



*Supplement of*

## **A European aerosol phenomenology – 6: scattering properties of atmospheric aerosol particles from 28 ACTRIS sites**

**Marco Pandolfi et al.**

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**Table S1:** Nephelometer data correction.

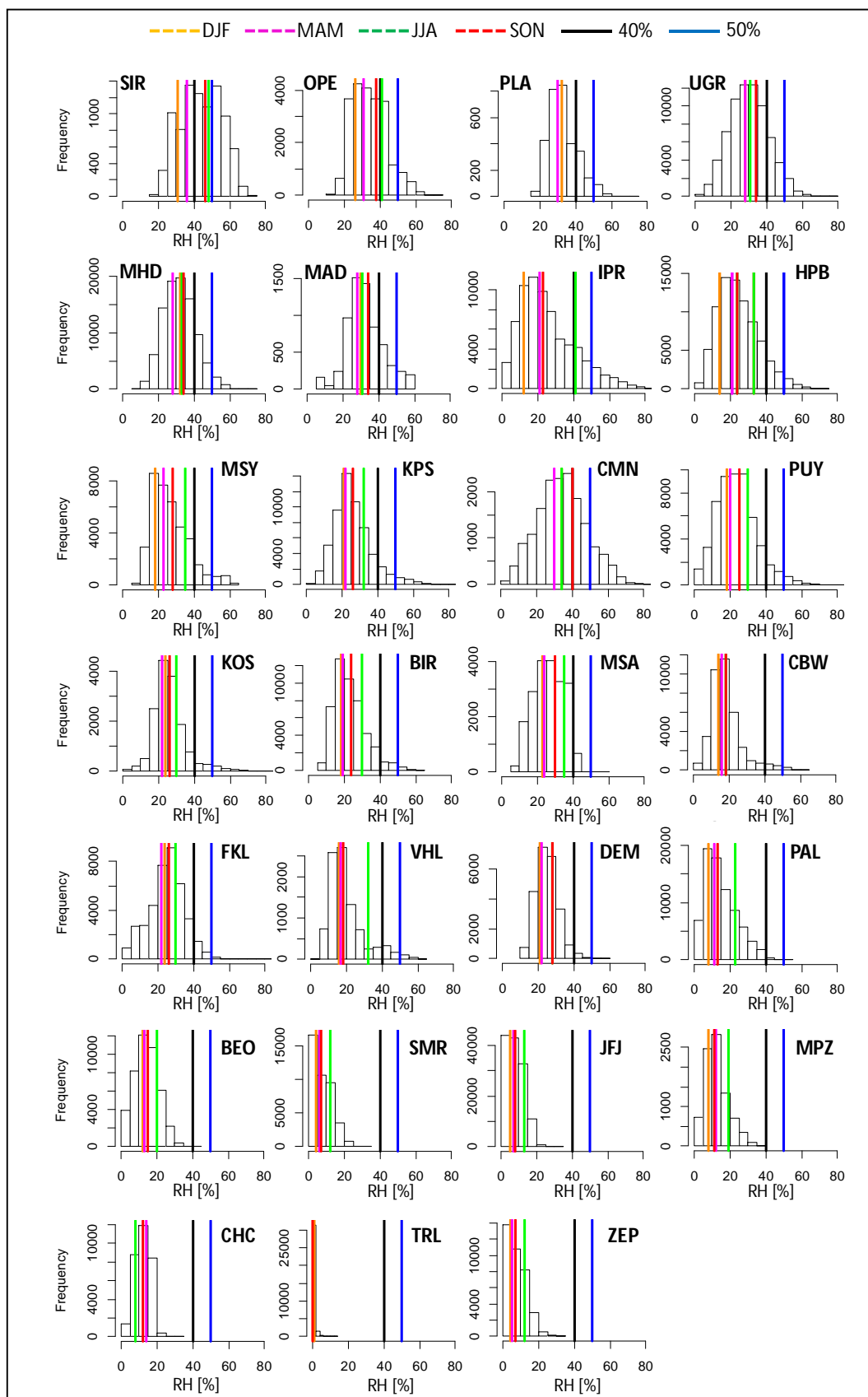
Observatory	correction	who	method	Notes
BEO	yes	data provider	Anderson&Ogren (1998)	
BIR	yes	data provider	Anderson&Ogren (1998)	
CBW	yes	data provider	Anderson&Ogren (1998)	
CHC	yes	data provider	Müller et al. (2011)	
CMN	no			1- $\lambda$
DEM	yes	data provider	Müller et al. (2011)	
FKL	no			1- $\lambda$
HPB	yes	data provider	Anderson&Ogren (1998)	
IPR	yes	data provider	Anderson&Ogren (1998)	
IZO	yes	data provider	Anderson&Ogren (1998)	
JFJ	yes	data provider	Anderson&Ogren (1998)	
KOS	yes	this work	Anderson&Ogren (1998)	
KPS	yes	data provider	Anderson&Ogren (1998)	
MAD	yes	data provider	Müller et al. (2011)	
MHD	yes	this work	Anderson&Ogren (1998)	
MPZ	yes	data provider	Anderson&Ogren (1998)	
MSA	yes	data provider	Müller et al. (2011)	
MSY	yes	data provider	Müller et al. (2011)	
OPE	yes	data provider	Müller et al. (2011)	
PAL	yes	data provider	Anderson&Ogren (1998)	
PLA	yes	this work	Anderson&Ogren (1998)	
PUY	yes	data provider	Anderson&Ogren (1998)	
SIR	no			1- $\lambda$
SMR	yes	data provider	Anderson&Ogren (1998)	
TRL	yes	data provider	Anderson&Ogren (1998)	
UGR	yes	data provider	Anderson&Ogren (1998)	
VHL	yes	data provider	Müller et al. (2011) (*)	
ZEP	yes	data provider	Anderson&Ogren (1998)	

(\*) DMPS data and a Mie-theory code for 2008 and 2009.

**Table S2:** Number (#) of  $\sigma_{sp}$  hourly data used in this investigation; % of hourly  $\sigma_{sp}$  collected at 40%<RH<50%; period with  $\sigma_{sp}$  and RH reported data. Stations are reported in decreasing order of %  $\sigma_{sp}$  data collected at 40%<RH<50%.

	# of $\sigma_{sp}$ data (1)	% of $\sigma_{sp}$ data collected at 40%<RH<50%	period with $\sigma_{sp}$ measurements	period with RH reported	note
<b>SIR</b>	5847	39.9	2012 - 2013	2012 - 2013	Instrument internal
<b>OPE</b>	21089	22.3	2012 - 2015	2012 - 2015	Instrument outlet
<b>PLA</b>	3021	16.1	2013 - 2014	2013 - 2014	Instrument internal
<b>UGR</b>	60502	15.8	2006 - 2015	2006 - 2015	Instrument internal
<b>MHD</b>	90002	15.6	2001 - 2013	2001 - 2013	Instrument internal
<b>MAD</b>	6545	14.0	2014	2014	Instrument internal
<b>IPR</b>	69317	10.0	2004 - 2014	2004 - 2014	RH controlled from 2009. Instrument internal
<b>HPB</b>	76954	7.5	2006 - 2015	2006 - 2015	Instrument internal
<b>MSY</b>	35662	6.2	2010 - 2015	2010 - 2015	Instrument internal
<b>KPS</b>	55066	6.2	2006 - 2014	2006 - 2014	Instrument internal
<b>CMN</b>	16305	5.5	2007 - 2015	2013 - 2015	Instrument internal
<b>PUY</b>	49756	5.0	2007 - 2014	2007 - 2014	Instrument internal
<b>KOS</b>	14757	4.0	2013 - 2015	2013 - 2015	Instrument internal
<b>BIR</b>	49508	3.8	2009 - 2015	2009 - 2015	Instrument internal
<b>MSA</b>	20101	3.4	2013 - 2015	2013 - 2015	Instrument internal
<b>CBW</b>	37298	2.9	2008 - 2012	2008 - 2012	Instrument internal
<b>FKL</b>	71531	2.8	2004 - 2015	2011 - 2015	Instrument internal after 2011
<b>VHL</b>	21436	2.3	2008 - 2014	2012 - 2014	Inlet
<b>DEM</b>	24244	1.8	2012 - 2015	2012 - 2015	Instrument internal
<b>PAL</b>	76330	0.3	2000 - 2015	2000 - 2006; 2009; 2012 - 2015	Instrument internal
<b>BEO</b>	56309	0.0	2007 - 2015	2007; 2010 - 2015	Instrument internal
<b>SMR</b>	78711	0.0	2006 - 2015	2011 - 2015	Instrument internal
<b>JFJ</b>	151259	0.0	1995 - 2014	2000 - 2014	Instrument internal
<b>MPZ</b>	75122	0.0	2007 - 2015	2012 - 2015	Instrument internal
<b>CHC</b>	8339	0.0	2012 - 2015	2012 - 2015	Instrument outlet
<b>TRL</b>	56035	0.0	2007 - 2015	2010 - 2011; 2014 - 2015	Instrument internal
<b>ZEP</b>	33977	0.0	2010 - 2014	2010 - 2014	Instrument internal
<b>IZO</b>	37309		2008 - 2015		RH not reported

(1) Green wavelength used as reference



**Figure S1:** Frequency distributions of sampled RH at ACTRIS observatories. Vertical lines: 40% GAW recommendation (black); 50% RH threshold used in this work (blue); median RH in winter (yellow); median RH in spring (magenta); median RH in summer (green); median RH in autumn (red).

**Table S3:** Percentage [%] of data coverage at the 28 ACTRIS stations included in this study.  $\lambda_1$  = blue;  $\lambda_2$  = green;  $\lambda_3$  = red. Percentages are calculated as the ratio between the number of scattering (backscattering) data used in this investigation and the total number of hours during the sampling period at each station. Removed data include data flagged as non valid by data providers (instrument failure, calibration periods, unspecified contamination or local influence, etc) or obtained at RH higher than 50%.

Station name/setting	# hours <sup>(1)</sup>	DATA COVERAGE [%] <sup>(5)</sup>							
		$\sigma_{sp}$ 1 [%] $\lambda_1$ [nm]	$\sigma_{sp}$ 2 [%] $\lambda_2$ [nm]	$\sigma_{sp}$ 3 [%] $\lambda_3$ [nm]	$\sigma_{bsp}$ 1 [%] $\lambda_1$ [nm]	$\sigma_{bsp}$ 2 [%] $\lambda_2$ [nm]	$\sigma_{bsp}$ 3 [%] $\lambda_3$ [nm]	SAE [%] <sup>(2)</sup>	BF and g [%] <sup>(3)</sup> $\lambda$ [nm]
<b>Arctic</b>									
Zeppelin (ZEP)	38913	87.3 450	87.3 550	87.3 700	87.3 450	87.3 550	87.3 700	66.5	19.4 550
Pallas (PAL)	140256	72.1 450	69.7 550	70.1 700	72.5 450	71.2 550	70.7 700	53.8	25.7 550
<b>Antarctic</b>									
Troll (TRL)	77712	72.1 450	72.1 550	72.1 700	64.5 450	64.5 550	64.5 700	21.2	1.1 550
<b>Mountain</b>									
Puy de Dome (PUY)	70128	70.1 450	71.0 550	71.1 700	68.5 450	68.5 550	68.5 700	59.3	42.6 550
Izaña (IZO)	68381	54.6 450	54.6 550	54.6 700	46.0 450	46.0 550	46.0 700	51.7	26.8 550
Montsec (MSA)	26280	76.5 450	76.5 525	76.5 635	75.5 450	75.5 525	75.5 635	63.9	49.1 525
Jungfrauoch (JFJ)	179545	84.2 450	84.2 550	84.2 700	83.8 450	83.8 550	83.8 700	53.9	21.8 550
Mt. Cimone (CMN)	72825	15.1 <sup>(*)</sup> 450	75.1 520 <sup>(4)</sup>	15.1 <sup>(*)</sup> 700	15.1 <sup>(*)</sup> 450	15.1 <sup>(*)</sup> 550	15.1 <sup>(*)</sup> 700	11.7 <sup>(*)</sup>	8.4 <sup>(*)</sup> 550
Hohenpeisse nberg (HPB)	87648	87.8 450	87.8 550	87.8 700	87.8 450	87.8 550	87.8 700	77.3	64.1 550
Beo Moussala (BEO)	76764	73.4 450	73.4 550	73.4 700	71.3 450	71.3 550	71.3 700	63.6	46.8 550
Mt. Chacaltaya (CHC)	8784	94.9 450	94.9 525	94.9 635	94.9 450	94.9 525	94.9 635	69.5	38.4 525
<b>Coastal</b>									
Preila (PLA)	18264	16.5 450	16.5 550	16.5 700	9.9 450	9.9 550	9.9 700	16.5	9.9 550
Mace Head (MHD)	109037	82.5 450	82.5 550	82.5 700	82.1 450	82.1 550	82.1 700	81.8	71.9 550
Finokalia (FKL)	102622		69.7 532 <sup>(5)</sup>						
<b>Regional/rural</b>									
Birkenes II (BIR)	56832	87.1 450	87.1 550	87.1 700	87.1 450	87.1 550	87.1 700	83.9	55.2 550
Hyytiälä (SMR)	84035	93.7 450	93.7 550	93.7 700	88.8 450	88.8 550	88.8 700	93.1	71.7 550
Vavihill (VHL)	50508	42.4 450	42.4 520	42.4 700 <sup>(6)</sup>				35.9 <sup>(7)</sup>	
O.Perenne (OPE)	28956	72.8 450	72.8 525	72.8 635	44.3 450	68.8 525	68.8 635	74.0	59.0 525
Cabauw (CBW)	43848	85.1 450	85.1 550	85.1 700	85.1 450	68.0 550	85.0 700	84.5	56.4 550
Montseny	52584	67.8	67.8	67.9	62.8	62.8	62.9	65.0	65.4

<b>(MSY)</b>		450	525	635	450	525	635		525
Kosetice <b>(KOS)</b>	24588	59.9 450	60.0 550	59.9 700	54.4 450	54.4 550	54.4 700	59.8	53.6 550
Melpitz <b>(MPZ)</b>	78224	94.6 450	96.0 550	94.7 700	86.2 450	86.3 550	86.5 700	94.5	85.2 550
Ispra <b>(IPR)</b>	96432	71.7 450	71.9 550	71.8 700	71.9 450	71.8 550	71.6 700	70.4	69.1 550
K-Pusztá <b>(KPS)</b>	75804	72.6 450	72.6 550	72.6 700	72.6 450	72.6 550	72.6 700	72.6	72.5 550
<b>Urban/sub-urban</b>									
Sirta <b>(SIR)</b>	12731	45.9 450							
Madrid <b>(MAD)</b>	8760	72.8 450	74.7 525	72.8 635	73.2 450	73.2 525	73.2 635	72.3	53.3 525
Granada <b>(UGR)</b>	87648	69.0 450	69.0 550	69.0 700	68.1 450	68.1 550	68.1 700	69.0	67.8 550
Athens <b>(DEM)</b>	35064	69.1 450	69.1 525 <sup>(8)</sup>	69.1 635 <sup>(9)</sup>	62.8 450	62.8 525	62.8 635	68.6 <sup>(10)</sup>	61.5 525

(\$) Data coverage referenced to # hours;

(\*\*) Only available for the years 2014 and 2015;

(1) Total number of hours for the periods reported for each station in Table 1 in the paper.

(2) SAE calculated from linear estimation using 3  $\lambda$ . SAE calculated from scattering data higher than 0.8 Mm<sup>-1</sup>.

(3) g calculated from scattering and backscattering data higher than 0.8 Mm<sup>-1</sup>.

(4) 520 nm until March 2014. After March 2014 it changed to 550 nm.

(5) 532nm from 2004 to 2011; 550nm for 2012 – 2013. SAE and g not available.

(6) The scattering at 700 nm changed to scattering at 635 nm starting from 2010.

(7) The SAE was calculated as linear fit using 450-520-635 nm scattering for 2008 – 2009. Starting from 2010 SAE was calculated using 700 nm instead of 635 nm.

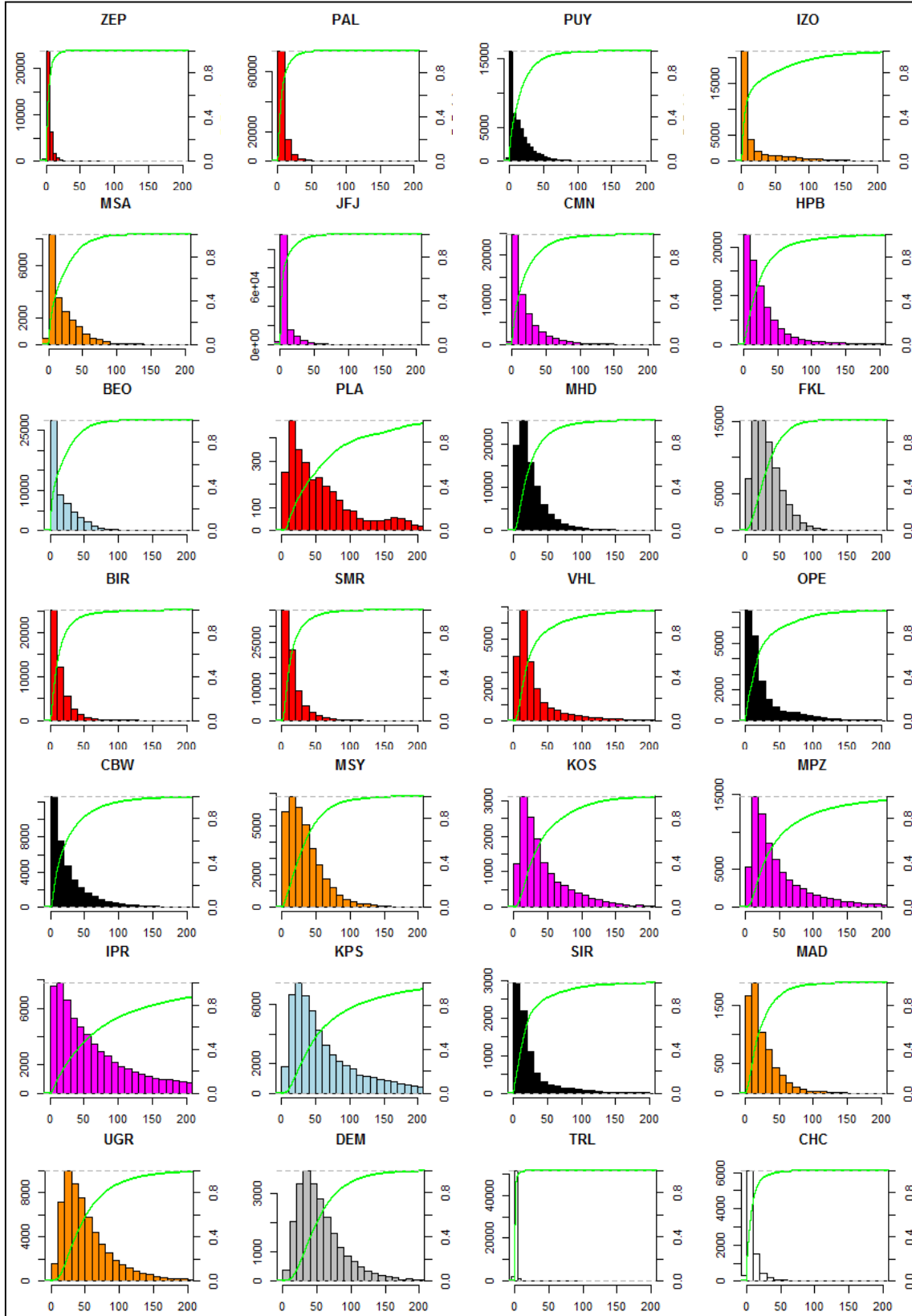
(8) During 2012 the wavelengths are: 450, 520, 700 nm. From 2013 the wavelengths are: 450, 525, 635 nm.

(9) During 2012 the wavelengths are: 450, 520, 700 nm. From 2013 the wavelengths are: 450, 525, 635 nm.

(10) The SAE was calculated as linear fit using 450-520-700 nm scattering for 2012 and then using 450-525-635 nm.

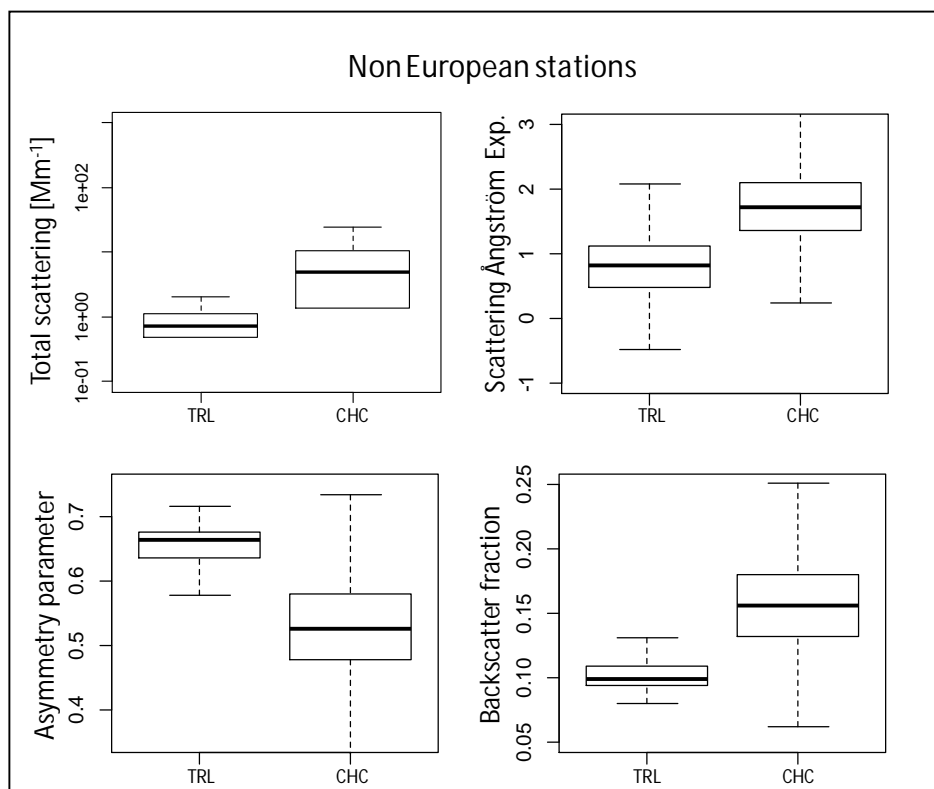
**Table S4:** Statistics of the aerosol particle scattering coefficient [ $\text{Mm}^{-1}$ ]. Statistics are reported for the whole period available at each station.

	$\lambda$	mean	SD	min	max	5th pc	25th pc	50th pc	75th pc	95th pc	skewness
<b><u>Arctic</u></b>											
ZEP	550	4.42	5.69	-0.83	81.35	0.17	1.15	2.82	5.58	13.99	4.42
PAL	550	7.85	15.66	-2.15	1875.14	0.40	1.88	4.29	9.45	26.48	1.4
<b><u>Antarctic</u></b>											
TRL	550	1.18	2.35	-1.02	76.62	0.04	0.48	0.72	1.12	3.27	10.6
<b><u>Mountain</u></b>											
PUY	550	16.38	22.16	-1.93	412.91	0.22	2.46	9.82	21.70	53.05	4.2
IZO	550	30.81	57.78	0.04	1233.41	0.99	2.85	7.32	33.80	131.32	4.8
MSA	525	20.65	22.35	-2.73	277.06	0.33	3.53	13.10	31.02	66.41	1.8
JFJ	550	7.35	11.96	-2.38	308.40	0.15	0.89	2.41	8.10	32.18	3.4
CMN	520	21.36	25.84	-5.60	582.04	0.69	4.30	12.43	28.83	71.53	2.7
HPB	550	30.17	35.45	0.12	522.88	2.30	8.47	19.07	37.41	100.47	2.9
BEO	550	19.00	23.75	-1.27	470.88	0.48	2.56	10.43	28.03	60.91	3.3
CHC	525	8.54	12.33	-1.59	205.14	0.05	1.40	4.94	10.62	30.06	2.8
<b><u>Coastal</u></b>											
PLA	550	64.78	60.02	2.68	482.45	8.48	20.67	45.65	85.02	189.17	1.7
MHD	550	28.43	29.02	0.05	470.28	4.61	10.93	19.83	35.57	80.20	3.4
FKL	532	33.50	23.24	0.19	759.50	7.04	17.30	28.94	44.55	74.14	3.4
<b><u>Regional/rural</u></b>											
BIR	550	14.71	20.69	-0.01	371.5	1.38	4.19	8.62	17.33	45.94	5.3
SMR	550	17.34	18.69	0.15	305.95	2.90	6.26	11.33	21.10	52.70	3.4
VHL	520	33.34	37.48	0.96	369.50	5.70	11.79	19.88	37.80	111.98	2.8
OPE	525	29.04	38.03	0.01	386.42	1.17	6.60	16.01	33.92	103.72	3.0
CBW	550	31.49	41.34	0.25	621.13	2.76	7.35	17.36	39.46	105.36	3.7
MSY	525	35.95	32.21	-1.48	539.71	4.06	14.44	28.27	47.81	92.55	2.8
KOS	550	46.05	41.30	0.00	324.27	7.73	18.02	32.36	60.52	129.15	2.0
MPZ	550	53.39	58.57	0.23	689.49	7.82	17.53	33.16	66.82	168.44	3.1
IPR	550	95.03	108.69	0.27	3239.14	5.76	22.72	56.12	126.29	315.54	2.7
KPS	550	74.01	71.95	2.14	811.46	11.72	27.11	48.99	95.24	219.92	2.4
<b><u>Urban/sub-urban</u></b>											
SIR	450	25.34	32.81	0.01	715.91	1.24	6.90	14.83	28.24	91.42	3.8
MAD	525	25.30	22.91	-0.61	254.62	3.37	9.90	18.04	33.89	68.72	2.4
UGR	550	55.21	44.43	-1.32	663.88	12.74	26.26	43.14	69.80	138.49	2.6
DEM	525	56.15	37.93	-3.11	554.88	15.23	30.67	47.39	71.19	125.64	2.3



**Figure S2:** Frequency (station color code as in Fig. 2) and cumulative frequency distributions (green line) of aerosol particle scattering coefficient.



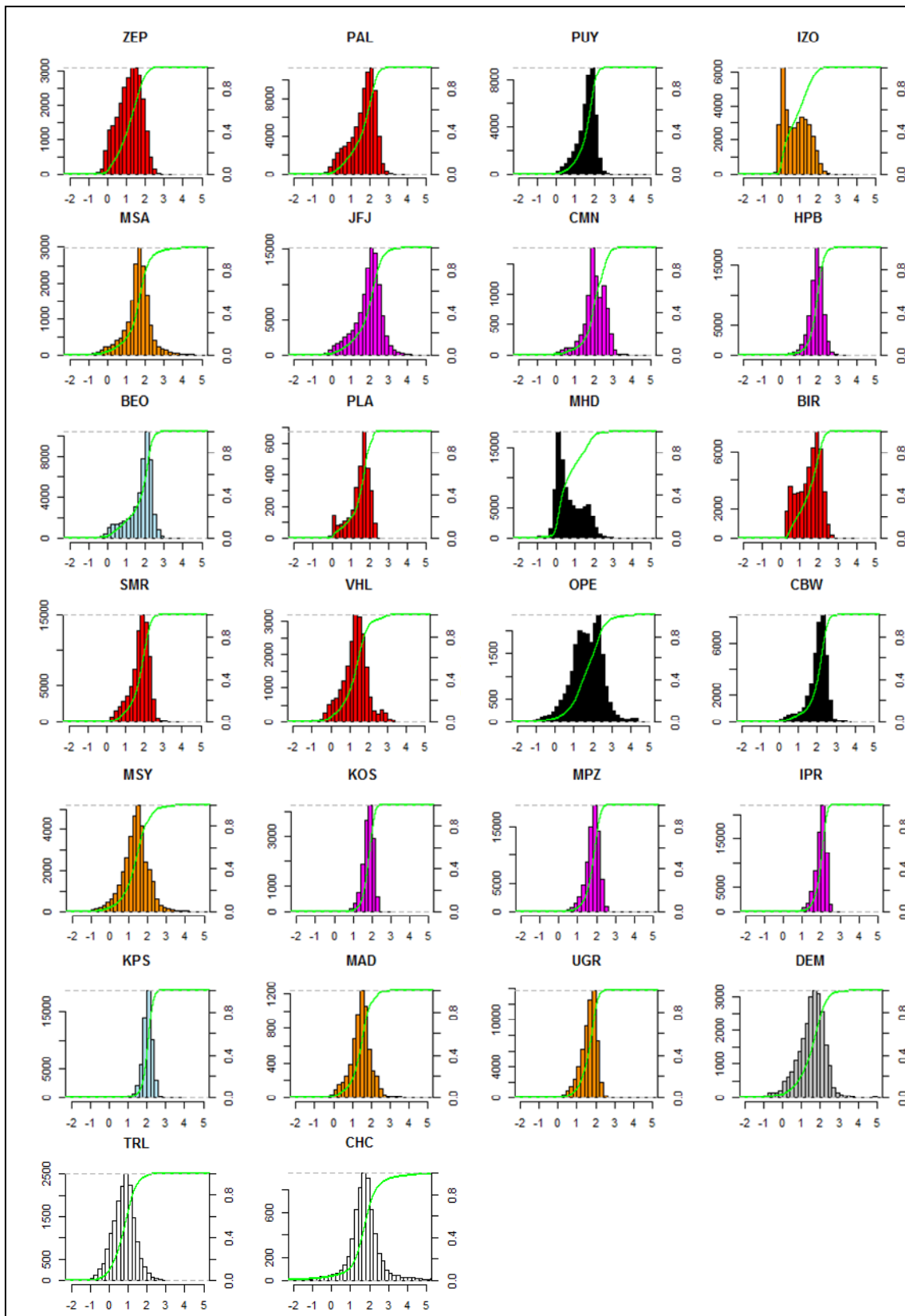


**Figure S3:** Total scattering, Scattering Angstrom Exponent, Asymmetry parameter and Backscatter fraction for the non-European stations TRL and CHC.

**Table S5:** Statistics of the scattering Ångström exponent calculated as linear fit using the three nephelometer wavelengths (b-g-r). Statistics are reported for the whole period available at each station. The mean values of SAE calculated using the blue and the green wavelengths (b-g) and using the green and red wavelengths (g-r) are also reported. The reported SAE values were calculated for  $\sigma_{sp} > 0.8 \text{ Mm}^{-1}$ .

	SAE (b-g-r)										SAE (b-g)	SAE (g-r)
	mean	SD	min	max	5th pc	25th pc	50th pc	75th pc	95th pc	skewness	mean	mean
<b><u>Arctic</u></b>												
ZEP	1.16	0.62	-1.29	3.21	0.06	0.73	1.22	1.64	2.09	-0.28	1.11	1.20
PAL	1.63	0.67	-1.91	3.89	0.30	1.25	1.78	2.12	2.47	-0.79	1.58	1.67
<b><u>Antarctic</u></b>												
TRL	0.81	0.53	-1.74	3.09	-0.09	0.48	0.82	1.12	1.68	-0.05	1.06	0.63
<b><u>Mountain</u></b>												
PUY	1.63	0.49	-1.22	4.54	0.65	1.42	1.74	1.96	2.23	-0.97	1.75	1.55
IZO	0.78	0.64	-1.97	3.71	-0.05	0.18	0.73	1.30	1.86	0.30	0.71	0.84
MSA	1.59	0.69	-1.48	5.14	0.26	1.30	1.65	1.96	2.58	-0.31	1.65	1.54
JFJ	1.90	0.70	-1.41	6.79	0.49	1.57	2.03	2.35	2.83	-0.74	1.80	1.99
CMN	2.00	0.58	-2.17	4.99	0.90	1.75	2.02	2.42	2.81	-0.94	1.94	2.06
HPB	1.85	0.37	-0.08	3.54	1.18	1.67	1.89	2.09	2.38	-0.84	1.82	1.88
BEO	1.72	0.68	-2.48	3.84	0.27	1.42	1.94	2.18	2.46	-1.22	1.78	1.67
CHC (a)	1.71	0.93	-2.92	5.92	0.26	1.35	1.72	2.09	3.05	-0.08	1.71	
<b><u>Coastal</u></b>												
PLA	1.45	0.56	-0.16	2.72	0.16	1.21	1.60	1.82	2.18	-0.97	1.51	1.41
MHD	0.69	0.74	-1.99	5.80	-0.13	0.13	0.47	1.22	1.94	0.91	0.57	0.78
<b><u>Regional/rural</u></b>												
BIR	1.44	0.64	-1.35	4.12	0.26	0.97	1.59	1.95	2.29	-0.41	1.38	1.50
SMR	1.75	0.50	-1.02	3.84	0.74	1.50	1.84	2.10	2.40	-0.83	1.71	1.78
VHL	1.27	0.68	-1.94	3.58	0.02	0.91	1.33	1.67	2.37	-0.26	1.38	1.24
OPE	1.66	0.83	-1.71	4.97	0.21	1.16	1.70	2.24	2.85	-0.21	1.60	1.69
CBW	2.00	0.53	-0.20	3.62	0.84	1.81	2.12	2.34	2.61	-1.32	1.85	2.12
MSY	1.37	0.72	-1.56	5.71	0.12	0.99	1.40	1.76	2.41	0.04	1.36	1.38
KOS	1.79	0.29	-1.19	3.20	1.27	1.63	1.82	1.99	2.19	-1.09	1.80	1.78
MPZ	1.76	0.39	-0.26	5.40	1.03	1.56	1.82	2.03	2.28	-0.82	1.70	1.76
IPR	1.96	0.30	-0.80	3.15	1.40	1.82	2.02	2.17	2.35	-1.36	1.83	2.07
KPS	2.03	0.26	0.28	3.92	1.56	1.89	2.05	2.19	2.42	-0.72	1.88	2.14
<b><u>Urban/sub-urban</u></b>												
MAD	1.43	0.54	-1.26	5.75	0.40	1.15	1.47	1.73	2.28	-0.29	1.56	1.32
UGR	1.62	0.41	-1.35	5.96	0.82	1.39	1.69	1.91	2.17	-0.79	1.58	1.65
DEM	1.51	0.72	-2.51	5.13	0.20	1.12	1.60	1.99	2.49	-0.50	1.40	1.68

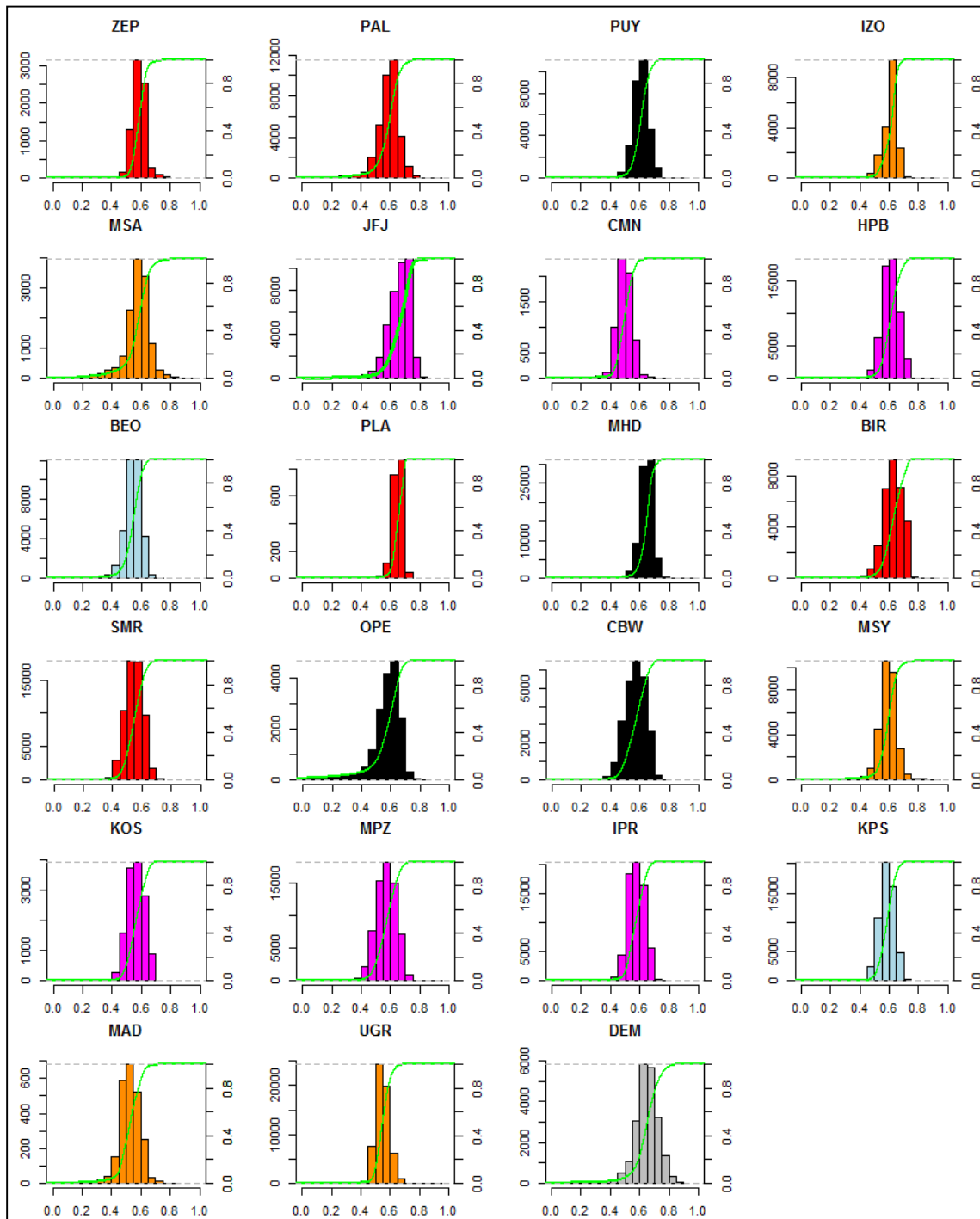
(a) At CHC the statistics are reported for SAE calculated using the blue and green wavelengths.



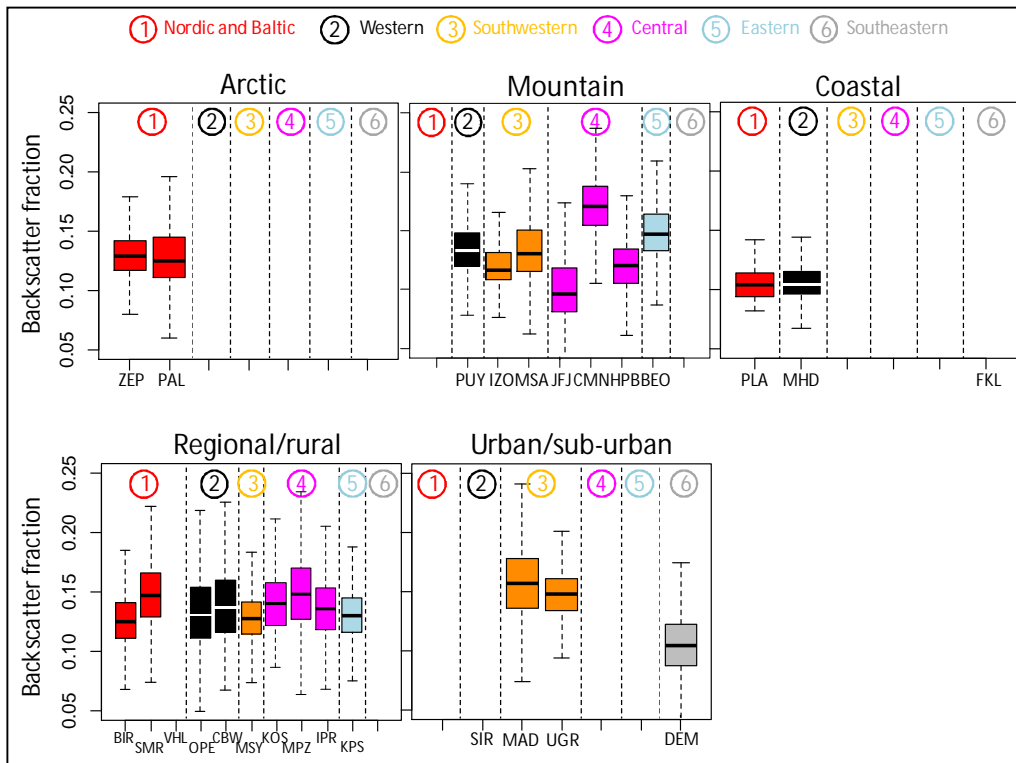
**Figure S4:** Frequency (station color code as in Fig. 4) and cumulative frequency distributions (green line) of scattering Ångström exponent. SAE at CHC was calculated using the blue and green wavelengths.

**Table S6:** Statistics of the asymmetry parameter (calculated for the wavelengths reported in Table S2). Statistics are reported for the whole period available at each station. The reported  $g$  values were calculated for  $\sigma_{sp} > 0.8 \text{ Mm}^{-1}$ .

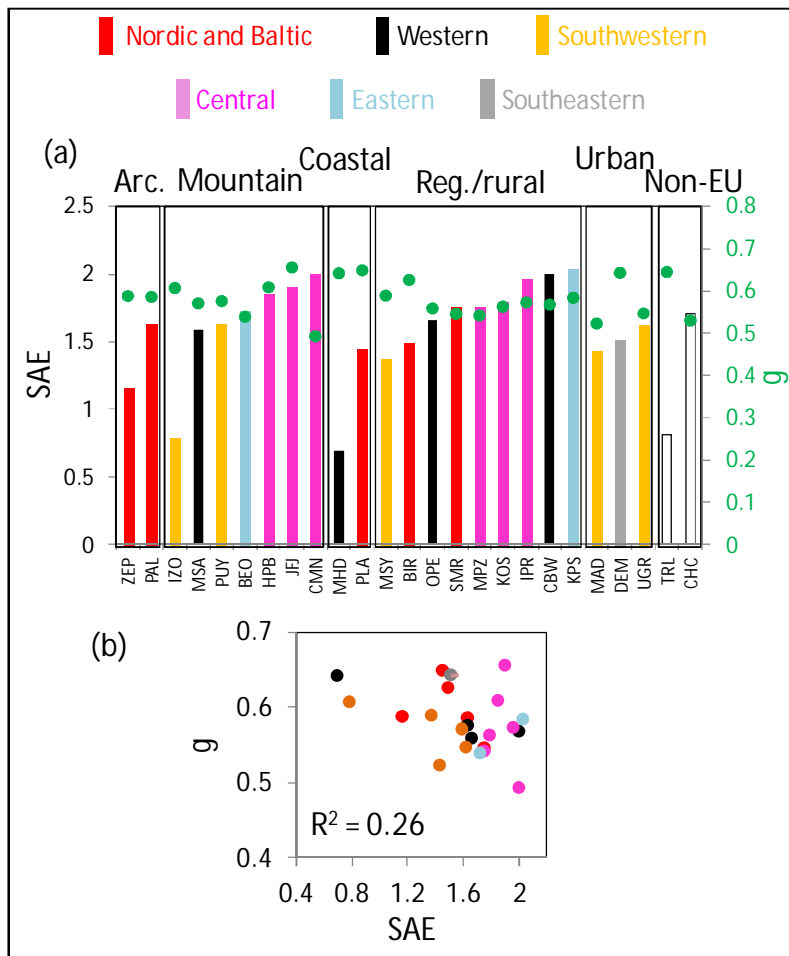
	mean	SD	min	max	5th pc	25th pc	50th pc	75th pc	95th pc	skewness
<b><u>Arctic</u></b>										
ZEP	0.588	0.046	0.110	0.789	0.519	0.558	0.587	0.617	0.653	0.07
PAL	0.586	0.079	-0.377	0.937	0.459	0.551	0.596	0.632	0.692	-1.59
<b><u>Antarctic</u></b>										
TRL	0.645	0.060	0.159	0.716	0.541	0.637	0.667	0.677	0.695	-3.59
<b><u>Mountain</u></b>										
PUY	0.576	0.053	0.002	0.851	0.493	0.544	0.577	0.610	0.660	-0.83
IZO	0.607	0.047	-0.378	0.885	0.520	0.581	0.618	0.638	0.666	-1.40
MSA	0.571	0.088	0.101	0.902	0.402	0.538	0.582	0.621	0.681	-1.44
JFJ	0.656	0.079	0.003	0.845	0.526	0.613	0.670	0.712	0.750	-1.76
CMN	0.493	0.051	0.083	0.797	0.416	0.460	0.494	0.528	0.573	-0.41
HPB	0.609	0.055	0.116	0.871	0.519	0.572	0.608	0.646	0.701	-0.16
BEO	0.539	0.066	-0.769	0.737	0.441	0.510	0.546	0.578	0.624	-3.24
CHC	0.530	0.088	0.111	0.851	0.399	0.478	0.523	0.580	0.681	0.06
<b><u>Coastal</u></b>										
PLA	0.649	0.035	0.479	0.711	0.590	0.626	0.651	0.677	0.697	-0.69
MHD	0.642	0.049	0.052	0.974	0.562	0.619	0.648	0.669	0.709	-1.24
<b><u>Regional/rural</u></b>										
BIR	0.593	0.053	0.039	0.809	0.503	0.560	0.596	0.631	0.668	-0.56
SMR	0.546	0.059	0.000	0.750	0.448	0.505	0.547	0.589	0.639	-0.19
OPE	0.559	0.142	-0.999	0.812	0.349	0.531	0.587	0.632	0.680	-4.33
CBW	0.568	0.068	0.292	0.756	0.454	0.518	0.571	0.621	0.675	-0.20
MSY	0.589	0.062	-0.860	0.938	0.498	0.558	0.592	0.625	0.674	-1.73
KOS	0.563	0.058	0.109	0.699	0.466	0.522	0.562	0.606	0.656	-0.17
MPZ	0.542	0.066	0.023	0.834	0.438	0.496	0.543	0.592	0.643	-0.27
IPR	0.573	0.057	0.187	0.793	0.488	0.532	0.572	0.614	0.663	-0.36
KPS	0.584	0.050	0.291	0.732	0.500	0.551	0.585	0.618	0.666	-0.16
<b><u>Urban/sub-urban</u></b>										
MAD	0.523	0.072	0.118	0.814	0.419	0.481	0.525	0.572	0.624	-0.86
UGR	0.547	0.045	-0.137	0.933	0.480	0.516	0.544	0.576	0.622	-0.16
DEM	0.643	0.088	-0.858	0.881	0.505	0.603	0.649	0.695	0.767	-1.97



**Figure S5:** Frequency (station color code as in Fig. 5) and cumulative frequency distributions (green line) of asymmetry parameter.



**Figure S6:** Backscatter fraction (BF) divided by station setting. Different colors highlight different geographical locations. Medians (horizontal lines in the boxes), percentiles 25<sup>th</sup> and 75<sup>th</sup> (lower and upper limits of the boxes, respectively) and percentiles 5<sup>th</sup> and 95<sup>th</sup> (lower and upper limits of the vertical dashed lines) are reported. Hourly data were used for the statistic.

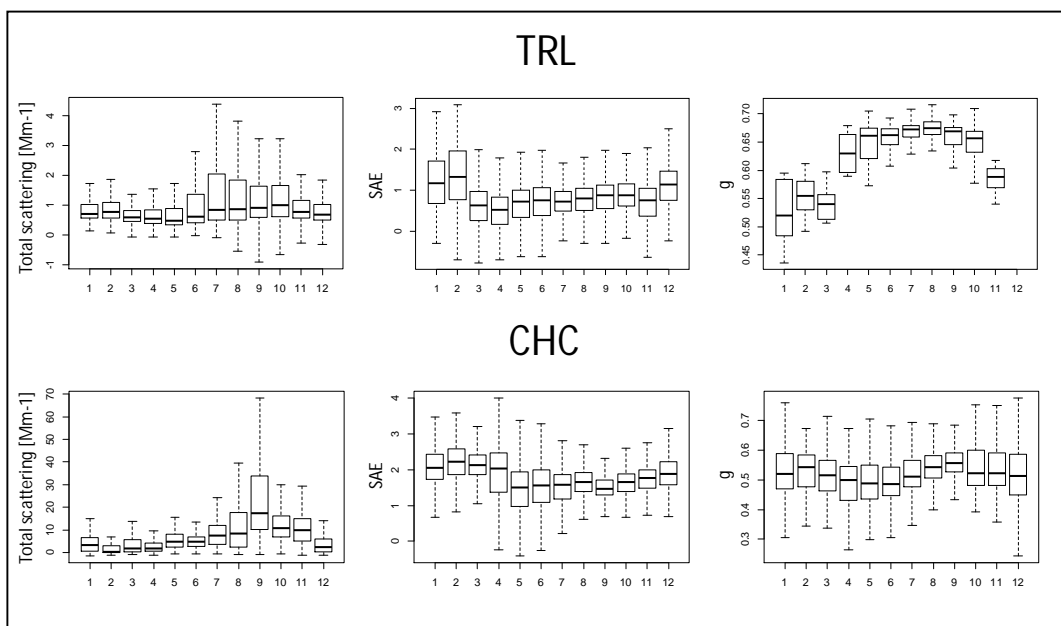


**Figure S7:** (a) SAE (bars) vs.  $g$  (green dots) at all stations included in this work and (b) SAE- $g$  scatterplot (mean values used for the scatterplot). Different colors highlight different geographical locations.

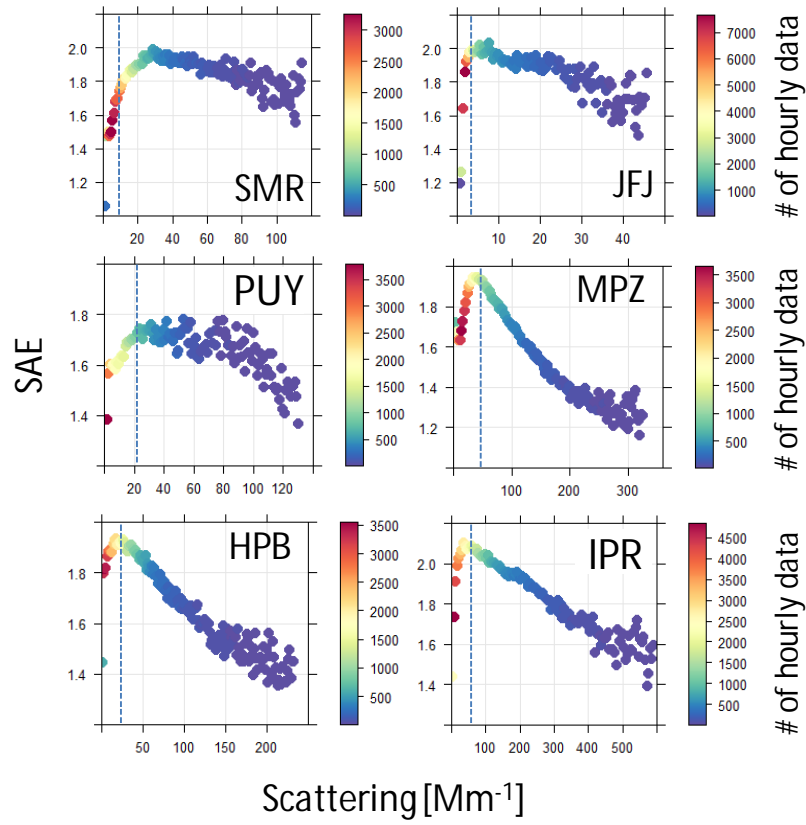
**Table S7:** Statistics of the backscatter fraction (calculated for the wavelengths reported in Table S2). Statistics are reported for the whole period available at each station. The reported BF values were calculated for  $\sigma_{sp} > 0.8 \text{ Mm}^{-1}$ .

	mean	SD	min	max	5th pc	25th pc	50th pc	75th pc	95th pc	skewness
<b><i>Arctic</i></b>										
ZEP	0.130	0.019	0.056	0.422	0.103	0.117	0.129	0.142	0.159	0.84
PAL	0.132	0.038	0.013	0.645	0.089	0.111	0.125	0.145	0.189	2.76
<b><i>Antarctic</i></b>										
TRO	0.107	0.029	0.080	0.388	0.088	0.094	0.099	0.109	0.149	4.81
<b><i>Mountain</i></b>										
PUY	0.135	0.024	0.037	0.489	0.100	0.120	0.133	0.148	0.172	7.19
IZO	0.121	0.020	0.028	0.645	0.098	0.108	0.116	0.131	0.159	2.17
MSA	0.140	0.048	0.023	0.489	0.093	0.115	0.131	0.151	0.224	2.90
JFJ	0.104	0.034	0.039	0.488	0.069	0.081	0.096	0.118	0.156	3.24
CMN	0.173	0.026	0.054	0.440	0.135	0.155	0.171	0.188	0.213	1.05
HPB	0.121	0.023	0.032	0.418	0.085	0.105	0.120	0.135	0.159	0.52
BEO	0.152	0.035	0.073	0.975	0.114	0.133	0.147	0.163	0.199	5.66
CHC	0.157	0.040	0.037	0.421	0.093	0.132	0.156	0.180	0.222	1.56
<b><i>Coastal</i></b>										
PLA	0.105	0.014	0.082	0.179	0.087	0.094	0.104	0.113	0.128	0.89
MHD	0.108	0.023	0.004	0.970	0.083	0.097	0.105	0.116	0.140	7.10
<b><i>Regional/rural</i></b>										
BIR	0.128	0.023	0.050	0.467	0.097	0.111	0.125	0.141	0.167	1.36
SMR	0.149	0.027	0.069	0.490	0.109	0.129	0.147	0.166	0.195	0.55
OPE	0.149	0.086	0.049	0.998	0.093	0.111	0.129	0.154	0.266	4.98
CBW	0.139	0.030	0.067	0.292	0.095	0.115	0.136	0.160	0.192	0.48
MSY	0.129	0.028	0.013	0.763	0.095	0.114	0.127	0.141	0.169	3.05
KOS	0.141	0.026	0.086	0.422	0.102	0.121	0.140	0.158	0.185	0.48
MPZ	0.150	0.031	0.025	0.477	0.107	0.127	0.148	0.170	0.200	1.10
IPR	0.136	0.025	0.055	0.368	0.099	0.118	0.135	0.153	0.174	0.85
KPS	0.131	0.021	0.075	0.293	0.098	0.116	0.130	0.145	0.168	0.40
<b><i>Urban/sub-urban</i></b>										
MAD	0.160	0.036	0.049	0.417	0.114	0.135	0.157	0.178	0.211	1.84
UGR	0.147	0.021	0.015	0.558	0.115	0.134	0.148	0.161	0.178	1.01
DEM	0.109	0.040	0.029	0.960	0.063	0.088	0.105	0.122	0.166	4.11

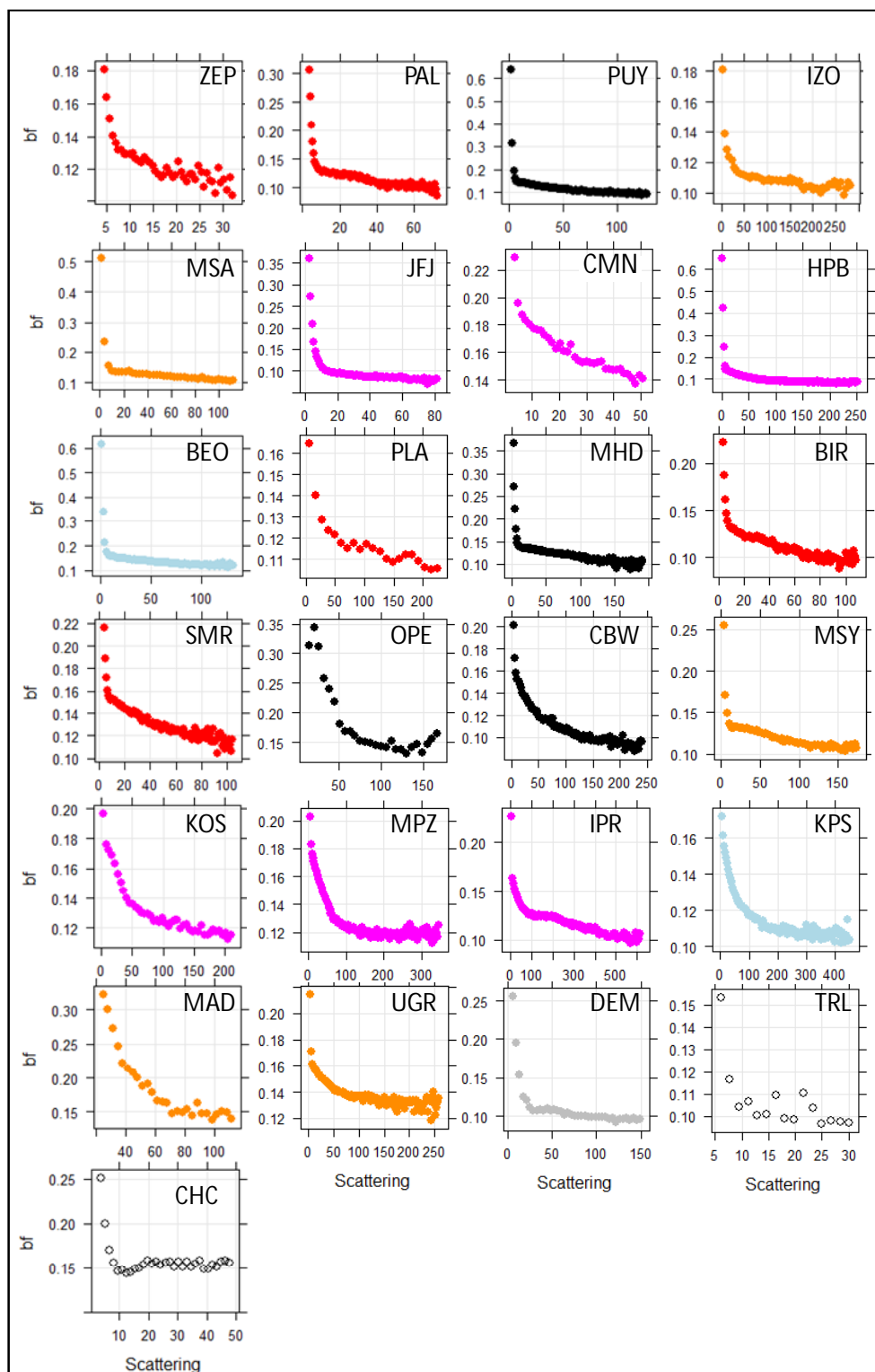




**Figure S8:** Seasonal cycles of  $\sigma_{sp}$  [Mm<sup>-1</sup>], SAE and  $g$  at TRL and CHC.



**Figure S9:** Relationships between SAE and scattering at some of the stations involved in this work. Points are colored by the number of samples in each bin. Dashed lines represent median  $\sigma_{sp}$  values at each station.



**Figure S10:** Scatterplots between scattering (x-axes) and backscatter fraction (bf; y-axes). Different colors highlight different geographical locations as in Fig.S6.

**Table S8:** Magnitude, p-value and total reduction (TR) of the trends of aerosol particle scattering coefficient ( $\sigma_{ap}$ ), scattering Ångström exponent (SAE), and backscatter fraction (BF). Trend results are reported for the whole period available at each station until 2015 (**bold**) and for the periods considered in Collaud Coen et al. (2013) and in Asmi et al. (2013) (Cf. Table 2). Trends are considered as statistically significant if p-value < 0.05. Statistically significant increasing or decreasing trends are highlighted with red and green colour, respectively. Non-statistically significant increasing or decreasing trends are highlighted with grey colour. \$: parameters removed in this work or in the work from Collaud Coen et al. (2013) because of measurement gaps, low data coverage or break points for one or more wavelengths. #: Only available for the period 2014-2015; ± not available. xx: available from 2008.

Station	period	$\sigma_{ap}$		SAE						BF	
		Magnitude ( $Mm^{-1}/year$ ) [p-value]	TR (%)	Magnitude ( $year^{-1}$ ) [p-value]	TR (%)	b-g Magnitude ( $year^{-1}$ ) [p-value]	TR (%)	g-r Magnitude ( $year^{-1}$ ) [p-value]	TR (%)	Magnitude ( $year^{-1}$ ) [p-value]	TR (%)
PAL	2000 - 2015	+0.017 [-0.067,0.120] p>0.05	+4.4	-0.019 [-0.029,-0.009] p<0.001	-17.3	-0.007 [-0.015,0.003] p>0.05	+6.6	-0.028 [-0.040,-0.015] p<0.001	-24.1	+0.0007 [0.0003,0.0013] P<0.001	+9.9
	2000 - 2010	-0.225 [-0.362,-0.094] p<0.001	-33.9	-0.042 [-0.062,-0.026] P<0.001	-24.7	\$	\$	\$	\$	+0.001 [0.0.002] p>0.05	+7.6
	2001 - 2010	-0.149 [-0.333,+0.009] p>0.05	-24.7	-0.049 [-0.076,-0.032] P<0.001	-26.6	\$	\$	\$	\$	+0.001 [0.0.002] p>0.05	+7.8
SMR	2006 - 2015	-0.588 [-0.962,-0.256] p<0.001	-30.3	+0.008 [-0.004,0.018] p>0.05	+4.7	+0.012 [0.001,0.021] P<0.05	+7.1	+0.004 [-0.008,0.017] p>0.05	+2.4	+0.0012 [0.0006,0.0019] p<0.001	+8.6
MHD	2001 - 2013	-0.063 [-0.392,0.337] p>0.05	-2.9	\$	\$	\$	\$	\$	\$	\$	\$
	2001 - 2010	+0.056 [-0.601,0.603] p>0.05	+2.0	\$	\$	\$	\$	\$	\$	\$	\$
PUY	2007 - 2014	-0.291 [-0.793,0.242] p>0.05	-13.0	-0.031 [-0.050,-0.013] p<0.001	-14.9	-0.022 [-0.040,-0.006] P<0.05	-9.4	-0.022 [-0.043,-0.0003] P<0.05	-10.7	+0.0013 [0.0003,0.0022] P<0.01	+8.7
HPB	2006 - 2015	-1.376 [-2.007,-0.753] p<0.01	-38.0	+0.0098 [0.0014,0.0181] p<0.05	+5.5	+0.0075 [0.0005,0.0146] p<0.05	+4.3	+0.0104 [0.0.0191] p>0.05	+5.8	+0.0007 [0.0002,0.0013] p<0.05	+6.0
IPR	2004 - 2014	-5.357 [-7.034,-4.024] p<0.001	-48.0	+0.0058 [0.0004,0.0118] p>0.05	+3.3	0.0003 [-0.0061,0.0086] p>0.05	+0.2	+0.0079 [0.0004,0.0160] p>0.05	+4.2	+0.0009 [0.0003,0.0016] P<0.05	+7.7
MPZ	2007 - 2015	-0.257 [-1.635,1.201] p>0.05	-4.3	-0.0001 [-0.0068,0.0062] p>0.05	-0.1	-0.0039 [-0.0111,0.0029] p>0.05	-2.0	-0.0004 [-0.0084,0.0065] p>0.05	-2.2	0.0009 [-0.0005,0.0023] p>0.05	+5.2
JFJ	1995 - 2015	-0.032 [-0.090,0.023] p>0.05	-10.2	\$	\$	\$	\$	\$	\$	\$	\$
	1995 - 2010	0.076 [-0.009,0.1749] p>0.05	+20.9	\$	\$	\$	\$	\$	\$	\$	\$
	1996 - 2010	0.083 [-0.005,0.1732] p>0.05	+21.8	\$	\$	\$	\$	\$	\$	\$	\$
CMN	2001 - 2010	-0.168 [-0.357,0.016] p>0.05	-21.4	\$	\$	\$	\$	\$	\$	\$	\$
	1997 - 2010	0.056 [-0.037,0.1522] p>0.05	+12.8	\$	\$	\$	\$	\$	\$	\$	\$
	2007 - 2015	-0.481 [-1.136,0.508] p>0.05	-21.6	#	#	#	#	#	#	#	#
BEO	2007 - 2015	-0.093 [-0.055,0.396] p>0.05	-4.9	-0.0474 [-0.0675,-0.0286] p<0.001	-22.0	-0.0201 [-0.0376,-0.0052] P<0.05	-9.7	-0.0688 [-0.914,-0.0484] P<0.001	-31.6	-0.0001 [-0.001,0.002] p>0.05	-0.2
KPS	2006 - 2014	+0.623 [-0.479,1.791] p>0.05	+8.7	-0.0034 [-0.0121,0.0076] p>0.05	-1.5	-0.0155 [-0.0228,-0.0072] P<0.001	-7.1	+0.0069 [-0.0055,0.019] p>0.05	+2.9	+0.0001 [-0.0003,0.0007] p>0.05	+0.9
IZO	2008 - 2015	-2.252 [-3.850,-0.856] p<0.01	-59.6	+0.0198 [-0.0063,0.0476] p>0.05	+22.0	+0.0048 [-0.0220,0.0325] p>0.05	+5.1	+0.0229 [0.0.0561] p>0.05	+25.4	\$	\$
UGR	2006 - 2015	-1.951 [-2.886,-1.141] p<0.001	-32.0	+0.0216 [0.0078,0.0358] p<0.001	+14.1	+0.0105 [-0.0003,0.016] p>0.05	+6.7	+0.0305 [0.0135,0.0452] p<0.001	+20.1	+0.0028 [0.0023,0.0033] p<0.001	+21.1

**Table S9:** Magnitude and p-value for the trends of aerosol particle scattering coefficient and PM<sub>10</sub> and/or PM<sub>2.5</sub> concentrations (PM mass concentration from www.ebas.nilu.no). Trend results are reported for common period at each station. Trends are considered as statistically significant if p-value < 0.05. Statistically significant decreasing trends are highlighted with green colour. Non statistically significant trends are highlighted with grey colour. NA: Not available for the considered period.

Station	period	Aerosol particle scattering coefficient		PM <sub>10</sub>		PM <sub>2.5</sub>	
		Magnitude [Mm <sup>-1</sup> /year] p-value	TR (%)	Magnitude [µgm <sup>-3</sup> /year] p-value	TR (%)	Magnitude [µgm <sup>-3</sup> /year] p-value	TR (%)
SMR	2006 - 2012	-0.498 [-1.119,0.150] p>0.05	-18.6	+0.023 [-0.198,0.256] p>0.05	+3.0	-0.069 [-0.238,0.096] p>0.05	-9.8
IPR	2004 - 2014	-5.357 [-7.034,-4.024] p<0.001	-48.0	NA	NA	-1.158 [-1.435,-0.919] p<0.001	-47.4
MPZ	2007 - 2014	+0.803 [-0.958,2.254] p>0.05	+12.4	+0.311 [-0.054,0.699] p>0.05	+12.0	+0.313 [-0.036,0.706] p>0.05	+15.0
JFJ	2006-2014	-0.116 [-0.294,-0.027] p<0.05	-20.7	-0.101 [-0.185,-0.038] p<0.01	-30.1	NA	NA