



*Supplement of*

**Examining the characteristics of aerosols: a statistical analysis  
based on a decade of lidar and photometer observations  
at the Eastern border of ACTRIS**

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## S1 related to Section 3.1 of the manuscript

Table S1: Detailed description of dominant aerosol types from photometer data

Aerosol Type	Angstrom Exponent Threshold	Aerosol Optical Depth Threshold	Physical interpretation	Notes
Urban/Industrial	$AE > 1.52$	$0.2 < AOD < 0.4$	Dominated by fine anthropogenic particles such as combustion emissions, traffic/industrial sources, and secondary aerosols	Most common in urbanized or industrial regions; often dominating during stagnant winter conditions and temperature inversions
Continental	$AE > 1.2$	$AOD < 0.2$	Aged, regionally transported fine-mode aerosols originating from mixed anthropogenic and biogenic sources	Represents the persistent baseline background in most continental regions
Dust	$AE < 1.15$	$AOD > 0.2$	Mineral dust, typically from Saharan or local resuspension processes	AE for “pure dust” can fall $< 0.5$ near source, but transported dust often shows higher AE due to mixing with fine-mode particles
Marine	$AE < 1.2$	$AOD < 0.2$	Optically coarse-mode particles resembling maritime aerosols (sea salt)	In continental regions, this class often reflects generic coarse-mode aerosols (weak dust, humidified particles), not necessarily true marine air masses
Mixed	$1.15 < AE < 1.52$	$AOD > 0.2$	<i>Overlapping contributions of both fine and coarse modes; optically heterogeneous column</i>	Common during transitions, high-AOD events, or multilayer structures (e.g., dust above pollution)
Biomass Burning	$AE > 1.52$	$AOD > 0.4$	<i>Fine-mode smoke from wildfires, agricultural burning, or regional biomass burning episodes</i>	More common in late summer/early autumn depending on region; may overlap with Continental fine-mode regime

Table S2: Monthly count of dominant aerosol types as identified from photometer data (the number represents the total number of points classified as a certain aerosol type)

Month	Biomass	Continental	Dust	Marine	Mixed	Urban/Industrial
1	9	3885	222	372	246	441
2	74	3234	622	396	239	775
3	492	3061	449	351	574	1723
4	143	4612	911	1100	666	1933
5	48	4550	911	1629	1208	970
6	333	3141	1391	404	1354	3362
7	1849	5415	1900	278	1731	6522
8	1646	5945	771	432	3098	6806
9	433	4451	747	1339	1693	2634
10	281	5115	544	1423	617	1492
11	55	2903	225	978	369	292
12	6	2293	14	384	105	349

Table S3: Seasonal count of dominant aerosol types as identified from photometer data (the number represents the total number of points classified as a certain aerosol type)

Season	Biomass	Continental	Dust	Marine	Mixed	Urban/Industrial
DJF	89	9412	858	1152	590	1565
JJA	3828	14501	4062	1114	6183	16690
MAM	683	12223	2271	3080	2448	4626
SON	769	12469	1516	3740	2679	4418

Table S4: Yearly count of dominant aerosol types as identified from photometer data (the number represents the total number of points classified as a certain aerosol type)

Year	Bio-mass	Conti-nental	Dust	Marine	Mixed	Ur-ban/In-dustrial
2015	679	1820	194	169	343	1507
2016	617	3133	815	352	607	2406
2017	509	4125	802	310	962	2182
2018	415	1726	765	738	1250	1608
2019	460	3940	180	644	1873	3252
2020	731	10794	912	1234	956	5161
2021	831	8802	2675	1354	2336	4870
2022	550	8108	1203	1526	1672	3381
2023	577	4963	951	1810	1610	2669
2024	0	1194	210	949	291	263

**S2 related to Section 3.3 of the manuscript**

*Table S5: Distribution by season in the entire air column of the regions with sources associated with the types of aerosols observed in the lidar and photometer measurements as identified with FLEXPART for the analyzed period*

	North Africa	Middle East	Mixed	North America	Sahara	Siberia	Europe
Winter	0.20%	0.00%	0.57%	0.00%	0.29%	0.00%	6.29%
Spring	1.24%	0.29%	7.72%	0.48%	2.19%	0.19%	22.97%
Summer	1.62%	1.24%	3.24%	2.29%	0.76%	0.48%	35.18%
Autumn	0.48%	0.19%	1.81%	0.29%	0.38%	0.48%	9.15%
Total	3.53%	1.72%	13.35%	3.05%	3.62%	1.14%	73.59%

*Table S6: Distribution by season in LT of the regions with sources associated with the types of aerosols observed in the lidar and photometer measurements as identified with FLEXPART for the analysed period.*

	North Africa	Middle East	Mixed	North America	Sahara	Siberia	Europe
Winter	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	1.72%
Spring	0.10%	0.00%	0.19%	0.00%	0.00%	0.00%	4.96%
Summer	0.00%	0.10%	0.76%	0.00%	0.00%	0.10%	17.16%
Autumn	0.10%	0.00%	0.10%	0.00%	0.19%	0.00%	1.62%
Total	0.29%	0.10%	1.05%	0.00%	0.19%	0.10%	25.45%

*Table S7: Distribution by season in HT of the regions with sources associated with the types of aerosols observed in the lidar and photometer measurements as identified with FLEXPART for the analyzed period*

	North Africa	Middle East	Mixed	North America	Sahara	Siberia	Europe
Winter	0.10%	0.00%	0.57%	0.00%	0.29%	0.00%	4.58%
Spring	1.14%	0.29%	7.53%	0.48%	2.19%	0.19%	18.02%
Summer	1.62%	1.14%	2.48%	2.29%	0.76%	0.38%	18.02%
Autumn	0.38%	0.19%	1.72%	0.29%	0.19%	0.48%	7.53%
Total	3.24%	1.62%	12.30%	3.05%	3.43%	1.05%	48.14%