Virkkula et al., Aerosol optical properties calculated from size distributions, filter samples and absorption photometer data at Dome C, Antarctica and their relationships between seasonal cycles of sources

SUPPLEMENT

Figures

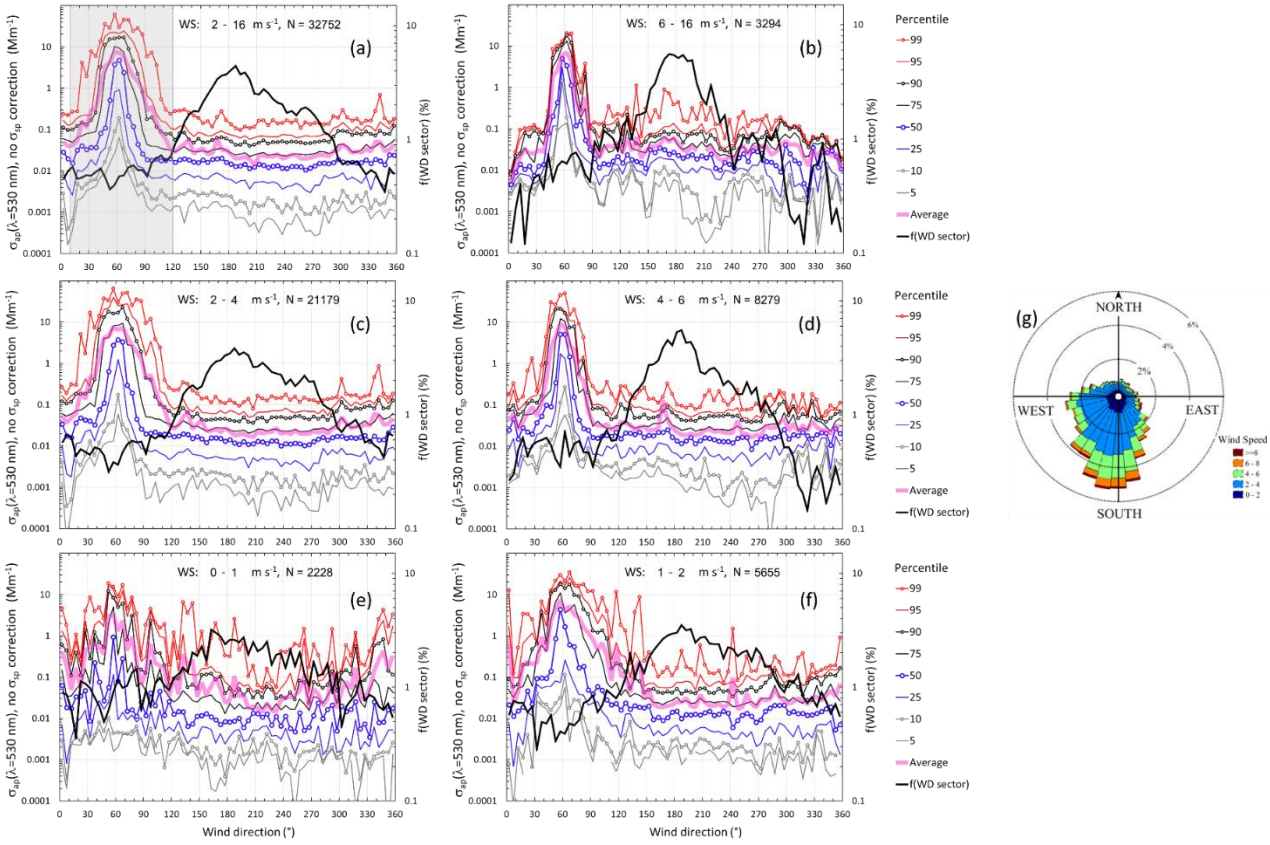

Figure S1. Absorption coefficient $\sigma_{ap,nsc}$ (λ=530nm) at different wind directions.

Table S1. Seasonal averages, 25th, 50th and 75th percentiles of mass concentrations calculated from the number size distributions (m(DMPS,$PM_{0.8}$) and m(DMPS,PM_{10})) and the sum of chemical constituents analyzed from the PM_1 and PM_{10} filter samples. N: for m(DMPS) the number of hourly data, for PM_1 and PM_{10} the number of filter samples. See the main text for detailed explanations.

m(size distributions)	m(DMPS,$PM_{0.8}$), ng m^{-3}					m(DMPS,PM_{10}), ng m^{-3}			
			Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75
JAN	1263	247	148	191	268	284	170	220	308
FEB	2480	299	174	272	386	349	203	318	451
MAR	1912	139	86	121	164	176	108	153	208
APR	1735	61	33	48	87	84	46	66	120
MAY	1880	42	17	26	37	75	31	46	67
JUN	1434	88	15	22	49	176	29	44	99
JUL	2471	85	17	32	57	172	34	65	116
AUG	1783	52	13	21	41	95	25	39	75
SEP	2021	72	33	49	71	115	52	79	113
OCT	2421	71	48	62	83	110	74	96	128
NOV	1275	151	94	122	208	202	126	163	279
DEC	1312	192	128	161	263	239	159	200	327
N_{tot}	21987								

m(filter samples)	PM_1, ng m^{-3}					PM_{10}, ng m^{-3}				
			Percentiles					Percentiles		
	N	AVE	25	50	75	N	AVE	25	50	75
JAN	45	141	82	141	183	159	167	111	143	208
FEB	41	179	116	172	238	161	235	143	194	287
MAR	45	92	66	88	114	183	164	93	138	207
APR	44	53	30	46	71	177	121	60	93	134
MAY	47	38	19	31	48	137	126	44	88	148
JUN	34	39	17	26	37	148	139	40	75	171
JUL	36	63	24	43	69	134	159	53	104	171
AUG	39	54	23	44	69	135	150	56	113	194
SEP	39	56	36	46	65	114	169	53	83	196
OCT	29	51	22	47	66	159	148	82	125	196
NOV	30	88	68	87	118	124	203	107	173	247
DEC	39	114	82	112	142	133	167	94	140	204
N_{tot}	468					1764				

Table S2. Seasonal averages, 25th, 50th and 75th percentiles of scattering coefficients calculated from the particle number size distributions (σ_{sp}(DMPS,$PM_{0.8}$) and σ_{sp}(DMPS,PM_{10})) at λ = 530 nm and from the filter samples (σ_{sp}(PM_1) and σ_{sp}(PM_{10})) at λ = 550 nm. See the main text for detailed explanations. Explanation of columns as in Table S1.

σ_{sp}(size distributions)	σ_{sp}(DMPS,$PM_{0.8}$), Mm^{-1}					σ_{sp}(DMPS,PM_{10}), Mm^{-1}				
			Percentiles				Percentiles			
	N	AVE	25	50	75	AVE	25	50	75
JAN	1263	0.43	0.17	0.29	0.44	0.54	0.21	0.37	0.56
FEB	2480	0.54	0.23	0.45	0.71	0.72	0.31	0.60	0.93
MAR	1912	0.23	0.14	0.20	0.32	0.33	0.20	0.29	0.46
APR	1735	0.13	0.05	0.10	0.15	0.19	0.08	0.15	0.23
MAY	1880	0.11	0.03	0.05	0.09	0.21	0.05	0.09	0.17
JUN	1434	0.30	0.03	0.06	0.14	0.57	0.07	0.11	0.27
JUL	2471	0.30	0.05	0.09	0.19	0.56	0.09	0.17	0.35
AUG	1783	0.16	0.04	0.06	0.12	0.27	0.06	0.09	0.19
SEP	2021	0.23	0.09	0.14	0.22	0.34	0.13	0.21	0.34
OCT	2421	0.18	0.10	0.15	0.21	0.27	0.16	0.22	0.32
NOV	1275	0.32	0.14	0.24	0.52	0.47	0.21	0.35	0.75
DEC	1312	0.31	0.19	0.25	0.42	0.44	0.26	0.34	0.58
N_{tot}	21987								

σ_{sp}(filter samples)	σ_{sp}(PM_1), Mm^{-1}					σ_{sp}(PM_{10}), Mm^{-1}				
			Percentiles					Percentiles		
	N	AVE	25	50	75	N	AVE	25	50	75
JAN	45	0.51	0.29	0.51	0.66	159	0.32	0.21	0.27	0.39
FEB	41	0.64	0.42	0.62	0.86	161	0.45	0.27	0.37	0.55
MAR	45	0.33	0.24	0.32	0.41	183	0.31	0.18	0.26	0.39
APR	44	0.19	0.11	0.17	0.26	177	0.23	0.11	0.18	0.26
MAY	47	0.14	0.07	0.11	0.17	137	0.24	0.08	0.17	0.28
JUN	34	0.14	0.06	0.09	0.13	148	0.26	0.08	0.14	0.32
JUL	36	0.23	0.09	0.16	0.25	134	0.30	0.10	0.20	0.33
AUG	39	0.19	0.08	0.16	0.25	135	0.28	0.11	0.22	0.37
SEP	39	0.20	0.13	0.16	0.23	114	0.32	0.10	0.16	0.37
OCT	29	0.18	0.08	0.17	0.24	159	0.28	0.16	0.24	0.37
NOV	30	0.32	0.24	0.31	0.43	124	0.39	0.20	0.33	0.47
DEC	39	0.41	0.30	0.40	0.51	133	0.32	0.18	0.27	0.39
N_{tot}	468					1764				

Table S3. Seasonal averages, 25th, 50th and 75th percentiles of scattering Ångström exponents of the wavelength pair λ = 467 nm and 660 nm calculated from the lower and upper estimates of scattering coefficients, (σ_{sp}(DMPS,$PM_{0.8}$) and σ_{sp}(DMPS,PM_{10}), respectively. See the main text for details. Unitless. Explanation of columns as in Table S1.

	α_{sp}(σ_{sp}(DMPS,$PM_{0.8}$))					α_{sp}(σ_{sp}(DMPS,PM_{10}))			
			Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75
JAN	1263	2.64	2.55	2.69	2.78	1.92	1.84	1.97	2.07
FEB	2480	2.62	2.55	2.63	2.76	1.90	1.83	1.91	2.03
MAR	1912	2.49	2.26	2.57	2.72	1.72	1.49	1.79	1.95
APR	1735	2.26	2.12	2.25	2.38	1.44	1.30	1.43	1.56
MAY	1880	2.24	2.11	2.24	2.36	1.17	1.04	1.17	1.30
JUN	1434	2.05	1.96	2.05	2.15	0.81	0.72	0.81	0.90
JUL	2471	2.09	1.98	2.05	2.16	0.89	0.79	0.86	0.97
AUG	1783	2.10	2.03	2.11	2.20	1.07	0.99	1.07	1.17
SEP	2021	2.08	1.98	2.11	2.21	1.21	1.10	1.23	1.33
OCT	2421	2.13	2.08	2.15	2.21	1.25	1.20	1.27	1.33
NOV	1275	2.27	2.15	2.31	2.43	1.36	1.24	1.40	1.52
DEC	1312	2.55	2.50	2.55	2.62	1.62	1.57	1.62	1.69
N_{tot}	21987								

Table S4. Seasonal averages, 25th, 50th and 75th percentiles of absorption coefficient. σ_{ap}(B1999, no σ_{sp} correction): σ_{ap} calculated by using Eq. (11) without scattering correction, essentially that calculated by the PSAP; $\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}),B1999)$: σ_{ap} calculated by using $\sigma_{sp}(DMPS,PM_{10})$ for the scattering correction in Eq. (11); $\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}),V2010)$: σ_{ap} calculated by using $\sigma_{sp}(DMPS,PM_{10})$ for the scattering correction in Eq. (12). Unit: Mm^{-1}.

	σ_{ap} (λ=530 nm), Mm^{-1}												
	$\sigma_{ap,nsc}$					$\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}),B1999)$				$\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}),V2010)$			
			Percentiles				Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75	AVE	25	50	75
JAN	838	0.0212	0.0135	0.0175	0.0228	0.0119	0.0058	0.0104	0.0161	0.0106	0.0046	0.0088	0.0143
FEB	1756	0.0229	0.0125	0.0151	0.0236	0.0114	0.0031	0.0080	0.0142	0.0099	0.0018	0.0062	0.0126
MAR	1227	0.0110	0.0071	0.0100	0.0137	0.0052	0.0016	0.0037	0.0077	0.0043	0.0007	0.0028	0.0065
APR	1052	0.0073	0.0051	0.0064	0.0093	0.0038	0.0013	0.0028	0.0064	0.0035	0.0008	0.0025	0.0062
MAY	1262	0.0082	0.0024	0.0040	0.0073	0.0042	0.0009	0.0018	0.0046	0.0038	0.0006	0.0014	0.0042
JUN	1056	0.0143	0.0027	0.0046	0.0151	0.0050	0.0005	0.0018	0.0067	0.0042	0.0002	0.0016	0.0056
JUL	1886	0.0147	0.0047	0.0076	0.0139	0.0069	0.0013	0.0036	0.0074	0.0064	0.0008	0.0032	0.0065
AUG	1059	0.0145	0.0062	0.0102	0.0146	0.0102	0.0045	0.0071	0.0098	0.0092	0.0040	0.0062	0.0092
SEP	1681	0.0267	0.0119	0.0217	0.0289	0.0208	0.0086	0.0183	0.0256	0.0192	0.0077	0.0166	0.0237
OCT	1961	0.0287	0.0219	0.0260	0.0329	0.0244	0.0185	0.0228	0.0285	0.0228	0.0172	0.0214	0.0266
NOV	1091	0.0398	0.0233	0.0297	0.0578	0.0320	0.0170	0.0239	0.0495	0.0297	0.0154	0.0222	0.0470
DEC	946	0.0266	0.0176	0.0211	0.0257	0.0203	0.0127	0.0160	0.0200	0.0189	0.0120	0.0147	0.0185
N_{tot}	15815												

Table S5. Seasonal averages, 25th, 50th and 75th percentiles of single-scattering albedo.

	Single-scattering albedo $\omega_0 = \sigma_{sp}(DMPS,PM_{10})/(\sigma_{sp}(DMPS,PM_{10}) + \sigma_{ap})$, λ = 530 nm												
	$\omega_0(\sigma_{ap,nsc})$					$\omega_0(\sigma_{sp}(DMPS,PM_{10}),B1999)$				$\omega_0(\sigma_{sp}(DMPS,PM_{10}),V2010)$			
			Percentiles				Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75	AVE	25	50	75
JAN	838	0.952	0.934	0.958	0.971	0.967	0.949	0.973	0.987	0.970	0.953	0.976	0.990
FEB	1756	0.957	0.931	0.972	0.979	0.972	0.946	0.987	0.995	0.975	0.951	0.990	0.998
MAR	1227	0.964	0.959	0.974	0.980	0.980	0.974	0.990	0.996	0.982	0.978	0.992	0.998
APR	1052	0.951	0.942	0.960	0.979	0.966	0.957	0.975	0.995	0.968	0.959	0.978	0.997
MAY	1262	0.955	0.933	0.965	0.976	0.970	0.947	0.981	0.992	0.973	0.951	0.984	0.994
JUN	1056	0.961	0.948	0.965	0.981	0.976	0.963	0.981	0.997	0.978	0.965	0.983	0.999
JUL	1886	0.944	0.923	0.948	0.978	0.959	0.937	0.963	0.994	0.962	0.943	0.967	0.996
AUG	1059	0.910	0.869	0.912	0.960	0.923	0.882	0.925	0.976	0.929	0.890	0.932	0.979
SEP	1681	0.891	0.855	0.898	0.937	0.905	0.868	0.911	0.951	0.911	0.877	0.919	0.957
OCT	1961	0.888	0.861	0.895	0.916	0.901	0.873	0.909	0.930	0.907	0.880	0.914	0.936
NOV	1091	0.910	0.893	0.922	0.939	0.924	0.907	0.936	0.954	0.929	0.914	0.940	0.958
DEC	946	0.933	0.924	0.937	0.948	0.947	0.938	0.952	0.963	0.950	0.941	0.955	0.966
N_{tot}	15815												

Table S6. Seasonal averages, 25th, 50th and 75th percentiles of absorption Ångström exponent.

	$\alpha_{ap}(\sigma_{ap} > 3 \times \delta\sigma_{ap})$														
	$\alpha_{ap}(\sigma_{ap,nsc})$					$\alpha_{ap}(\sigma_{sp}(DMPS,PM_{10}),B1999)$					$\alpha_{ap}(\sigma_{sp}(DMPS,PM_{10}),V2010)$				
			Percentiles					Percentiles					Percentiles		
	N	AVE	25	50	75	N	AVE	25	50	75	N	AVE	25	50	75
JAN	835	0.90	0.78	0.89	1.07	695	0.45	0.14	0.40	0.75	620	1.29	1.06	1.28	1.51
FEB	1743	0.93	0.50	0.82	1.22	983	0.84	0.34	0.83	1.51	870	1.17	0.76	1.21	1.49
MAR	1217	0.70	0.35	0.60	1.04	645	0.34	-0.27	0.37	0.94	530	1.29	0.71	1.46	1.67
APR	1045	0.69	0.50	0.69	0.84	529	0.56	0.39	0.52	0.99	494	1.35	1.22	1.34	1.49
MAY	1208	0.75	0.50	0.78	0.99	535	0.81	0.60	0.89	1.03	392	1.44	1.25	1.44	1.74
JUN	1044	0.80	0.60	0.79	0.97	429	0.94	0.60	0.89	1.27	262	1.73	1.37	1.67	2.23
JUL	1832	0.90	0.73	0.91	1.09	1180	0.88	0.63	0.89	1.12	917	1.54	1.44	1.62	1.77
AUG	1028	0.96	0.82	0.96	1.10	913	0.93	0.78	0.95	1.12	760	1.46	1.20	1.48	1.75
SEP	1668	0.93	0.86	0.96	1.04	1589	0.88	0.79	0.92	1.02	1472	1.41	1.23	1.41	1.59
OCT	1952	0.89	0.81	0.90	0.98	1952	0.84	0.73	0.84	0.94	1945	1.35	1.18	1.33	1.49
NOV	1089	0.87	0.79	0.89	0.95	1089	0.76	0.67	0.80	0.86	1062	1.38	1.22	1.34	1.48
DEC	946	0.83	0.72	0.84	0.92	936	0.55	0.42	0.60	0.74	946	1.29	1.12	1.27	1.43
N_{tot}	15607					11475					10270				

Table S7. Seasonal averages, 25th, 50th and 75th percentiles of equivalent Black Carbon concentrations calculated from the absorption coefficients at λ=530 nm calculated by using the B1999 algorithm without any scattering corrections and with B1999 and V2010 algorithms using $\sigma_{sp} = \sigma_{sp}(DMPS,PM_{10})$ for the scattering corrections and assuming MAC = 7.78 $m^2\ g^{-1}$.

		eBC, ng m^{-3}											
		eBC($\sigma_{ap,nsc}$)				eBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, B1999)				eBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, V2010)			
			Percentiles				Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75	AVE	25	50	75
JAN	838	2.72	1.73	2.25	2.93	1.53	0.74	1.34	2.07	1.36	0.60	1.12	1.84
FEB	1756	2.95	1.60	1.94	3.03	1.47	0.40	1.03	1.83	1.27	0.23	0.80	1.62
MAR	1227	1.41	0.91	1.29	1.76	0.66	0.20	0.48	0.99	0.55	0.09	0.36	0.84
APR	1052	0.94	0.66	0.82	1.19	0.49	0.17	0.37	0.83	0.45	0.10	0.32	0.80
MAY	1262	1.06	0.30	0.52	0.93	0.54	0.12	0.23	0.59	0.48	0.08	0.18	0.54
JUN	1056	1.84	0.34	0.59	1.94	0.64	0.06	0.23	0.86	0.54	0.02	0.21	0.72
JUL	1886	1.89	0.61	0.98	1.79	0.88	0.16	0.46	0.94	0.82	0.11	0.41	0.84
AUG	1059	1.87	0.80	1.31	1.87	1.31	0.57	0.92	1.26	1.18	0.51	0.79	1.18
SEP	1681	3.43	1.54	2.79	3.71	2.68	1.10	2.35	3.28	2.46	0.98	2.13	3.04
OCT	1961	3.69	2.82	3.35	4.23	3.13	2.38	2.92	3.67	2.93	2.21	2.75	3.42
NOV	1091	5.11	2.99	3.81	7.43	4.11	2.19	3.07	6.35	3.82	1.98	2.86	6.04
DEC	946	3.42	2.26	2.71	3.30	2.60	1.63	2.06	2.57	2.43	1.54	1.89	2.38
N_{tot}	15815												

Table S8. Seasonal averages, 25th, 50th and 75th percentiles of mass fractions of equivalent Black Carbon concentrations calculated from eBC/m(DMPS,$PM_{0.8}$)×100%.

		eBC mass fraction: eBC/m(DMPS,$PM_{0.8}$), %											
		feBC($\sigma_{ap,nsc}$)				feBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, B1999)				feBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, V2010)			
			Percentiles				Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75	AVE	25	50	75
JAN	838	1.16	0.80	1.10	1.42	0.75	0.36	0.68	1.03	0.67	0.29	0.60	0.94
FEB	1756	1.19	0.64	0.90	1.39	0.72	0.14	0.39	1.06	0.64	0.08	0.31	0.95
MAR	1227	1.03	0.63	0.93	1.22	0.53	0.12	0.35	0.73	0.45	0.06	0.27	0.63
APR	1052	1.87	0.88	1.53	2.39	1.25	0.15	0.92	1.76	1.17	0.09	0.82	1.69
MAY	1262	2.38	1.25	1.74	3.54	1.53	0.41	0.90	2.79	1.38	0.29	0.76	2.60
JUN	1056	2.76	1.40	2.29	3.28	1.66	0.21	1.24	2.30	1.50	0.07	1.10	2.15
JUL	1886	3.66	1.69	3.75	5.11	2.59	0.48	2.64	4.09	2.34	0.32	2.34	3.67
AUG	1059	5.62	2.68	5.70	7.90	4.66	1.62	4.73	7.07	4.27	1.41	4.33	6.51
SEP	1681	6.33	3.87	5.78	7.74	5.44	2.90	4.99	7.01	5.06	2.57	4.49	6.43
OCT	1961	5.89	4.41	5.68	7.13	5.11	3.65	4.84	6.37	4.78	3.39	4.57	5.97
NOV	1091	3.68	2.48	3.08	4.88	3.05	1.80	2.45	3.96	2.83	1.61	2.31	3.76
DEC	946	1.98	1.50	1.85	2.42	1.53	1.06	1.40	1.95	1.43	0.98	1.29	1.76
N_{tot}	15815												

Table S9. Seasonal averages, 25th, 50th and 75th percentiles of mass fractions of equivalent Black Carbon concentrations calculated from eBC/m(DMPS,PM_{10})×100%.

		eBC mass fraction: eBC/m(DMPS,PM_{10}), %											
		feBC($\sigma_{ap,nsc}$)				feBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, B1999)				feBC($\sigma_{ap}(\sigma_{sp}(DMPS,PM_{10}))$, V2010)			
			Percentiles				Percentiles				Percentiles		
	N	AVE	25	50	75	AVE	25	50	75	AVE	25	50	75
JAN	838	1.01	0.70	0.95	1.23	0.65	0.32	0.59	0.90	0.58	0.25	0.52	0.82
FEB	1756	1.02	0.55	0.77	1.19	0.61	0.12	0.33	0.91	0.54	0.07	0.26	0.82
MAR	1227	0.81	0.50	0.73	0.97	0.42	0.10	0.28	0.57	0.36	0.05	0.22	0.50
APR	1052	1.36	0.64	1.12	1.74	0.91	0.11	0.67	1.28	0.85	0.07	0.60	1.23
MAY	1262	1.32	0.69	0.97	1.96	0.85	0.23	0.50	1.55	0.76	0.16	0.42	1.44
JUN	1056	1.37	0.70	1.14	1.63	0.83	0.10	0.62	1.14	0.75	0.04	0.55	1.07
JUL	1886	1.81	0.84	1.86	2.53	1.28	0.24	1.31	2.03	1.16	0.16	1.16	1.82
AUG	1059	3.06	1.46	3.10	4.30	2.54	0.88	2.57	3.85	2.33	0.77	2.35	3.54
SEP	1681	3.96	2.42	3.62	4.84	3.40	1.81	3.12	4.39	3.17	1.61	2.81	4.03
OCT	1961	3.80	2.85	3.67	4.60	3.30	2.36	3.12	4.11	3.09	2.19	2.95	3.85
NOV	1091	2.75	1.85	2.30	3.65	2.28	1.34	1.83	2.96	2.11	1.20	1.73	2.81
DEC	946	1.60	1.21	1.49	1.95	1.23	0.85	1.12	1.57	1.15	0.79	1.03	1.41
N_{tot}	15815												

Table S10. Seasonal cycles of emissions of major absorbing and scattering aerosols.
BC emission:s Southern Hemisphere emissions from GFED v3.1data base (http://www.globalfiredata.org),
SSA: Sea-Spray Aerosol flux from the Southern Ocean, Grythe et al. (2014)

	BC emissions, g m^{-2}			SSA
Month	South America	Africa	Oceania	flux, g m^{-2} s^{-1}
JAN	4.9	3.1	8.9	0.924
FEB	6.1	2.1	5.2	1.227
MAR	7.4	2.8	2.0	1.253
APR	7.1	10.1	8.2	1.417
MAY	9.6	72.2	20.6	1.534
JUN	19.1	195.8	16.7	1.475
JUL	56.4	278.9	23.3	1.691
AUG	347.1	356.4	60.0	1.565
SEP	342.9	302.9	94.6	1.565
OCT	57.5	115.1	122.0	1.306
NOV	17.0	16.5	54.0	1.306
DEC	6.8	4.5	23.9	1.056