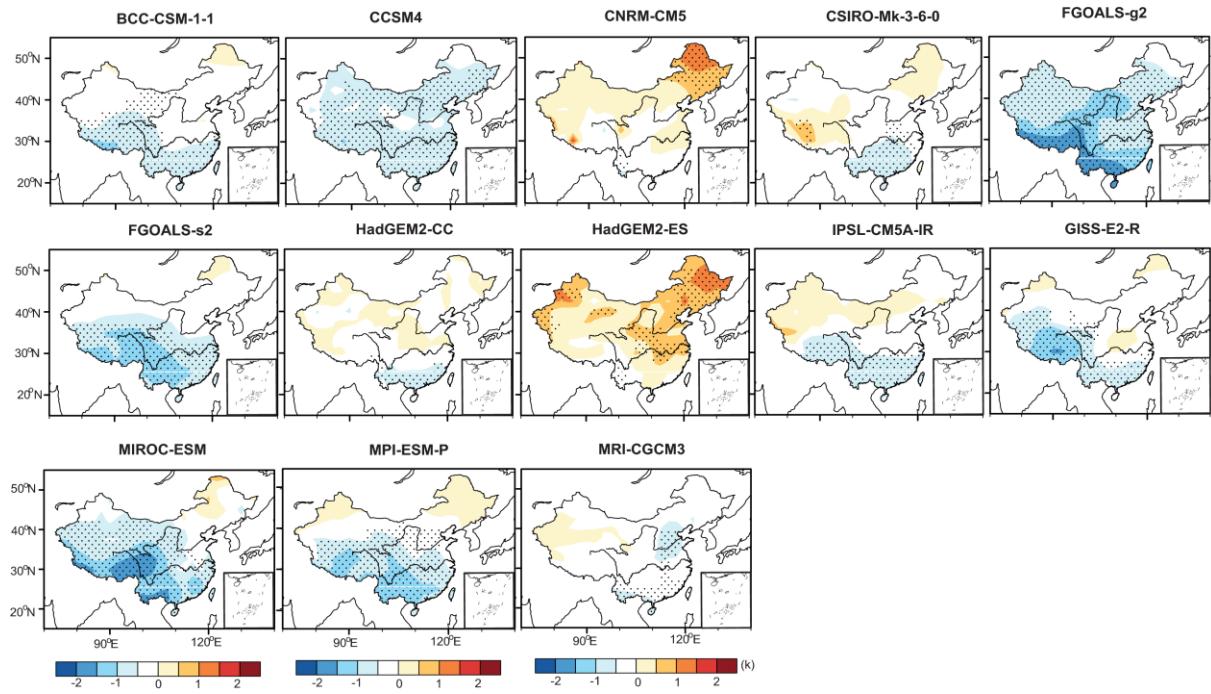
Fig. S1. Annual temperature anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval)
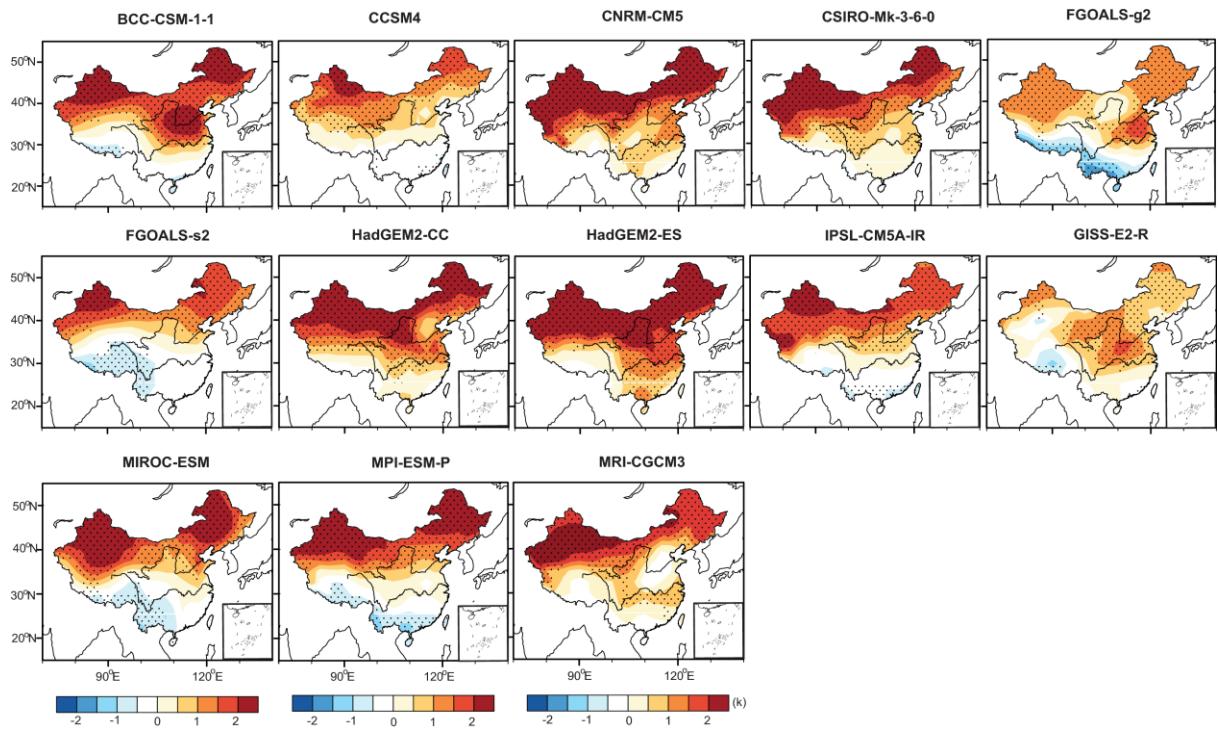
Fig. S2. MTWA temperature anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval)
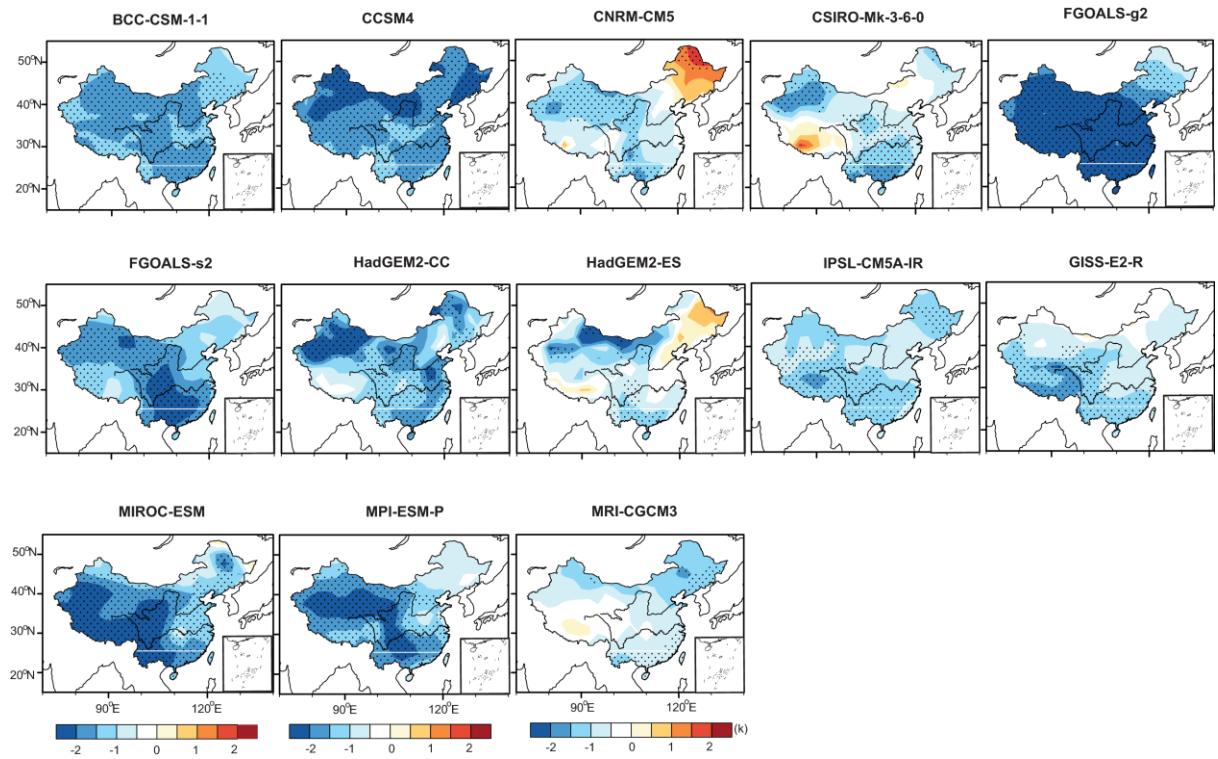
Fig. S3. MTCO temperature anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval)
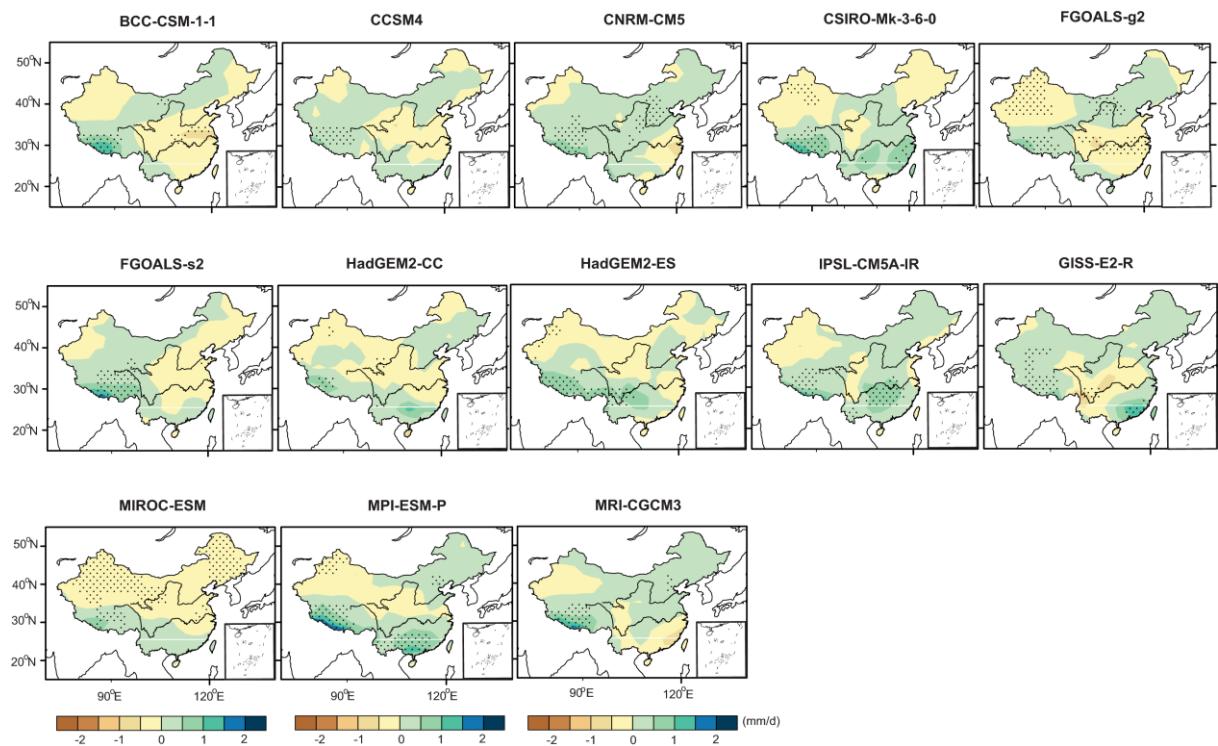
Fig. S4. Annual precipitation anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval).
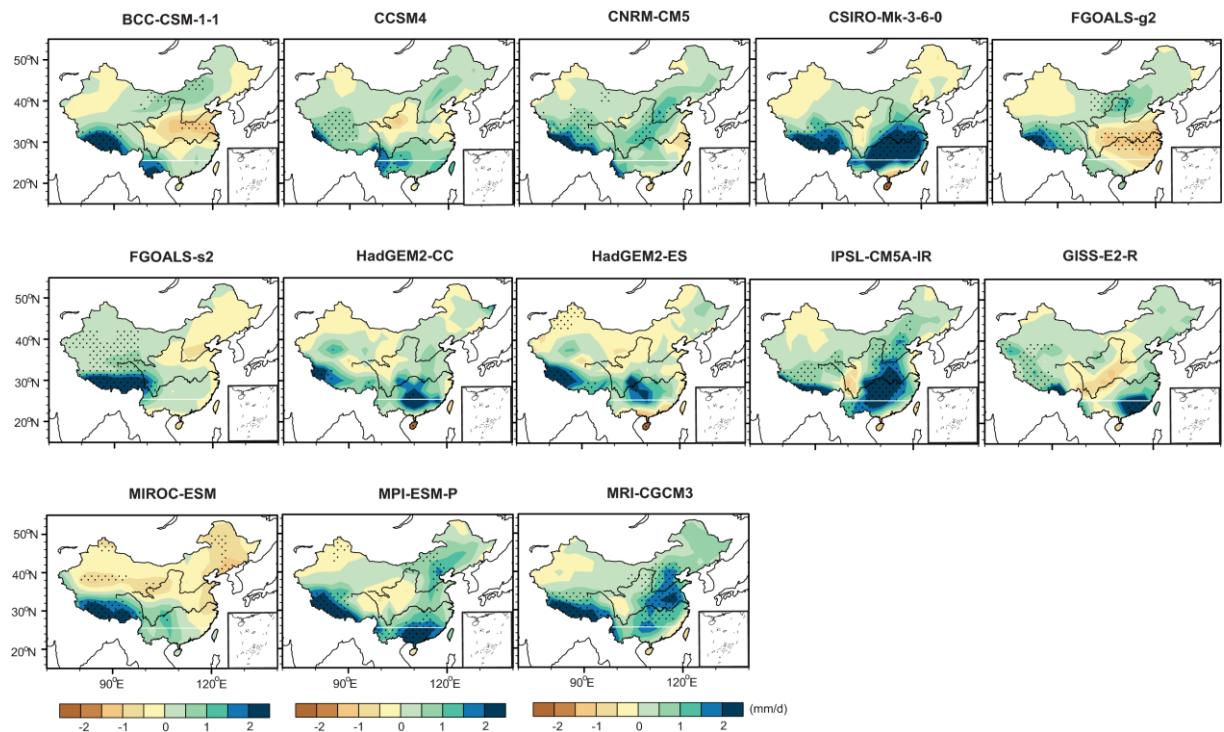
Fig. S5. Summer (JJA) precipitation anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval).
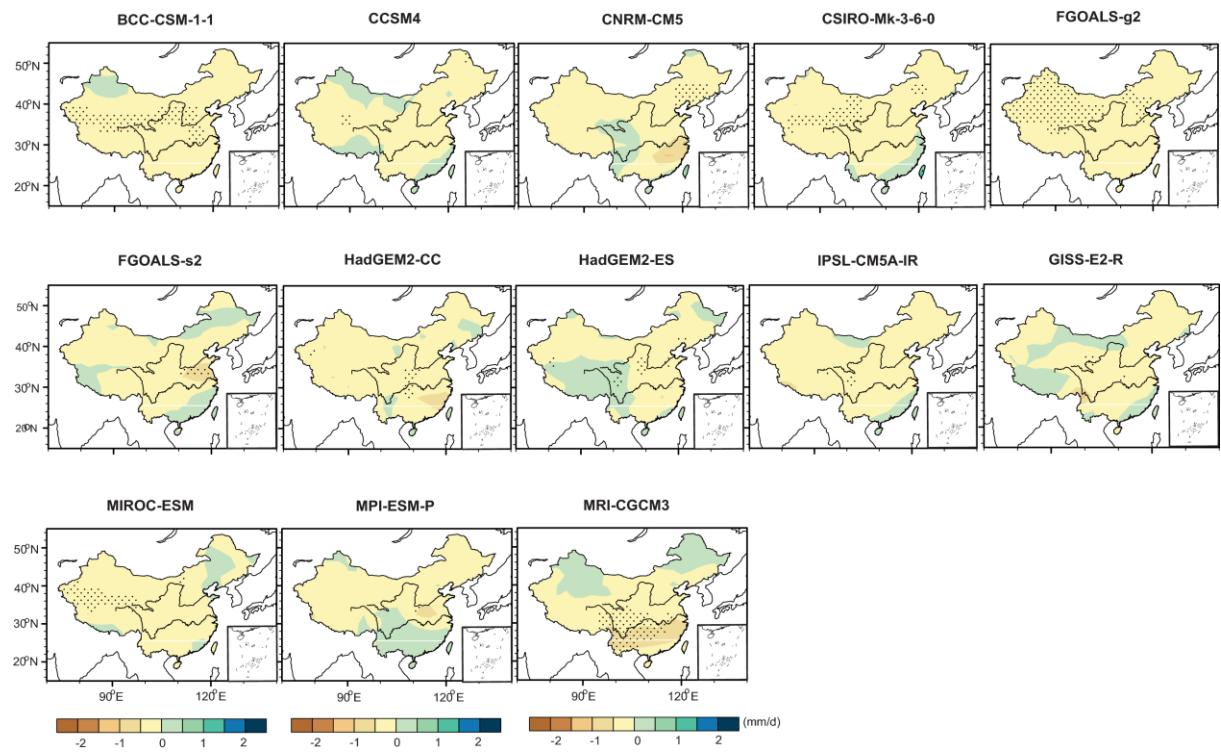
Fig. S6. Winter (DJF) precipitation anomaly (MH-PI) calculated as the last 30-year means of each model, the area with points pass the t-test (for 95% confidence interval).
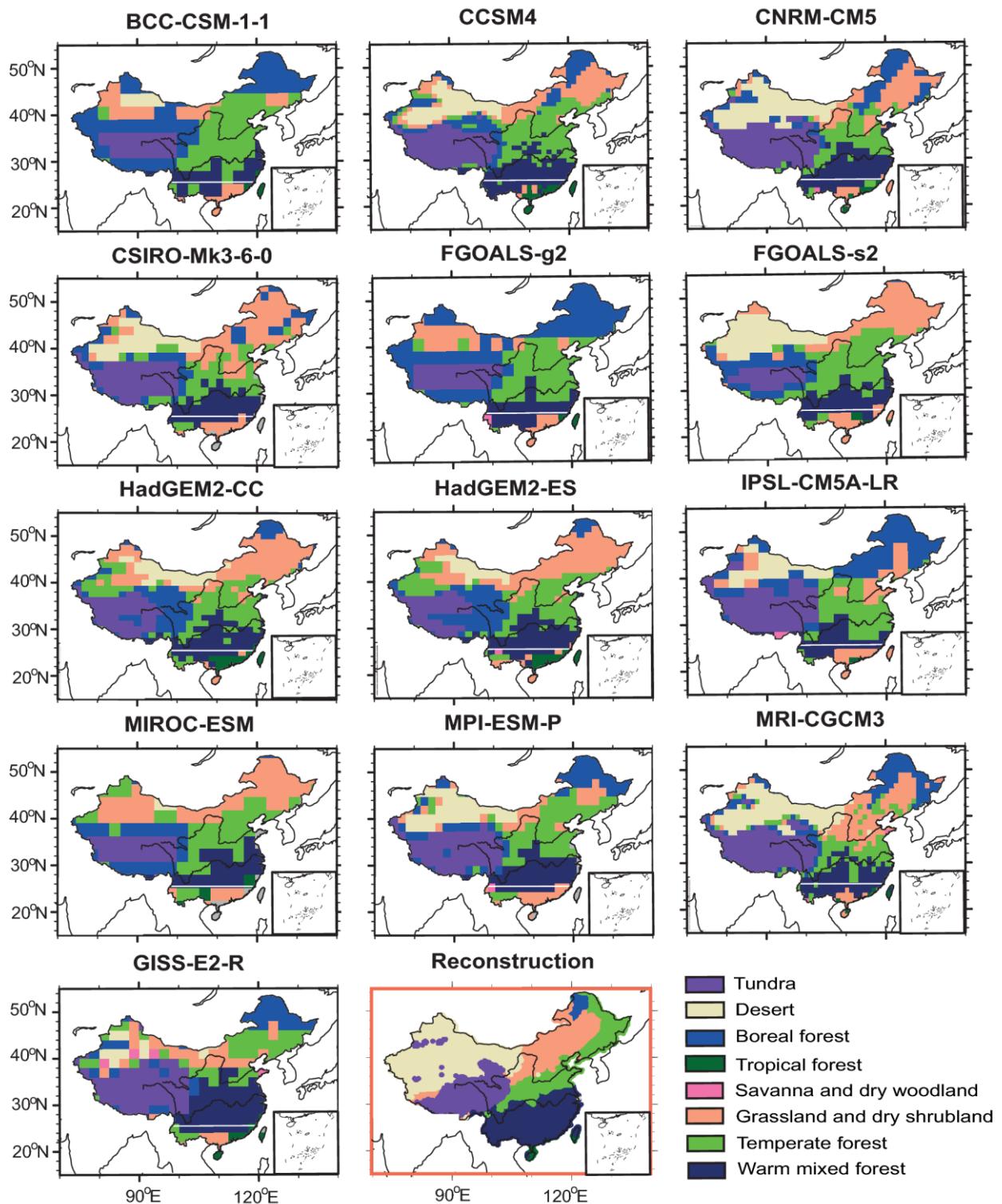
Fig. S7. Comparison of interpolated megabiomes distribution (plot in red rectangle) with the simulated spatial pattern from BIOME4 of each model for pre-Industrial.
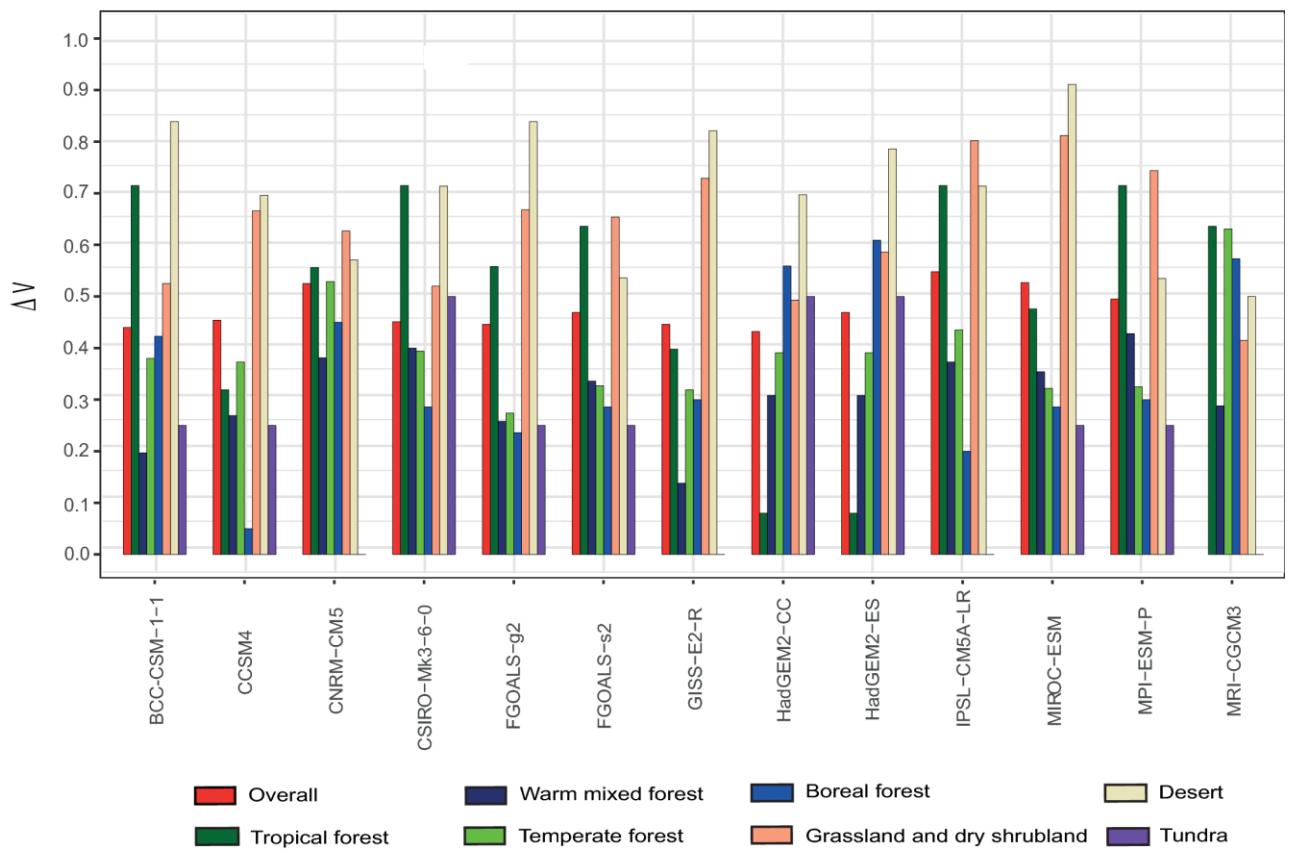
Fig. S8. The ΔV values of overall and each megabiomes for all 13 models during mid-Holocene, compared to the reconstruction.
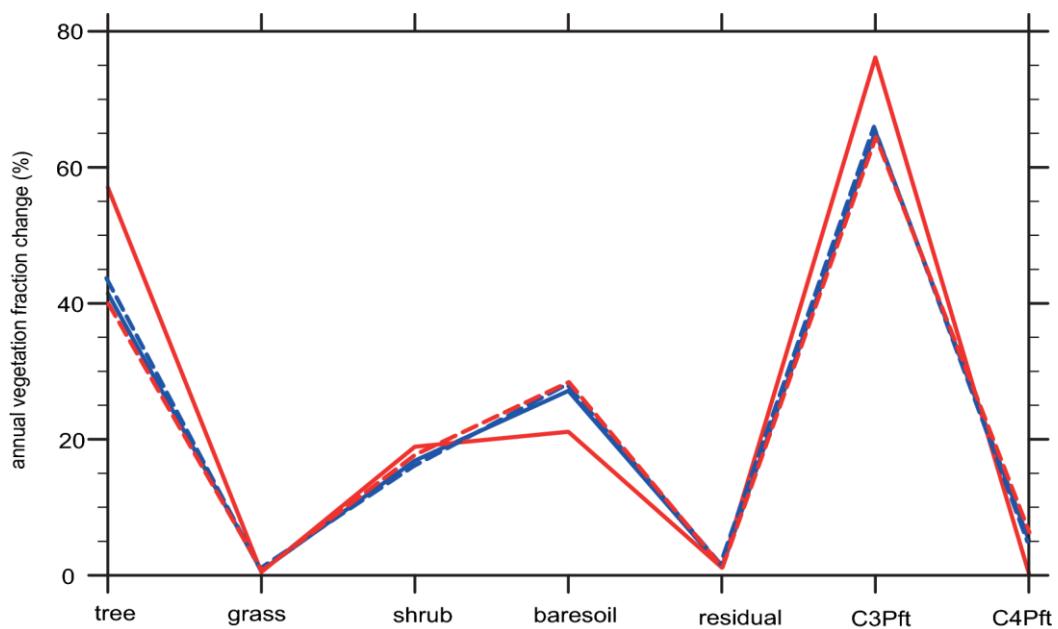
Fig. S9. Annual vegetation fraction change (PI: blue line; MH: red line) calculated as the last 30-year means of HadGEM2-ES (PI: blue solid line; MH: red solid line) and HaGEM2-CC (PI: blue dash line; MH: red dash line).