Supporting Information

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Validation of Paleoclimate and Paleobiome Simulations

Mesozoic Biomes Derived from LPJ. LPJ is a dynamic global vegetation model that computes photosynthesis, evapotranspiration, and ultimately net primary production and surface cover of vegetation through 10 plant functional types (PFTs). These PFTs are differentiated by physiological, morphological, phenological, bioclimatic, and fire response attributes (1). The phenology differentiation is constructed referring to phenology of present-day groups of plants: evergreen, raingreen, and summergreen. Such a distinction is neither relevant nor very well constrained for Mesozoic vegetation, so here the woody PFTs have been gathered according to their bioclimatic characteristics (tables 1 and 2 in ref. 1), ultimately giving tropical, temperate, and boreal biomes. Temperate and tropical herbaceous PFTs were kept in the analysis (Table S2).

Testing the Impact of pCO_2: A Model–Data Comparison. The aim of this part is to test the 15 simulations performed with FOAM-LPJ for the five continental configurations and for the three atmospheric CO_2 concentrations used here (560, 1,120, and 2,240 ppm). The five continental configurations stand for the Late Triassic, the Early Jurassic, the Early Cretaceous, the mid-Cretaceous, and the Late Cretaceous. We first compare our model outputs, e.g., biomes, to the geographical distribution of climate-sensitive sediments. Based on the works of Warren, Scotese, Parrish et al., and Chumakov et al. (2–5), we have plotted the location of evaporites and coals on our five paleogeographic maps (Fig. S1).

Coals are indicators of a humid climate and are found at low and high latitudes. They are not discriminating for the temperature and can be found under cool or warm climatic conditions (3). For the Late Triassic, very few sites characterized by the presence of coal deposits exist. When computing the spatial fit between coals and simulated biomes (i.e., the percentage of coal sites that are not found in an arid biome), it appears that atmospheric CO_2 concentrations of 1,120 and 2,240 ppm are better to fit the data (Table S1). Indeed, some desert regions appear at 560 ppm over the high latitudes where coal deposits are found. For the Early Jurassic (180 Ma), many more sites with coal deposits have been listed. Here again, except for one site located at 35°S to 75°E, the agreement between model and data is perfect for the high CO_2 levels (1,120 and 2,240 ppm). An atmospheric CO_2 level of 560 ppm induces the extension of desert regions over the northern high latitudes where coal deposits are found. For the Cretaceous geographies, the same conclusions can be drawn. First, most of the coal deposits are located outside the desert areas, and second, a CO_2 concentration of 560 ppm does a less good job in simulating humid areas fitting the coal's distribution.

Evaporites are generally used in the literature to constrain the areal extent of arid zones. However, based on the study of the South Atlantic evaporitic basin (visible on the Early Cretaceous map), Chaboureau et al. (6) have demonstrated that the evaporites deposited in the southern part of the Central segment (20°S–10°S) may have been controlled by the climate favoring aridity and high saline waters. In contrast, the evaporites of the northern part (10°S to 5°N) can hardly be reconciled with the climatic conditions occurring there and may be due to hydrothermal sources. This hypothesis is supported by the gradient found in the mineralogical composition from the north to the south. From this study, we also note that seasonally arid climate is enough to simulate environmental conditions in agreement with the formation of evaporites. If now we look at the geographical distribution of the evaporites on our maps, one can first conclude that they are less abundant than the coal deposits. Second, evaporitic basins are mainly localized over the desert area, although some are found over the tropical biome. A closer inspection shows that most of the evaporites found over the tropical biome are close to the tropical–desert transition area. In detail, this transition is marked by savannah, which corresponds to a highly seasonal climate (one rainy season and one arid season).

As an intermediate conclusion, for each time interval, no big mismatch appears between our bioclimatic maps and the data record. This shows that (*i*) our numerical simulations can be trusted for use as a basis to interpret the way the angiosperms have colonized the temperate areas and (*ii*) 1,120 and 2,240 ppm scenarios produce better fit with continental data than 560 ppm.

To go a step further in our model–data comparison and find out the best fit between 1,120 and 2,240 ppm for each time interval, we need to compare our climatic simulations with other proxies, namely, reconstructed sea surface temperatures. Unfortunately, such datasets are not available for the Late Triassic and the Early Jurassic. Thus, for these periods we relied on pCO_2 estimates from the literature to choose our scenarios. These estimates have high uncertainties, and most rely on stomatal analyses of different tree species. The latest studies suggest values of *ca.* 900 ppmv (7), whereas most studies agree on a background atmospheric pCO_2 of *ca.* 1,000 ppm for the late Triassic and the early Jurassic [whereas a doubling of this value likely occurred at the Triassic–Jurassic boundary event (8–11)]. Given this information and the good fit of coals with our simulation (Table S1), we chose 1,120 ppm as the best-fit scenario for the late Triassic and the early Jurassic.

Tentative reconstructions of sea surface temperature (SST) gradients are available for Cretaceous times, for which foraminifera and fish tooth $\delta^{18}O_p$, TEX_{86}, and D47 are used (12–20). Because of uncertainties concerning our understanding of the way marine organisms record temperature, an envelope delimited by simulated winter and summer SSTs in the northern hemisphere is plotted for each simulation in Fig. S2. Temperatures have been averaged between 60°W and 140°E because most SSTs estimates are coming from Tethysian locations. Because they are driving evaporation budget and related moisture advection toward the continent, we pay particular attention to midlatitude to high-latitude SSTs.

For the Aptian, high-latitude SSTs have been derived from the clumped isotope thermometry D47 measured on Berrasian–late Valanginian belemnites (12), which allows us to estimate temperature during shell biomineralization and to assess $\delta^{18}O$ shells independent of seawater $\delta^{18}O$. Accounting for error bars, the authors suggest temperatures ranging from 10 to 20 °C at that time. At 1,120 ppm (Fig. S2*A*), simulated SSTs at the same latitude are clearly out of this range (0–7 °C), whereas the fit is better at 2,240 ppmv, temperatures ranging from 4 °C to 17 °C (Fig. S2*B*). At low latitude, the congruence with the TEX86 data is also better with 2,240-ppm simulation, whereas temperatures are underestimated at 1,120 ppm.

For 90 Ma, the temperatures have been reconstructed from rudists (18), TEX_{86} measurements (14), and planktonic foraminifera $\delta^{18}O$ (19) and show strong variations. For instance, temperature at 30°N range from 16 °C to 32 °C depending on the proxy used. The main uncertainties in the reconstruction of paleotemperatures from biogenic carbonate include assumptions about the equilibrium fractionation in extinct species, about the true δ water value, and about the possible diagenesis. Here the selected planktonic foraminifera data in the study of (19) exclude altered carbon material, but the nonequilibrium calcification could cause underestimated actual upper ocean water temperatures by the isotopic measurements. In contrast to the foraminifera, the outer layer of certain groups of rudist is compact and has a good potential to preserve the original chemical and isotopic composition (18). For both 1,120 and 2,240 ppm scenarios, our simulations fail to capture the lower range of low-latitude reconstructions (by the planktonic foraminifera). At 2,240 ppm, simulated temperatures are high enough at 60°N to encompass reconstructed temperatures from foraminifera, which range between 17 °C and 20 °C at this latitude (Fig. S2*D*) and are consistent with the high values at the low latitudes. The 1,120-ppm experiment depicts temperatures that are too cool to match the data (Fig. S2*C*).

For 70 Ma, the robustness of the reconstructed temperatures from fish tooth $\delta^{18}O_p$ (16) is more important because the oxygen isotopes of biogenic phosphate are less prone to postmortem alteration (in comparison with biogenic carbonate) and no nonequilibrium oxygen isotope fractionation has been observed during precipitation of biogenic apatite. For 1,120 ppm the envelope fit with 70% of reconstructed temperatures from fish tooth $\delta^{18}O_p$ (Fig. S2*E*) versus only 51% with 2,240 ppm (Fig. S2*F*). In particular, the midlatitude to high-latitude reconstructions (11–12 °C at 50°) fit better with simulated SSTs from the 1,120-ppm scenario (10 °C in winter, 26 °C in summer), whereas the sensitivity of the simulated low-latitude summer and winter SSTs is low and less discriminating (between 25 °C and 35 °C at 20° of latitudes).

To summarize, although model–data discrepancies still exist, as the reader can easily see in Fig. S2, their comparison shows the best correspondence for atmospheric CO_2 at 2,240 ppm for the Early and mid-Cretaceous and 1,120 ppm for the Late Cretaceous (Fig. S2). Therefore, we have integrated and discussed the results of these best-fit model–data simulations in our manuscript.

Assessment of Model Limitations

For consistency purposes, we used identical atmospheric CO_2 concentration (pCO_2) for FOAM and LPJ in our analysis. However, despite the common use of LPJ-like models (e.g., Biome4) to assess global vegetation changes under past and future climate conditions, the behavior of such algorithms under pCO_2 far higher than present, such as those of the Mesozoic, has not been studied to our knowledge. For example, the CO_2 fertilization effect (CO_2 rise that leads to an increase in photosynthesis activity that ultimately drives a strong enhancement of net primary productivity) has been shown to be correctly simulated in temperate areas and overestimated in tropical forests for present day (21), but to what extent this effect and limitations are valid for Mesozoic vegetation and pCO_2 remains unknown. To test this potential limitation and make sure that the vegetation changes discussed in the paper are linked to climate and not to an artificial fertilization effect, the climatic outputs from the FOAM experiments were used to force LPJ offline with varying prescribed pCO_2, from 280 ppm to 2,240 ppm.

Fig. S3 shows the impact of CO_2 fertilization: increasing prescribed pCO_2 from 280 ppm to 1,120 or 2,240 ppm in LPJ drives a rise in temperate PFTs at the global scale, at the expense of desert areas. This phenomenon is independent from the chosen climatic scenario (here 1,120 ppm or 2,240 ppm) from FOAM. Most importantly, Fig. S3 shows that the LPJ CO_2 effect does not affect the trend of temperate biome evolution through time: the picture of increasing temperate biome fractions throughout the Mesozoic is still valid when LPJ is forced with pCO_2 as low as 280 ppm, confirming that climate is playing the most important role in this trend.

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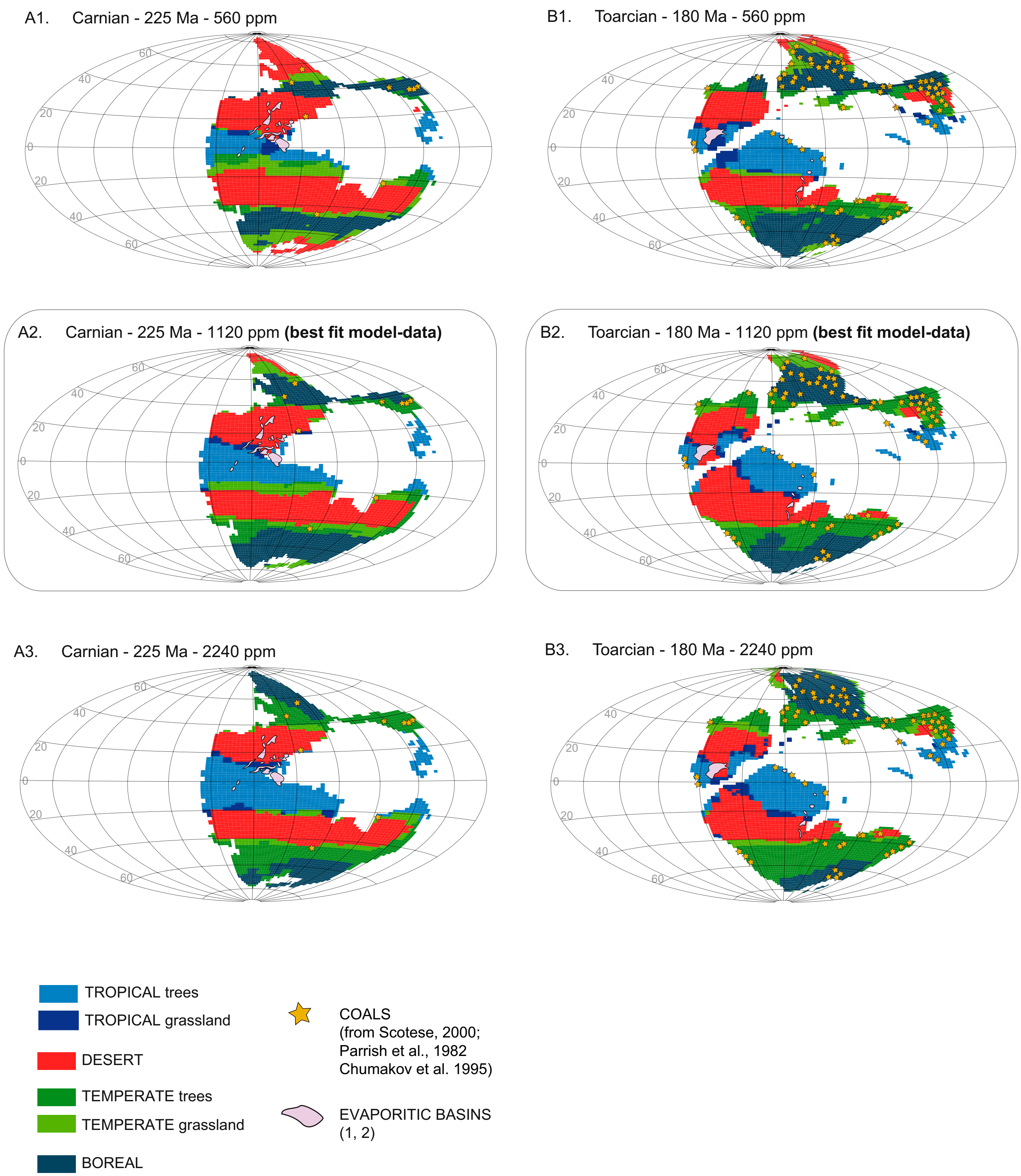
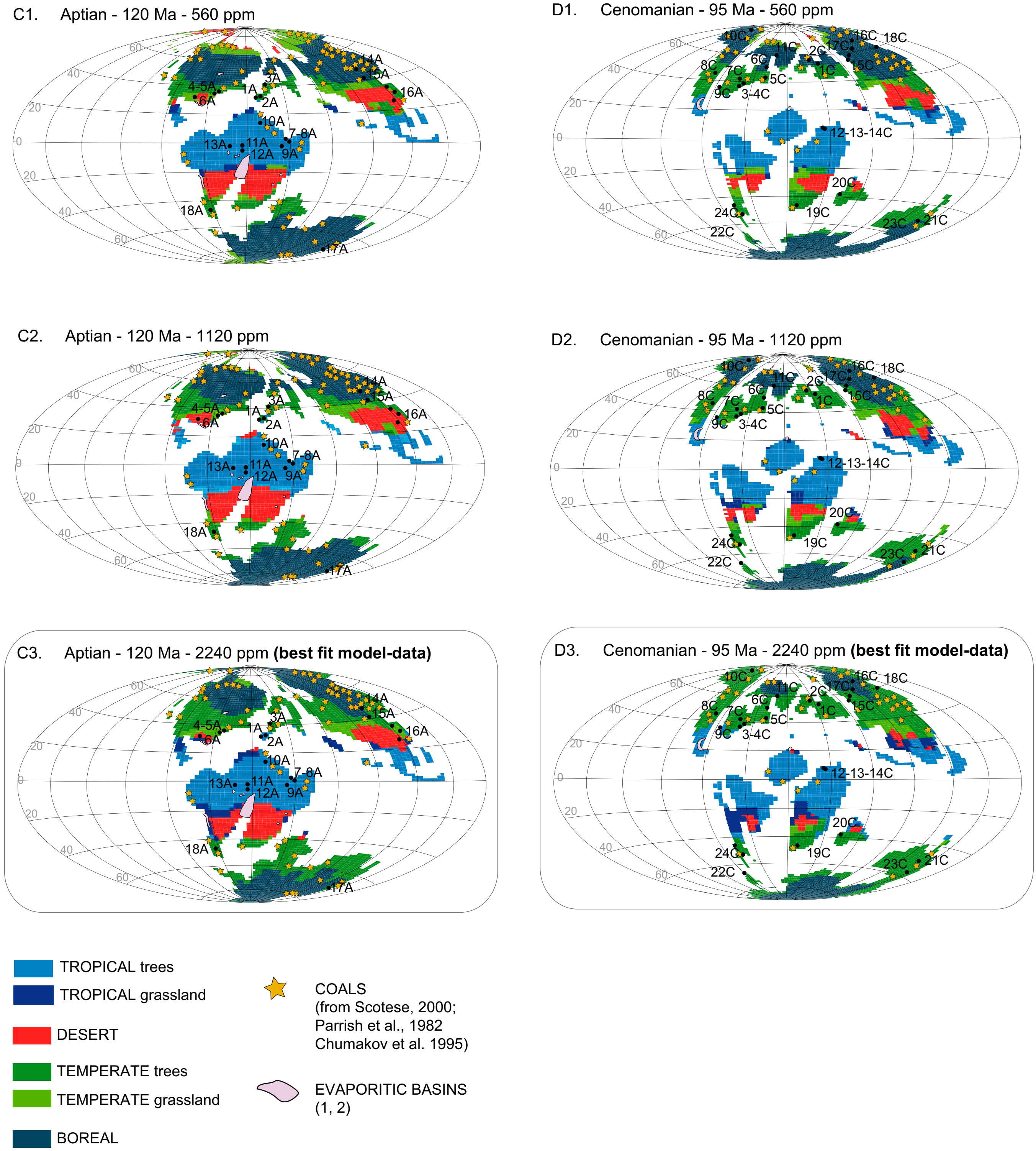


Fig. S1. (Continued)



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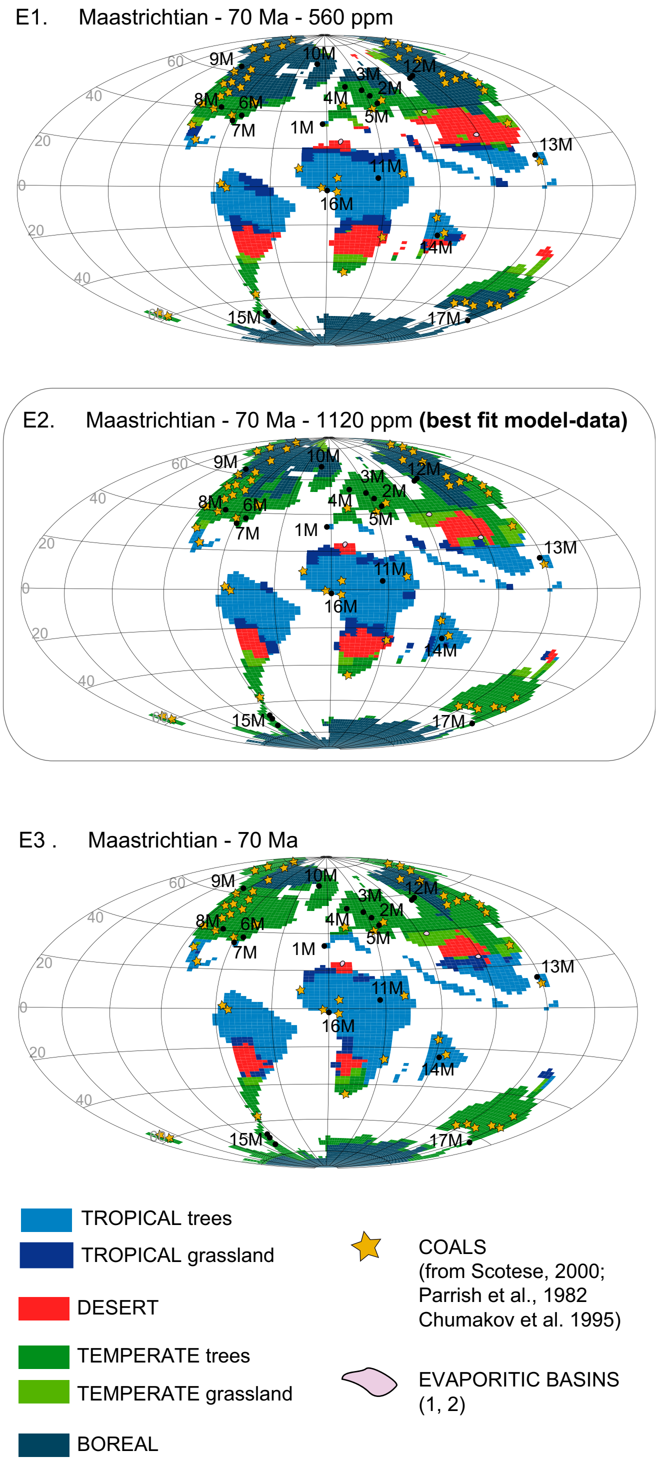

Fig. S1. Evolution of biomes as simulated by FOAM-LPJ: evaporites and coals for each continental configuration and for three atmospheric CO_2 concentrations. Yellow stars show the locations of coal deposits. Evaporitic basins are represented with light blue shading. Maps with rectangles show our best-fit model–data scenario discussed in the main text.

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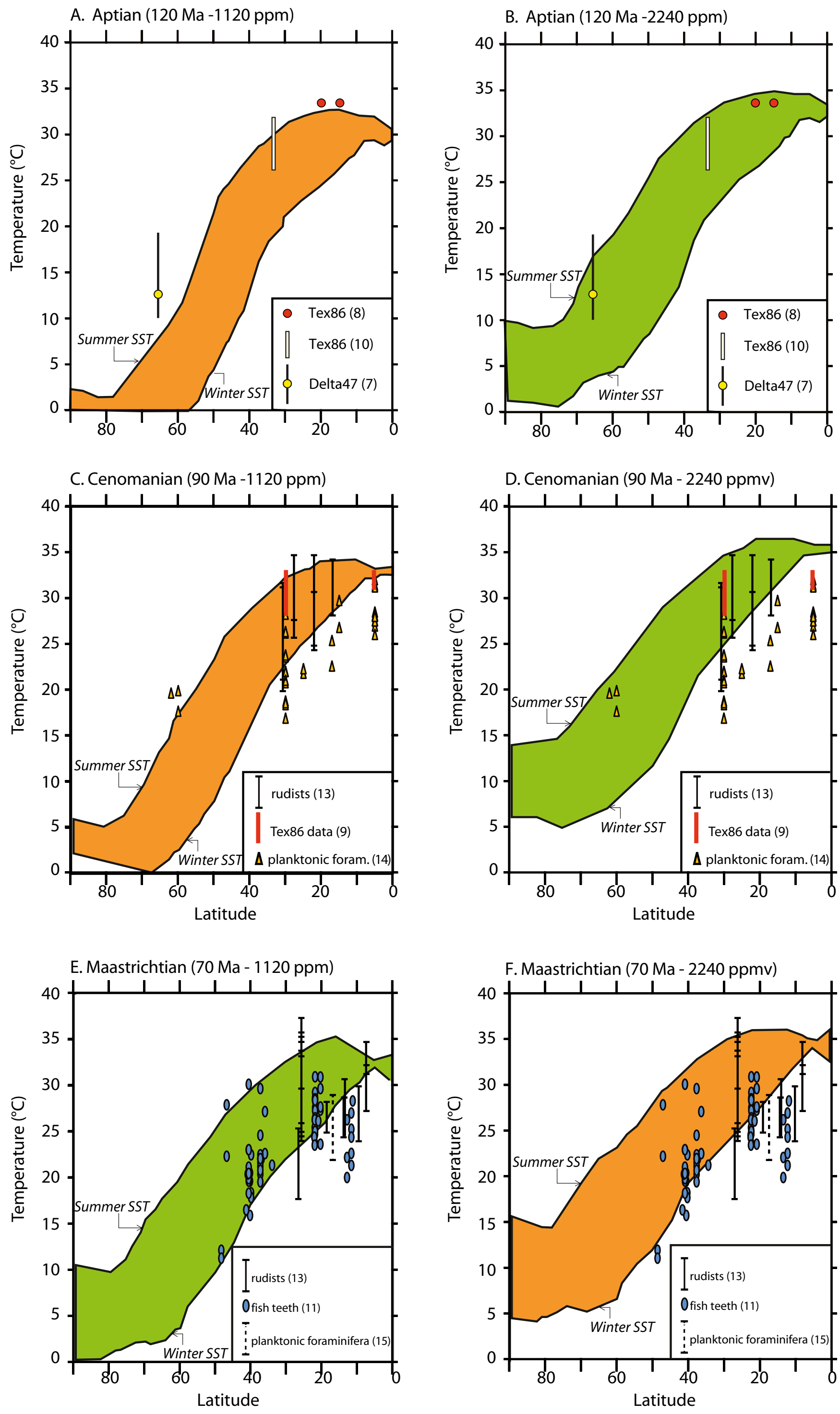

Fig. S2. Comparison between our climate simulations (green and orange envelopes; see the text for more details) and the latitudinal thermal gradient based on sea surface temperature reconstructions for the Aptian (*A* and *B*), the Cenomanian–Turonian (*C* and *D*), and the Campanian–Maastrtichtian (*E* and *F*).

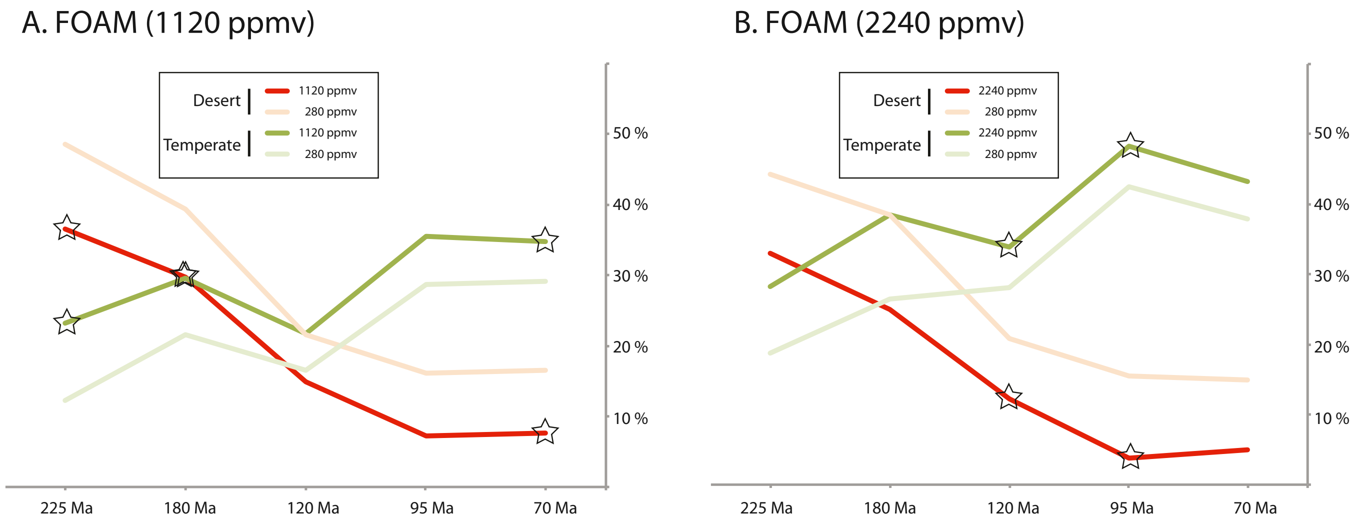

Fig. S3. Evolution of temperate (woody and herbaceous) and desert fractions simulated in LPJ. LPJ is either launched using the same CO_2 as the one used in FOAM (runs shown in the main text) or performed using the preindustrial CO_2 concentration. (*A*) Climate runs at 1,120 ppm and (*B*) climate runs at 2,240 ppm. Stars indicate the best-fit simulations retained in the manuscript.

Table S1. Percentage of coals located under nondesertic biome

Timeslices	% of coals under nondesertic biomes at 560 ppm	% of coals under nondesertic biomes at 1120 ppm	% of coals under nondesertic biomes at 2240 ppm
Late Triassic (225 Ma)	87.8%	**89.9%**	89.9%
Early Jurassic (180 Ma)	95.9%	**98.6%**	98.6%
Early Cretaceous (120 Ma)	95.9%	98.6%	**100%**
Mid-Cretaceous (90 Ma)	97.5%	100%	**100%**
Late Cretaceous (70 Ma)	98.2%	**100%**	100%

The best-fit scenarios are in bold.

Table S2. Correspondence between LPJ plant functional types and biomes used in this study

LPJ original PFTs	Corresponding biomes in this study
Tropical broad-leaved evergreen	Tropical
Tropical broad-leaved raingreen	Tropical
Temperate needle-leaved evergreen	Temperate
Temperate broad-leaved evergreen	Temperate
Temperate broad-leaved summergreen	Temperate
Boreal needle-leaved summergreen	Boreal
Boreal needle-leaved evergreen	Boreal
Boreal broad-leaved summergreen	Boreal
Temperate herbaceous	Temperate herbaceous
Tropical herbaceous	Tropical herbaceous
Desert	Desert

Table S3. Details of the main fossil sites (numbered in Fig. 2) according to the review by Friis et al. (1) and their climate correspondence in this study

No.	Country	Locality	Type of fossils	Dating	Ref(s).	LPJ biome (this study)
1A	Portugal	Torres Vedras	Mesofossils	Late Barremian–Early Aptian	2–4	Tropical
1A	Portugal	Cos-Juncal–Nazaré–Leiria	Mesofossils	LateAptian	2–4	Tropical
1A	Portugal	Figueira da Foz	Mesofossils	LateAptian	4, 5	Tropical
1A	Portugal	Torres Vedras	Fragmentary angiosperm remains of leaf floras	Late Barremian–Early Aptian	6–8	Tropical
1A	Portugal	Catefica	Diverse well-preserved flowers, fruits, seeds	Late Barremian–Aptian	9, 10	Tropical
1A	Portugal	Cercal	Leaf floras	Aptian–Albian	2, 6, 7, 11	Tropical
1A	Portugal	Nazare	Angiosperm leaves	Late Albian	6, 7, 9, 12	Tropical
1A	Portugal	Famalicao	Mesofossil flora (diverse)	Late Aptian	9, 12–15	Tropical
1A	Portugal	Vale de Agua	Angiosperm flowers, fruits, seeds and dispersed stamens	Late Aptian–Early Albian	9,10, 12, 13, 16–21	Tropical
1A	Portugal	Juncal	Macrofossil and mesofossil flora	Late Aptian–Early Albian	9	Tropical
1A	Portugal	Figueira da Foz	Leaves of angiosperms	Late Aptian–Early Albian	6, 7	Tropical
1A	Portugal	Buarcos	Angiosperm flowers, fruits, seeds (diverse mesofossils)	Late Aptian–Early Albian	10, 12, 13, 17, 22, 23	Tropical
1A	Portugal	Villa Verde	Mesofossil floras	Late Aptian–Early Albian	24, 25	Tropical
2A	Spain	Cuenca	Mesofossil floras, tricolpate pollen	Late Barremian	26	Tropical
3A	Great Britain	Isle of White	Pollen	Barremian–Aptian	27	Temperate
3A	Great Britain	Kingsclere Borehole, Berkshire	Pollen	Barremian–Aptian boundary	28, 29	Temperate
3A	Great Britain	"Wealden sediments"	Macrofossils and mesofossils	Barremian	27, 30, 31	Temperate
4A	Virginia	Bank near Brooke	Macrofossils (leafs)	Early to Middle Albian	32–34	Temperate
4A	Virginia	Drewry's Bluff	Macrofossils, mesofossil (fruits, seeds, and stamens of angiosperms)	Aptian	23, 35–39	Temperate
4A	Virginia	Dutch Gap	Macrofossils (rare), mesofossils (diverse)	Early Aptian	23, 32, 35, 36, 39, 40	Temperate
5A	Maryland and Washington, DC	Kenilworth	Pollen, mesofossils (fruits, seeds)	Early Albian or Late Aptian	12, 41	Temperate
6A	Texas	Glenrose	Pollen	Early Albian	36	Arid
7A	Israel	Negev	Pollen	Late Barremian–LateAptian	42, 43	Tropical
8A	Jordan	Mahis	Mesofossils	Albian	44	Tropical
9A	Egypt	Dakhla basin	Pollen	Aptian or Early Albian	45	Tropical
10A	Tunisia	Bir el Karma and Foum el Hassan	Mesofossils	Late Aptian–Early Albian	46, 47	Tropical
11A	Gabon	North Gabon	Pollen	Late Barremian	48	Tropical
12A	Congo	Congo	Pollen	Barremian	49	Tropical
13A	Brazil	Araripe basin	Macrofossils, pollens	Late Aptian–Early Albian	50–58	Tropical
14A	Transbaikalia	Semion Valley	Mesofossils, pollen	Aptian–Early Albian	59	Cold/temperate
15A	Mongolia		Pollen	Aptian or Late Barremian	60, 61	Temperate
16A	China	Heilongjiang Province	Angiosperm fossils	Aptian	62	Temperate
16A	China	Jixi Basin	Angiosperm fossils	Mid-Barremian–Early Aptian	63	Temperate
16A	China	Liaoning	Angiosperm fossils (Archaefructus)	Early to Early–Late Aptian	64–67	Arid
17A	Australia	Gippsland Basin	Angiosperm	Aptian	68	Cold/temperate
18A	South America	Santa Cruz Province	Angiosperms	Early–Late Aptian	69–75	Temperate
1C	Czech Republic	Bohemian Basin	Mesofossils (diverse)	Cenomanian to Santonian	76-85	Temperate
2C	Germany	Prangenhaus and Rohdenhaus	Mesofossils (diverse)	Late Albian–Early Cenomanian	86	Temperate
3C	Virginia	Puddledock	Mesofossils (diverse)	Middle Albian	12, 87–91	Temperate

Table S3. Cont.

No.	Country	Locality	Type of fossils	Dating	Ref(s).	LPJ biome (this study)
4C	Maryland and Washington, DC	Kenilworth	Mesofossils, pollen	Middle Albian	12, 41	Temperate
4C	Maryland and Washington, DC	West Brothers	Macrofossil floras (flowers, fruits and seeds, diverse)	Late Albian	92–94	Temperate
4C	Maryland and Washington, DC	Mauldin Mountain	Mesofossilflora (diverse)	Earliest Cenomanian	94–96	Temperate
4C	Maryland and Washington, DC	Bull Mountain	Macrofossil floras (diverse)	Late Albian	96	Temperate
5C	New Jersey	Old Crossman Clay Pit	Angiosperm flowers, fruits and seeds, pollen	Turonian age	97–113	Temperate
6C	Massachusetts	Gay Head	Macrofossils (diverse), mesofossils	Earliest Campanian	114, 115	Temperate
7C	Alabama	Shirley's Mill	Macrofossils	Middle to Late Cenomanian	116	Temperate
8C	Kansas	Linnenberger's Ranch	Mesofossils, pollen	Early Cenomanian	117–124	Temperate
8C	Kansas	Hoisington locality	Angiosperm leaves	Early Cenomanian	122, 123	Temperate
8C	Kansas	Rose Creek locality	Macrofossils, angiosperm leaves	Early Cenomanian	125, 126	Temperate
9C	Texas	Arthur's Bluff	Macrofossil flora (leaves), pollen	Cenomanian	119, 120, 127–131	Tropical
10C	Alaska	Alaska	Angiosperms	Latest Albian–Cenomanian	132	Temperate
11C	Greenland	Nuussuaq and Vartenhuk	Angiosperms (rare)	Late Albian	133	Temperate
11C	Greenland	Disko, Nuussuaq, and in the Umanak Fjord	Angiosperms (diverse)	Latest Albian or earliest Campanian	133, 134	Temperate
12C	Israel	Gerofit and Qetura	Angiosperms (diverse)	Early Turonian	135–139	Tropical
13C	Jordan	Jordan	Angiosperm leaves (diverse)	Cenomanian	140	Tropical
14C	Lebanon	Nammoura	Angiosperms (leaves)	Cenomanian	141, 142	Tropical
15C	Kazakhstan	Northwestern Kazakhstan	Macrofossils, mesofossils	From the latest Albian to the Maastrichtian	143–147	Temperate
15C	Kazakhstan	Western Kazakhstan (Karatsche-Tau and Kyzyl-Shen)	Angiosperms (diverse leaves)	Middle Albian	144, 145	Temperate
15C	Kazakhstan	Northwestern Kazakhstan (Sarbay Iron Quarry)	Macrofossil (leaves), diverse mesofossil floras (flowers, fruits, seeds and twig)	Cenomanian–Early Turonian	143, 146, 148–151	Temperate
15C	Kazakhstan	Kachar	Mesofossil floras (angiosperm fruits and seeds)	Cenomanian–Turonian	147, 152	Temperate
15C	Kazakhstan	Southern Kazakhstan (Karatau range)	Macrofossil floras	Turonian	153	Temperate
16C	Siberia	West Siberia (Chulym–Yenisei)	Diverse macrofossil floras (leaves, reproductive structures)	Cenomanian	154, 155	Cold
16C	Siberia	Lena–Vilyuy River Basin	Macrofossil floras	Early Cenomanian	156, 157	Cold
17C	Northeastern Russia	Eliseevskoye	Macrofossil floras (leaves and reproductive organs)	Latest Albian–Early Cenomanian	158	Cold?
18C	East of Russia	Southern Primorye region	Angiosperm remains	Early to Middle Albian	159	Temperate
19C	Southern Africa	Southern tip of South Africa	Pollen	Cenomanian	160	Temperate
19C	Southern Africa	Central Botswana	"Angiosperms mentioned"	Cenomanian–Coniacian	161	Temperate
20C	Madagascar	Morondova Basin	Pollen	Early Cenomanian	162	Temperate
21C	Australia	Eromanga Basin	Macrofossils (diverse leaves)	Latest Albian–Early Cenomanian	163	Temperate
22C	Antarctica	Alexander Island	Angiosperms (diverse)	Late Albian	164–167	Temperate
23C	New Zealand	Pitt Island	Angiosperm leaves	Turonian	168	Temperate

Table S3. Cont.

No.	Country	Locality	Type of fossils	Dating	Ref(s).	LPJ biome (this study)
24C	South America	Santa Cruz Province, Bajo de los Corrales	Angiosperm leaves	Late Albian–Early Cenomanian	169, 170	Temperate
1M	Portugal	Mira	Mesoflora (diverse flowers, fruits, seeds, and stamens)	Campanian–Maastrichtian age	8, 171–175	Tropical
1M	Portugal	Esgueira	Pollen, macrofossils (diverse), mesofossils	Campanian–Maastrichtian	172, 173, 175, 176	Tropical
2M	Austria	Grünbach	Macrofossils	EarlyCampanian	177	Temperate
2M	Austria	Gmünd	Pollen	Santonian	178	Temperate
3M	Germany	Aachen	Angiosperm remains	Santonian	78, 179–183	Temperate
3M	Germany	Quedlinburg–Blankenberg area	Macrofossil (leaf, reproductive organs), mesofossil floras (diverse)	Mid to Late Santonian	78, 184, 185	Temperate
3M	Germany	Eisleben	Macrofossils floras (diverse)	Maastrichtian	78	Temperate
3M	Germany	Walbeck	Macrofossil and mesofossil floras (diverse)	Late Maastrichtian	78	Temperate
4M	Sweden	Äsen	Angiosperm flowers, fruits, and seeds	Campanian	92, 174, 180, 186–194	Temperate
5M	Romania	Budurone	Mesofossil floras	Maastrichtian	195	Temperate
6M	North Carolina	Neuse River Cutoff	Mesofossil floras (diverse)	Early Campanian	92, 146, 196–198	Temperate
7M	Georgia	Upatoi Creek	Mesofossil floras	Coniacian	199	Temperate
7M	Georgia	Allon Quarry	Macrofossil and mesofossil floras	Late Santonian	200–205	Temperate
8M	Colorado	Denver Basin	Mesofossil floras	Maastrichtian	206	Temperate
9M	Canada	Vancouver Island, British Columbia; Brannan Lake	Mesofossil floras	Early Campanian	207–209	Cold
10M	Greenland	Disko,Nuussuaq, and in the Umanak Fjord area	Angiosperm remains (diverse)	Earliest Campanian	133, 210–216	Cold
11M	Sudan	JebelMudaha	Pollen and mesofossils (angiosperm fruits and leaves)	Turonian to Early Senonian	217, 218	Tropical
12M	Kazakhstan	Northwestern Kazakhstan	Macrofossil and mesofossil floras	From the latest Albian to the Maastrichtian	143–147	Temperate
12M	Kazakhstan	Taldysay	Angiosperm reproductive organs (mesofossils)	Santonian–Early Campanian	151	Temperate
13M	Japan	Hokkaido; Sankebetsu River, Hidaka–Monbetsu River, Kumaoizawa	Mesofossils	Coniacian–Santonian	219–222	Tropical
13M	Japan	Honshu	Angiosperms	EarlyConiacian	223–226	Tropical
13M	Japan	Gokurakuzawa	Mesofossils	EarlySantonian	227	Tropical
14M	India	Chhindwara district of Madhya Pradesh	Reproductive structures, fruits, seeds	Maastrichtian	228–237	Tropical
15M	Antarctica	Antarctic Peninsula	Mesofossil flora (diverse)	Late Santonian	238, 239	Temperate
15M	Antarctica	James Ross Island	Macrofossil floras (leaves)	Coniacian	167	Temperate
15M	Antarctica	South Shetland Islands	Pollen, leaf assemblages	Late Campanian to probably Early Maastrichtian	240	Temperate
16M	Nigeria		Fruit and seed floras	Maastrichtian	241–244	Tropical
17M	New Zealand	Pakawau Bush Road	Flowers	Campanian or Maastrichtian	245, 246	Temperate

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