Supplementary Table 1. Summary of Principal Component Analysis (PCA) results for (a) Akvaqiak Lake, (b) Qipisarqo Lake, (c) core HU021 and (d) core HU085. Sum of all eigenvalues (total variance): 3.1708 for Akvaqiak Lake, 8.1800 for Qipisarqo Lake, 12.2310 for core HU021, 19.5172 for core HU085. Mean of the eigenvalues: 0.3171 for Akvaqiak Lake, 0.4812 for Qipisarqo Lake, 0.8154 for core HU021, 1.1481 for core HU085.

Variable	PCA axis 1	PCA axis 2	PCA axis 3
a) Akvaqiak Lake			
Eigenvalues	1.9065	0.4287	0.2998
% variance	60.12	13.52	9.46
b) Qipisarqo Lake			
Eigenvalues	3.615	2.109	0.7266
% variance	44.19	25.78	8.88
c) core HU021			
Eigenvalues	2.9506	1.9136	1.643
% variance	24.12	15.65	13.43
d) core HU085			
Eigenvalue	5.3704	3.6884	2.2308
% variance	27.52	18.90	11.43

Supplementary Table 2. PCA eigenvectors (variable loadings) for (a) Akvaqiak Lake, (b) Qipisarqo Lake, (c) core HU021 and (d) core HU085

Taxa	PCA axis 1	PCA axis 2	PCA axis 3
a) Akvaqiak Lake			
Betula	-0.3807	-0.1679	0.5014
Ericales	-0.3229	-0.2485	-0.7237
Salix	-0.0740	0.5523	0.0786
Poaceae	-0.0151	0.5502	-0.0149
Picea + Pinus	-0.0016	0.2265	-0.0941
Saxifragaceae	0.0104	0.1705	0.2461
Dryas	0.1031	0.0368	0.1272
Oxyria	0.1970	0.0637	-0.0885
Alnus	0.4365	-0.4502	0.2768
Cyperaceae	0.7106	0.1179	-0.2201
b) Qipisarqo Lake			
Betula	-0.4699	0.2898	-0.4240
Ericales	-0.3720	-0.0345	0.2529
Salix	-0.0523	-0.4109	0.1639
Crassulaceae	-0.0304	-0.0584	0.0412
Saxifragaceae	-0.0104	-0.1859	0.1061
Dryas	-0.0039	-0.0465	0.0453
Ambrosia	0.0107	-0.1772	-0.0075
Oxyria	0.0190	-0.1327	0.0710
Poaceae	0.0356	-0.0978	0.1085
Brassicaceae	0.0361	-0.0322	0.0574
Thalictrum	0.0816	-0.0346	-0.0297
Artemisia	0.0855	0.0974	0.0055
Ranunculaceae	0.1008	-0.0278	0.0602
Cupressaceae	0.2140	0.0517	-0.3716
Picea + Pinus	0.2538	-0.1435	-0.6926
Cyperaceae	0.2644	-0.6364	-0.0727
Alnus	0.6555	0.4545	0.2581
c) core HU021			
Spiniferites ramosus	-0.4545	0.2226	-0.0544
Islandinium minutum	-0.4219	-0.6318	-0.3691
Bitectatodinium tepikiense	-0.4153	-0.0885	0.0363
Nemotosphaeropsis labyrinthus	-0.3309	0.0587	0.0735
Spiniferites ssp.	-0.2106	0.3964	-0.4881
Brigantedinium spp.	-0.0601	-0.3956	0.2001
Impagidinium pallidum	-0.0502	-0.0502	-0.2882
Pentapharsodinium dalei	0.0216	0.0356	-0.1812
Impagidinium patulum	0.0771	-0.0632	-0.0802
Selenopemphix quanta	0.0842	-0.3219	0.2360
Impagidinium sphaericum	0.0872	-0.1363	-0.0861
Impagidinium aculeatum	0.1002	-0.1716	-0.3943
Operculodinium centrocarpum	0.1236	-0.0192	0.1154
Ataxiodinium choane	0.2407	-0.2579	-0.1369
Spiniferites elongatus	0.4226	-0.0019	-0.4505
d) core HU085			
Trinovantedinium applanatum	-0.2447	-0.2177	0.1256
Brigantedinium spp.	-0.1857	-0.2063	0.2297
Pyxidinopsis reticulata	-0.1164	0.0762	0.2236
Impagidinium pallidum	-0.0947	0.1458	-0.3004
Pentapharsodinium dalei	-0.0909	0.1862	0.7666
Bitectatodinium tepikiense	-0.0523	0.2676	-0.0144
Impagidinium sphaericum	-0.0509	0.4109	0.1548
Nemotosphaeropsis labyrinthus	-0.0485	0.0114	-0.0283
Operculodinium centrocarpum	-0.0403	-0.0959	-0.0184
Impagidinium paradoxum	0.0656	0.1243	0.2800
Spiniferites elongatus	0.1493	-0.0865	0.0840
Impagidinium aculeatum	0.1633	0.0342	-0.0141
Impagidinium spp.	0.3147	-0.2465	0.0976
Impagidinium patulum	0.3658	-0.1943	0.1194
Spiniferites ssp.	0.3832	-0.2068	0.2495
Spiniferites mirabilis-hyperacanthus	0.4543	0.6352	-0.0623
Spiniferites ramosus	0.4756	-0.1722	-0.0520

Supplementary Table 3. Redundancy Analysis (RDA) results on the modern pollen assemblages from the Arctic biome (n=256 sites). Sum of all unconstrained eigenvalues (total inertia): 1.000, Sum of all canonical eigenvalues: 0.254. (a) Summary of RDA results, (b) RDA eigenvectors (variable loadings) and (c) inter-set correlation matrix between RDA axes 1-3 and the 4 climate variables.
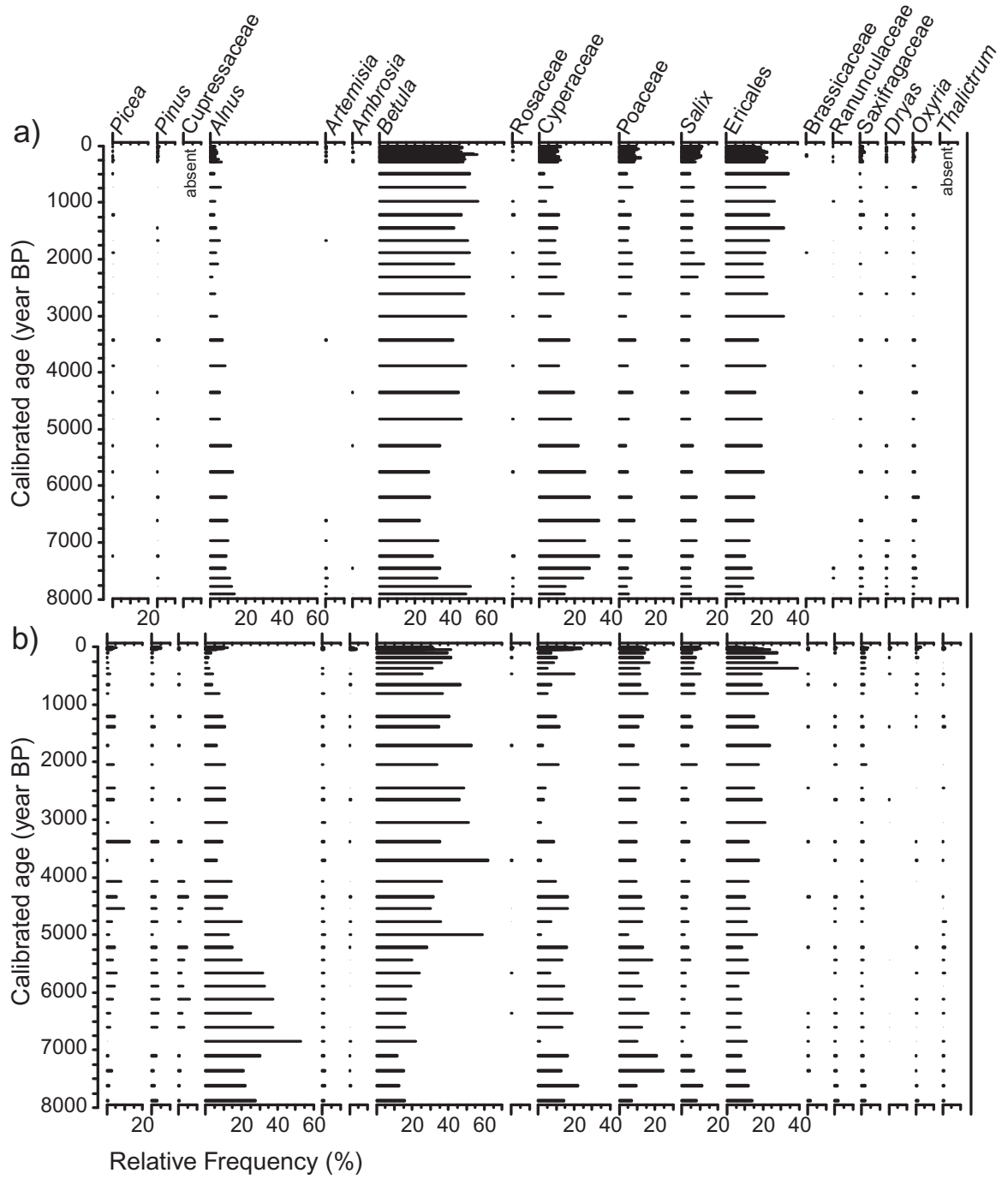
Variable	RDA axis 1	RDA axis 2	RDA axis 3
a) Summary of RDA results			
Eigenvalues	0.184	0.051	0.014
% variance explained (taxa data)	18.4	5.1	1.4
% variance explained (taxa-environment)	72.5	20.1	5.5
Species-environment correlation	0.812	0.616	0.368
p-value (999 Monte Carlo permutations with Bonferroni adjustement)	0.001	0.001	0.001
b) RDA eigenvectors			
Abies	0.0052	-0.0686	-0.0686
Alnus	-0.2559	0.1550	0.0546
Ambrosia	0.0059	-0.2813	-0.2010
Apiaceae	0.1596	0.0282	0.0149
Artemisia	-0.3993	-0.0576	-0.0171
Tubuliflorae-Liguliflorae	-0.1566	0.1211	0.0318
Betula	0.6118	0.0742	0.1194
Brassicaceae	-0.5264	0.0398	0.2389
Caryophyllaceae	-0.3277	-0.2275	0.0614
Chenopodiaceae	-0.0996	-0.1869	-0.1418
Corylus	0.0300	-0.1332	-0.0701
Cupressaceae	0.4500	-0.0553	-0.0461
Cyperaceae	-0.0493	0.3888	-0.1975
Dryas	-0.4157	-0.0797	-0.0909
Ericales	0.5265	-0.2967	-0.0458
Fabaceae	-0.0634	-0.1694	-0.1161
Fraxinus	0.0946	-0.0426	-0.0983
Larix	0.0125	-0.0598	-0.0416
Myrica	-0.0589	-0.0390	-0.0059
Onagraceae	0.0134	-0.0581	-0.1143
Oxyria/Rumex	-0.5732	-0.2693	0.1029
Papaveraceae	-0.3119	-0.1784	-0.1778
Picea	-0.5204	0.0690	0.0692
Pinus	-0.3770	-0.2064	-0.2076
Plantago	-0.1406	0.0583	0.0550
Poaceae	0.0203	0.1261	0.1332
Polygonaceae	-0.0821	-0.1088	-0.0986
Populus	-0.0083	0.0051	-0.0474
Quercus	-0.0848	-0.0212	-0.0098
Ranunculaceae	-0.0888	-0.0564	0.0365
Rosaceae	-0.5196	0.0335	0.0387
Salix	-0.0223	-0.3667	0.0269
Saxifragaceae	-0.6560	-0.1230	0.0427
Scrophulariacea	-0.1090	-0.0986	-0.1057
Thalictrum	0.3161	0.0018	0.1730
c) Inter-set correlation matrix			
January SAT	0.7890	-0.0302	0.0653
July SAT	0.5611	0.3970	-0.1069
Annual Precipitation	0.6315	-0.1602	0.0103
JJAS Sunshine	-0.3178	0.2778	0.1910

Supplementary Table 4. Correlation matrix between the 4 climate variables (from RDA)
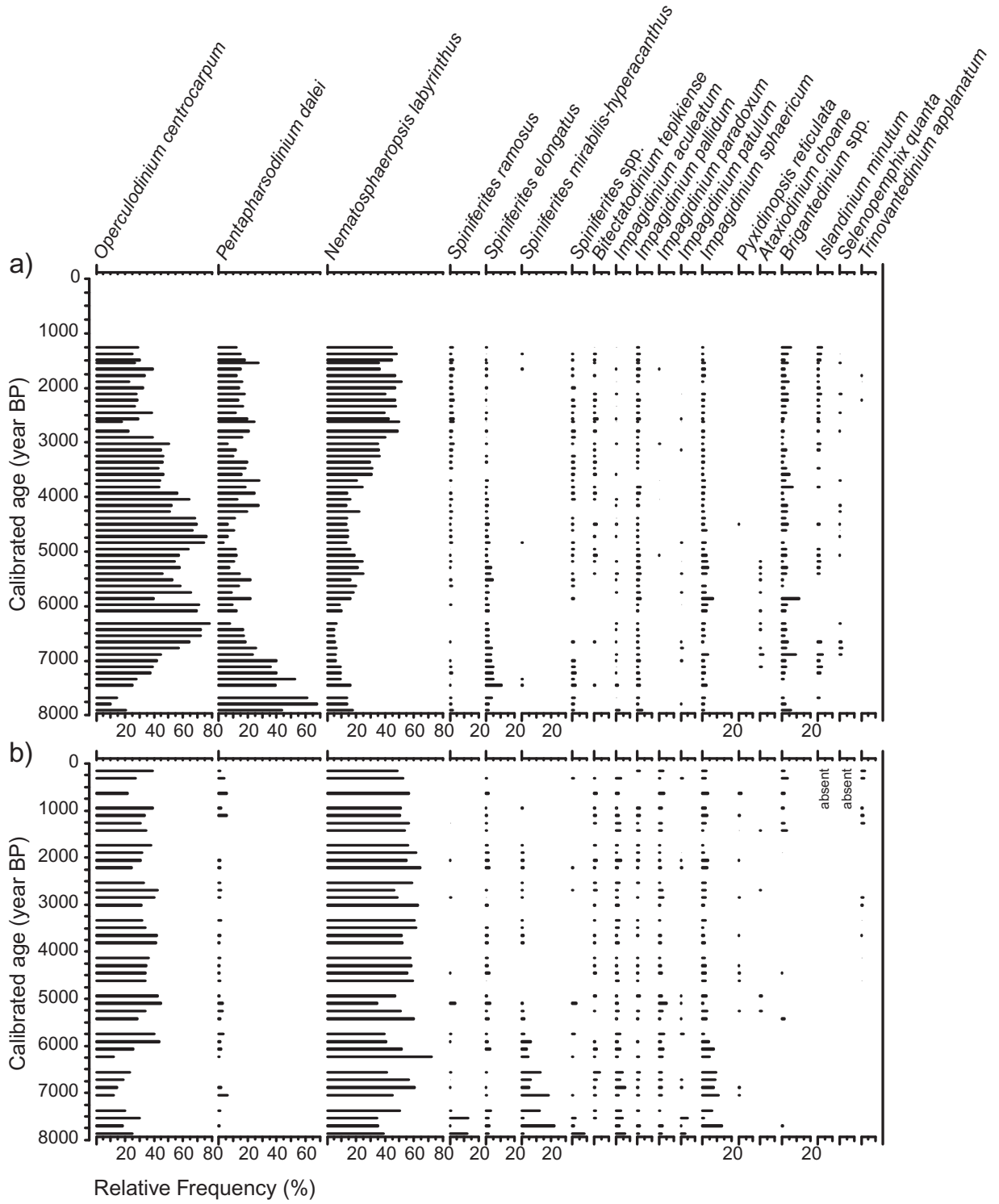
Variable	January SAT	July SAT	Annual P	JJAS Sunshine
January SAT	1			
July SAT	0.6110	1		
Annual P	0.8594	0.4495	1	
JJAS Sunshine	-0.2171	-0.0356	-0.0564	1

1   **Supplementary Figure 1**. Summary pollen diagrams from Akvaqiak (a) and Qipisarqo (b)

2   composite lake sediment cores for the past 8000 calibrated years. Only taxa with a value greater-

3   than or equal to 1% in at least one sample are illustrated. The following taxa are not illustrated:

4   *Abies*, *Myrica*, Chenopodiaceae, *Populus*, Tubuliflorae-Liguliflorae, *Plantago*, Onagraceae,

5   Apiaceae, Fabaceae, Caryophyllaceae, Scrophulariaceae, Polygonaceae, Papaveraceae. They

6   were however included in the basic sum used to compute the relative frequencies. The taxa are

7   ordered from those typical of warmer environments (Low Arctic shrub tundra) on the left, to

8   those characterizing sites that are increasingly polar (High Arctic herb tundra) to the right. To

9   allow a better between-core comparison we used the same upper limit scales for each taxa.

10

11   **Supplementary Figure 2**. Summary dinocyst diagrams of core HU021 (a) and HU085 (b)

12   marine sediment cores for the past 8000 calibrated years. Only taxa with a value greater-than or

13   equal to 1% are illustrated. The following taxa are not illustrated: *Impagidinium strialatum*,

14   *Impagidinium* spp., cyst of cf. *Scrippsiella trifida*, *Operculodinium israelianum*, *Spiniferites*

15   *lazus,* Protoperidinioids, cyst of *Polykrikos schwartzii*, *Echinidinium* cf. *karaense*. They were

16   however included in the basic sum used to compute the relative frequencies. To allow a better

17   comparison between the two diagrams, we used the same upper limit scales for each taxa.

18

19

Supplementary Figure 1

Supplementary Figure 2