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			
Eigenvalues	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.

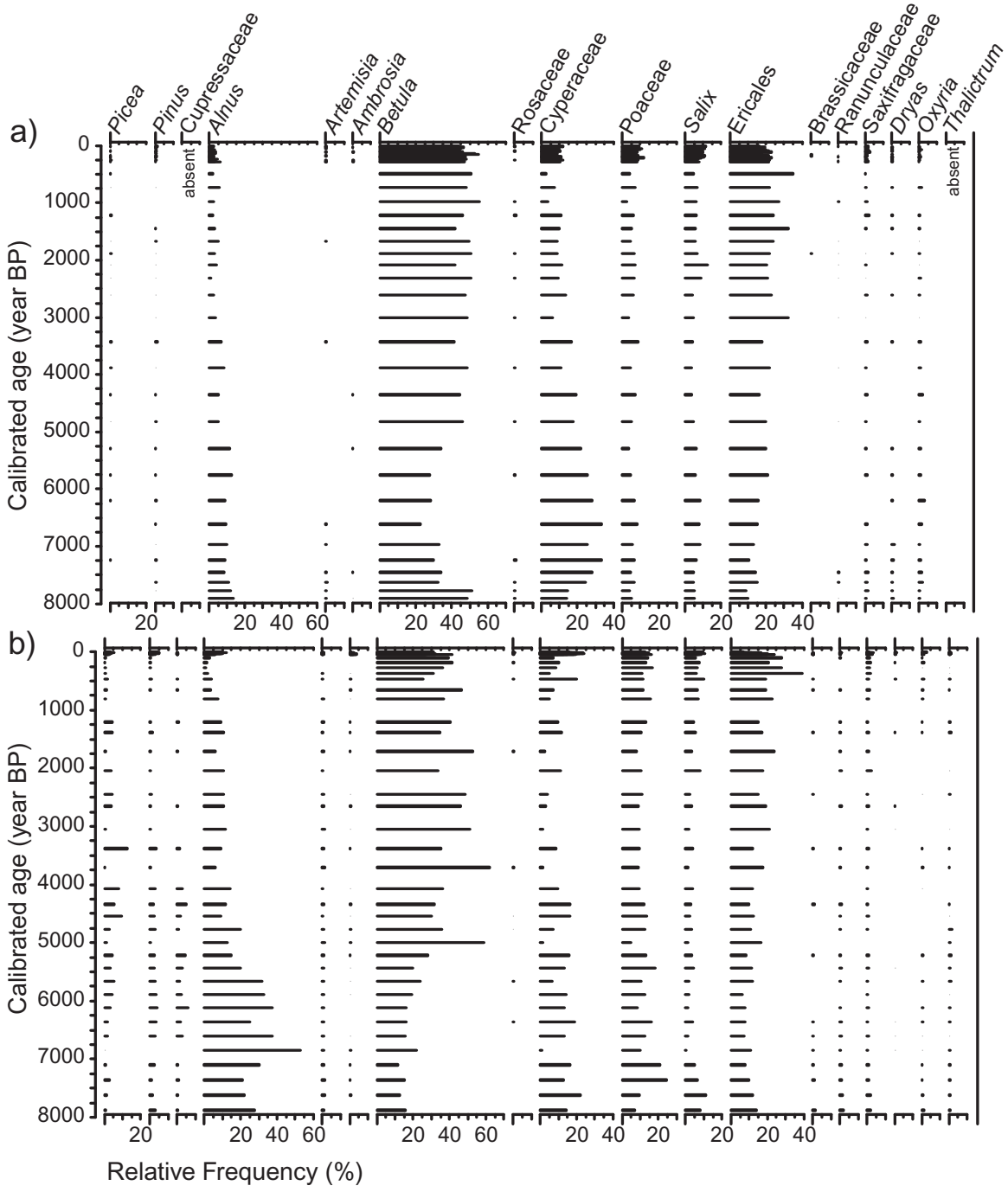
Variable	RDA axis 1	RDA axis 2	RDA axis 3
a) Summary of RDA results			
Eigenvalues	0.184	0.051	0.014
% variance explained (taxa data)	18.4	5.1	1.4
% variance explained (taxa-environment)	72.5	20.1	5.5
Species-environment correlation	0.812	0.616	0.368
p-value (999 Monte Carlo permutations with Bonferroni 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)

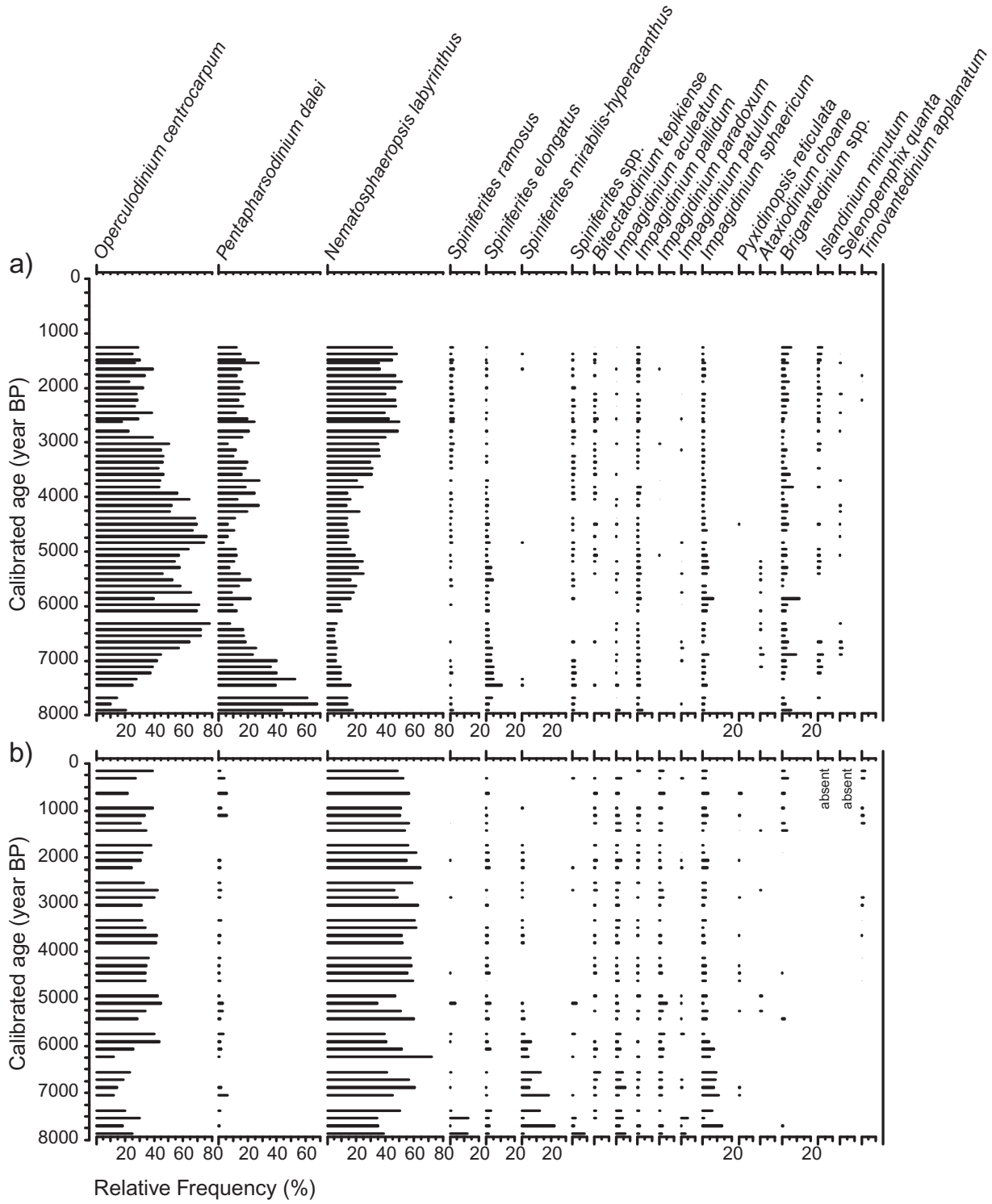
Variable	January SAT	July SAT	Annual P	JJAS Sunshine
January SAT	1			
July SAT	0.6110	1		
Annual P	0.8594	0.4495	1	
JJAS Sunshine	-0.2171	-0.0356	-0.0564	1

Supplementary Figure 1. Summary pollen diagrams from Akvaqiak (a) and Qipisarqo (b) composite lake sediment cores for the past 8000 calibrated years. Only taxa with a value greater-than or equal to 1% in at least one sample are illustrated. The following taxa are not illustrated: *Abies*, *Myrica*, Chenopodiaceae, *Populus*, Tubuliflorae-Liguliflorae, *Plantago*, Onagraceae, Apiaceae, Fabaceae, Caryophyllaceae, Scrophulariaceae, Polygonaceae, Papaveraceae. They were however included in the basic sum used to compute the relative frequencies. The taxa are ordered from those typical of warmer environments (Low Arctic shrub tundra) on the left, to those characterizing sites that are increasingly polar (High Arctic herb tundra) to the right. To allow a better between-core comparison we used the same upper limit scales for each taxa.

Supplementary Figure 2. Summary dinocyst diagrams of core HU021 (a) and HU085 (b) marine sediment cores for the past 8000 calibrated years. Only taxa with a value greater-than or equal to 1% are illustrated. The following taxa are not illustrated: *Impagidinium strialatum*, *Impagidinium* spp., cyst of cf. *Scrippsiella trifida*, *Operculodinium israelianum*, *Spiniferites lazus*, Protoperidinioids, cyst of *Polykrikos schwartzii*, *Echinidinium* cf. *karaense*. They were however included in the basic sum used to compute the relative frequencies. To allow a better comparison between the two diagrams, we used the same upper limit scales for each taxa.



Supplementary Figure 1



Supplementary Figure 2