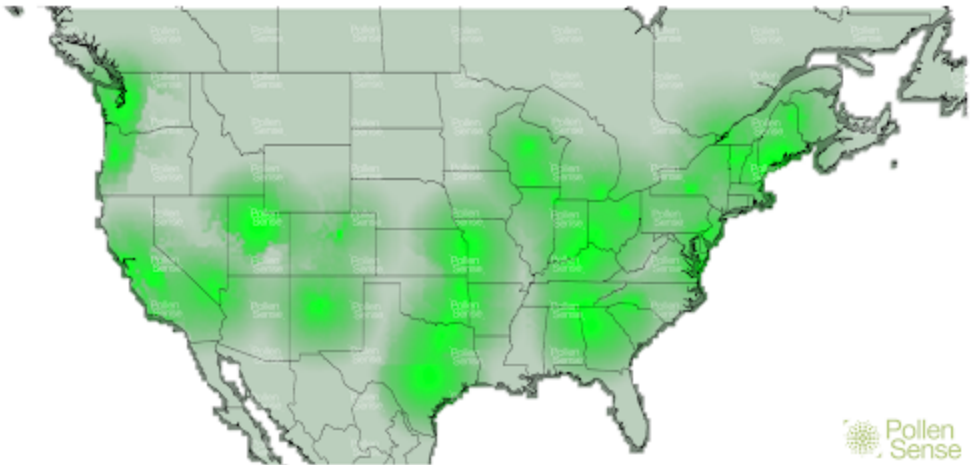


Figure S1. Relative site density map of Pollen Sense sensors as of 12 August 2024, and representative of the density through 2025.

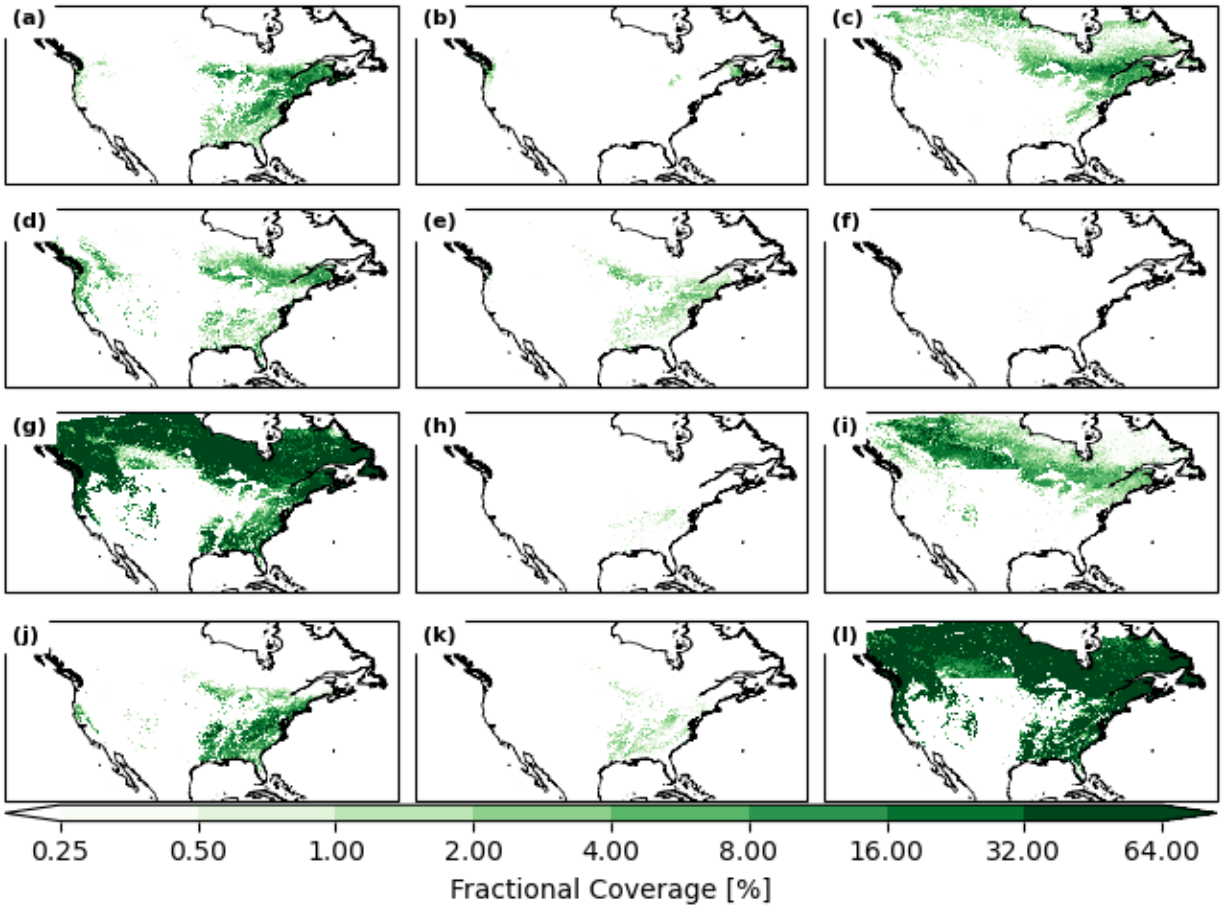


Figure S2. Land cover fraction (% coverage) for 11 tree taxa from the Biogenic Emissions Landuse Database version 6 (BELD6) on its native 4 km resolution grid, including (**a**) *Acer* (maple), (**b**) *Alnus* (alder), (**c**) *Betula* (birch), (**d**) *Cupressaceae* (cedar/juniper), (**e**) *Fraxinus* (ash), (**f**) *Morus* (mulberry), (**g**) *Pinaceae* (pine), (**h**) *Platanus* (sycamore), (**i**) *Populus* (poplar/aspen), (**j**) *Quercus* (oak), (**k**) *Ulmus* (elm), and (**l**), the sum of (**a**–**k**).

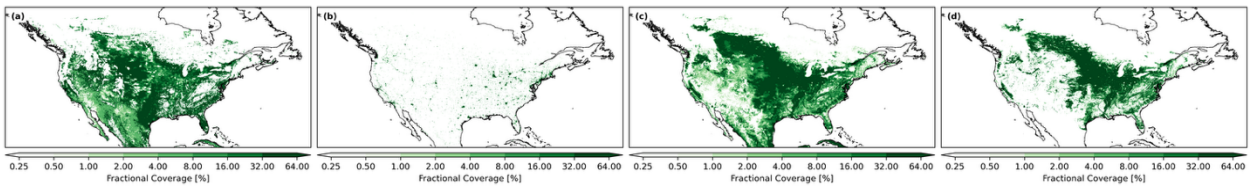


Figure S3. Fractional distribution of **(a)** CLM Grasses, (**b**) CLM Urban, (**c**) CLM crops (**d**) BELD6 summed crops.

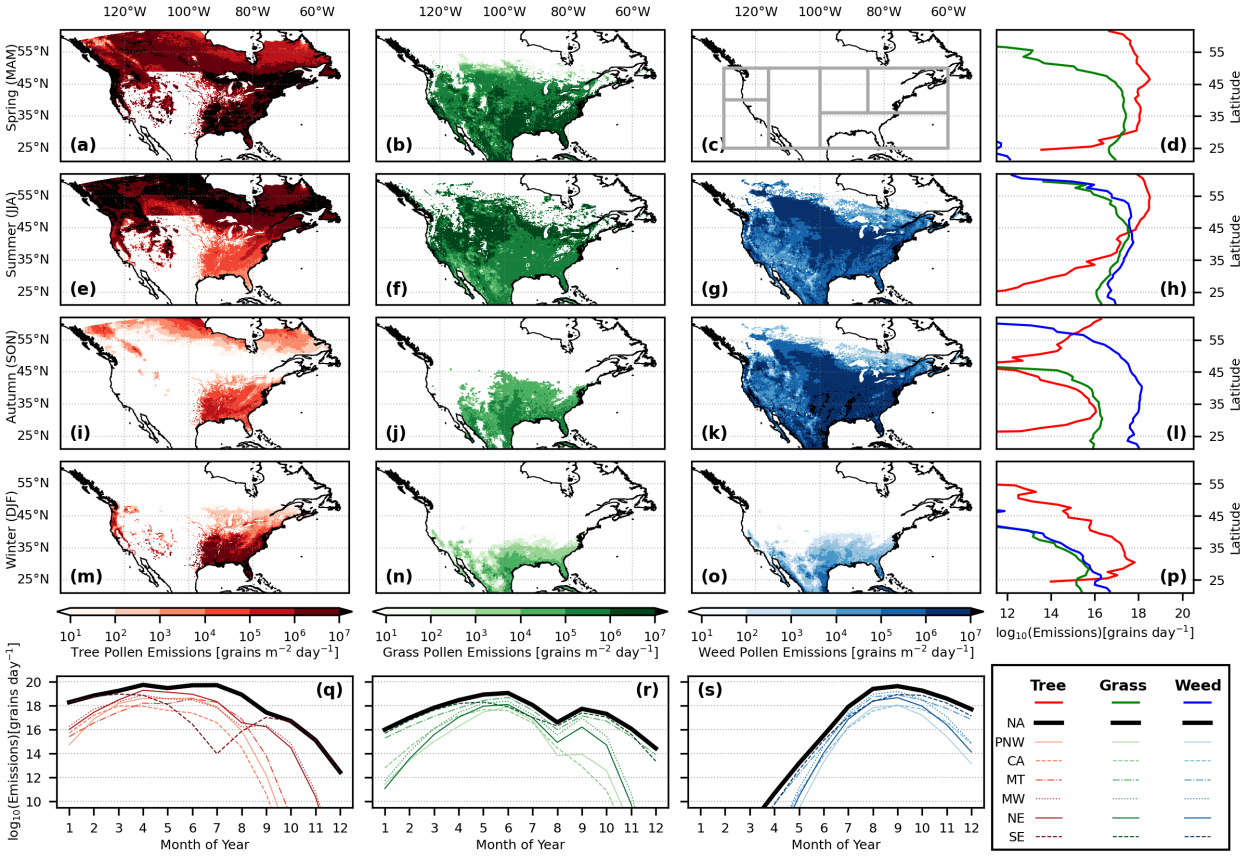


Figure S4. As Fig. 1, but with the error in C4 grasses fixed.

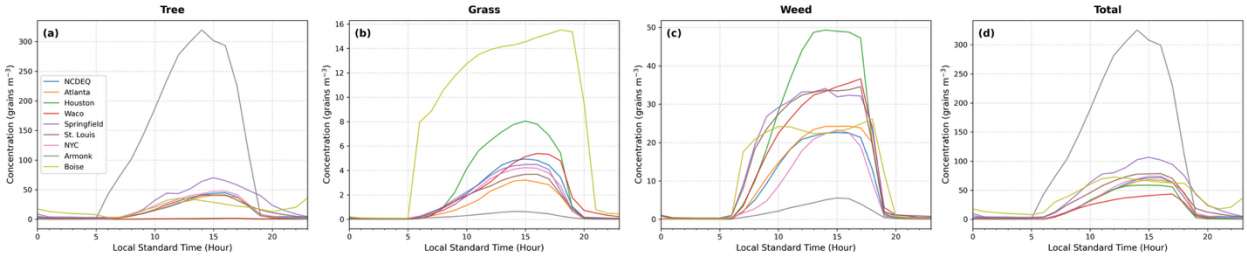


Figure S5. Average (1 Jan - 31 Dec, 2025) diurnal cycle of RAP-Chem modeled (**a**) tree, (**b**) grass, (**c**) weed, and (**d**) total pollen over the AAAAI NAB sites.

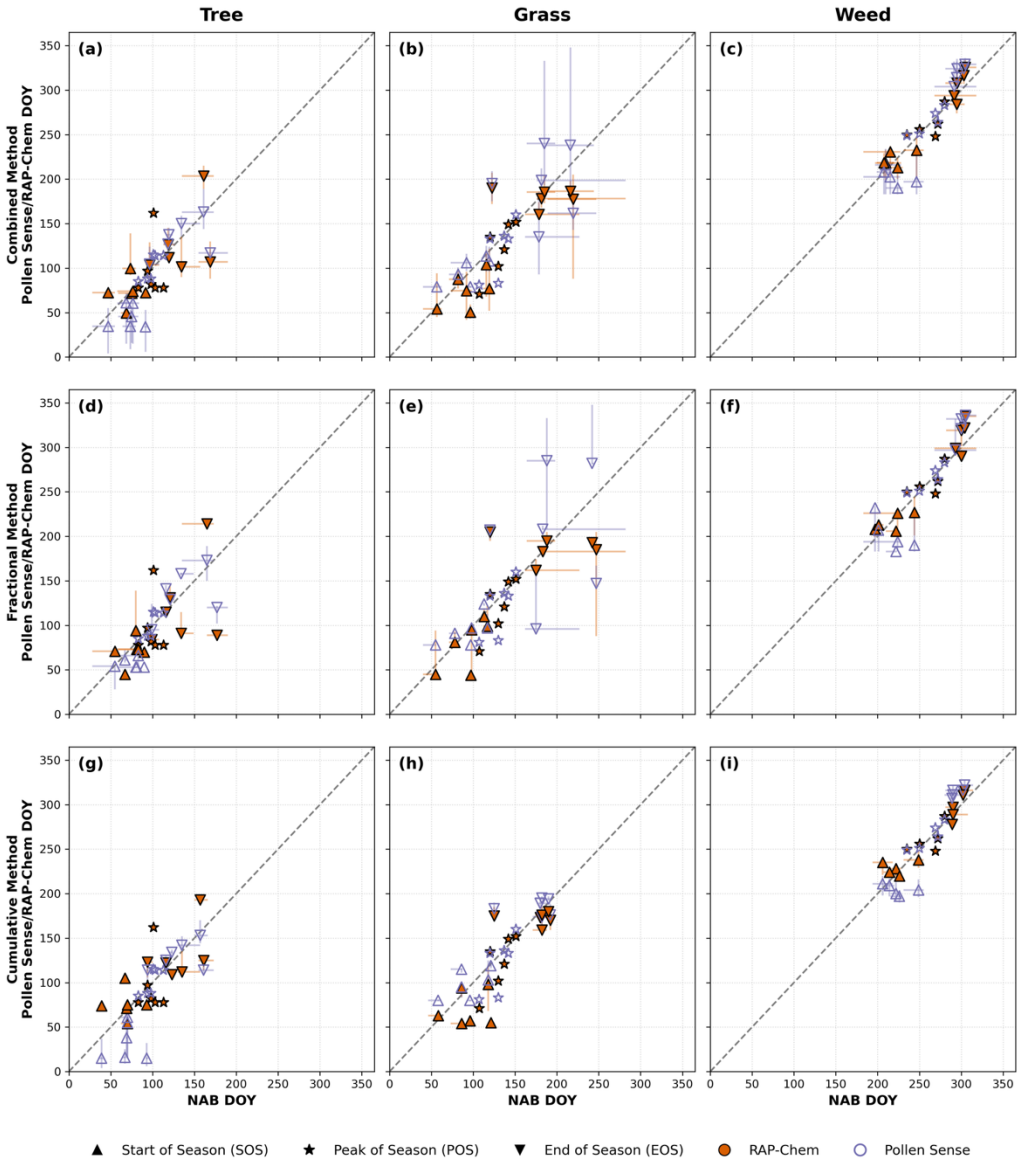


Figure S6. Phenological indicators (start of season (SOS), peak of season (POS), and end of season (EOS) of tree (column 1), grass (column 2), and weed (column 3) pollen over the AAAAI NAB sites for RAP-Chem (solid) and Pollen Sense (open) for the (**a**–**c**) combined fractional and cumulative method, (**d**–**f**) fractional method, (**g**–**i**) cumulative method. Central estimates use 5% (SOS) and 95% (EOS) of the cumulative total for the cumulative method and 5% of the POS concentration for the fractional method; error bars span 2.5% (97.5%) and 7.5% (92.5%) for the cumulative method and 2.5% and 7.5% of POS for the fractional method.

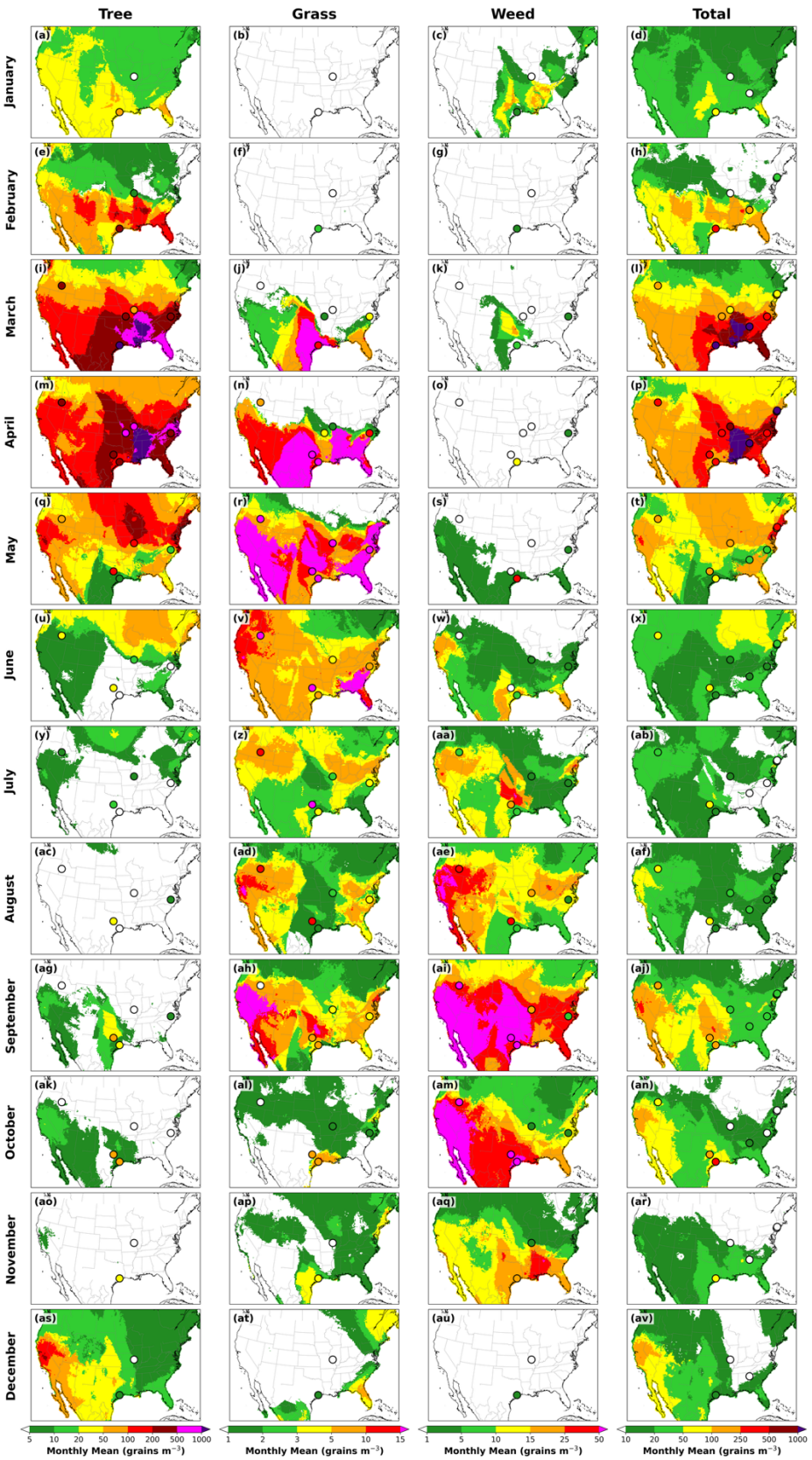


Figure S7. Monthly (rows) spatial averages of tree, grass, weed, and total pollen (columns) for Pollen Sense. NAB averages are overlain where available.

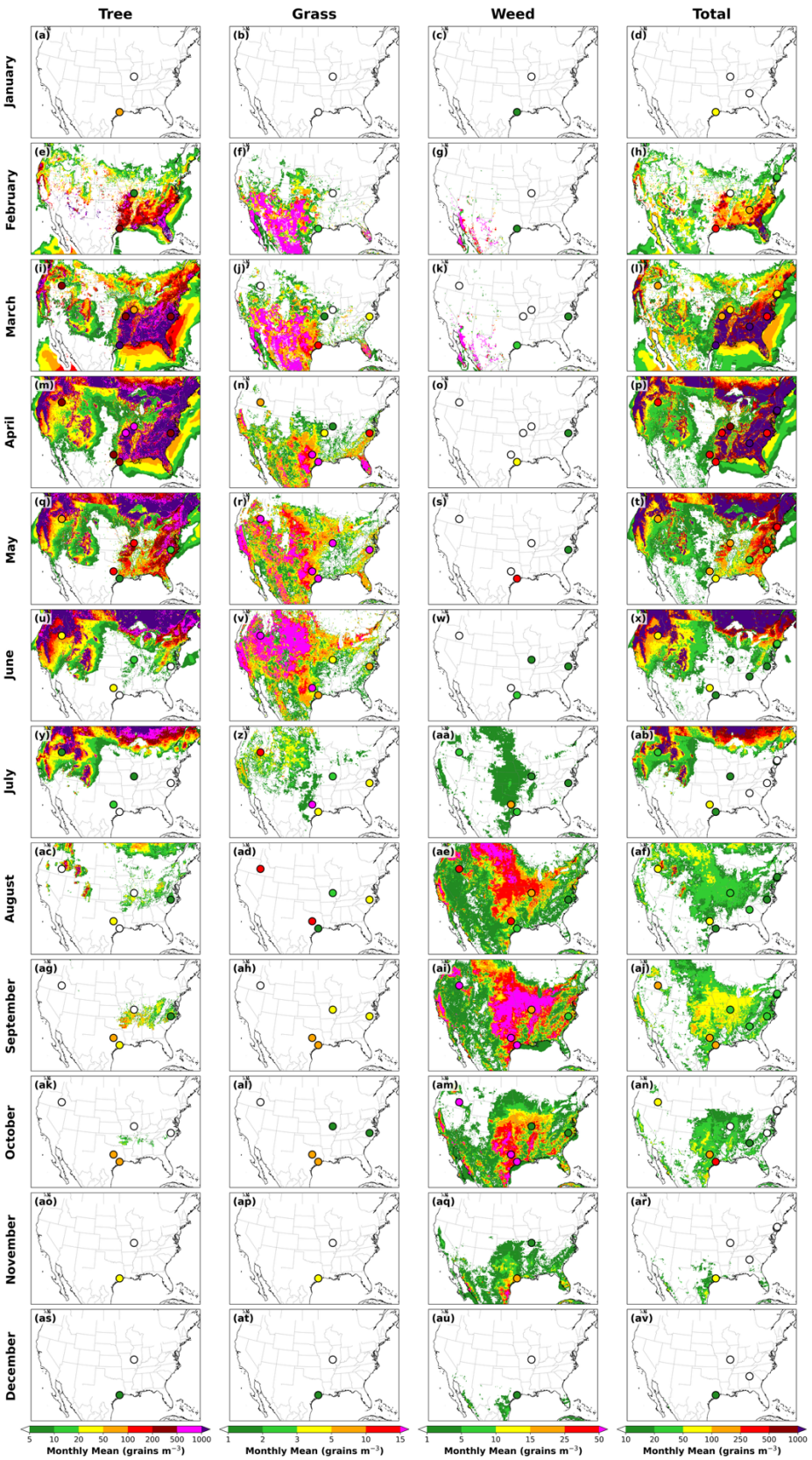


Figure S8. Monthly (rows) spatial averages of tree, grass, weed, and total pollen (columns) for RAP-Chem. NAB averages are overlain where available.

Table S1. Summary of surface AAAAI NAB pollen sites.

Site Name/Operator	City, State	Lat, Lon	URL
North Carolina Department of Environmental Quality	Raleigh, NC	35.8133°N, 78.714373°W	https://www.deq.nc.gov/about/divisions/air-quality/air-quality-monitoring/pollen-monitoring/historical-pollen-reports
Atlanta Allergy and Asthma Clinic[a]	Marietta, GA	33.971177°N, 84.549538°W	https://www.atlantaallergy.com/pollen_counts/index/2025/
City of Houston	Houston, TX	29.6826°N, 95.3233°W	http://www.houstontx.gov/health/Pollen-Mold/index.html
Allergy & Asthma Care of Waco	Waco, TX	31.549167°N, 97.146389°W	https://www.allergywaco.com/daily-pollen-count
Springfield-Greene County Health Department[b]	Springfield, MO	37.2088°N, 93.2942°W	http://health.springfieldmo.gov/pollen
Saint Louis County Health Department	St. Louis, MO	38.7357°N, 90.3108°W	https://pollenandmold.stlouisco.com/
Fordham College at Lincoln Center[a]	New York, NY	40.77°N, 73.99°W	https://docs.google.com/spreadsheets/d/1m2Op3h86NFPQUpPDugqACCJatEhR_-ea_C_0nLNdSOE/edit?gid=0#gid=0
Louis Calder Center[a]	Armonk, NY	41.12615°N, 73.744735°W	https://docs.google.com/spreadsheets/d/1m2Op3h86NFPQUpPDugqACCJatEhR_-ea_C_0nLNdSOE/edit?gid=0#gid=0
Boise Valley Asthma & Allergy Clinic	Boise, ID	43.6185°N, 116.2415° W	https://www.bvaac.com/past-pollen-counts/

[a]Total pollen only
[b]Data only available for March-April, 2025.

Table S2. Pollen Sense classification and category mapping.

Group	Code	Taxon	Rank	Common Name
Tree	ACE	*Acer*	genus	Maple / box elder
Tree	ALN	*Alnus*	genus	Alder
Tree	BET	*Betula*	genus	Birch
Tree	CAR	*Carya*	genus	Hickory / pecan
Tree	CED	*Cedrus*	genus	True cedar
Tree	CORY	*Corylus*	genus	Hazel
Tree	CUP	Cupressaceae	family	Juniper / cedar / cypress
Tree	FAG	*Fagus*	genus	Beech
Tree	FRA	*Fraxinus*	genus	Ash
Tree	LIQ	*Liquidambar*	genus	Sweetgum
Tree	MOR	*Morus*	genus	Mulberry
Tree	OLE	*Olea*	genus	Olive
Tree	PIN	*Pinus*	genus	Pine
Tree	PLAT	*Platanus*	genus	Sycamore / plane
Tree	POP	*Populus*	genus	Cottonwood / poplar / aspen
Tree	QUE	*Quercus*	genus	Oak
Tree	SAL	*Salix*	genus	Willow
Tree	TSU	*Tsuga*	genus	Hemlock
Tree	ULM	*Ulmus*	genus	Elm
Grass	POA	Poaceae	family	Grasses
Weed	AMB-IVA	*Ambrosia / Iva*	genus pair	Ragweed / marsh elder
Weed	ART	*Artemisia*	genus	Sagebrush / mugwort
Weed	CHE-AMA	*Chenopodium / Amaranthus*	genus pair	Chenopod / amaranth / pigweed
Weed	PLA	*Plantago*	genus	Plantain
Weed	RUM	*Rumex*	genus	Dock / sorrel
Weed	URT	Urticaceae	family	Nettle / pellitory

Table S3. Summary statistics for tree pollen NAB, Pollen Sense (PS), and RAP-Chem (RC). Metrics include the mean concentration, Spearman rank correlations (e.g., *r*(NAB,PS)), and phenology metrics averaged across both fractional and cumulative methods and rounded to the nearest DOY: (start of season (SOS), peak of season (POS), and end of season (EOS). The mean and *r* are calculated over both the full time series as well as the NAB season, defined by SOS and EOS. NAB sites are labeled by the row number of Table S1 and the regions are defined in Fig. 1 caption. Phenology is not computed for Springfield, MO (site 5). For the regional columns, Pollen Sense and RAP-Chem means and *r*(PS,RC) use the regional-mean daily series over grid cells where Pollen Sense is defined, and their SOS, POS, and EOS are averages over grid cells where both datasets define a season. NAB regional values are averages of the member-site values (Fisher z-averaged for *r*), and the regional season is bounded by the mean member-site NAB SOS and EOS.

	NAB Site/Region														
Category	1	2	3	4	5	6	7	8	9	PNW	CA	MT	MW	NE	SE
NAB mean full	55.1	n/a	306.3	21.7	43.5	61.8	n/a	n/a	45.4	45.4	n/a	n/a	52.7	n/a	127.7
PS mean full	70.7	60.4	56.5	76.4	63.5	73.6	60.3	61.4	25.6	16.7	10.3	34.4	55.3	20.8	42.5
RC mean full	102.1	79.6	3.3	2.0	25.6	15.5	15.7	317.5	18.7	297.4	32.7	103.4	118.1	170.3	72.1
NAB mean seas	415.1	n/a	1806.2	193.6	n/a	306.7	n/a	n/a	202.6	202.6	n/a	n/a	306.7	n/a	805
PS mean seas	421.6	n/a	305.2	84.4	n/a	379.1	n/a	n/a	68.3	37.9	n/a	n/a	241.9	n/a	199.8
RC mean seas	487	n/a	14.4	3.2	n/a	84.6	n/a	n/a	37.5	757.5	n/a	n/a	376.2	n/a	311.6
r(NAB,PS) full	0.71	n/a	0.62	0.62	0.62	0.63	n/a	n/a	0.88	0.88	n/a	n/a	0.63	n/a	0.65
r(NAB,RC) full	0.73	n/a	0.12	0.52	-0.07	0.45	n/a	n/a	0.48	0.48	n/a	n/a	0.20	n/a	0.50
r(PS,RC) full	0.43	0.41	0.17	0.05	0.05	0.24	0.47	0.54	0.12	0.38	0.21	0.22	0.59	0.66	0.5
r(NAB,PS) seas	0.74	n/a	0.88	0.68	n/a	0.46	n/a	n/a	0.69	0.69	n/a	n/a	0.46	n/a	0.78
r(NAB,RC) seas	-0.19	n/a	0.69	0.72	n/a	-0.12	n/a	n/a	-0.12	-0.12	n/a	n/a	-0.12	n/a	0.48
r(PS,RC) seas	-0.08	n/a	0.65	0.35	n/a	-0.11	n/a	n/a	-0.11	-0.09	n/a	n/a	-0.08	n/a	0.45
SOS NAB	66	n/a	47	92	n/a	76	n/a	n/a	64	64	n/a	n/a	76	n/a	68
SOS PS	70	62	36	38	n/a	68	70	71	36	30	28	39	61	52	52
SOS RC	50	54	72	72	n/a	74	76	78	100	95	74	97	75	87	54
POS NAB	94	n/a	83	98	n/a	113	n/a	n/a	101	101	n/a	n/a	113	n/a	92
POS PS	90	90	85	90	n/a	102	121	121	100	83	121	101	115	121	88
POS RC	97	109	78	82	n/a	78	109	109	162	141	114	132	103	122	81
EOS NAB	119	n/a	96	178	n/a	136	n/a	n/a	162	162	n/a	n/a	136	n/a	131
EOS PS	124	108	116	116	n/a	137	164	164	154	171	141	163	158	172	121
EOS RC	126	114	104	107	n/a	102	140	137	206	180	168	176	149	166	116

Table S4. As Table S4, but for grass pollen.

	NAB Site/Region														
Category	1	2	3	4	5	6	7	8	9	PNW	CA	MT	MW	NE	SE
NAB mean full	3.4	n/a	7.3	5.1	0.3	4.3	n/a	n/a	5.7	5.7	n/a	n/a	2.3	n/a	5.3
PS mean full	3.1	4	5.4	7.3	2.7	2.3	6.0	5.1	3.1	2.2	1.7	3.8	2.1	1.2	2.5
RC mean full	1.7	1	2.6	1.8	1.6	1.3	1.4	0.2	8.1	0.9	0.9	3.9	0.8	0.1	0.5
NAB mean seas	8.9	n/a	10.8	24.9	n/a	12.2	n/a	n/a	21.4	21.4	n/a	n/a	12.2	n/a	14.9
PS mean seas	4.3	n/a	8.5	8.0	n/a	6	n/a	n/a	6.5	4.7	n/a	n/a	4.4	n/a	4.7
RC mean seas	4.0	n/a	5.3	1.7	n/a	2.7	n/a	n/a	21.3	2.3	n/a	n/a	2.3	n/a	0.7
r(NAB,PS) full	0.37	n/a	0.43	0.64	0.41	0.59	n/a	n/a	0.52	0.52	n/a	n/a	0.51	n/a	0.49
r(NAB,RC) full	0.48	n/a	0.49	0.81	0.15	0.34	n/a	n/a	0.67	0.67	n/a	n/a	0.25	n/a	0.62
r(PS,RC) full	0.47	0.39	0.46	0.46	0.32	0.37	0.17	0.25	0.32	0.57	0.51	0.47	0.49	0.3	0.44
r(NAB,PS) seas	0.26	n/a	0.39	0.65	n/a	0.26	n/a	n/a	0.19	0.19	n/a	n/a	0.26	n/a	0.45
r(NAB,RC) seas	0.49	n/a	0.44	0.81	n/a	0.33	n/a	n/a	0.58	0.58	n/a	n/a	0.33	n/a	0.61
r(PS,RC) seas	0.39	n/a	0.24	0.63	n/a	0.54	n/a	n/a	0.25	0.64	n/a	n/a	0.58	n/a	0.59
SOS NAB	82	n/a	58	92	n/a	119	n/a	n/a	116	116	n/a	n/a	119	n/a	77
SOS PS	102	104	79	79	n/a	118	130	130	130	123	95	101	122	132	93
SOS RC	88	80	54	50	n/a	77	104	112	104	119	82	84	105	123	68
POS NAB	137	n/a	130	107	n/a	142	n/a	n/a	151	151	n/a	n/a	142	n/a	125
POS PS	136	133	83	81	n/a	133	140	140	160	151	128	127	151	155	115
POS RC	121	109	102	71	n/a	149	154	154	152	156	123	114	144	154	107
EOS NAB	224	n/a	232	299	n/a	224	n/a	n/a	238	238	n/a	n/a	224	n/a	252
EOS PS	240	238	224	196	n/a	280	220	220	277	263	221	243	258	264	209
EOS RC	178	168	160	179	n/a	186	185	186	186	185	166	154	183	181	164

Table S5. As Table S4, but for weed pollen.

	NAB Site/Region														
Category	1	2	3	4	5	6	7	8	9	PNW	CA	MT	MW	NE	SE
NAB mean full	1.9	n/a	53.1	10.0	0.0	4.7	n/a	n/a	18.2	18.2	n/a	n/a	2.3	n/a	21.7
PS mean full	5.8	7.9	14.2	16.7	10.3	5.9	7.6	6.3	9.6	5.9	5.7	10.3	6.3	2.3	4.3
RC mean full	8.2	9.1	16.9	13	14.3	14	7.0	1.7	12	1.1	0.8	3.1	6.0	0.9	1.7
NAB mean seas	5.3	n/a	270.5	96.2	n/a	17.3	n/a	n/a	116.5	116.5	n/a	n/a	17.3	n/a	124
PS mean seas	18.7	n/a	54.8	38.1	n/a	21	n/a	n/a	30.6	21.8	n/a	n/a	20.7	n/a	12
RC mean seas	35.3	n/a	82.4	41.8	n/a	59.1	n/a	n/a	59	5.4	n/a	n/a	25.6	n/a	6.5
r(NAB,PS) full	0.29	n/a	0.56	0.69	n/a	0.72	n/a	n/a	0.89	0.89	n/a	n/a	0.72	n/a	0.53
r(NAB,RC) full	0.30	n/a	0.57	0.90	n/a	0.71	n/a	n/a	0.91	0.91	n/a	n/a	0.71	n/a	0.66
r(PS,RC) full	0.69	0.71	0.75	0.58	0.70	0.84	0.75	0.75	0.85	0.83	0.79	0.69	0.75	0.71	0.65
r(NAB,PS) seas	0.66	n/a	0.60	0.72	n/a	0.07	n/a	n/a	0.05	0.05	n/a	n/a	0.07	n/a	0.66
r(NAB,RC) seas	0.55	n/a	0.36	0.67	n/a	0.36	n/a	n/a	0.13	0.13	n/a	n/a	0.36	n/a	0.54
r(PS,RC) seas	0.60	n/a	0.12	0.74	n/a	0.55	n/a	n/a	0.10	0.07	n/a	n/a	0.69	n/a	0.71
SOS NAB	215	n/a	246	200	n/a	208	n/a	n/a	224	224	n/a	n/a	208	n/a	221
SOS PS	202	204	197	216	n/a	208	188	189	190	202	207	202	203	208	213
SOS RC	230	236	232	218	n/a	218	218	218	213	212	209	213	219	221	228
POS NAB	250	n/a	280	274	n/a	235	n/a	n/a	269	269	n/a	n/a	235	n/a	268
POS PS	251	253	283	264	n/a	249	249	249	274	262	246	257	250	248	270
POS RC	256	252	287	262	n/a	250	246	238	248	241	250	252	252	249	273
EOS NAB	295	n/a	304	302	n/a	292	n/a	n/a	294	294	n/a	n/a	292	n/a	301
EOS PS	324	324	329	324	n/a	304	302	300	314	312	301	316	314	312	321
EOS RC	308	300	326	316	n/a	294	290	286	284	280	296	294	284	282	315

Table S6. Average and standard deviation (Fisher's z-transformed) of Spearman rank correlation across the NAB sites for NAB vs. RAP-Chem and Pollen Sense vs. RAP-Chem where SPP are reconstituted as intact pollen. Correlations in parentheses are calculated by smoothing each time series by a 5-day centered rolling average and dropping pollen counts < 0.05 grains m^{-3}.

Category	NAB vs. RAP-Chem	Pollen Sense vs. RAP-Chem
Tree	0.41 ± 0.27 (0.45 ± 0.41)	0.30 ± 0.19 (0.65 ± 0.14)
Grass	0.52 ± 0.21 (0.54 ± 0.37)	0.36 ± 0.10 (0.60 ± 0.10)
Weed	0.74 ± 0.23 (0.76 ± 0.11)	0.75 ± 0.08 (0.77 ± 0.08)
Total	0.44 ± 0.20 (0.54 ± 0.27)	0.43 ± 0.15 (0.57 ± 0.19)

Table S7. Summary statistics of tree, grass, and weed phenological indicators for Pollen Sense vs. RAP-Chem. Region definitions are provided in Figure 1.

Class	Region	Indicator	% within 7 d	% within 14 d	% within 30 d	Spatial *r*
Tree	Domain	SOS	7.2	14.6	26.5	-0.21
Tree	Domain	POS	11.5	25.8	40.1	0.15
Tree	Domain	EOS	15.1	29.2	70.2	0.60
Tree	PNW	SOS	0.0	0.0	4.5	0.02
Tree	PNW	POS	3.8	5.2	20.3	0.03
Tree	PNW	EOS	19.9	45.5	79.1	0.16
Tree	CA	SOS	0.0	1.2	32.6	-0.23
Tree	CA	POS	11.5	27.5	49.8	0.23
Tree	CA	EOS	11.0	17.6	46.7	-0.12
Tree	MT	SOS	4.0	7.7	27.2	-0.14
Tree	MT	POS	7.6	16.1	31.9	0.04
Tree	MT	EOS	10.5	21.0	51.8	0.19
Tree	MW	SOS	20.0	41.6	68.3	-0.31
Tree	MW	POS	21.6	34.4	67.7	0.52
Tree	MW	EOS	23.0	43.9	79.5	0.71
Tree	NE	SOS	8.8	17.3	41.1	-0.43
Tree	NE	POS	32.5	56.4	77.6	0.27
Tree	NE	EOS	25.0	55.0	93.5	0.74
Tree	SE	SOS	32.5	65.6	93.9	0.22
Tree	SE	POS	26.6	68.8	96.1	0.42
Tree	SE	EOS	46.7	70.4	95.5	0.21
Grass	Domain	SOS	21.7	38.2	74.7	0.83
Grass	Domain	POS	23.4	38.0	62.7	0.66
Grass	Domain	EOS	0.7	3.3	12.1	0.58
Grass	PNW	SOS	23.0	49.1	79.2	0.21
Grass	PNW	POS	53.4	67.6	77.3	0.32
Grass	PNW	EOS	0.0	0.0	1.5	-0.36
Grass	CA	SOS	17.6	37.2	58.6	0.49
Grass	CA	POS	1.3	12.2	48.3	-0.11
Grass	CA	EOS	0.0	0.4	44.4	-0.02
Grass	MT	SOS	16.9	29.7	62.0	0.67
Grass	MT	POS	24.3	35.7	50.6	0.57
Grass	MT	EOS	0.3	4.5	8.2	0.64
Grass	MW	SOS	26.1	44.3	79.1	0.77
Grass	MW	POS	16.3	21.7	56.4	0.32
Grass	MW	EOS	0.2	1.0	4.0	0.14
Grass	NE	SOS	39.5	69.0	94.1	0.83
Grass	NE	POS	21.7	63.1	96.7	0.64
Grass	NE	EOS	0.0	0.0	0.5	0.22
Grass	SE	SOS	9.1	16.1	69.6	0.52
Grass	SE	POS	6.4	21.1	58.5	0.28
Grass	SE	EOS	2.0	5.8	30.2	0.11
Weed	Domain	SOS	37.5	58.1	87.7	0.09
Weed	Domain	POS	30.0	53.3	77.9	0.31
Weed	Domain	EOS	15.1	31.4	56.6	0.11
Weed	PNW	SOS	44.8	71.9	98.8	-0.01
Weed	PNW	POS	30.8	37.1	60.2	-0.05
Weed	PNW	EOS	1.3	4.7	38.6	-0.09
Weed	CA	SOS	91.1	97.1	99.3	0.27
Weed	CA	POS	25.5	49.8	99.7	0.17
Weed	CA	EOS	35.6	73.9	99.4	0.24
Weed	MT	SOS	39.9	66.6	96.8	-0.01
Weed	MT	POS	21.8	50.5	83.4	0.22
Weed	MT	EOS	20.1	33.5	54.6	-0.31
Weed	MW	SOS	17.1	37.7	88.6	-0.28
Weed	MW	POS	53.4	85.0	89.4	0.38
Weed	MW	EOS	2.4	15.1	58.7	-0.29
Weed	NE	SOS	41.9	52.3	85.5	-0.41
Weed	NE	POS	47.1	67.2	85.8	0.25
Weed	NE	EOS	5.1	15.1	48.3	-0.18
Weed	SE	SOS	38.3	55.6	79.6	-0.51
Weed	SE	POS	14.2	49.2	65.1	0.12
Weed	SE	EOS	28.6	77.4	99.7	0.43