Figure S1: Maps of the average dust mass density (kg m^{-2}) based on reanalysis data of MERRA-2. The analysis was focused in up to three days from the sampling period around the area of the sampling site (the blue marker). Darker shades represent higher amount of suspended dust. The maps, combined with the air mass backtrajectory analysis, used to trace the potential source of the dust storm, marked by the green arrows (see also green symbols in Figure 1 in the main text). The data was derived from the Giovanni website (http://giovanni.sci.gsfc.nasa.gov/giovanni).

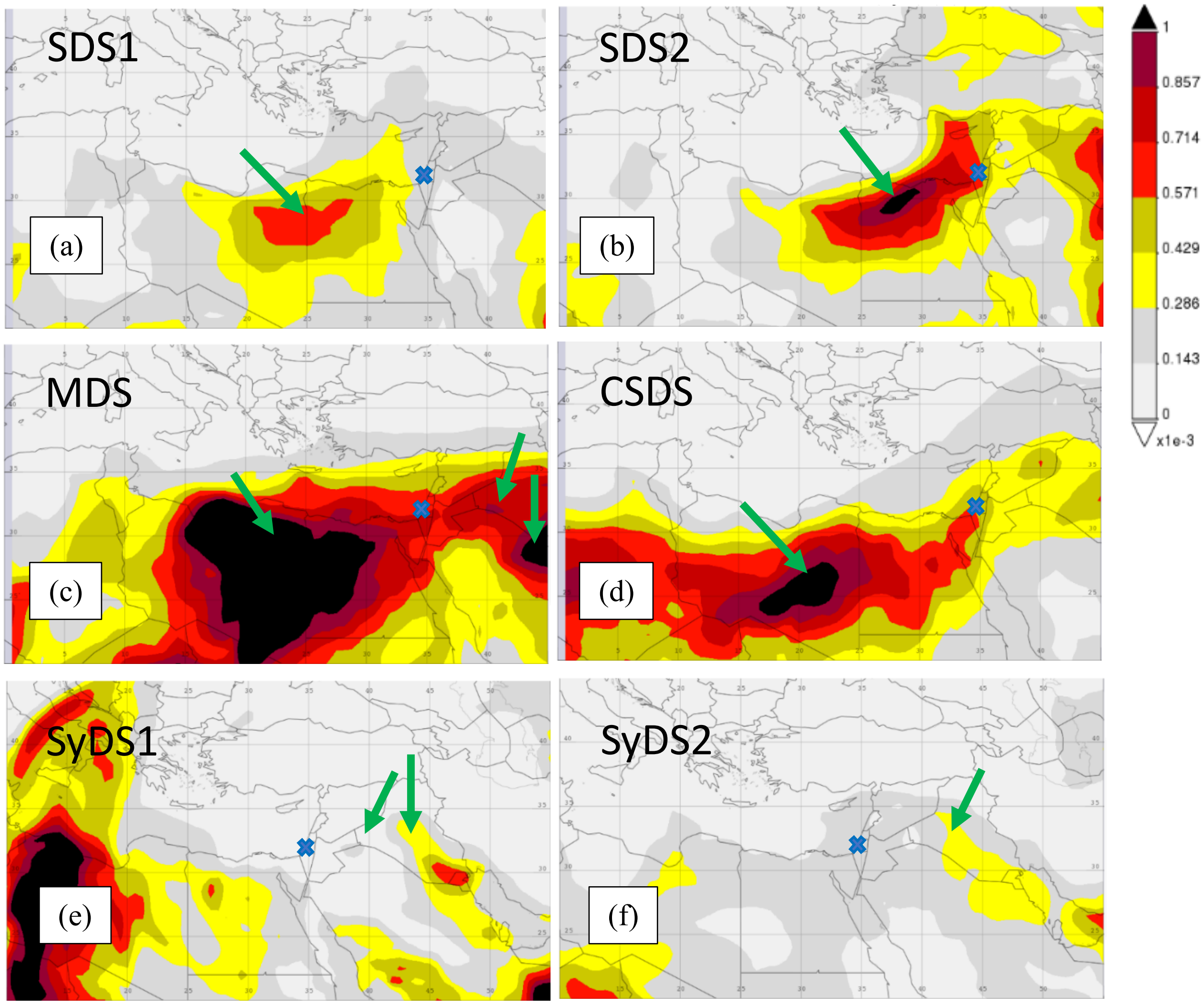

Figure S2: Analysis of dust sources for cases where the observed suspended dust mass from MERRA did not overlap with the back trajectories analysis. Panel (a) shows air mass backward analysis for the MDS event (similarly to Figure 2) and a satellite image from "zoom earth" taken on 11 April 2017 AM, the day before the sampling started, and a dust plume over the Red Sea. Panel (b) shows the backward trajectory for CSDS and Satellite image from "zoom earth" taken on 26 April 2016 AM, the day before the sampling started, and a dust plume over the Eastern Mediterranean.

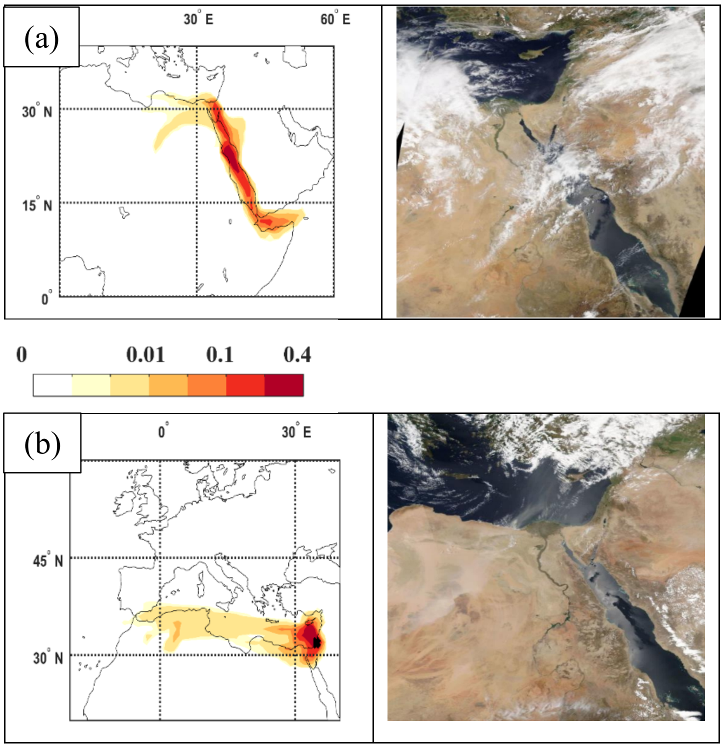

Figure S3: **Super-aggregates particles covered the 0.3 µm filter collected during SyDS2. EDX analysis showed that the particles were rich with potassium.**

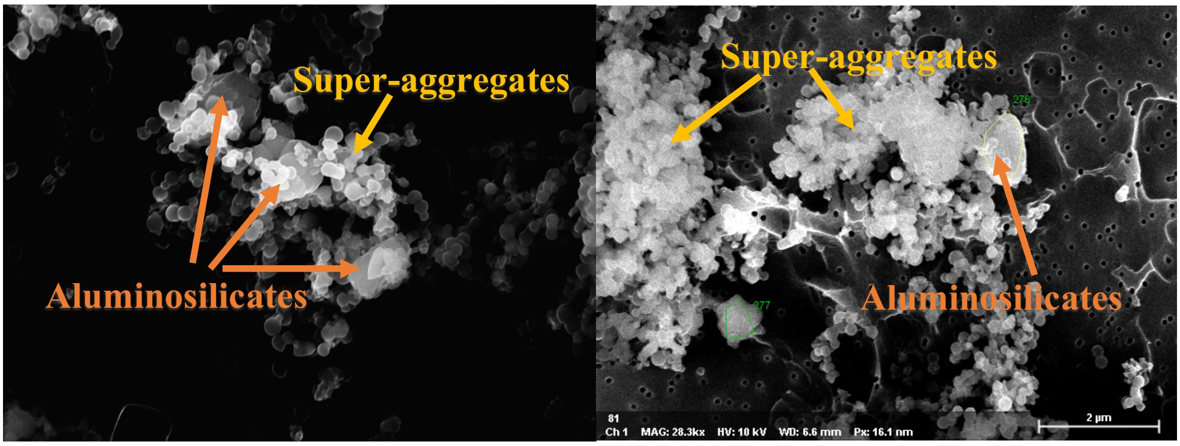

Figure S4: Representative SEM micrographs of a filter that was collected in SDS1 event. The different color shading represents the different chemical elements that were indicated by EDX analysis. The filter was covered by particles with a common occurrence of Si and Al, suggesting that mineral dust was dominated. Some mineral dust particles were also rich in Ca and Mg, while S, Fe and K were mostly concentrated in specific particles. Occurrence of NaCl particles was also observed based on the coexistence of Na and Cl in the same particles.

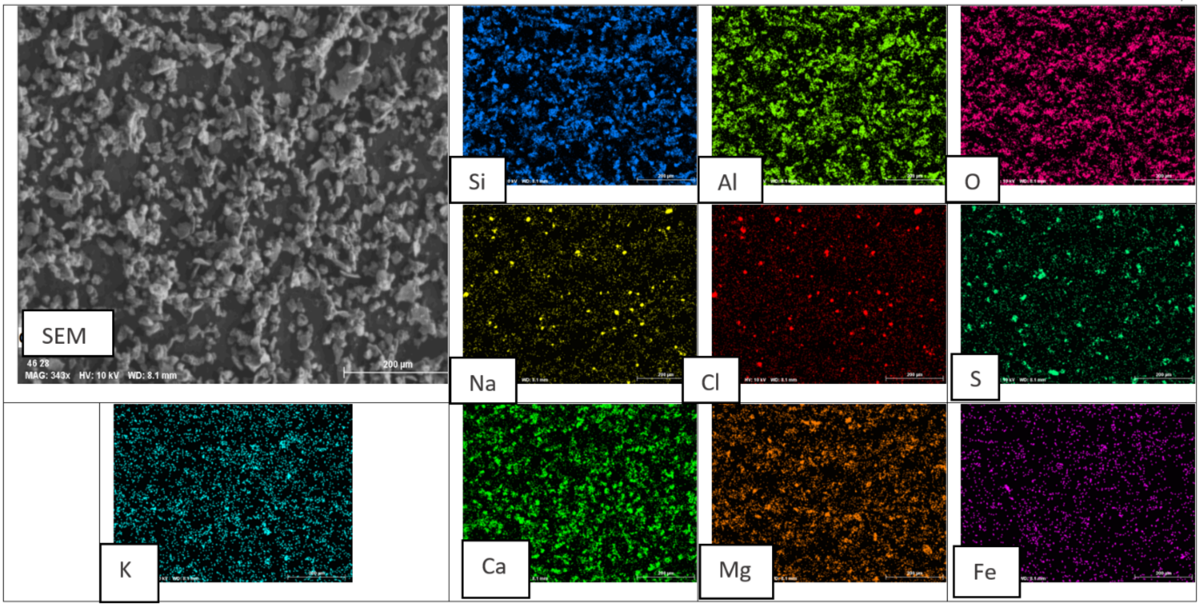

Table S1: The expected percentage range of the chosen minerals in airborne particles. The values are based on values from Atkinson et al. (2013) and Boose et al. (2016) of transported mineral dust.

Mineral	Atkinson et al. (2013)	Boose et al. (2016)	Used in this study
K-feldspar	1 – 25 %	2.4 - 5.7 %	1 - 25%
Na/Ca-feldspar	0.8 – 13.8 %	3.1 – 7.6 %	0.8 – 13.8%
Quartz	7 – 67 %	13.6 – 24.1	7 – 67%

Figure S5: Average cumulative concentrations (*K(T)*) of the background impurities (grey data; blank filter) in the (a) BINARY and (b) WISDOM setups compared to the averaged cumulative ice nuclei concentrations obtained from the airborne samples for the different size-classes (purple and yellow data).

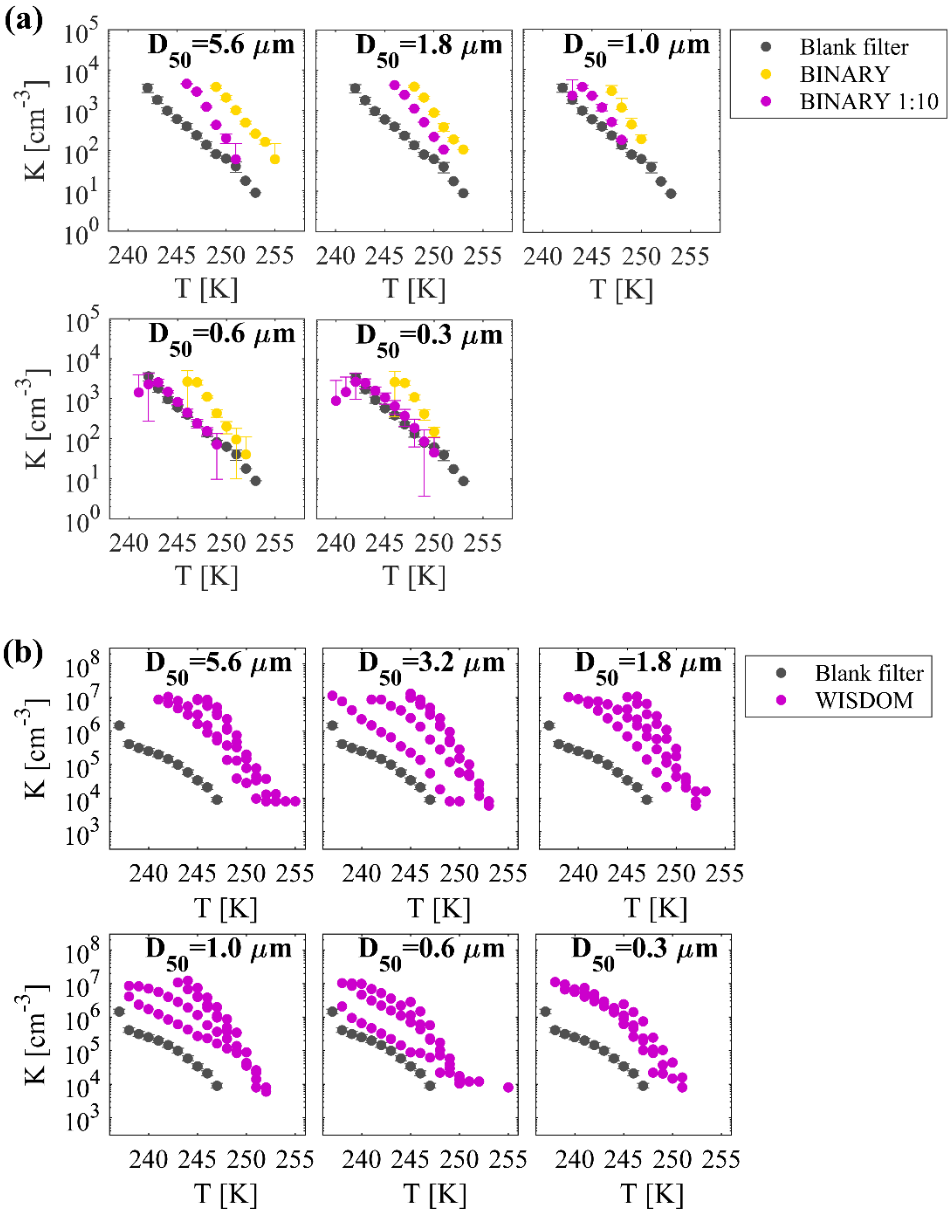

Table S2. Parameterization coefficients (95% confidence bounds) for each size class of each event, for the relation: $n_s(T) = exp[y_0 + a/(\mathrm{b} + \exp[(T-248)/c])]\ [m^{-2}]$.

	D_{50} [µm]	coefficients	R^2	Valid T range [K]
Supermicron class dusty atmosphere	5.6	yo = 10.98 (10.86, 11.11) a =28.63 (22.66, 34.59) b = 1.424 (0.9445, 1.904) c = 5.815 (4.736, 6.893)	0.96	[242,255]
	3.2	yo = 10.99 (10.9,11.08) a = 36.65 (32.97, 40.32) b =2.533 (2.214, 2.851) c = 3.234 (2.941, 3.527)	0.985	[242,253]
	1.8	yo =10.99 (10.9, 11.08) a = 36.65 (32.97, 40.32) b =2.533 (2.214, 2.851) c = 3.234 (2.941, 3.527)	0.985	[241,253]
	1.0	yo =10.97 (9.843, 12.09) a =26.69 (21.55, 31.82) b = 1.895 (1.407, 2.383) c =3.417 (2.601, 4.234)	0.883	[238,252]
Submicron class dusty atmosphere	0.6	yo =2 15.79 (14.84, 16.75) a = 6.229 (3.368, 9.089) b =0.7726 (0.5114, 1.034) c =2.09 (1.477, 2.703)	0.932	[238,255]
	0.3	yo = 15.46 (12.94, 17.98) a =5.148 (-1.583, 11.88) b =0.7357 (0.06841, 1.403) c =2.016 (0.8725, 3.161)	0.862	[238,251]