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Atmospheric Chemistry and Physics Discussions

Supplement of

A global aerosol classification algorithm incorporating multiple satellite data sets of aerosol and trace gas abundances

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1. Subdivision of urban/industrial source

The additional information on urban/industrial (URB) sources that can be gained by displaying the enhancements in trace gases other than NO_2 is introduced in the manuscript (Sect. 4.2). In Fig. 8, the results of this analysis were shown for summer 2007-2011; here we present all four seasons.

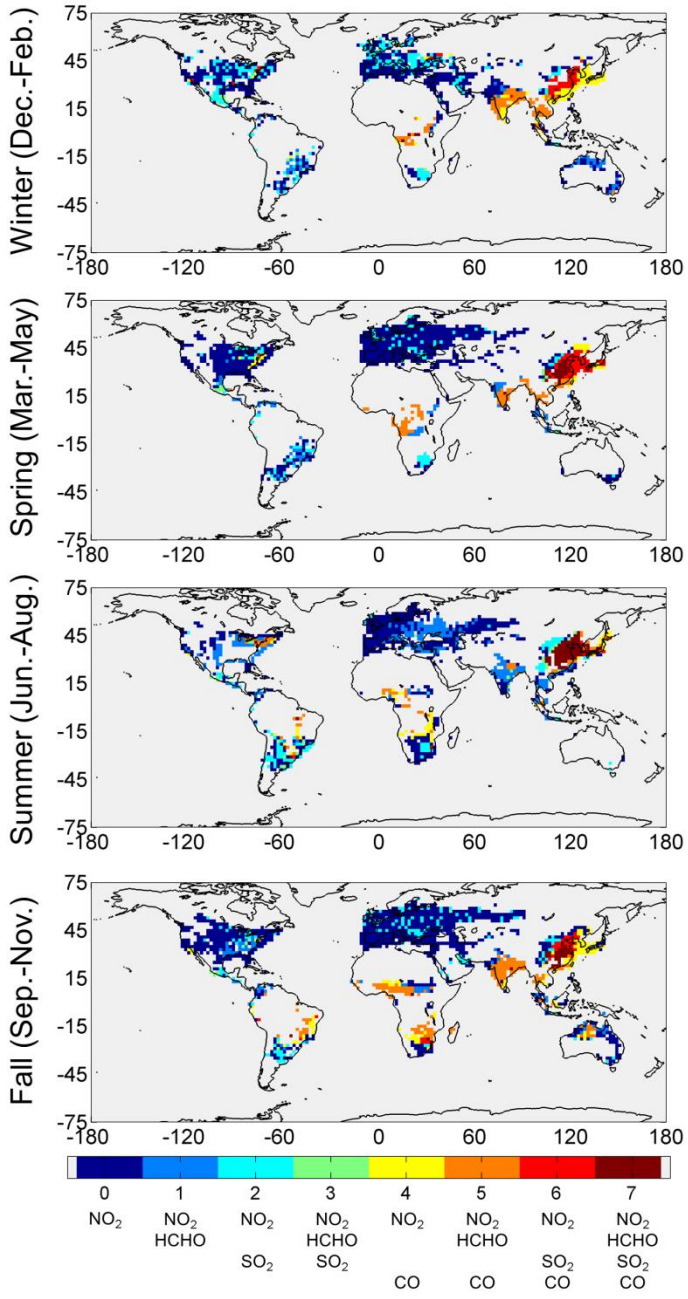

Figure S1. Trace gas composition for grid boxes with URB source type. Data are from (top to bottom): December-February, March-May, June-August, and September-November 2007-2011. The presence of enhanced trace gas columns (in addition to NO_2) is indicated by 1, 2, or 4 for HCHO, SO_2, and CO, respectively: 1 thus indicates enhanced NO_2 and HCHO, 2 enhanced NO_2 and SO_2, 3 enhanced NO_2 and HCHO and SO_2, etc. Gray areas are not dominated by URB. Note that the third panel from the top is identical to Fig. 8 in the manuscript.

2. Sensitivity studies

2.1. Cloud fraction

To investigate the dependence of GACA results to cloud cover, the algorithm was run with monthly mean trace gas data to which different cloud filters had been applied: effective cloud fraction (CF) up to 5%, 20%, 40%, and 100% were tested, as well as CF>40%. The cloud filter was only applied to the short-lived trace gases NO_2, HCHO, and SO_2, and to UVAI.
There is a clear shift to more neutral aerosols at the cost of non-absorbing aerosols with increasing CF, which is due to the influence of clouds on UVAI. In addition, for the strictest CF criterion (upper plot), much of the large absorbing particles over the equatorial Atlantic Ocean are lost. This is attributed to mis-classification of desert dust by CF algorithm, FRESCO.

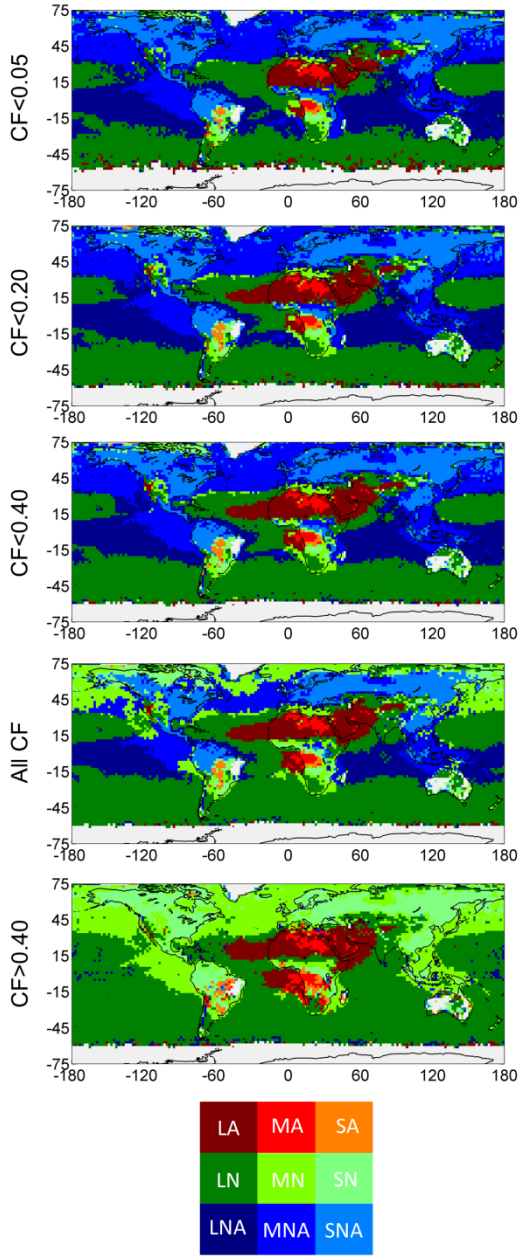

Figure S2. Global aerosol type distribution according to GACA-type for different cloud filter settings. Data are from June-August 2007-2011; the second panel from the top is identical to the third panel of Fig. 4 in the manuscript (except for the resolution).

The source type maps are hardly influenced by changes in cloud filter settings; in the upper panel (CF<5%) the plume of desert dust over ocean is lost (see above) and in the lowermost panel the strong decrease in SNA aerosols leads to the disappearance of BIO. Otherwise, the patterns remain unchanged.

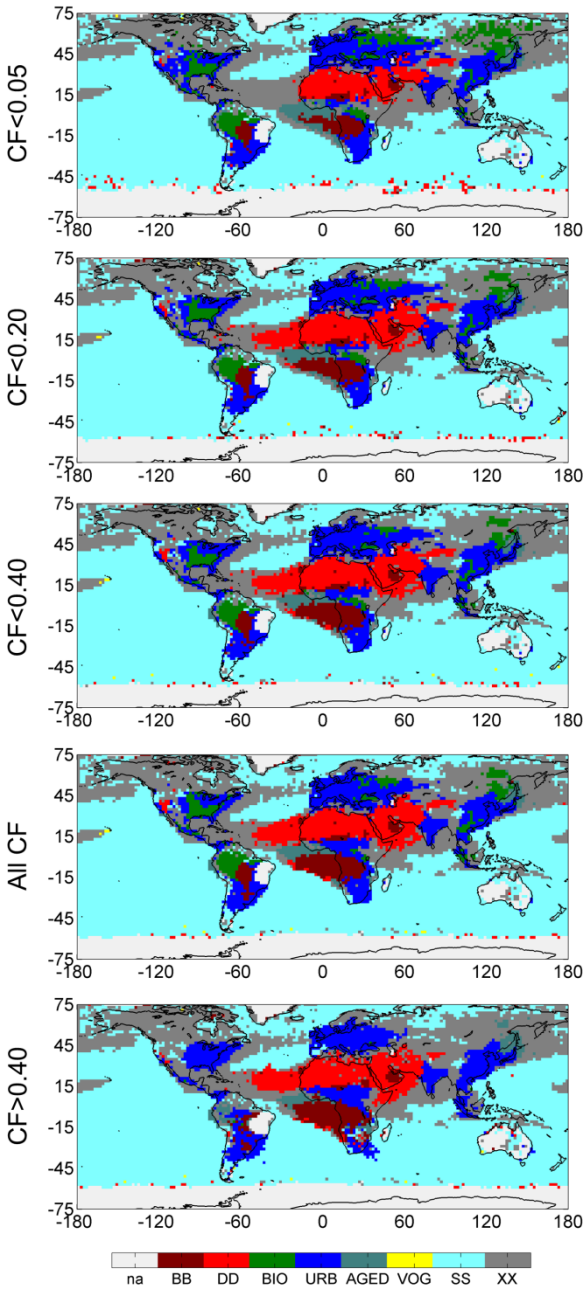

Figure S3. Global aerosol source distribution according to GACA-source for different cloud filter settings. Data are from June-August 2007-2011; the second panel from the top is identical to the third panel of Fig. 6 in the manuscript.

2.2. Outliers

In the standard GACA set-up, outliers are discarded prior to analysis. If this step is removed from the algorithm, the resulting source maps are very similar to those from the standard run (compare Fig. S4 with Fig. 6 in the manuscript). The most apparent changes are the appearance of several VOG plumes in the spring and summer maps and the BB signal from the exceptional fire season that occurred in the summer of 2010 in Russia. In South America more grid boxes are assigned to BB in summer and fall.

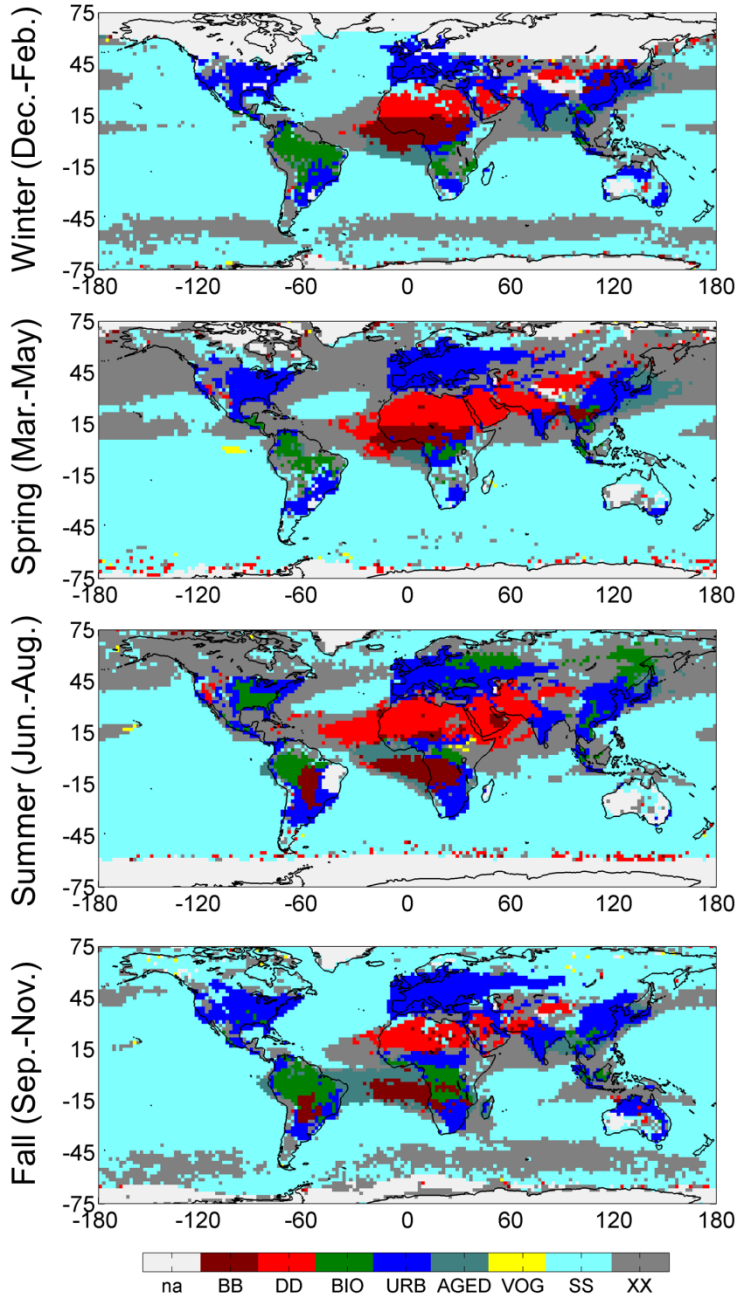

Figure S4. Global aerosol source distribution according to GACA-source without outlier removal. Data are from June-August 2007-2011.

3. Regional studies – data

The following tables contain all data shown in Figs. 10-12 in the manuscript.

Table S1a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in South America (10-15°S/60-65°W). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0.117	0	0	0.042	0	0	0.002	0	0	0.161
	2008	0.092	0	0	0.042	0	0	0.005	0	0	0.139
DJF	2009	0.1	0	0	0.06	0	0	0.004	0	0	0.164
	2010	0.082	0	0	0.052	0	0	0.007	0	0	0.141
	2011	0.122	0	0	0.026	0	0	0	0	0	0.148
	2007	0.064	0	0	0.044	0	0	0.002	0	0	0.11
	2008	0.054	0	0	0.051	0	0	0.003	0	0	0.108
MAM	2009	0.065	0	0	0.048	0	0	0.003	0	0	0.116
	2010	0.051	0	0	0.043	0	0	0.003	0	0	0.097
	2011	0.077	0	0	0.025	0	0	0	0	0	0.102
	2007	0.025	0.285	0	0	0	0	0	0	0	0.31
	2008	0.246	0	0	0.017	0	0	0	0	0	0.263
JJA	2009	0.08	0	0	0.003	0	0	0	0	0	0.083
	2010	0.025	0.049	0.407	0	0.018	0.017	0	0	0	0.516
	2011	0.128	0	0	0.006	0	0	0	0	0	0.134
	2007	0.144	0.216	0.396	0	0	0.394	0	0	0	1.15
	2008	0.341	0.012	0	0	0	0	0	0	0	0.353
SON	2009	0.235	0	0	0	0	0	0	0	0	0.235
	2010	0.235	0	0.455	0	0	0	0	0	0	0.69
	2011	0.294	0	0	0	0	0	0	0	0	0.294
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.002	0	0	0.117	0	0	0	0	0.042	0.161
	2008	0.005	0	0	0.092	0	0	0	0	0.042	0.139
DJF	2009	0.004	0	0	0	0	0	0	0	0.16	0.164
	2010	0.007	0	0	0	0	0.082	0	0	0.052	0.141
	2011	0	0	0	0.122	0	0	0	0	0.026	0.148
	2007	0.002	0	0	0.064	0	0	0	0.044	0	0.11
	2008	0.003	0	0	0	0	0	0	0.051	0.054	0.108
MAM	2009	0.003	0	0	0	0	0	0	0.048	0.065	0.116
	2010	0.003	0	0	0	0	0	0	0.043	0.051	0.097
	2011	0	0	0	0.077	0	0	0	0.025	0	0.102
	2007	0	0	0	0.025	0.285	0	0	0	0	0.31
	2008	0.017	0	0	0.246	0	0	0	0	0	0.263
JJA	2009	0.003	0	0	0.08	0	0	0	0	0	0.083
	2010	0.084	0.407	0	0.025	0	0	0	0	0	0.516
	2011	0.006	0	0	0.128	0	0	0	0	0	0.134
	2007	0	0.79	0	0.144	0.216	0	0	0	0	1.15
	2008	0.012	0	0	0.341	0	0	0	0	0	0.353
SON	2009	0	0	0	0.235	0	0	0	0	0	0.235
	2010	0	0.455	0	0.235	0	0	0	0	0	0.69
	2011	0	0	0	0.294	0	0	0	0	0	0.294

Table S1b. AOD assigned to each aerosol component by MACC (abbreviations explained in Table 1 in the manuscript) for the region in South America (10-15°S/60-65°W). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.002	0.04	0.087	0.024	0.033	0.186
	2008	0.002	0.045	0.104	0.028	0.041	0.22
DJF	2009	0.003	0.036	0.114	0.03	0.043	0.226
	2010	0.002	0.031	0.128	0.025	0.031	0.217
	2011	0.006	0.033	0.121	0.057	0.058	0.274
	2007	0.003	0.021	0.077	0.02	0.019	0.141
	2008	0.003	0.031	0.081	0.024	0.027	0.167
MAM	2009	0.002	0.021	0.079	0.02	0.023	0.146
	2010	0.002	0.02	0.093	0.019	0.019	0.153
	2011	0.003	0.026	0.08	0.027	0.032	0.168
	2007	0.031	0.022	0.237	0.02	0.018	0.329
	2008	0.022	0.023	0.176	0.018	0.023	0.261
JJA	2009	0.006	0.022	0.082	0.016	0.02	0.147
	2010	0.019	0.025	0.208	0.032	0.022	0.306
	2011	0.007	0.029	0.074	0.018	0.025	0.153
	2007	0.094	0.048	0.676	0.062	0.076	0.955
	2008	0.025	0.042	0.242	0.039	0.06	0.407
SON	2009	0.014	0.045	0.171	0.035	0.054	0.319
	2010	0.029	0.017	0.395	0.046	0.026	0.514
	2011	0.022	0.04	0.206	0.036	0.057	0.36

Table S2a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in southern Africa (0-5°S/15-20°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0	0	0	0	0.13	0.009	0	0.04	0.234	0.413
	2008	0.004	0.003	0	0.048	0.064	0.016	0.053	0.11	0.105	0.403
DJF	2009	0.01	0.004	0	0.06	0.097	0.004	0.015	0.072	0.043	0.305
	2010	0.048	0.004	0	0.164	0.119	0.008	0.004	0.054	0.007	0.408
	2011	0.044	0	0	0.138	0.089	0	0.023	0.057	0.059	0.41
	2007	0.083	0.028	0	0.062	0.065	0	0.005	0.043	0	0.286
	2008	0.083	0.025	0	0.104	0.069	0	0	0	0	0.281
MAM	2009	0.069	0.004	0	0.113	0.052	0	0	0.009	0	0.247
	2010	0.054	0.059	0	0.126	0.074	0	0.006	0.025	0	0.344
	2011	0.069	0.009	0	0.186	0.024	0	0.024	0.031	0	0.343
	2007	0.003	0.029	0.057	0	0.145	0.396	0	0	0.023	0.653
	2008	0	0.034	0.081	0	0.089	0.428	0	0	0.037	0.669
JJA	2009	0.009	0.018	0.035	0.026	0.09	0.587	0	0	0.025	0.79
	2010	0	0	0.053	0.006	0.122	0.559	0	0	0.031	0.771
	2011	0	0.016	0.039	0.008	0.138	0.642	0	0	0	0.843
	2007	0.232	0.07	0	0.011	0	0	0	0	0	0.313
	2008	0.173	0.093	0.045	0.029	0	0	0	0	0	0.34
SON	2009	0.141	0.111	0	0.08	0	0	0	0	0	0.332
	2010	0.209	0.116	0.01	0	0	0	0	0	0	0.335
	2011	0.309	0.131	0.063	0	0	0	0	0	0	0.503
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.009	0.234	0	0	0.17	0	0	0	0	0.413
	2008	0.023	0.105	0	0	0.276	0	0	0	0	0.404
DJF	2009	0.032	0.043	0	0	0.229	0	0	0	0	0.304
	2010	0.023	0	0	0.048	0.337	0	0	0	0	0.408
	2011	0.023	0.059	0	0.044	0.284	0	0	0	0	0.41
	2007	0.005	0	0	0.083	0.17	0	0	0	0.028	0.286
	2008	0	0.025	0	0.083	0.173	0	0	0	0	0.281
MAM	2009	0.013	0	0	0.069	0.165	0	0	0	0	0.247
	2010	0.031	0	0	0.054	0.259	0	0	0	0	0.344
	2011	0.034	0	0	0.069	0.217	0	0	0	0.024	0.344
	2007	0.026	0.482	0	0	0.145	0	0	0	0	0.653
	2008	0.037	0.509	0	0	0.089	0	0	0	0.034	0.669
JJA	2009	0.112	0.587	0	0	0.09	0	0	0	0	0.789
	2010	0.037	0.611	0	0	0.122	0	0	0	0	0.77
	2011	0.064	0.642	0	0	0.138	0	0	0	0	0.844
	2007	0.011	0	0	0.232	0.07	0	0	0	0	0.313
	2008	0	0.045	0	0.173	0.122	0	0	0	0	0.34
SON	2009	0	0	0	0.141	0.191	0	0	0	0	0.332
	2010	0.01	0	0	0.209	0.116	0	0	0	0	0.335
	2011	0.063	0	0	0.309	0.131	0	0	0	0	0.503

Table S2b. AOD assigned to each aerosol component by MACC(abbreviations explained in Table 1 in the manuscript) for the region in southern Africa (0-5°S/15-20°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.021	0.156	0.183	0.042	0.025	0.427
	2008	0.017	0.129	0.158	0.042	0.027	0.373
DJF	2009	0.016	0.101	0.147	0.039	0.03	0.332
	2010	0.017	0.119	0.167	0.039	0.027	0.369
	2011	0.021	0.134	0.195	0.048	0.027	0.424
	2007	0.012	0.076	0.129	0.039	0.039	0.296
	2008	0.012	0.066	0.119	0.044	0.045	0.286
MAM	2009	0.011	0.072	0.12	0.037	0.041	0.281
	2010	0.013	0.076	0.146	0.04	0.04	0.316
	2011	0.014	0.098	0.141	0.05	0.051	0.354
	2007	0.057	0.04	0.438	0.049	0.05	0.634
	2008	0.062	0.065	0.47	0.056	0.073	0.727
JJA	2009	0.076	0.076	0.486	0.062	0.074	0.775
	2010	0.072	0.061	0.506	0.064	0.065	0.767
	2011	0.077	0.089	0.499	0.076	0.087	0.829
	2007	0.02	0.038	0.174	0.036	0.052	0.32
	2008	0.024	0.06	0.198	0.039	0.053	0.374
SON	2009	0.024	0.047	0.189	0.041	0.048	0.35
	2010	0.02	0.04	0.197	0.043	0.048	0.349
	2011	0.024	0.074	0.209	0.044	0.066	0.417

Table S3a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in Southeast USA (30-35°N/80-85°W). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0.018	0.022	0	0.024	0.015	0	0	0	0	0.079
	2008	0.019	0	0	0.052	0.008	0	0	0	0	0.079
DJF	2009	0.027	0.018	0	0.019	0.004	0	0	0	0	0.068
	2010	0.026	0	0	0.038	0	0	0	0	0	0.064
	2011	0.039	0	0	0.028	0	0	0	0	0	0.067
	2007	0.145	0.009	0	0.002	0	0	0	0	0	0.156
	2008	0.091	0	0	0.021	0	0	0	0	0	0.112
MAM	2009	0.089	0	0	0.029	0	0	0	0	0	0.118
	2010	0.073	0	0	0.033	0	0	0	0	0	0.106
	2011	0.128	0	0	0.011	0	0	0	0	0	0.139
	2007	0.361	0	0	0.022	0	0	0	0	0	0.383
	2008	0.266	0	0	0	0	0	0	0	0	0.266
JJA	2009	0.211	0	0	0.017	0	0	0	0	0	0.228
	2010	0.208	0	0	0	0	0	0	0	0	0.208
	2011	0.336	0	0	0	0	0	0	0	0	0.336
	2007	0.105	0	0	0.014	0	0	0	0	0	0.119
	2008	0.098	0	0	0.01	0	0	0	0	0	0.108
SON	2009	0.083	0	0	0.005	0	0	0	0	0	0.088
	2010	0.101	0	0	0.01	0	0	0	0	0	0.111
	2011	0.139	0	0	0.006	0	0	0	0	0	0.145
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.039	0	0	0	0.04	0	0	0	0	0.079
	2008	0.027	0	0	0	0.052	0	0	0	0	0.079
DJF	2009	0.041	0	0	0	0.027	0	0	0	0	0.068
	2010	0.064	0	0	0	0	0	0	0	0	0.064
	2011	0	0	0	0	0.039	0	0	0.028	0	0.067
	2007	0.012	0	0	0	0.145	0	0	0	0	0.157
	2008	0	0	0	0	0.112	0	0	0	0	0.112
MAM	2009	0	0	0	0	0.118	0	0	0	0	0.118
	2010	0	0	0	0	0.107	0	0	0	0	0.107
	2011	0	0	0	0	0.14	0	0	0	0	0.14
	2007	0	0	0	0.361	0.022	0	0	0	0	0.383
	2008	0	0	0	0.266	0	0	0	0	0	0.266
JJA	2009	0	0	0	0.211	0.017	0	0	0	0	0.228
	2010	0	0	0	0.208	0	0	0	0	0	0.208
	2011	0	0	0	0.336	0	0	0	0	0	0.336
	2007	0	0	0	0	0.12	0	0	0	0	0.12
	2008	0.01	0	0	0	0.098	0	0	0	0	0.108
SON	2009	0.005	0	0	0	0.083	0	0	0	0	0.088
	2010	0.01	0	0	0.101	0	0	0	0	0	0.111
	2011	0.006	0	0	0.139	0	0	0	0	0	0.145

Table S3b. AOD assigned to each aerosol component by MACC (abbreviations explained in Table 1 in the manuscript) for the region in Southeast USA (30-35°N/80-85°W). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.006	0.021	0.013	0.07	0.03	0.141
	2008	0.009	0.032	0.016	0.087	0.036	0.18
DJF	2009	0.006	0.027	0.02	0.094	0.049	0.196
	2010	0.006	0.017	0.011	0.066	0.018	0.119
	2011	0.008	0.028	0.038	0.09	0.034	0.198
	2007	0.01	0.039	0.035	0.147	0.025	0.256
	2008	0.008	0.049	0.027	0.124	0.031	0.239
MAM	2009	0.007	0.043	0.031	0.121	0.038	0.24
	2010	0.006	0.036	0.03	0.122	0.022	0.216
	2011	0.012	0.055	0.047	0.126	0.03	0.268
	2007	0.011	0.064	0.067	0.248	0.025	0.416
	2008	0.009	0.078	0.053	0.176	0.027	0.342
JJA	2009	0.007	0.067	0.05	0.15	0.022	0.296
	2010	0.005	0.05	0.054	0.168	0.026	0.303
	2011	0.011	0.075	0.083	0.196	0.027	0.392
	2007	0.006	0.031	0.018	0.089	0.026	0.17
	2008	0.004	0.035	0.015	0.077	0.027	0.158
SON	2009	0.005	0.031	0.022	0.093	0.023	0.173
	2010	0.005	0.025	0.02	0.083	0.016	0.148
	2011	0.006	0.035	0.022	0.088	0.027	0.177

Table S4a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in Northwest Europe (48-53°N/3-8°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0	0.019	0	0	0.092	0	0	0	0	0.111
	2008	0	0.013	0	0	0.088	0	0	0.035	0	0.136
DJF	2009	0	0	0	0.007	0.06	0	0	0.065	0.005	0.137
	2010	0	0.011	0	0	0.03	0	0.069	0.029	0	0.139
	2011	0	0.031	0	0.022	0.023	0	0.006	0.019	0	0.101
	2007	0.142	0.015	0	0.049	0	0	0	0	0	0.206
	2008	0.105	0	0	0.05	0.006	0	0	0	0	0.161
MAM	2009	0.142	0.004	0	0.049	0.006	0	0	0	0	0.201
	2010	0.084	0.001	0	0.064	0	0	0.015	0	0	0.164
	2011	0.123	0	0	0.071	0	0	0	0	0	0.194
	2007	0.135	0	0	0.082	0	0	0.003	0	0	0.22
	2008	0.11	0	0	0.06	0	0	0.007	0	0	0.177
JJA	2009	0.128	0	0	0.06	0	0	0.003	0	0	0.191
	2010	0.082	0	0	0.068	0	0	0.004	0	0	0.154
	2011	0.112	0	0	0.051	0	0	0.009	0	0	0.172
	2007	0.083	0.011	0	0.018	0.013	0	0.003	0	0	0.128
	2008	0.06	0.004	0	0.042	0.02	0	0.008	0.011	0	0.145
SON	2009	0.072	0.014	0	0.029	0.007	0	0.012	0.01	0	0.144
	2010	0.04	0.003	0	0.035	0.001	0	0.003	0.002	0	0.084
	2011	0.071	0	0	0.027	0	0	0.002	0	0	0.1
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.019	0	0	0	0.092	0	0	0	0	0.111
	2008	0.049	0	0	0	0.088	0	0	0	0	0.137
DJF	2009	0.012	0	0	0	0.125	0	0	0	0	0.137
	2010	0.07	0	0	0	0.069	0	0	0	0	0.139
	2011	0.101	0	0	0	0	0	0	0	0	0.101
	2007	0	0	0	0	0.191	0.015	0	0	0	0.206
	2008	0.006	0	0	0	0.155	0	0	0	0	0.161
MAM	2009	0.01	0	0	0	0.191	0	0	0	0	0.201
	2010	0.001	0	0	0	0.162	0	0	0	0	0.163
	2011	0	0	0	0	0.193	0	0	0	0	0.193
	2007	0.003	0	0	0	0.216	0	0	0	0	0.219
	2008	0.007	0	0	0	0.171	0	0	0	0	0.178
JJA	2009	0.003	0	0	0	0.187	0	0	0	0	0.19
	2010	0.004	0	0	0	0.15	0	0	0	0	0.154
	2011	0.009	0	0	0	0.163	0	0	0	0	0.172
	2007	0.003	0	0	0	0.125	0	0	0	0	0.128
	2008	0.015	0	0	0	0.13	0	0	0	0	0.145
SON	2009	0.007	0	0	0	0.137	0	0	0	0	0.144
	2010	0.009	0	0	0	0.076	0	0	0	0	0.085
	2011	0.002	0	0	0	0.097	0	0	0	0	0.099

Table S4b. AOD assigned to each aerosol component by MACC (abbreviations explained in Table 1 in the manuscript) for the region in Northwest Europe (48-53°N/3-8°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.004	0.01	0.005	0.028	0.131	0.177
	2008	0.008	0.017	0.009	0.053	0.062	0.149
DJF	2009	0.004	0.015	0.006	0.044	0.057	0.126
	2010	0.004	0.013	0.01	0.042	0.073	0.141
	2011	0.005	0.015	0.008	0.057	0.073	0.158
	2007	0.01	0.032	0.012	0.113	0.035	0.202
	2008	0.008	0.048	0.01	0.103	0.057	0.226
MAM	2009	0.008	0.043	0.013	0.11	0.043	0.216
	2010	0.008	0.034	0.011	0.106	0.038	0.197
	2011	0.01	0.042	0.015	0.127	0.034	0.228
	2007	0.009	0.034	0.02	0.124	0.028	0.215
	2008	0.009	0.043	0.022	0.105	0.033	0.211
JJA	2009	0.008	0.045	0.018	0.111	0.033	0.215
	2010	0.009	0.034	0.026	0.109	0.03	0.208
	2011	0.008	0.046	0.019	0.101	0.038	0.212
	2007	0.006	0.024	0.009	0.068	0.046	0.151
	2008	0.005	0.036	0.008	0.065	0.048	0.162
SON	2009	0.007	0.03	0.01	0.074	0.065	0.187
	2010	0.006	0.021	0.009	0.064	0.043	0.143
	2011	0.007	0.034	0.01	0.075	0.041	0.167

Table S5a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in Thailand (15-20°N/100-105°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0.024	0.038	0.033	0.012	0.059	0.052	0.021	0.035	0.016	0.29
	2008	0.053	0.037	0	0.036	0.035	0	0.035	0.035	0	0.231
DJF	2009	0.034	0.04	0	0.026	0.082	0.025	0.025	0.035	0	0.267
	2010	0.1	0.06	0	0.052	0	0	0.025	0	0	0.237
	2011	0.07	0.002	0	0.061	0.027	0	0.039	0.006	0	0.205
	2007	0.083	0.06	0.162	0.047	0.046	0.078	0.023	0	0	0.499
	2008	0.086	0.138	0.047	0.051	0.084	0	0.056	0.022	0	0.484
MAM	2009	0.085	0.086	0.056	0.081	0.099	0.051	0.034	0	0	0.492
	2010	0.058	0.07	0.207	0.063	0.109	0.046	0.028	0.016	0	0.597
	2011	0.249	0.008	0	0.163	0.011	0	0.033	0	0	0.464
	2007	0.079	0	0	0.068	0	0	0.115	0	0	0.262
	2008	0.061	0	0	0.069	0	0	0.166	0	0	0.296
JJA	2009	0.057	0	0	0.071	0	0	0.125	0	0	0.253
	2010	0.053	0	0	0.095	0	0	0.118	0.006	0	0.272
	2011	0.078	0	0	0.09	0	0	0.125	0	0	0.293
	2007	0.135	0	0	0.172	0	0	0.035	0	0	0.342
	2008	0.077	0.001	0	0.059	0	0	0.085	0	0	0.222
SON	2009	0.098	0	0	0.114	0	0	0.036	0	0	0.248
	2010	0.067	0	0	0.079	0	0	0.084	0	0	0.23
	2011	0.098	0	0	0.075	0	0	0.068	0	0	0.241
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.016	0.181	0	0	0.068	0.024	0	0	0	0.289
	2008	0	0	0	0.053	0.178	0	0	0	0	0.231
DJF	2009	0.025	0.122	0	0	0.12	0	0	0	0	0.267
	2010	0	0	0	0.1	0.138	0	0	0	0	0.238
	2011	0.008	0	0	0.07	0.128	0	0	0	0	0.206
	2007	0	0.24	0	0.083	0.176	0	0	0	0	0.499
	2008	0.022	0.047	0	0.086	0.328	0	0	0	0	0.483
MAM	2009	0	0.107	0	0.085	0.299	0	0	0	0	0.491
	2010	0.062	0.207	0	0.058	0.27	0	0	0	0	0.597
	2011	0.052	0	0	0.249	0.163	0	0	0	0	0.464
	2007	0	0	0	0.079	0.184	0	0	0	0	0.263
	2008	0	0	0	0	0.296	0	0	0	0	0.296
JJA	2009	0	0	0	0.057	0.195	0	0	0	0	0.252
	2010	0.006	0	0	0.053	0.213	0	0	0	0	0.272
	2011	0	0	0	0.078	0.215	0	0	0	0	0.293
	2007	0	0	0	0	0.342	0	0	0	0	0.342
	2008	0.001	0	0	0.077	0.144	0	0	0	0	0.222
SON	2009	0	0	0	0.098	0.15	0	0	0	0	0.248
	2010	0	0	0	0.067	0.162	0	0	0	0	0.229
	2011	0	0	0	0.098	0.143	0	0	0	0	0.241

Table S5b. AOD assigned to each aerosol component by MACC (abbreviations explained in Table 1 in the manuscript) for the region in Thailand (15-20°N/100-105°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.017	0.064	0.082	0.107	0.042	0.313
	2008	0.015	0.063	0.052	0.126	0.027	0.282
DJF	2009	0.022	0.09	0.089	0.14	0.052	0.392
	2010	0.017	0.066	0.065	0.116	0.033	0.297
	2011	0.018	0.067	0.074	0.142	0.035	0.336
	2007	0.025	0.106	0.127	0.149	0.049	0.455
	2008	0.02	0.14	0.09	0.184	0.061	0.495
MAM	2009	0.023	0.118	0.12	0.13	0.043	0.434
	2010	0.033	0.161	0.159	0.178	0.055	0.585
	2011	0.021	0.102	0.134	0.176	0.052	0.485
	2007	0.007	0.052	0.046	0.106	0.056	0.268
	2008	0.007	0.084	0.042	0.098	0.06	0.29
JJA	2009	0.006	0.071	0.039	0.093	0.051	0.261
	2010	0.008	0.059	0.047	0.094	0.06	0.268
	2011	0.007	0.076	0.046	0.103	0.067	0.299
	2007	0.013	0.05	0.048	0.185	0.039	0.334
	2008	0.008	0.044	0.042	0.121	0.041	0.257
SON	2009	0.011	0.046	0.046	0.148	0.032	0.282
	2010	0.011	0.041	0.049	0.154	0.042	0.297
	2011	0.009	0.046	0.044	0.13	0.038	0.267

Table S6a. AOD assigned to each aerosol type and source by GACA (abbreviations explained in Table 1 in the manuscript) for the region in Northeast China (35-40°N/115-120°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

GACA type											
Season	Year	SNA	SN	SA	MNA	MN	MA	LNA	LN	LA	total
	2007	0	0.029	0.02	0	0.03	0.095	0	0.054	0.25	0.478
	2008	0	0.079	0.046	0	0.027	0.012	0	0.109	0.209	0.482
DJF	2009	0	0.014	0	0	0.052	0.06	0	0.038	0.365	0.529
	2010	0	0.091	0.025	0	0.041	0.048	0	0.162	0.147	0.514
	2011	0.008	0.061	0.038	0	0.052	0	0	0.188	0.139	0.486
	2007	0	0.02	0.018	0	0.263	0.019	0	0.242	0.274	0.836
	2008	0	0.019	0	0	0.261	0.291	0	0.117	0.219	0.907
MAM	2009	0	0.032	0	0.024	0.282	0.009	0.01	0.235	0.141	0.733
	2010	0.016	0.052	0	0.037	0.163	0	0	0.433	0.01	0.711
	2011	0	0	0	0	0.122	0	0	0.591	0	0.713
	2007	0.401	0.014	0.012	0.115	0.191	0.197	0	0	0	0.93
	2008	0.423	0	0	0.127	0.362	0	0	0.023	0	0.935
JJA	2009	0.178	0.02	0	0.235	0.101	0	0	0.082	0	0.616
	2010	0.425	0	0	0.575	0	0	0	0	0	1
	2011	0.434	0	0	0.431	0.05	0	0.045	0	0	0.96
	2007	0.112	0.061	0	0.07	0.138	0.019	0	0.074	0.028	0.502
	2008	0.135	0.075	0	0.063	0.142	0	0	0.108	0	0.523
SON	2009	0.05	0.066	0	0.127	0.155	0	0	0.179	0	0.577
	2010	0.16	0.025	0	0.132	0.107	0	0.007	0.126	0.005	0.562
	2011	0.115	0.038	0	0.25	0.16	0	0.005	0	0	0.568
GACA source											
Season	Year	na	BB	DD	BIO	URB	AGED	VOG	SS	XX	total
	2007	0.079	0.345	0	0	0.054	0	0	0	0	0.478
	2008	0.039	0.255	0	0	0.188	0	0	0	0	0.482
DJF	2009	0.014	0.425	0	0	0.09	0	0	0	0	0.529
	2010	0.073	0.239	0	0	0.203	0	0	0	0	0.515
	2011	0.008	0.177	0	0	0.301	0	0	0	0	0.486
	2007	0.057	0.274	0	0	0.505	0	0	0	0	0.836
	2008	0.019	0.51	0	0	0.378	0	0	0	0	0.907
MAM	2009	0.076	0.141	0	0	0.517	0	0	0	0	0.734
	2010	0.115	0	0	0	0.596	0	0	0	0	0.711
	2011	0	0	0	0	0.713	0	0	0	0	0.713
	2007	0.026	0.197	0	0	0.708	0	0	0	0	0.931
	2008	0.023	0	0	0	0.912	0	0	0	0	0.935
JJA	2009	0.02	0	0	0	0.596	0	0	0	0	0.616
	2010	0	0	0	0	1	0	0	0	0	1
	2011	0.096	0	0	0	0.865	0	0	0	0	0.961
	2007	0.047	0	0	0	0.456	0	0	0	0	0.503
	2008	0	0	0	0	0.524	0	0	0	0	0.524
SON	2009	0	0.066	0	0	0.511	0	0	0	0	0.577
	2010	0.037	0	0	0	0.525	0	0	0	0	0.562
	2011	0.043	0	0	0	0.525	0	0	0	0	0.568

Table S6b. AOD assigned to each aerosol component by MACC (abbreviations explained in Table 1 in the manuscript) for the region in Northeast China (35-40°N/115-120°E). Seasons: DJF: December-February, MAM: March-May, JJA: June-August, SON: September-November.

Season	Year	BC	DD	OC	SO4	SS	total
	2007	0.031	0.135	0.051	0.31	0.024	0.551
	2008	0.026	0.129	0.023	0.16	0.012	0.35
DJF	2009	0.037	0.147	0.031	0.239	0.015	0.469
	2010	0.03	0.119	0.061	0.384	0.026	0.621
	2011	0.035	0.115	0.041	0.288	0.021	0.5
	2007	0.04	0.206	0.057	0.428	0.02	0.751
	2008	0.041	0.314	0.068	0.425	0.027	0.876
MAM	2009	0.035	0.234	0.061	0.328	0.018	0.676
	2010	0.032	0.237	0.054	0.348	0.022	0.693
	2011	0.034	0.237	0.055	0.282	0.02	0.629
	2007	0.038	0.155	0.077	0.432	0.022	0.725
	2008	0.037	0.211	0.074	0.456	0.029	0.807
JJA	2009	0.035	0.212	0.074	0.39	0.02	0.732
	2010	0.043	0.205	0.089	0.513	0.028	0.878
	2011	0.045	0.239	0.099	0.535	0.032	0.95
	2007	0.035	0.154	0.05	0.348	0.014	0.602
	2008	0.03	0.184	0.038	0.261	0.012	0.525
SON	2009	0.032	0.184	0.046	0.279	0.014	0.555
	2010	0.032	0.153	0.047	0.31	0.014	0.556
	2011	0.03	0.185	0.053	0.356	0.02	0.644