



Supplement of

Optical properties and shape-dependent retrievals of the imaginary part of the refractive index of freshly emitted Saharan dust

Jesús Yus-Díez et al.

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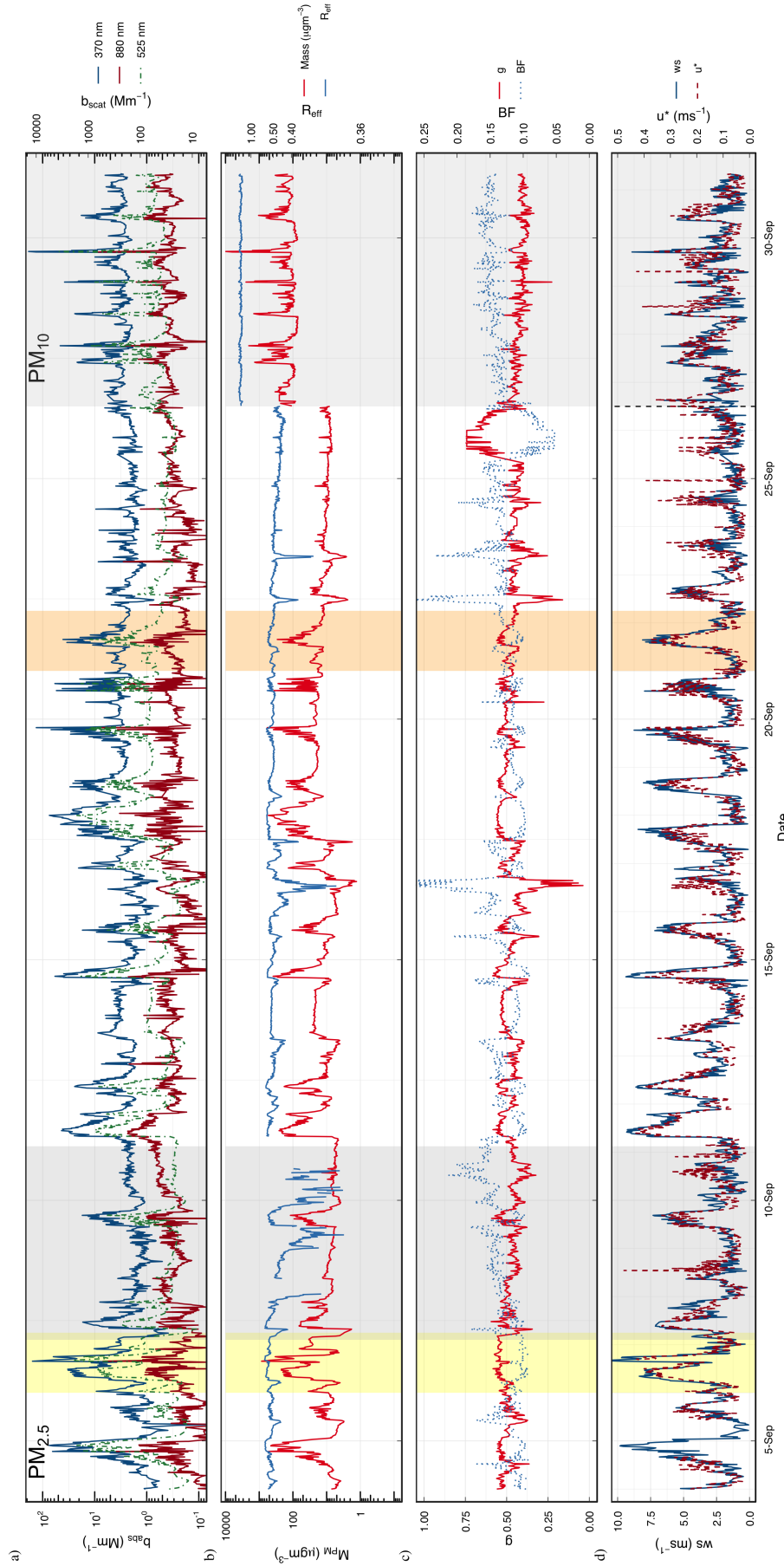


Figure S1: Time evolution during the FRAGMENT-Morocco campaign of 15 min averages of: (a) absorption coefficients at 370 and 880 nm and corrected scattering at 525 nm; (b) mass concentration and particle effective radius; (c) asymmetry parameter, g , and backscatter fraction, BF; and (d) wind speed and friction velocity, u_* . From 4 September to 26 September, the optical instruments sampled through a PM_{2.5} inlet, whereas from 26 September onward they sampled through a PM₁₀ inlet, as indicated by the labels and shaded background. Periods A, B, and C are marked by the orange, yellow, and grey shading, respectively.

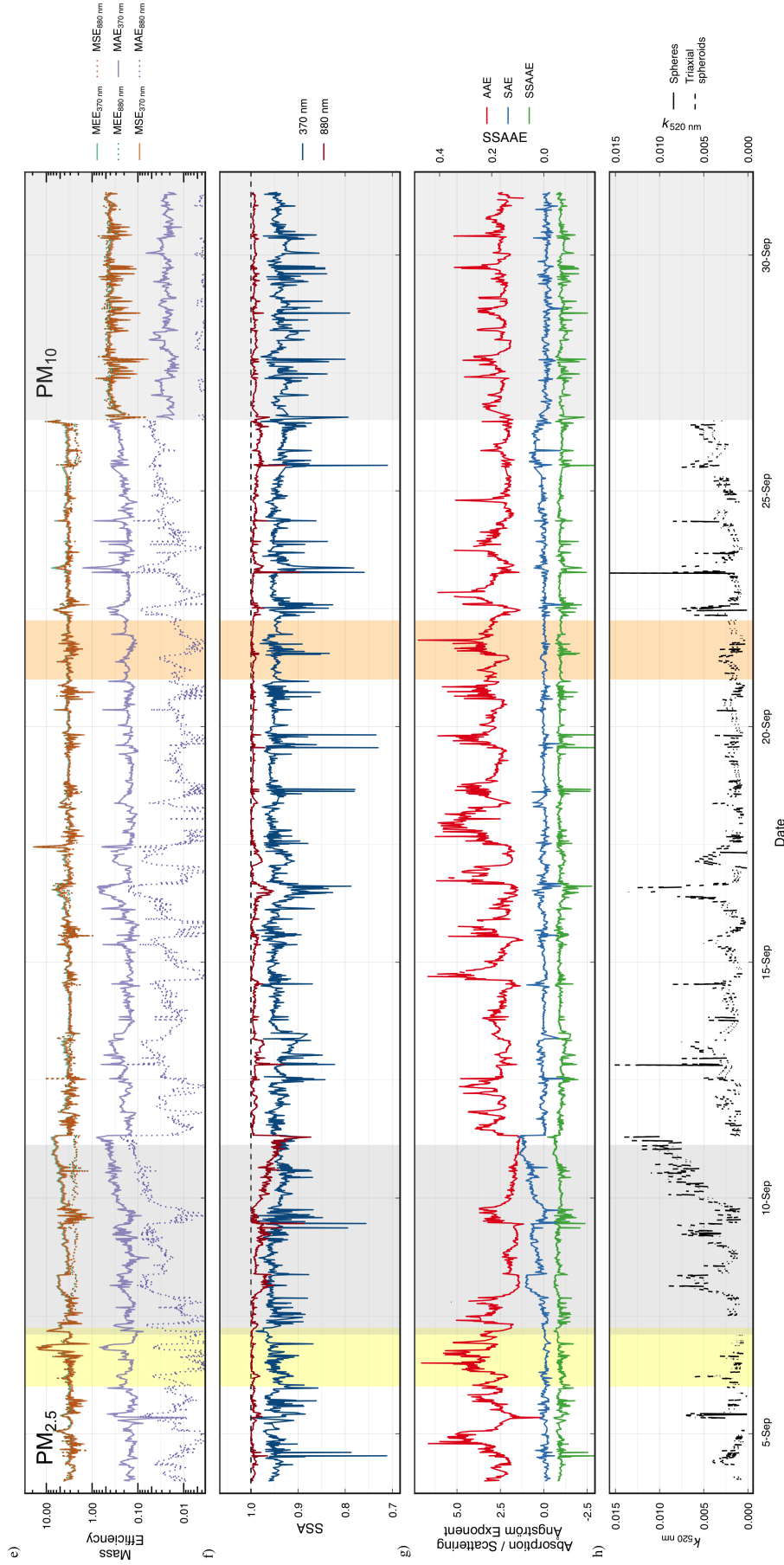


Figure S1: [Continuation:] Time evolution during the FRAGMENT-Morocco campaign of 15 min averages of: (e) mass absorption, scattering, and extinction efficiencies (MAE, MSE, and MEE); (f) single scattering albedo (SSA) at 370 and 880 nm; (g) absorption, scattering, extinction, and SSA Ångström exponents (AAE, SAE, and SSAE); and (h) the conditionally retrieved imaginary part of the complex refractive index, (k), for spheres and triaxial ellipsoids under the central assumptions described in Sect. 2.6.

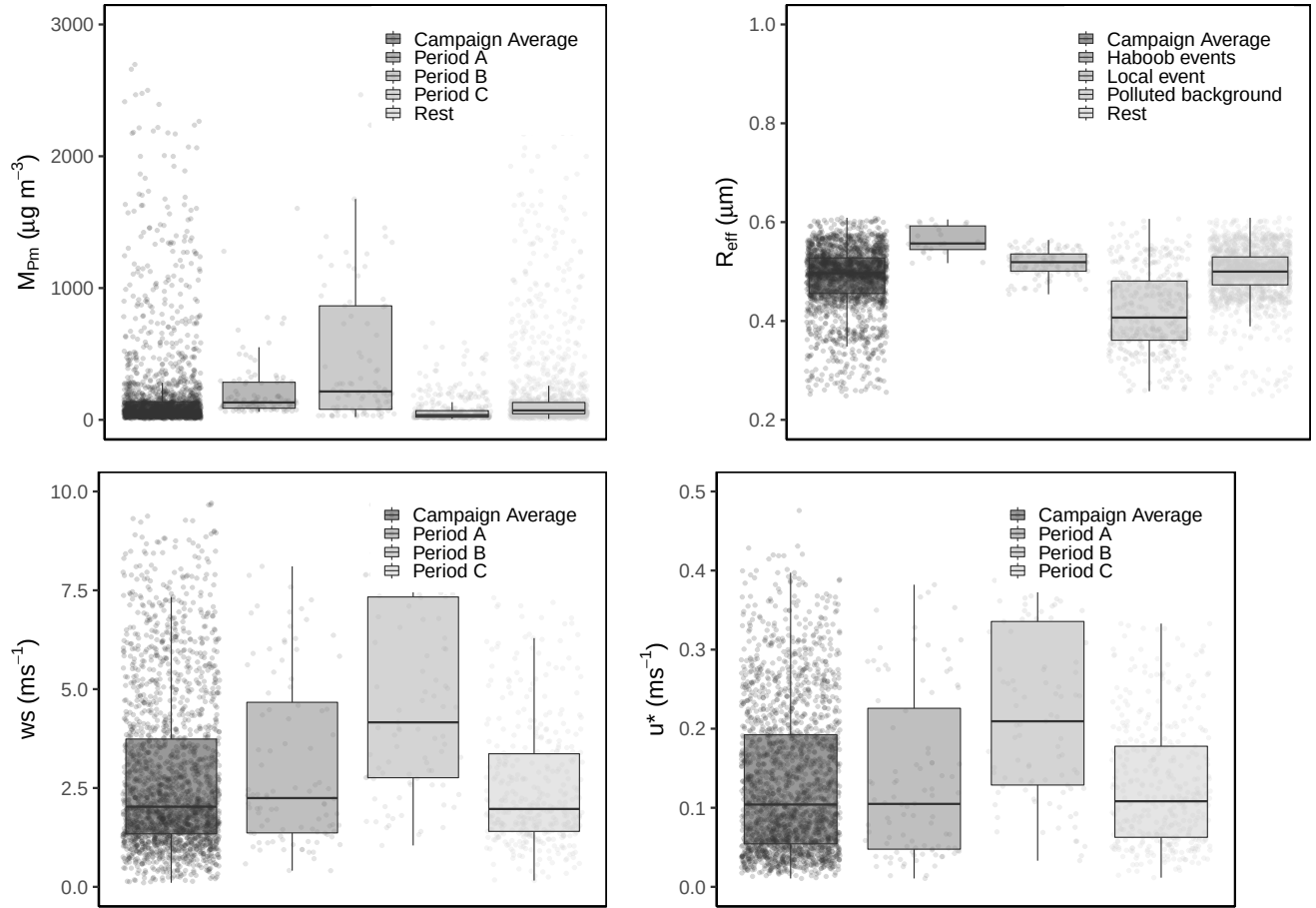


Figure S2: Mass concentration (M_{PM}) and effective radius (R_{eff}) for the selected representative periods, retrieved from the FIDAS particle number size distribution, together with wind speed (ws) and friction velocity (u_*) measured with the 3D windsonic anemometers.

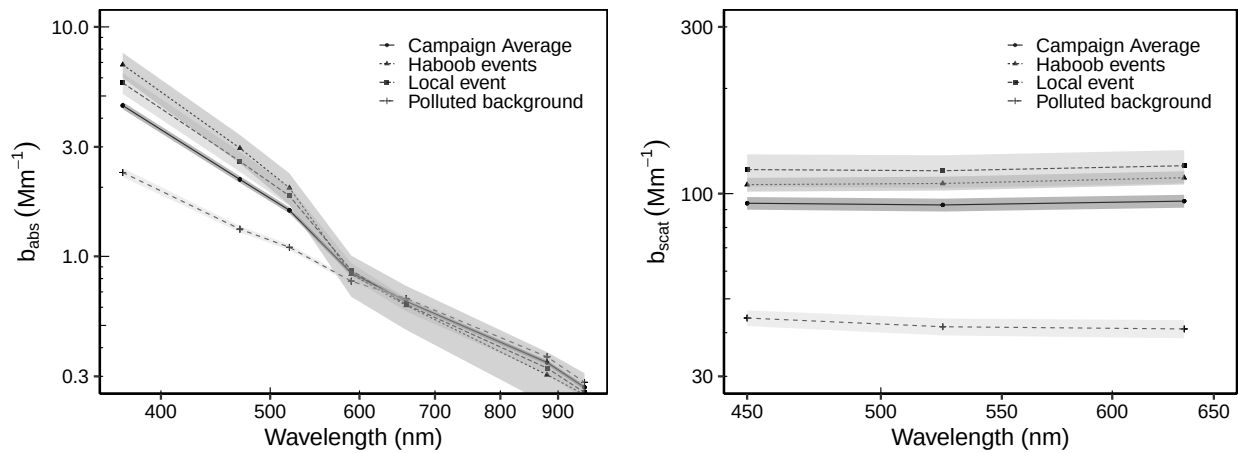


Figure S3: Extensive optical measurements for the selected representative periods: absorption coefficients (b_{abs}) at the 7 AE33 measuring wavelengths (370, 470, 520, 590, 660, 880, 950 nm), b) corrected scattering coefficients (b_{scat}) at the 3 wavelengths (450, 525, 635 nm) from the polar integrating nephelometer. Symbols represent the mean, whereas the shaded area represents the standard error.

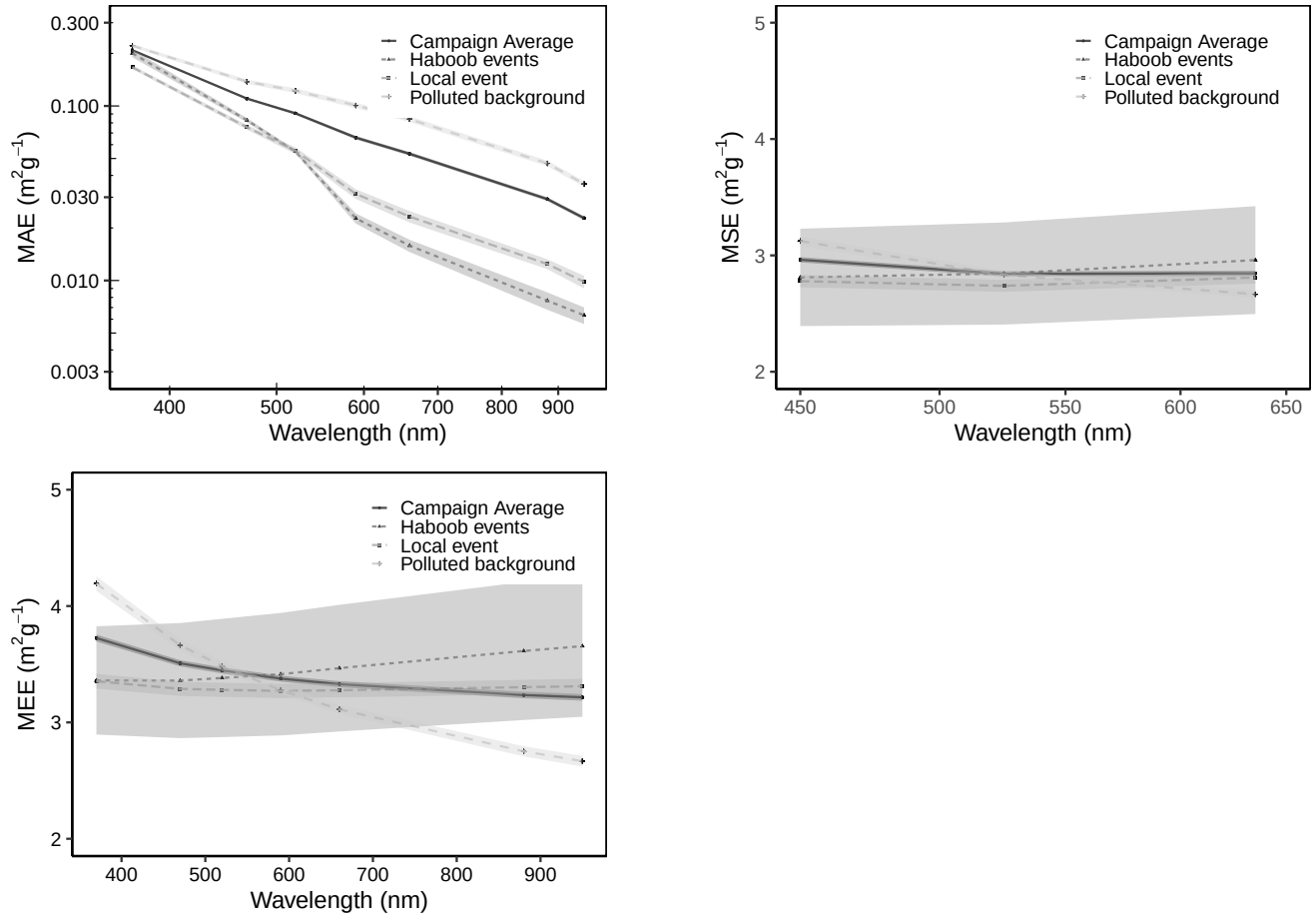


Figure S4: Mass absorption, scattering, and extinction efficiencies for the selected typical event periods: mass absorption efficiency (MAE) at the seven AE33 measuring wavelengths (370, 470, 520, 590, 660, 880, 950 nm), mass scattering efficiency (MSE) at the three nephelometer wavelengths (450, 525, 635 nm), and mass extinction efficiency (MEE) at the seven AE33 measuring wavelengths. Symbols represent the mean, whereas the shaded area represents the standard error.

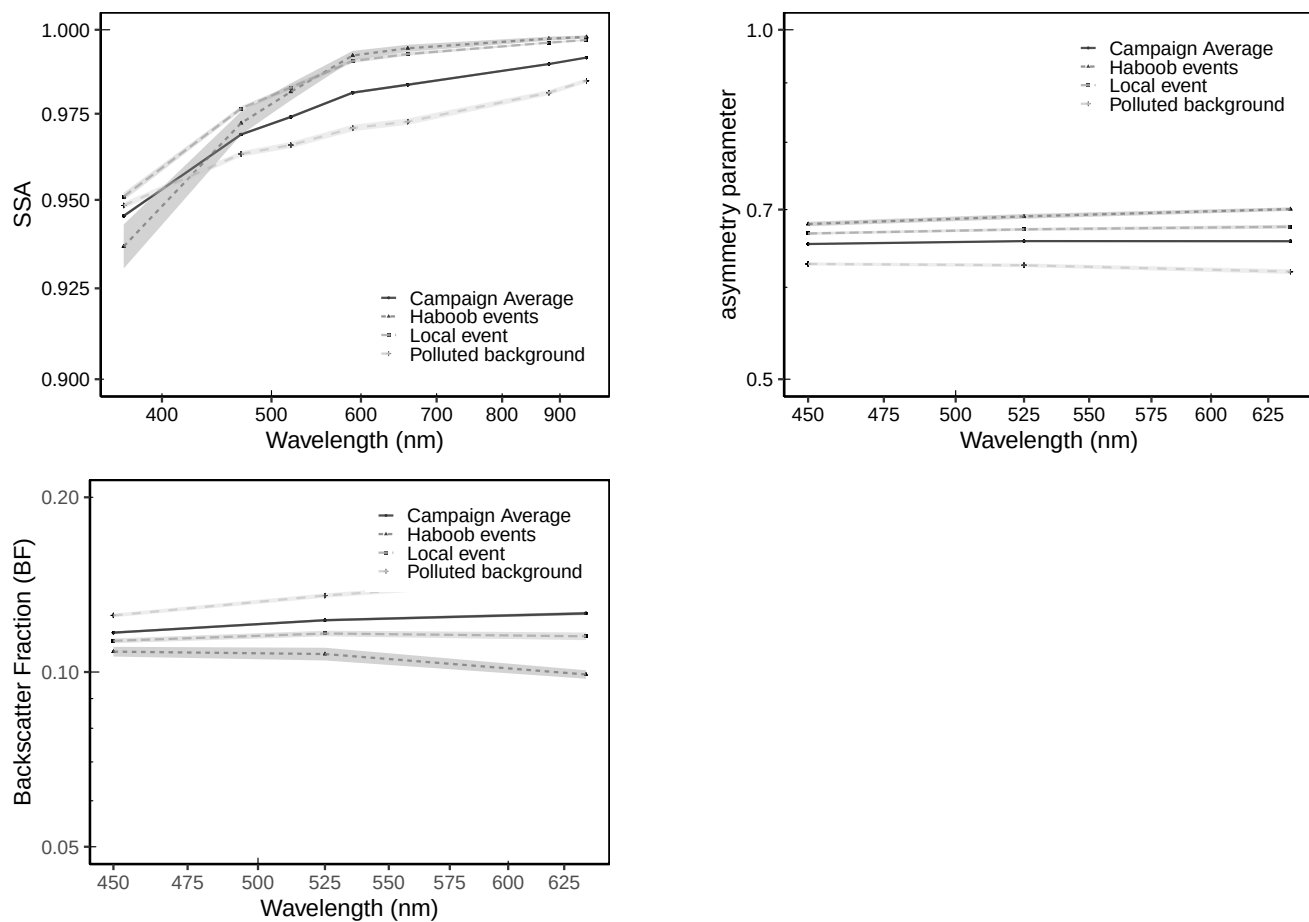


Figure S5: Single scattering albedo, SSA (upper-left panel), asymmetry parameter, g (upper-right panel), and the backscatter fraction, BF (lower panel), for the selected representative periods at the seven AE33 measuring wavelengths. Symbols represent the mean, whereas the shaded area represents the standard error.

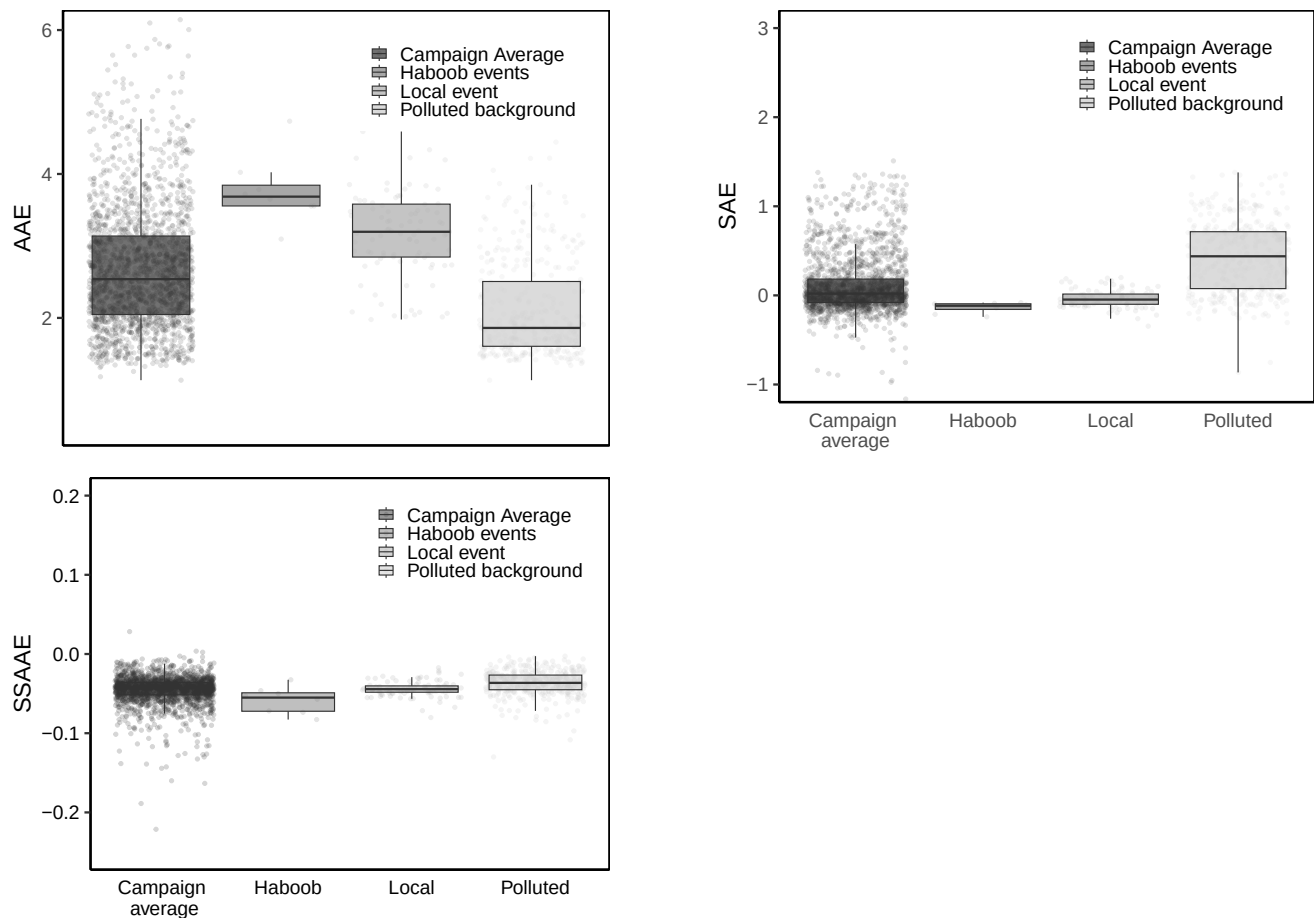


Figure S6: Ångström Exponents for the selected representative periods: absorption Ångström exponent (AAE), scattering Ångström exponent (SAE), and SSA Ångström exponent (SSAAE).

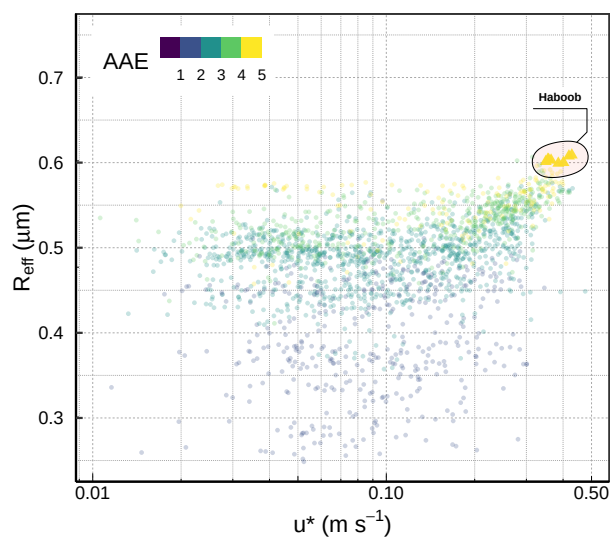


Figure S7: Relationship between the particle effective radius (R_{eff}), wind friction velocity (u_*) and absorption Ångström exponent (AAE). The haboob period is highlighted

Table S1: Imaginary part of the complex refractive index k as in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for **Spheres**. k is retrieved for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.01 (1.36-2.32-3.50)	1.18 (0.74-1.43-2.32)	0.94 (0.54-1.21-2.16)	0.51 (0.20-0.80-1.68)	0.39 (0.10-0.68-1.52)	0.28 (0.10-0.50-1.13)	0.23 (0.10-0.41-0.96)			
1.48	2.15	2.24 (1.50-2.60-3.91)	1.33 (0.82-1.61-2.59)	1.05 (0.61-1.35-2.42)	0.57 (0.22-0.89-1.88)	0.45 (0.12-0.76-1.71)	0.31 (0.10-0.56-1.25)	0.26 (0.10-0.45-1.05)			
1.48	2.50	2.46 (1.64-2.86-4.50)	1.46 (0.91-1.77-2.86)	1.17 (0.68-1.49-2.67)	0.63 (0.24-0.99-2.08)	0.49 (0.14-0.83-1.89)	0.34 (0.10-0.60-1.35)	0.28 (0.10-0.49-1.13)			
1.49	1.80	1.99 (1.34-2.30-3.47)	1.18 (0.72-1.42-2.29)	0.93 (0.54-1.19-2.12)	0.49 (0.20-0.79-1.66)	0.39 (0.10-0.67-1.50)	0.28 (0.10-0.50-1.12)	0.22 (0.10-0.41-0.96)			
1.49	2.15	2.22 (1.48-2.57-3.88)	1.32 (0.82-1.59-2.56)	1.04 (0.60-1.33-2.38)	0.56 (0.22-0.88-1.86)	0.43 (0.12-0.74-1.69)	0.30 (0.10-0.55-1.24)	0.26 (0.10-0.45-1.05)			
1.49	2.50	2.44 (1.63-2.82-4.25)	1.44 (0.90-1.75-2.82)	1.15 (0.66-1.47-2.63)	0.62 (0.24-0.97-2.05)	0.47 (0.14-0.82-1.86)	0.33 (0.10-0.60-1.34)	0.28 (0.10-0.48-1.13)			
1.50	1.80	1.99 (1.33-2.28-3.42)	1.16 (0.72-1.40-2.26)	0.92 (0.53-1.18-2.10)	0.49 (0.20-0.78-1.64)	0.39 (0.10-0.66-1.48)	0.28 (0.10-0.49-1.11)	0.22 (0.10-0.41-0.94)			
1.50	2.15	2.20 (1.47-2.54-3.84)	1.30 (0.80-1.57-2.53)	1.03 (0.60-1.32-2.35)	0.55 (0.22-0.87-1.83)	0.43 (0.12-0.73-1.66)	0.30 (0.10-0.55-1.22)	0.25 (0.10-0.45-1.04)			
1.50	2.50	2.41 (1.61-2.79-4.00)	1.43 (0.88-1.72-2.78)	1.13 (0.66-1.45-2.59)	0.60 (0.24-0.95-2.02)	0.47 (0.12-0.81-1.83)	0.33 (0.10-0.59-1.33)	0.27 (0.10-0.48-1.12)			
1.51	1.80	1.97 (1.32-2.26-3.38)	1.16 (0.72-1.39-2.24)	0.91 (0.52-1.16-2.08)	0.49 (0.20-0.77-1.62)	0.37 (0.10-0.65-1.46)	0.26 (0.10-0.49-1.10)	0.22 (0.10-0.40-0.94)			
1.51	2.15	2.18 (1.46-2.52-3.81)	1.28 (0.80-1.55-2.51)	1.01 (0.58-1.30-2.32)	0.54 (0.22-0.85-1.81)	0.43 (0.12-0.72-1.64)	0.30 (0.10-0.54-1.22)	0.25 (0.10-0.44-1.03)			
1.51	2.50	2.39 (1.60-2.76-4.00)	1.41 (0.88-1.70-2.74)	1.11 (0.64-1.43-2.55)	0.60 (0.24-0.94-1.98)	0.47 (0.12-0.80-1.81)	0.33 (0.10-0.59-1.32)	0.27 (0.10-0.48-1.11)			
1.52	1.80	1.95 (1.31-2.24-3.35)	1.14 (0.70-1.37-2.22)	0.90 (0.52-1.15-2.04)	0.47 (0.18-0.76-1.60)	0.37 (0.10-0.64-1.44)	0.26 (0.10-0.48-1.08)	0.22 (0.10-0.40-0.93)			
1.52	2.15	2.16 (1.44-2.50-3.78)	1.27 (0.78-1.53-2.48)	1.00 (0.58-1.28-2.29)	0.53 (0.21-0.84-1.78)	0.41 (0.12-0.71-1.61)	0.30 (0.10-0.54-1.20)	0.24 (0.10-0.44-1.02)			
1.52	2.50	2.37 (1.58-2.74-4.00)	1.40 (0.86-1.68-2.72)	1.10 (0.64-1.41-2.52)	0.59 (0.24-0.93-1.96)	0.45 (0.12-0.78-1.77)	0.32 (0.10-0.58-1.30)	0.27 (0.10-0.47-1.11)			
1.53	1.80	1.94 (1.30-2.23-3.32)	1.13 (0.70-1.36-2.20)	0.89 (0.52-1.14-2.02)	0.47 (0.18-0.75-1.58)	0.37 (0.10-0.63-1.42)	0.26 (0.10-0.48-1.08)	0.22 (0.10-0.40-0.92)			
1.53	2.15	2.15 (1.44-2.47-3.74)	1.26 (0.78-1.51-2.45)	0.99 (0.57-1.27-2.26)	0.53 (0.20-0.83-1.75)	0.41 (0.12-0.70-1.58)	0.30 (0.10-0.53-1.20)	0.24 (0.10-0.44-1.02)			
1.53	2.50	2.35 (1.56-2.71-4.00)	1.38 (0.86-1.66-2.68)	1.09 (0.62-1.39-2.49)	0.58 (0.22-0.91-1.93)	0.45 (0.12-0.77-1.75)	0.32 (0.10-0.58-1.30)	0.27 (0.10-0.47-1.10)			
1.54	1.80	1.93 (1.30-2.21-3.30)	1.12 (0.70-1.35-2.18)	0.88 (0.50-1.12-2.00)	0.47 (0.18-0.74-1.56)	0.37 (0.10-0.62-1.40)	0.26 (0.10-0.47-1.06)	0.22 (0.10-0.39-0.92)			
1.54	2.15	2.13 (1.42-2.45-3.68)	1.24 (0.77-1.50-2.42)	0.98 (0.56-1.25-2.24)	0.52 (0.20-0.82-1.73)	0.41 (0.12-0.69-1.56)	0.29 (0.10-0.53-1.18)	0.24 (0.10-0.43-1.01)			
1.54	2.50	2.33 (1.55-2.68-4.00)	1.36 (0.84-1.64-2.66)	1.07 (0.62-1.37-2.45)	0.57 (0.22-0.90-1.90)	0.45 (0.12-0.76-1.72)	0.32 (0.10-0.57-1.28)	0.26 (0.10-0.47-1.10)			
1.55	1.80	1.91 (1.28-2.19-3.27)	1.11 (0.68-1.33-2.16)	0.87 (0.50-1.11-1.98)	0.46 (0.18-0.73-1.54)	0.36 (0.10-0.62-1.38)	0.26 (0.10-0.47-1.06)	0.22 (0.10-0.39-0.91)			
1.55	2.15	2.12 (1.41-2.43-3.64)	1.24 (0.76-1.48-2.40)	0.97 (0.56-1.23-2.20)	0.51 (0.20-0.81-1.70)	0.39 (0.11-0.69-1.54)	0.28 (0.10-0.52-1.16)	0.24 (0.10-0.43-1.00)			
1.55	2.50	2.31 (1.53-2.66-4.00)	1.34 (0.84-1.62-2.62)	1.05 (0.61-1.35-2.42)	0.56 (0.22-0.89-1.87)	0.43 (0.12-0.75-1.70)	0.31 (0.10-0.57-1.28)	0.26 (0.10-0.46-1.08)			

Table S2: Imaginary part of the complex refractive index k as in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for **Oblate-Prolate Biaxial distribution**. k is retrieved for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	1.99 (1.34-2.29-3.42)	1.19 (0.74-1.43-2.30)	0.94 (0.54-1.20-2.13)	0.51 (0.20-0.80-1.67)	0.39 (0.10-0.68-1.52)	0.28 (0.10-0.51-1.14)	0.24 (0.10-0.42-0.97)			
1.48	2.15	2.22 (1.50-2.56-3.86)	1.34 (0.82-1.60-2.58)	1.05 (0.62-1.34-2.39)	0.57 (0.22-0.89-1.87)	0.45 (0.12-0.75-1.70)	0.31 (0.10-0.56-1.26)	0.26 (0.10-0.45-1.06)			
1.48	2.50	2.45 (1.64-2.83-4.50)	1.46 (0.91-1.76-2.84)	1.17 (0.68-1.48-2.64)	0.63 (0.24-0.98-2.06)	0.49 (0.14-0.83-1.87)	0.34 (0.10-0.60-1.35)	0.28 (0.10-0.49-1.13)			
1.49	1.80	1.97 (1.34-2.27-3.39)	1.18 (0.74-1.41-2.28)	0.93 (0.54-1.19-2.11)	0.50 (0.20-0.79-1.65)	0.39 (0.10-0.67-1.50)	0.28 (0.10-0.51-1.14)	0.24 (0.10-0.42-0.96)			
1.49	2.15	2.20 (1.48-2.54-3.80)	1.32 (0.82-1.58-2.56)	1.04 (0.60-1.33-2.36)	0.56 (0.22-0.88-1.84)	0.43 (0.12-0.75-1.68)	0.31 (0.10-0.56-1.24)	0.26 (0.10-0.45-1.05)			
1.49	2.50	2.43 (1.62-2.79-4.00)	1.45 (0.90-1.74-2.81)	1.15 (0.67-1.46-2.60)	0.62 (0.24-0.96-2.03)	0.48 (0.14-0.82-1.85)	0.34 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.13)			
1.50	1.80	1.96 (1.32-2.25-3.35)	1.16 (0.72-1.39-2.26)	0.92 (0.54-1.17-2.08)	0.49 (0.20-0.78-1.63)	0.39 (0.10-0.66-1.48)	0.28 (0.10-0.50-1.12)	0.24 (0.10-0.41-0.96)			
1.50	2.15	2.18 (1.46-2.51-3.75)	1.30 (0.80-1.56-2.52)	1.03 (0.60-1.31-2.33)	0.55 (0.22-0.87-1.82)	0.43 (0.12-0.74-1.66)	0.31 (0.10-0.55-1.24)	0.26 (0.10-0.45-1.05)			
1.50	2.50	2.40 (1.60-2.76-4.00)	1.43 (0.88-1.72-2.78)	1.13 (0.66-1.44-2.56)	0.61 (0.24-0.95-2.00)	0.47 (0.13-0.81-1.82)	0.33 (0.10-0.60-1.34)	0.28 (0.10-0.48-1.13)			
1.51	1.80	1.95 (1.31-2.22-3.33)	1.15 (0.72-1.38-2.23)	0.91 (0.52-1.16-2.05)	0.49 (0.20-0.77-1.61)	0.39 (0.10-0.66-1.47)	0.28 (0.10-0.50-1.12)	0.23 (0.10-0.41-0.96)			
1.51	2.15	2.16 (1.46-2.48-3.71)	1.28 (0.80-1.54-2.50)	1.01 (0.59-1.29-2.30)	0.55 (0.22-0.86-1.80)	0.43 (0.12-0.73-1.64)	0.30 (0.10-0.55-1.24)	0.26 (0.10-0.45-1.04)			
1.51	2.50	2.37 (1.58-2.73-4.00)	1.41 (0.88-1.69-2.74)	1.11 (0.65-1.42-2.53)	0.60 (0.24-0.94-1.97)	0.47 (0.12-0.80-1.80)	0.33 (0.10-0.59-1.34)	0.28 (0.10-0.48-1.12)			
1.52	1.80	1.93 (1.30-2.20-3.29)	1.14 (0.70-1.36-2.20)	0.90 (0.52-1.15-2.03)	0.49 (0.20-0.76-1.59)	0.38 (0.10-0.65-1.46)	0.28 (0.10-0.49-1.10)	0.22 (0.10-0.41-0.95)			
1.52	2.15	2.14 (1.44-2.46-3.67)	1.27 (0.78-1.52-2.46)	1.01 (0.58-1.28-2.27)	0.54 (0.22-0.85-1.78)	0.43 (0.12-0.72-1.62)	0.30 (0.10-0.54-1.22)	0.26 (0.10-0.45-1.04)			
1.52	2.50	2.35 (1.58-2.70-4.00)	1.40 (0.86-1.67-2.70)	1.11 (0.64-1.40-2.50)	0.59 (0.24-0.93-1.95)	0.47 (0.12-0.79-1.78)	0.33 (0.10-0.59-1.32)	0.27 (0.10-0.48-1.12)			
1.53	1.80	1.91 (1.28-2.18-3.26)	1.12 (0.70-1.35-2.18)	0.89 (0.52-1.13-2.01)	0.47 (0.19-0.75-1.57)	0.37 (0.10-0.64-1.44)	0.27 (0.10-0.49-1.10)	0.22 (0.10-0.41-0.94)			
1.53	2.15	2.12 (1.42-2.43-3.63)	1.26 (0.78-1.50-2.44)	0.99 (0.58-1.26-2.24)	0.53 (0.22-0.83-1.75)	0.41 (0.12-0.71-1.60)	0.30 (0.10-0.54-1.22)	0.25 (0.10-0.44-1.04)			
1.53	2.50	2.32 (1.56-2.67-4.00)	1.38 (0.86-1.65-2.67)	1.09 (0.64-1.39-2.47)	0.59 (0.23-0.92-1.93)	0.45 (0.12-0.78-1.76)	0.33 (0.10-0.59-1.32)	0.27 (0.10-0.48-1.11)			
1.54	1.80	1.89 (1.28-2.16-3.22)	1.12 (0.70-1.33-2.15)	0.88 (0.51-1.12-1.99)	0.47 (0.18-0.74-1.55)	0.37 (0.10-0.63-1.42)	0.26 (0.10-0.49-1.09)	0.22 (0.10-0.40-0.94)			
1.54	2.15	2.10 (1.42-2.41-3.59)	1.24 (0.78-1.48-2.41)	0.98 (0.57-1.25-2.21)	0.53 (0.20-0.82-1.73)	0.41 (0.12-0.70-1.58)	0.30 (0.10-0.54-1.20)	0.25 (0.10-0.44-1.03)			
1.54	2.50	2.30 (1.54-2.64-3.96)	1.36 (0.84-1.63-2.64)	1.07 (0.62-1.37-2.44)	0.58 (0.22-0.90-1.90)	0.45 (0.12-0.77-1.74)	0.32 (0.10-0.58-1.30)	0.27 (0.10-0.47-1.11)			
1.55	1.80	1.88 (1.27-2.14-3.20)	1.10 (0.68-1.32-2.12)	0.87 (0.50-1.11-1.97)	0.47 (0.18-0.73-1.53)	0.37 (0.10-0.63-1.40)	0.26 (0.10-0.48-1.08)	0.22 (0.10-0.40-0.93)			
1.55	2.15	2.08 (1.40-2.38-3.56)	1.22 (0.76-1.47-2.38)	0.97 (0.56-1.23-2.19)	0.52 (0.20-0.81-1.71)	0.41 (0.12-0.70-1.56)	0.30 (0.10-0.53-1.20)	0.24 (0.10-0.44-1.02)			
1.55	2.50	2.28 (1.52-2.61-3.90)	1.34 (0.84-1.61-2.61)	1.06 (0.62-1.35-2.40)	0.57 (0.22-0.89-1.87)	0.45 (0.12-0.76-1.71)	0.32 (0.10-0.58-1.30)	0.27 (0.10-0.47-1.10)			

Table S3: Imaginary part of the complex refractive index k as in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for **spheroid shape distribution from [1]**. k is retrieved for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.37 (1.60-2.71-4.00)	1.42 (0.90-1.71-2.72)	1.13 (0.66-1.44-2.52)	0.61 (0.24-0.95-1.95)	0.47 (0.12-0.80-1.79)	0.32 (0.10-0.58-1.28)	0.26 (0.10-0.46-1.08)			
1.48	2.15	2.62 (1.77-3.01-4.50)	1.59 (0.98-1.89-3.02)	1.25 (0.73-1.59-2.82)	0.67 (0.26-1.05-2.17)	0.51 (0.14-0.88-1.97)	0.35 (0.10-0.62-1.39)	0.29 (0.10-0.50-1.16)			
1.48	2.50	2.86 (1.94-3.29-5.00)	1.73 (1.08-2.07-3.33)	1.37 (0.80-1.74-3.07)	0.74 (0.28-1.14-2.36)	0.57 (0.16-0.95-2.14)	0.37 (0.10-0.66-1.48)	0.31 (0.10-0.53-1.23)			
1.49	1.80	2.34 (1.58-2.68-4.00)	1.41 (0.88-1.69-2.68)	1.11 (0.64-1.42-2.49)	0.60 (0.24-0.93-1.93)	0.47 (0.12-0.79-1.77)	0.32 (0.10-0.57-1.28)	0.26 (0.10-0.46-1.08)			
1.49	2.15	2.59 (1.74-2.97-4.50)	1.56 (0.98-1.87-2.98)	1.24 (0.72-1.57-2.78)	0.66 (0.26-1.03-2.15)	0.51 (0.14-0.87-1.95)	0.35 (0.10-0.62-1.38)	0.29 (0.10-0.50-1.16)			
1.49	2.50	2.82 (1.90-3.25-5.00)	1.71 (1.06-2.04-3.29)	1.35 (0.78-1.72-3.04)	0.73 (0.28-1.13-2.34)	0.55 (0.16-0.94-2.12)	0.37 (0.10-0.66-1.47)	0.31 (0.10-0.53-1.23)			
1.50	1.80	2.31 (1.56-2.65-3.95)	1.40 (0.88-1.66-2.64)	1.11 (0.64-1.40-2.46)	0.59 (0.23-0.92-1.91)	0.45 (0.12-0.78-1.75)	0.32 (0.10-0.57-1.26)	0.26 (0.10-0.46-1.08)			
1.50	2.15	2.55 (1.72-2.93-4.50)	1.54 (0.96-1.85-2.94)	1.23 (0.72-1.55-2.74)	0.66 (0.26-1.02-2.13)	0.51 (0.14-0.86-1.93)	0.35 (0.10-0.62-1.38)	0.28 (0.10-0.50-1.16)			
1.50	2.50	2.79 (1.88-3.21-5.00)	1.69 (1.04-2.02-3.25)	1.34 (0.78-1.70-3.00)	0.72 (0.28-1.11-2.32)	0.55 (0.15-0.93-2.10)	0.37 (0.10-0.66-1.47)	0.31 (0.10-0.53-1.22)			
1.51	1.80	2.28 (1.54-2.62-3.91)	1.38 (0.86-1.64-2.62)	1.09 (0.64-1.38-2.43)	0.58 (0.23-0.91-1.89)	0.45 (0.12-0.77-1.73)	0.32 (0.10-0.57-1.26)	0.26 (0.10-0.46-1.07)			
1.51	2.15	2.53 (1.70-2.90-4.50)	1.52 (0.95-1.82-2.90)	1.21 (0.70-1.53-2.70)	0.65 (0.26-1.01-2.09)	0.51 (0.14-0.85-1.91)	0.35 (0.10-0.61-1.37)	0.28 (0.10-0.49-1.16)			
1.51	2.50	2.76 (1.86-3.17-4.50)	1.67 (1.04-1.99-3.20)	1.33 (0.76-1.67-2.96)	0.71 (0.28-1.10-2.29)	0.55 (0.14-0.93-2.08)	0.37 (0.10-0.66-1.47)	0.30 (0.10-0.53-1.22)			
1.52	1.80	2.26 (1.52-2.59-3.87)	1.36 (0.85-1.62-2.58)	1.07 (0.62-1.37-2.40)	0.58 (0.22-0.90-1.87)	0.45 (0.12-0.76-1.71)	0.32 (0.10-0.56-1.25)	0.26 (0.10-0.46-1.06)			
1.52	2.15	2.51 (1.68-2.87-4.50)	1.50 (0.94-1.80-2.88)	1.19 (0.70-1.52-2.68)	0.64 (0.25-1.00-2.07)	0.49 (0.14-0.84-1.89)	0.34 (0.10-0.61-1.36)	0.28 (0.10-0.49-1.16)			
1.52	2.50	2.73 (1.84-3.13-4.50)	1.65 (1.02-1.97-3.16)	1.31 (0.76-1.66-2.94)	0.70 (0.28-1.09-2.27)	0.53 (0.14-0.92-2.06)	0.37 (0.10-0.66-1.47)	0.30 (0.10-0.53-1.22)			
1.53	1.80	2.24 (1.52-2.56-3.83)	1.34 (0.84-1.60-2.54)	1.07 (0.62-1.35-2.37)	0.57 (0.22-0.89-1.84)	0.45 (0.12-0.76-1.69)	0.31 (0.10-0.56-1.24)	0.26 (0.10-0.45-1.06)			
1.53	2.15	2.47 (1.66-2.84-4.00)	1.48 (0.92-1.78-2.84)	1.17 (0.68-1.50-2.64)	0.63 (0.24-0.99-2.05)	0.49 (0.14-0.83-1.87)	0.34 (0.10-0.61-1.36)	0.28 (0.10-0.49-1.14)			
1.53	2.50	2.70 (1.82-3.09-4.50)	1.63 (1.01-1.94-3.12)	1.29 (0.74-1.63-2.90)	0.69 (0.27-1.08-2.24)	0.53 (0.14-0.91-2.04)	0.37 (0.10-0.65-1.46)	0.30 (0.10-0.52-1.22)			
1.54	1.80	2.21 (1.50-2.53-3.79)	1.32 (0.83-1.58-2.52)	1.05 (0.61-1.33-2.34)	0.56 (0.22-0.88-1.82)	0.43 (0.12-0.75-1.66)	0.31 (0.10-0.55-1.24)	0.26 (0.10-0.45-1.06)			
1.54	2.15	2.45 (1.64-2.80-4.00)	1.46 (0.92-1.75-2.80)	1.17 (0.68-1.48-2.60)	0.62 (0.24-0.98-2.03)	0.49 (0.14-0.83-1.85)	0.34 (0.10-0.60-1.35)	0.28 (0.10-0.49-1.14)			
1.54	2.50	2.67 (1.80-3.06-4.50)	1.61 (1.00-1.92-3.07)	1.27 (0.74-1.61-2.86)	0.68 (0.26-1.06-2.21)	0.53 (0.14-0.90-2.02)	0.37 (0.10-0.65-1.45)	0.30 (0.10-0.52-1.22)			
1.55	1.80	2.18 (1.48-2.50-3.75)	1.31 (0.82-1.56-2.48)	1.04 (0.60-1.32-2.31)	0.56 (0.22-0.87-1.80)	0.43 (0.12-0.74-1.64)	0.30 (0.10-0.55-1.23)	0.26 (0.10-0.45-1.05)			
1.55	2.15	2.42 (1.62-2.77-4.00)	1.45 (0.90-1.73-2.76)	1.15 (0.66-1.46-2.58)	0.62 (0.24-0.96-2.01)	0.47 (0.13-0.82-1.83)	0.33 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.14)			
1.55	2.50	2.64 (1.78-3.02-4.50)	1.59 (0.98-1.89-3.03)	1.25 (0.73-1.59-2.82)	0.68 (0.26-1.05-2.19)	0.53 (0.14-0.89-2.00)	0.36 (0.10-0.65-1.44)	0.30 (0.10-0.52-1.22)			

Table S4: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for **Triaxial spheroids**: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	3.02 (2.06-3.40-5.00)	1.70 (1.02-2.02-3.20)	1.29 (0.72-1.64-2.91)	0.65 (0.10-1.02-2.18)	0.47 (0.10-0.82-1.92)	0.21 (0.10-0.53-1.26)	0.11 (0.10-0.41-1.04)			
1.48	2.15	3.36 (2.30-3.79-5.50)	1.92 (1.16-2.27-3.61)	1.46 (0.82-1.85-3.28)	0.74 (0.16-1.15-2.43)	0.55 (0.10-0.92-2.16)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.48	2.50	3.68 (2.52-4.14-6.50)	2.12 (1.28-2.49-3.96)	1.62 (0.90-2.03-3.60)	0.81 (0.20-1.27-2.68)	0.59 (0.10-1.01-2.37)	0.31 (0.10-0.64-1.49)	0.17 (0.10-0.48-1.21)			
1.49	1.80	3.00 (2.06-3.38-5.00)	1.69 (1.00-2.00-3.18)	1.28 (0.72-1.63-2.89)	0.65 (0.10-1.01-2.16)	0.47 (0.10-0.81-1.90)	0.21 (0.10-0.53-1.26)	0.11 (0.10-0.41-1.04)			
1.49	2.15	3.34 (2.28-3.76-5.50)	1.91 (1.14-2.25-3.58)	1.45 (0.82-1.83-3.26)	0.73 (0.16-1.14-2.42)	0.55 (0.10-0.92-2.16)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.49	2.50	3.66 (2.50-4.12-6.50)	2.11 (1.26-2.48-3.94)	1.61 (0.90-2.02-3.58)	0.81 (0.20-1.26-2.66)	0.59 (0.10-1.01-2.36)	0.31 (0.10-0.64-1.50)	0.17 (0.10-0.48-1.22)			
1.50	1.80	2.98 (2.04-3.36-5.00)	1.67 (1.00-1.99-3.15)	1.27 (0.72-1.62-2.86)	0.64 (0.10-1.00-2.14)	0.47 (0.10-0.81-1.90)	0.21 (0.10-0.53-1.26)	0.11 (0.10-0.41-1.04)			
1.50	2.15	3.32 (2.28-3.74-5.50)	1.89 (1.14-2.24-3.55)	1.45 (0.81-1.82-3.22)	0.73 (0.14-1.13-2.40)	0.53 (0.10-0.91-2.14)	0.26 (0.10-0.59-1.38)	0.15 (0.10-0.45-1.14)			
1.50	2.50	3.64 (2.50-4.10-6.50)	2.10 (1.26-2.47-3.91)	1.61 (0.90-2.01-3.56)	0.80 (0.20-1.25-2.64)	0.59 (0.10-1.01-2.34)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.22)			
1.51	1.80	2.96 (2.02-3.33-5.00)	1.67 (1.00-1.98-3.13)	1.26 (0.72-1.60-2.84)	0.64 (0.10-1.00-2.13)	0.47 (0.10-0.81-1.88)	0.21 (0.10-0.53-1.26)	0.11 (0.10-0.41-1.04)			
1.51	2.15	3.29 (2.26-3.70-5.50)	1.87 (1.12-2.22-3.52)	1.43 (0.80-1.81-3.21)	0.72 (0.14-1.13-2.38)	0.53 (0.10-0.91-2.13)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.51	2.50	3.61 (2.47-4.06-6.25)	2.08 (1.26-2.45-3.88)	1.59 (0.88-2.00-3.54)	0.80 (0.20-1.25-2.63)	0.59 (0.10-1.00-2.34)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.22)			
1.52	1.80	2.92 (2.00-3.30-5.00)	1.65 (0.98-1.96-3.11)	1.25 (0.70-1.59-2.82)	0.63 (0.10-0.99-2.12)	0.47 (0.10-0.80-1.88)	0.20 (0.10-0.53-1.25)	0.11 (0.10-0.41-1.04)			
1.52	2.15	3.26 (2.24-3.67-5.50)	1.86 (1.12-2.21-3.50)	1.42 (0.80-1.80-3.19)	0.72 (0.14-1.12-2.38)	0.53 (0.10-0.90-2.11)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.52	2.50	3.58 (2.44-4.03-6.00)	2.06 (1.24-2.43-3.86)	1.57 (0.88-1.99-3.52)	0.79 (0.20-1.24-2.62)	0.59 (0.10-1.00-2.33)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.23)			
1.53	1.80	2.90 (1.98-3.27-5.00)	1.63 (0.98-1.94-3.08)	1.24 (0.70-1.58-2.80)	0.63 (0.10-0.98-2.11)	0.45 (0.10-0.80-1.86)	0.20 (0.10-0.53-1.25)	0.11 (0.10-0.41-1.04)			
1.53	2.15	3.23 (2.22-3.64-5.50)	1.85 (1.10-2.19-3.47)	1.41 (0.78-1.78-3.16)	0.71 (0.14-1.11-2.36)	0.53 (0.10-0.90-2.10)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.53	2.50	3.54 (2.42-3.99-6.00)	2.05 (1.22-2.41-3.84)	1.57 (0.88-1.97-3.50)	0.79 (0.19-1.23-2.61)	0.59 (0.10-0.99-2.32)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.24)			
1.54	1.80	2.88 (1.97-3.24-5.00)	1.62 (0.96-1.93-3.06)	1.23 (0.70-1.57-2.78)	0.62 (0.10-0.98-2.09)	0.45 (0.10-0.79-1.86)	0.20 (0.10-0.53-1.24)	0.11 (0.10-0.41-1.04)			
1.54	2.15	3.21 (2.20-3.61-5.50)	1.83 (1.10-2.17-3.44)	1.40 (0.78-1.77-3.14)	0.70 (0.12-1.11-2.36)	0.53 (0.10-0.89-2.10)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.54	2.50	3.51 (2.40-3.96-6.00)	2.03 (1.22-2.40-3.82)	1.55 (0.86-1.96-3.48)	0.78 (0.18-1.23-2.60)	0.59 (0.10-0.99-2.32)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.24)			
1.55	1.80	2.84 (1.95-3.21-4.50)	1.61 (0.96-1.91-3.04)	1.21 (0.69-1.56-2.76)	0.62 (0.10-0.97-2.08)	0.45 (0.10-0.79-1.84)	0.20 (0.10-0.53-1.24)	0.11 (0.10-0.41-1.04)			
1.55	2.15	3.17 (2.18-3.57-5.25)	1.81 (1.08-2.15-3.42)	1.39 (0.78-1.76-3.12)	0.70 (0.12-1.10-2.34)	0.53 (0.10-0.89-2.08)	0.26 (0.10-0.59-1.38)	0.14 (0.10-0.45-1.14)			
1.55	2.50	3.48 (2.38-3.92-6.00)	2.01 (1.20-2.38-3.78)	1.55 (0.86-1.95-3.46)	0.78 (0.18-1.22-2.58)	0.57 (0.10-0.99-2.31)	0.31 (0.10-0.64-1.50)	0.18 (0.10-0.49-1.24)			

Table S5: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape A** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.13 (1.48-2.47-3.69)	1.27 (0.82-1.54-2.43)	1.03 (0.61-1.30-2.28)	0.56 (0.22-0.87-1.79)	0.43 (0.12-0.74-1.66)	0.31 (0.10-0.55-1.23)	0.25 (0.10-0.45-1.03)			
1.48	2.15	2.35 (1.61-2.72-4.00)	1.44 (0.90-1.71-2.71)	1.15 (0.68-1.44-2.52)	0.63 (0.24-0.96-1.98)	0.49 (0.14-0.82-1.82)	0.34 (0.10-0.60-1.33)	0.28 (0.10-0.49-1.14)			
1.48	2.50	2.57 (1.74-2.96-4.50)	1.56 (0.98-1.86-3.00)	1.25 (0.74-1.58-2.80)	0.68 (0.26-1.05-2.18)	0.53 (0.14-0.89-1.99)	0.36 (0.10-0.65-1.44)	0.30 (0.10-0.52-1.20)			
1.49	1.80	2.11 (1.46-2.45-3.65)	1.30 (0.82-1.54-2.39)	1.03 (0.60-1.30-2.26)	0.57 (0.22-0.87-1.77)	0.43 (0.12-0.74-1.63)	0.31 (0.10-0.55-1.22)	0.26 (0.10-0.45-1.04)			
1.49	2.15	2.33 (1.60-2.70-3.99)	1.43 (0.88-1.69-2.68)	1.15 (0.66-1.43-2.49)	0.62 (0.24-0.96-1.95)	0.49 (0.14-0.81-1.80)	0.34 (0.10-0.60-1.33)	0.28 (0.10-0.49-1.14)			
1.49	2.50	2.55 (1.72-2.93-4.50)	1.54 (0.98-1.85-2.98)	1.23 (0.72-1.56-2.78)	0.67 (0.26-1.04-2.15)	0.53 (0.14-0.89-1.97)	0.36 (0.10-0.65-1.44)	0.30 (0.10-0.52-1.20)			
1.50	1.80	2.10 (1.46-2.43-3.63)	1.28 (0.80-1.52-2.41)	1.03 (0.59-1.28-2.24)	0.56 (0.22-0.86-1.76)	0.43 (0.12-0.73-1.62)	0.30 (0.10-0.55-1.22)	0.25 (0.10-0.45-1.04)			
1.50	2.15	2.30 (1.58-2.67-3.94)	1.42 (0.88-1.68-2.66)	1.13 (0.66-1.42-2.46)	0.62 (0.24-0.95-1.93)	0.49 (0.14-0.81-1.79)	0.34 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.13)			
1.50	2.50	2.53 (1.70-2.91-4.50)	1.53 (0.96-1.83-2.95)	1.23 (0.72-1.55-2.75)	0.67 (0.26-1.03-2.13)	0.51 (0.14-0.88-1.96)	0.36 (0.10-0.64-1.44)	0.30 (0.10-0.52-1.20)			
1.51	1.80	2.08 (1.44-2.41-3.60)	1.27 (0.80-1.51-2.38)	1.01 (0.60-1.28-2.22)	0.55 (0.22-0.85-1.73)	0.43 (0.12-0.73-1.59)	0.30 (0.10-0.55-1.21)	0.25 (0.10-0.45-1.04)			
1.51	2.15	2.28 (1.57-2.65-3.92)	1.40 (0.88-1.66-2.66)	1.12 (0.66-1.41-2.44)	0.61 (0.24-0.94-1.91)	0.47 (0.12-0.80-1.76)	0.33 (0.10-0.60-1.32)	0.28 (0.10-0.48-1.14)			
1.51	2.50	2.51 (1.69-2.88-4.50)	1.51 (0.96-1.81-2.93)	1.21 (0.72-1.53-2.72)	0.66 (0.26-1.02-2.11)	0.51 (0.14-0.87-1.94)	0.36 (0.10-0.64-1.44)	0.29 (0.10-0.52-1.20)			
1.52	1.80	2.07 (1.44-2.39-3.57)	1.25 (0.80-1.50-2.38)	1.01 (0.60-1.26-2.20)	0.55 (0.22-0.84-1.74)	0.42 (0.12-0.72-1.58)	0.30 (0.10-0.54-1.20)	0.25 (0.10-0.44-1.03)			
1.52	2.15	2.26 (1.56-2.63-3.89)	1.40 (0.88-1.65-2.66)	1.11 (0.66-1.40-2.42)	0.61 (0.24-0.93-1.90)	0.47 (0.12-0.79-1.78)	0.33 (0.10-0.59-1.33)	0.28 (0.10-0.48-1.12)			
1.52	2.50	2.48 (1.68-2.86-4.50)	1.50 (0.96-1.80-2.89)	1.19 (0.71-1.52-2.70)	0.65 (0.26-1.02-2.09)	0.51 (0.14-0.86-1.92)	0.36 (0.10-0.64-1.43)	0.30 (0.10-0.52-1.20)			
1.53	1.80	2.05 (1.42-2.36-3.54)	1.23 (0.79-1.47-2.32)	0.98 (0.58-1.25-2.16)	0.53 (0.22-0.83-1.72)	0.42 (0.12-0.71-1.57)	0.30 (0.10-0.54-1.20)	0.24 (0.10-0.44-1.02)			
1.53	2.15	2.24 (1.54-2.59-3.85)	1.36 (0.86-1.63-2.61)	1.09 (0.64-1.38-2.42)	0.59 (0.24-0.92-1.90)	0.46 (0.12-0.79-1.74)	0.33 (0.10-0.59-1.30)	0.27 (0.10-0.48-1.11)			
1.53	2.50	2.45 (1.66-2.82-4.00)	1.49 (0.94-1.77-2.84)	1.19 (0.70-1.50-2.65)	0.65 (0.26-1.00-2.07)	0.51 (0.14-0.86-1.91)	0.36 (0.10-0.63-1.42)	0.29 (0.10-0.52-1.20)			
1.54	1.80	2.03 (1.40-2.33-3.49)	1.23 (0.78-1.46-2.30)	0.99 (0.58-1.23-2.12)	0.53 (0.21-0.83-1.68)	0.41 (0.12-0.71-1.57)	0.30 (0.10-0.53-1.19)	0.24 (0.10-0.44-1.02)			
1.54	2.15	2.21 (1.52-2.56-3.82)	1.35 (0.86-1.61-2.55)	1.09 (0.62-1.36-2.38)	0.59 (0.24-0.91-1.87)	0.46 (0.12-0.78-1.73)	0.33 (0.10-0.58-1.30)	0.27 (0.10-0.48-1.11)			
1.54	2.50	2.41 (1.64-2.78-4.00)	1.48 (0.92-1.75-2.79)	1.19 (0.68-1.48-2.59)	0.65 (0.26-0.99-2.02)	0.51 (0.14-0.85-1.90)	0.35 (0.10-0.63-1.40)	0.29 (0.10-0.51-1.20)			
1.55	1.80	1.99 (1.39-2.29-3.41)	1.22 (0.78-1.44-2.25)	0.98 (0.57-1.22-2.08)	0.53 (0.20-0.82-1.64)	0.41 (0.11-0.70-1.53)	0.30 (0.10-0.53-1.16)	0.24 (0.10-0.43-1.01)			
1.55	2.15	2.19 (1.50-2.53-3.78)	1.33 (0.84-1.59-2.53)	1.06 (0.62-1.34-2.35)	0.57 (0.22-0.90-1.84)	0.45 (0.12-0.77-1.71)	0.32 (0.10-0.58-1.30)	0.26 (0.10-0.47-1.10)			
1.55	2.50	2.38 (1.63-2.75-4.00)	1.46 (0.92-1.73-2.80)	1.17 (0.68-1.46-2.57)	0.64 (0.26-0.98-2.01)	0.49 (0.14-0.84-1.88)	0.35 (0.10-0.63-1.39)	0.29 (0.10-0.51-1.19)			

Table S6: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape B** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.24 (1.56-2.57-3.82)	1.35 (0.86-1.61-2.52)	1.09 (0.64-1.36-2.35)	0.59 (0.24-0.90-1.85)	0.45 (0.12-0.77-1.70)	0.32 (0.10-0.57-1.26)	0.26 (0.10-0.46-1.07)			
1.48	2.15	2.45 (1.68-2.82-4.00)	1.50 (0.94-1.77-2.77)	1.20 (0.70-1.49-2.59)	0.65 (0.26-0.99-2.03)	0.51 (0.14-0.84-1.86)	0.35 (0.10-0.61-1.34)	0.29 (0.10-0.50-1.16)			
1.48	2.50	2.67 (1.80-3.06-4.50)	1.62 (1.02-1.92-3.01)	1.29 (0.76-1.62-2.80)	0.71 (0.28-1.08-2.20)	0.55 (0.14-0.91-2.00)	0.37 (0.10-0.66-1.45)	0.31 (0.10-0.53-1.22)			
1.49	1.80	2.22 (1.54-2.55-3.78)	1.35 (0.86-1.59-2.47)	1.08 (0.64-1.34-2.32)	0.59 (0.23-0.89-1.83)	0.45 (0.12-0.76-1.68)	0.32 (0.10-0.56-1.26)	0.26 (0.10-0.46-1.07)			
1.49	2.15	2.43 (1.66-2.79-4.00)	1.48 (0.94-1.75-2.76)	1.19 (0.69-1.48-2.56)	0.65 (0.26-0.98-2.01)	0.51 (0.14-0.83-1.84)	0.35 (0.10-0.61-1.34)	0.29 (0.10-0.49-1.15)			
1.49	2.50	2.65 (1.79-3.02-4.50)	1.61 (1.00-1.90-3.05)	1.29 (0.76-1.61-2.76)	0.70 (0.28-1.07-2.16)	0.55 (0.14-0.90-1.99)	0.37 (0.10-0.65-1.45)	0.31 (0.10-0.52-1.22)			
1.50	1.80	2.19 (1.53-2.52-3.76)	1.34 (0.86-1.58-2.46)	1.06 (0.62-1.33-2.26)	0.58 (0.23-0.89-1.80)	0.45 (0.12-0.75-1.66)	0.32 (0.10-0.56-1.24)	0.26 (0.10-0.46-1.07)			
1.50	2.15	2.41 (1.66-2.76-4.00)	1.47 (0.92-1.73-2.74)	1.17 (0.68-1.46-2.56)	0.64 (0.25-0.98-1.99)	0.49 (0.14-0.83-1.82)	0.35 (0.10-0.61-1.36)	0.28 (0.10-0.49-1.14)			
1.50	2.50	2.61 (1.78-2.99-4.50)	1.60 (1.00-1.88-3.00)	1.27 (0.75-1.59-2.76)	0.70 (0.28-1.06-2.16)	0.53 (0.14-0.90-1.98)	0.37 (0.10-0.65-1.44)	0.31 (0.10-0.52-1.22)			
1.51	1.80	2.18 (1.51-2.49-3.73)	1.33 (0.84-1.56-2.43)	1.06 (0.62-1.32-2.23)	0.57 (0.22-0.88-1.78)	0.45 (0.12-0.75-1.64)	0.32 (0.10-0.56-1.23)	0.26 (0.10-0.46-1.06)			
1.51	2.15	2.38 (1.64-2.73-4.00)	1.43 (0.92-1.71-2.71)	1.15 (0.68-1.45-2.52)	0.63 (0.25-0.97-1.98)	0.49 (0.14-0.82-1.80)	0.34 (0.10-0.61-1.34)	0.28 (0.10-0.49-1.14)			
1.51	2.50	2.59 (1.76-2.96-4.50)	1.58 (1.00-1.86-2.96)	1.27 (0.74-1.58-2.75)	0.69 (0.27-1.05-2.14)	0.53 (0.14-0.89-1.96)	0.37 (0.10-0.65-1.43)	0.30 (0.10-0.52-1.22)			
1.52	1.80	2.14 (1.50-2.46-3.67)	1.32 (0.84-1.55-2.42)	1.05 (0.62-1.31-2.24)	0.57 (0.22-0.87-1.76)	0.45 (0.12-0.74-1.63)	0.31 (0.10-0.56-1.23)	0.26 (0.10-0.45-1.06)			
1.52	2.15	2.36 (1.62-2.70-4.00)	1.44 (0.92-1.70-2.68)	1.15 (0.68-1.44-2.50)	0.63 (0.24-0.96-1.96)	0.49 (0.13-0.82-1.79)	0.34 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.14)			
1.52	2.50	2.55 (1.74-2.93-4.50)	1.56 (0.98-1.85-2.95)	1.25 (0.72-1.56-2.73)	0.68 (0.26-1.04-2.13)	0.53 (0.14-0.88-1.95)	0.37 (0.10-0.65-1.43)	0.30 (0.10-0.52-1.21)			
1.53	1.80	2.11 (1.48-2.44-3.64)	1.30 (0.82-1.53-2.34)	1.04 (0.61-1.29-2.20)	0.57 (0.22-0.86-1.74)	0.45 (0.12-0.74-1.61)	0.31 (0.10-0.55-1.21)	0.26 (0.10-0.45-1.05)			
1.53	2.15	2.34 (1.60-2.67-3.97)	1.42 (0.90-1.68-2.66)	1.14 (0.67-1.42-2.48)	0.61 (0.24-0.95-1.93)	0.48 (0.13-0.81-1.78)	0.34 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.14)			
1.53	2.50	2.53 (1.72-2.90-4.50)	1.54 (0.98-1.82-2.91)	1.23 (0.72-1.54-2.69)	0.68 (0.26-1.03-2.11)	0.53 (0.14-0.88-1.94)	0.37 (0.10-0.64-1.43)	0.30 (0.10-0.52-1.21)			
1.54	1.80	2.09 (1.46-2.41-3.59)	1.29 (0.82-1.51-2.32)	1.03 (0.60-1.28-2.18)	0.56 (0.22-0.86-1.74)	0.43 (0.12-0.73-1.60)	0.31 (0.10-0.55-1.21)	0.26 (0.10-0.45-1.04)			
1.54	2.15	2.31 (1.58-2.64-3.93)	1.41 (0.90-1.66-2.61)	1.12 (0.66-1.41-2.43)	0.61 (0.24-0.94-1.90)	0.47 (0.13-0.80-1.77)	0.34 (0.10-0.60-1.32)	0.28 (0.10-0.49-1.14)			
1.54	2.50	2.51 (1.71-2.87-4.00)	1.50 (0.96-1.80-2.88)	1.21 (0.72-1.53-2.66)	0.66 (0.26-1.02-2.09)	0.51 (0.14-0.87-1.92)	0.35 (0.10-0.64-1.42)	0.29 (0.10-0.52-1.21)			
1.55	1.80	2.07 (1.46-2.38-3.56)	1.28 (0.80-1.50-2.29)	1.02 (0.60-1.27-2.17)	0.55 (0.22-0.85-1.72)	0.43 (0.12-0.72-1.59)	0.30 (0.10-0.54-1.20)	0.26 (0.10-0.45-1.04)			
1.55	2.15	2.27 (1.57-2.61-3.90)	1.40 (0.89-1.64-2.57)	1.12 (0.65-1.39-2.39)	0.61 (0.24-0.93-1.88)	0.47 (0.12-0.79-1.75)	0.33 (0.10-0.59-1.32)	0.28 (0.10-0.48-1.13)			
1.55	2.50	2.48 (1.70-2.83-4.00)	1.50 (0.96-1.78-2.84)	1.21 (0.71-1.51-2.64)	0.66 (0.26-1.01-2.07)	0.51 (0.14-0.86-1.90)	0.36 (0.10-0.64-1.42)	0.29 (0.10-0.52-1.20)			

Table S7: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape C** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.65 (1.82-3.03-4.50)	1.55 (1.00-1.86-2.91)	1.23 (0.74-1.55-2.70)	0.65 (0.26-1.02-2.04)	0.51 (0.14-0.85-1.86)	0.34 (0.10-0.60-1.31)	0.28 (0.10-0.48-1.11)			
1.48	2.15	2.90 (1.96-3.32-5.00)	1.73 (1.10-2.05-3.26)	1.37 (0.80-1.71-2.98)	0.74 (0.28-1.12-2.26)	0.55 (0.16-0.93-2.04)	0.37 (0.10-0.64-1.42)	0.30 (0.10-0.51-1.20)			
1.48	2.50	3.13 (2.10-3.59-5.50)	1.87 (1.18-2.23-3.55)	1.49 (0.88-1.86-3.26)	0.80 (0.31-1.21-2.48)	0.61 (0.16-1.00-2.22)	0.39 (0.10-0.68-1.51)	0.31 (0.10-0.54-1.26)			
1.49	1.80	2.63 (1.78-2.99-4.50)	1.54 (1.00-1.84-2.90)	1.23 (0.72-1.54-2.66)	0.65 (0.26-1.01-2.02)	0.50 (0.14-0.84-1.84)	0.34 (0.10-0.60-1.30)	0.28 (0.10-0.48-1.11)			
1.49	2.15	2.86 (1.94-3.28-5.00)	1.71 (1.08-2.02-3.22)	1.35 (0.80-1.69-2.96)	0.73 (0.28-1.11-2.24)	0.55 (0.15-0.92-2.02)	0.37 (0.10-0.64-1.42)	0.30 (0.10-0.51-1.20)			
1.49	2.50	3.10 (2.08-3.55-5.50)	1.85 (1.18-2.20-3.51)	1.47 (0.86-1.84-3.23)	0.79 (0.30-1.20-2.44)	0.59 (0.16-1.00-2.21)	0.39 (0.10-0.68-1.51)	0.31 (0.10-0.54-1.26)			
1.50	1.80	2.59 (1.76-2.95-4.50)	1.53 (0.98-1.82-2.83)	1.21 (0.72-1.52-2.64)	0.65 (0.26-1.00-2.00)	0.49 (0.14-0.83-1.83)	0.34 (0.10-0.59-1.30)	0.28 (0.10-0.48-1.10)			
1.50	2.15	2.84 (1.92-3.23-5.00)	1.68 (1.08-2.00-3.17)	1.33 (0.78-1.67-2.92)	0.72 (0.28-1.10-2.22)	0.55 (0.14-0.91-2.01)	0.37 (0.10-0.64-1.39)	0.29 (0.10-0.51-1.20)			
1.50	2.50	3.07 (2.06-3.50-5.50)	1.83 (1.16-2.18-3.47)	1.46 (0.86-1.82-3.20)	0.78 (0.30-1.19-2.42)	0.59 (0.16-0.99-2.19)	0.39 (0.10-0.68-1.51)	0.31 (0.10-0.54-1.26)			
1.51	1.80	2.55 (1.74-2.91-4.50)	1.52 (0.98-1.79-2.80)	1.20 (0.72-1.50-2.58)	0.65 (0.26-0.99-1.96)	0.49 (0.14-0.83-1.80)	0.33 (0.10-0.59-1.30)	0.28 (0.10-0.47-1.10)			
1.51	2.15	2.80 (1.90-3.19-5.00)	1.65 (1.06-1.97-3.08)	1.31 (0.78-1.65-2.88)	0.70 (0.28-1.08-2.21)	0.53 (0.14-0.91-1.99)	0.36 (0.10-0.64-1.40)	0.29 (0.10-0.51-1.19)			
1.51	2.50	3.03 (2.04-3.47-5.25)	1.81 (1.14-2.15-3.43)	1.44 (0.84-1.80-3.16)	0.78 (0.30-1.18-2.40)	0.59 (0.16-0.98-2.17)	0.39 (0.10-0.68-1.50)	0.31 (0.10-0.54-1.27)			
1.52	1.80	2.51 (1.72-2.88-4.50)	1.51 (0.96-1.78-2.74)	1.19 (0.70-1.49-2.54)	0.64 (0.25-0.98-1.97)	0.49 (0.13-0.82-1.78)	0.33 (0.10-0.59-1.29)	0.27 (0.10-0.47-1.10)			
1.52	2.15	2.77 (1.88-3.16-4.75)	1.63 (1.06-1.96-3.06)	1.29 (0.77-1.64-2.86)	0.69 (0.28-1.08-2.18)	0.53 (0.14-0.90-1.98)	0.36 (0.10-0.64-1.40)	0.29 (0.10-0.51-1.18)			
1.52	2.50	3.00 (2.02-3.43-5.00)	1.79 (1.14-2.13-3.40)	1.43 (0.83-1.78-3.12)	0.77 (0.30-1.17-2.38)	0.59 (0.16-0.97-2.14)	0.39 (0.10-0.68-1.50)	0.31 (0.10-0.54-1.26)			
1.53	1.80	2.48 (1.70-2.84-4.00)	1.49 (0.95-1.75-2.71)	1.18 (0.70-1.47-2.51)	0.63 (0.24-0.96-1.94)	0.49 (0.12-0.81-1.77)	0.33 (0.10-0.58-1.29)	0.27 (0.10-0.47-1.09)			
1.53	2.15	2.74 (1.84-3.12-4.50)	1.62 (1.04-1.93-3.05)	1.29 (0.76-1.62-2.82)	0.69 (0.28-1.06-2.15)	0.53 (0.14-0.89-1.96)	0.35 (0.10-0.63-1.40)	0.29 (0.10-0.51-1.18)			
1.53	2.50	2.96 (1.99-3.39-5.00)	1.77 (1.12-2.10-3.36)	1.41 (0.82-1.76-3.08)	0.76 (0.30-1.16-2.35)	0.57 (0.16-0.97-2.13)	0.39 (0.10-0.68-1.50)	0.31 (0.10-0.54-1.26)			
1.54	1.80	2.43 (1.68-2.80-4.00)	1.48 (0.94-1.73-2.67)	1.17 (0.69-1.45-2.47)	0.63 (0.24-0.95-1.93)	0.49 (0.12-0.80-1.76)	0.33 (0.10-0.58-1.26)	0.27 (0.10-0.47-1.09)			
1.54	2.15	2.69 (1.82-3.08-4.50)	1.61 (1.03-1.90-3.02)	1.27 (0.76-1.60-2.78)	0.69 (0.28-1.05-2.12)	0.53 (0.14-0.88-1.92)	0.35 (0.10-0.63-1.38)	0.29 (0.10-0.50-1.17)			
1.54	2.50	2.92 (1.96-3.34-5.00)	1.74 (1.10-2.07-3.28)	1.39 (0.82-1.74-3.05)	0.75 (0.30-1.14-2.33)	0.57 (0.16-0.95-2.10)	0.39 (0.10-0.67-1.48)	0.31 (0.10-0.54-1.26)			
1.55	1.80	2.40 (1.66-2.77-4.00)	1.46 (0.92-1.71-2.65)	1.15 (0.68-1.43-2.46)	0.62 (0.24-0.94-1.92)	0.47 (0.12-0.79-1.74)	0.33 (0.10-0.57-1.26)	0.27 (0.10-0.47-1.10)			
1.55	2.15	2.65 (1.80-3.04-4.50)	1.59 (1.02-1.88-2.99)	1.26 (0.74-1.58-2.76)	0.68 (0.26-1.04-2.09)	0.53 (0.14-0.87-1.91)	0.35 (0.10-0.63-1.38)	0.29 (0.10-0.50-1.16)			
1.55	2.50	2.89 (1.94-3.30-5.00)	1.71 (1.10-2.05-3.27)	1.36 (0.80-1.72-3.02)	0.74 (0.29-1.13-2.31)	0.56 (0.16-0.95-2.08)	0.37 (0.10-0.67-1.48)	0.31 (0.10-0.54-1.26)			

Table S8: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape D** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.99 (2.04-3.37-5.00)	1.77 (1.13-2.09-3.27)	1.40 (0.82-1.74-3.00)	0.75 (0.30-1.14-2.30)	0.57 (0.16-0.95-2.07)	0.37 (0.10-0.66-1.45)	0.31 (0.10-0.52-1.23)			
1.48	2.15	3.23 (2.20-3.64-5.50)	1.92 (1.22-2.26-3.56)	1.53 (0.90-1.89-3.28)	0.82 (0.32-1.24-2.50)	0.61 (0.16-1.03-2.27)	0.41 (0.10-0.70-1.54)	0.33 (0.10-0.56-1.31)			
1.48	2.50	3.45 (2.34-3.91-6.00)	2.07 (1.30-2.43-3.81)	1.63 (0.96-2.03-3.53)	0.88 (0.34-1.32-2.68)	0.66 (0.18-1.10-2.43)	0.43 (0.12-0.74-1.62)	0.35 (0.10-0.58-1.35)			
1.49	1.80	2.96 (2.03-3.34-5.00)	1.74 (1.12-2.06-3.23)	1.38 (0.82-1.73-2.98)	0.74 (0.30-1.13-2.28)	0.57 (0.16-0.94-2.04)	0.37 (0.10-0.66-1.44)	0.30 (0.10-0.52-1.22)			
1.49	2.15	3.20 (2.18-3.61-5.50)	1.90 (1.21-2.24-3.51)	1.51 (0.89-1.87-3.24)	0.81 (0.32-1.22-2.48)	0.61 (0.16-1.02-2.24)	0.41 (0.10-0.70-1.54)	0.33 (0.10-0.56-1.31)			
1.49	2.50	3.42 (2.34-3.87-6.00)	2.04 (1.30-2.41-3.80)	1.63 (0.96-2.02-3.49)	0.87 (0.34-1.31-2.67)	0.65 (0.18-1.09-2.40)	0.43 (0.12-0.74-1.61)	0.35 (0.10-0.58-1.35)			
1.50	1.80	2.94 (2.02-3.31-5.00)	1.74 (1.11-2.05-3.20)	1.37 (0.82-1.71-2.94)	0.74 (0.28-1.12-2.26)	0.57 (0.15-0.94-2.04)	0.37 (0.10-0.66-1.44)	0.30 (0.10-0.52-1.22)			
1.50	2.15	3.17 (2.16-3.59-5.50)	1.86 (1.20-2.23-3.50)	1.48 (0.88-1.86-3.24)	0.79 (0.32-1.22-2.47)	0.61 (0.16-1.01-2.23)	0.39 (0.10-0.70-1.54)	0.32 (0.10-0.56-1.31)			
1.50	2.50	3.40 (2.32-3.85-6.00)	2.03 (1.28-2.40-3.78)	1.61 (0.94-2.00-3.49)	0.86 (0.34-1.31-2.66)	0.65 (0.18-1.08-2.39)	0.43 (0.12-0.74-1.61)	0.35 (0.10-0.58-1.36)			
1.51	1.80	2.91 (2.00-3.28-5.00)	1.72 (1.10-2.03-3.18)	1.37 (0.81-1.70-2.93)	0.74 (0.29-1.12-2.25)	0.57 (0.15-0.93-2.02)	0.37 (0.10-0.66-1.44)	0.31 (0.10-0.52-1.23)			
1.51	2.15	3.15 (2.14-3.56-5.50)	1.86 (1.20-2.21-3.48)	1.48 (0.88-1.85-3.22)	0.79 (0.32-1.21-2.46)	0.61 (0.16-1.01-2.21)	0.39 (0.10-0.70-1.54)	0.33 (0.10-0.56-1.31)			
1.51	2.50	3.38 (2.30-3.82-6.00)	2.00 (1.28-2.38-3.76)	1.59 (0.94-1.99-3.47)	0.85 (0.34-1.30-2.65)	0.65 (0.18-1.08-2.40)	0.42 (0.12-0.74-1.62)	0.34 (0.10-0.58-1.36)			
1.52	1.80	2.87 (1.96-3.26-5.00)	1.71 (1.10-2.01-3.14)	1.35 (0.80-1.69-2.90)	0.73 (0.28-1.11-2.23)	0.55 (0.14-0.93-2.02)	0.37 (0.10-0.65-1.44)	0.31 (0.10-0.52-1.23)			
1.52	2.15	3.13 (2.12-3.53-5.50)	1.86 (1.18-2.19-3.43)	1.47 (0.86-1.84-3.16)	0.79 (0.32-1.21-2.44)	0.61 (0.16-1.00-2.19)	0.39 (0.10-0.70-1.54)	0.33 (0.10-0.56-1.30)			
1.52	2.50	3.35 (2.28-3.80-5.50)	1.97 (1.27-2.37-3.72)	1.57 (0.94-1.98-3.43)	0.85 (0.34-1.29-2.64)	0.65 (0.18-1.08-2.39)	0.42 (0.12-0.74-1.63)	0.34 (0.10-0.59-1.36)			
1.53	1.80	2.84 (1.94-3.22-5.00)	1.69 (1.08-1.99-3.10)	1.35 (0.80-1.67-2.86)	0.72 (0.28-1.10-2.21)	0.55 (0.14-0.92-2.00)	0.37 (0.10-0.65-1.42)	0.30 (0.10-0.52-1.22)			
1.53	2.15	3.09 (2.10-3.50-5.25)	1.84 (1.18-2.17-3.38)	1.46 (0.86-1.82-3.14)	0.79 (0.30-1.19-2.42)	0.59 (0.16-1.00-2.18)	0.39 (0.10-0.70-1.54)	0.33 (0.10-0.56-1.31)			
1.53	2.50	3.33 (2.26-3.76-5.50)	1.97 (1.26-2.34-3.68)	1.57 (0.92-1.96-3.40)	0.84 (0.33-1.28-2.62)	0.64 (0.18-1.07-2.38)	0.41 (0.12-0.74-1.63)	0.34 (0.10-0.59-1.37)			
1.54	1.80	2.81 (1.94-3.19-4.50)	1.67 (1.08-1.97-3.02)	1.33 (0.79-1.65-2.80)	0.71 (0.28-1.08-2.16)	0.55 (0.14-0.91-1.97)	0.37 (0.10-0.65-1.41)	0.30 (0.10-0.52-1.20)			
1.54	2.15	3.04 (2.08-3.46-5.00)	1.83 (1.16-2.15-3.31)	1.45 (0.86-1.80-3.07)	0.78 (0.30-1.18-2.38)	0.59 (0.16-0.99-2.14)	0.39 (0.10-0.69-1.51)	0.33 (0.10-0.55-1.30)			
1.54	2.50	3.29 (2.24-3.73-5.50)	1.96 (1.24-2.32-3.59)	1.56 (0.92-1.94-3.33)	0.84 (0.32-1.27-2.56)	0.63 (0.18-1.06-2.31)	0.42 (0.12-0.74-1.62)	0.35 (0.10-0.58-1.37)			
1.55	1.80	2.78 (1.92-3.15-4.50)	1.65 (1.06-1.95-3.01)	1.31 (0.78-1.64-2.76)	0.70 (0.28-1.08-2.15)	0.53 (0.14-0.90-1.93)	0.37 (0.10-0.64-1.40)	0.30 (0.10-0.52-1.20)			
1.55	2.15	3.02 (2.06-3.43-5.00)	1.80 (1.16-2.13-3.31)	1.43 (0.84-1.78-3.06)	0.78 (0.30-1.17-2.36)	0.59 (0.16-0.98-2.13)	0.39 (0.10-0.69-1.50)	0.33 (0.10-0.55-1.30)			
1.55	2.50	3.25 (2.20-3.69-5.50)	1.94 (1.24-2.30-3.59)	1.55 (0.91-1.93-3.31)	0.84 (0.32-1.26-2.56)	0.63 (0.18-1.05-2.31)	0.42 (0.12-0.73-1.62)	0.35 (0.10-0.58-1.37)			

Table S9: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape E** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.19 (1.52-2.52-3.74)	1.34 (0.86-1.59-2.49)	1.08 (0.64-1.35-2.32)	0.59 (0.23-0.90-1.82)	0.45 (0.12-0.76-1.67)	0.32 (0.10-0.56-1.24)	0.26 (0.10-0.46-1.06)			
1.48	2.15	2.41 (1.66-2.78-4.00)	1.48 (0.94-1.76-2.80)	1.18 (0.69-1.49-2.59)	0.64 (0.26-0.99-2.02)	0.49 (0.14-0.84-1.85)	0.34 (0.10-0.61-1.36)	0.28 (0.10-0.49-1.14)			
1.48	2.50	2.63 (1.78-3.02-4.50)	1.61 (1.02-1.91-3.09)	1.29 (0.76-1.62-2.85)	0.70 (0.28-1.08-2.22)	0.54 (0.14-0.91-2.02)	0.37 (0.10-0.65-1.45)	0.30 (0.10-0.52-1.21)			
1.49	1.80	2.16 (1.50-2.49-3.70)	1.34 (0.84-1.57-2.47)	1.07 (0.62-1.34-2.29)	0.58 (0.23-0.89-1.80)	0.45 (0.12-0.76-1.66)	0.32 (0.10-0.56-1.23)	0.26 (0.10-0.45-1.05)			
1.49	2.15	2.37 (1.64-2.74-4.00)	1.45 (0.93-1.73-2.75)	1.17 (0.68-1.47-2.57)	0.63 (0.26-0.98-2.01)	0.49 (0.14-0.83-1.84)	0.34 (0.10-0.61-1.35)	0.28 (0.10-0.49-1.14)			
1.49	2.50	2.61 (1.76-2.98-4.50)	1.59 (1.00-1.89-3.02)	1.27 (0.76-1.60-2.81)	0.70 (0.28-1.07-2.20)	0.53 (0.14-0.90-2.00)	0.37 (0.10-0.65-1.44)	0.30 (0.10-0.52-1.21)			
1.50	1.80	2.13 (1.48-2.46-3.64)	1.32 (0.84-1.56-2.42)	1.05 (0.62-1.32-2.25)	0.57 (0.22-0.88-1.78)	0.45 (0.12-0.75-1.64)	0.31 (0.10-0.56-1.22)	0.26 (0.10-0.45-1.06)			
1.50	2.15	2.34 (1.62-2.71-4.00)	1.44 (0.92-1.72-2.73)	1.15 (0.68-1.46-2.54)	0.63 (0.25-0.97-1.99)	0.49 (0.14-0.82-1.82)	0.34 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.14)			
1.50	2.50	2.56 (1.75-2.95-4.50)	1.57 (1.00-1.87-2.98)	1.27 (0.74-1.59-2.78)	0.69 (0.27-1.06-2.17)	0.53 (0.14-0.89-1.98)	0.37 (0.10-0.65-1.43)	0.30 (0.10-0.52-1.21)			
1.51	1.80	2.11 (1.46-2.44-3.60)	1.29 (0.82-1.54-2.39)	1.03 (0.62-1.31-2.22)	0.57 (0.22-0.87-1.77)	0.43 (0.12-0.74-1.62)	0.30 (0.10-0.55-1.22)	0.26 (0.10-0.45-1.06)			
1.51	2.15	2.31 (1.60-2.68-3.94)	1.43 (0.90-1.70-2.68)	1.15 (0.68-1.44-2.50)	0.63 (0.24-0.96-1.96)	0.49 (0.14-0.81-1.79)	0.33 (0.10-0.60-1.34)	0.28 (0.10-0.49-1.14)			
1.51	2.50	2.55 (1.72-2.92-4.50)	1.56 (0.98-1.85-2.96)	1.25 (0.74-1.57-2.73)	0.68 (0.26-1.04-2.14)	0.53 (0.14-0.88-1.95)	0.37 (0.10-0.64-1.43)	0.30 (0.10-0.52-1.21)			
1.52	1.80	2.09 (1.46-2.41-3.56)	1.28 (0.82-1.52-2.36)	1.02 (0.60-1.29-2.21)	0.55 (0.22-0.86-1.76)	0.43 (0.12-0.73-1.62)	0.30 (0.10-0.55-1.22)	0.26 (0.10-0.45-1.04)			
1.52	2.15	2.28 (1.58-2.65-3.90)	1.42 (0.89-1.68-2.65)	1.13 (0.66-1.42-2.48)	0.62 (0.24-0.95-1.94)	0.49 (0.13-0.81-1.77)	0.34 (0.10-0.60-1.32)	0.28 (0.10-0.49-1.13)			
1.52	2.50	2.51 (1.70-2.88-4.50)	1.54 (0.98-1.82-2.91)	1.23 (0.72-1.55-2.68)	0.67 (0.26-1.03-2.10)	0.53 (0.14-0.87-1.92)	0.36 (0.10-0.64-1.42)	0.30 (0.10-0.52-1.20)			
1.53	1.80	2.06 (1.44-2.37-3.53)	1.27 (0.80-1.50-2.34)	1.02 (0.60-1.27-2.17)	0.55 (0.22-0.85-1.73)	0.43 (0.12-0.73-1.58)	0.30 (0.10-0.54-1.20)	0.25 (0.10-0.44-1.04)			
1.53	2.15	2.25 (1.56-2.61-3.84)	1.40 (0.88-1.65-2.62)	1.13 (0.66-1.40-2.44)	0.61 (0.24-0.94-1.92)	0.47 (0.12-0.80-1.75)	0.33 (0.10-0.59-1.32)	0.28 (0.10-0.48-1.12)			
1.53	2.50	2.47 (1.68-2.84-4.00)	1.52 (0.96-1.80-2.89)	1.21 (0.72-1.53-2.67)	0.67 (0.26-1.02-2.08)	0.51 (0.14-0.86-1.91)	0.36 (0.10-0.64-1.40)	0.29 (0.10-0.51-1.19)			
1.54	1.80	2.04 (1.42-2.34-3.48)	1.26 (0.80-1.48-2.30)	1.01 (0.58-1.26-2.13)	0.55 (0.22-0.84-1.70)	0.43 (0.12-0.72-1.56)	0.30 (0.10-0.54-1.19)	0.25 (0.10-0.44-1.02)			
1.54	2.15	2.22 (1.54-2.57-3.80)	1.37 (0.88-1.63-2.55)	1.11 (0.66-1.38-2.39)	0.60 (0.24-0.93-1.89)	0.47 (0.12-0.79-1.74)	0.33 (0.10-0.59-1.30)	0.27 (0.10-0.48-1.11)			
1.54	2.50	2.44 (1.66-2.80-4.00)	1.50 (0.94-1.78-2.83)	1.21 (0.70-1.50-2.62)	0.66 (0.26-1.00-2.06)	0.51 (0.14-0.85-1.88)	0.35 (0.10-0.63-1.40)	0.29 (0.10-0.51-1.19)			
1.55	1.80	2.01 (1.41-2.30-3.42)	1.24 (0.79-1.46-2.23)	0.99 (0.58-1.24-2.11)	0.54 (0.22-0.83-1.68)	0.43 (0.12-0.71-1.55)	0.30 (0.10-0.53-1.18)	0.24 (0.10-0.44-1.02)			
1.55	2.15	2.19 (1.52-2.53-3.76)	1.35 (0.86-1.61-2.54)	1.08 (0.64-1.36-2.33)	0.59 (0.24-0.91-1.85)	0.46 (0.12-0.78-1.72)	0.32 (0.10-0.58-1.30)	0.27 (0.10-0.47-1.10)			
1.55	2.50	2.39 (1.64-2.76-4.00)	1.48 (0.93-1.75-2.80)	1.19 (0.70-1.48-2.59)	0.65 (0.26-0.99-2.03)	0.51 (0.14-0.84-1.86)	0.35 (0.10-0.62-1.40)	0.29 (0.10-0.51-1.18)			

Table S10: As in Tables 2 and 3 but for all the possible combination of real part of the refractive index and particle density for all the wavelengths for the **Irregular shape F** from [2]: Imaginary part of the complex refractive index k for periods characterized as *dust events* throughout the PM2.5 part of the campaign. The retrieval of the averaged optical measurements is shown in bold, while the 5th percentile, the mean, and the 95th percentile of the distribution from the 15-min retrievals are shown within the parenthesis. All retrievals in this table are shown multiplied by 10^3 for clarity.

n_r	ρ_p	k : Imaginary refractive index									
		370 nm	470 nm	520 nm	590 nm	660 nm	880 nm	950 nm			
1.48	1.80	2.64 (1.82-2.98-4.50)	1.58 (1.00-1.85-2.87)	1.25 (0.74-1.55-2.67)	0.68 (0.26-1.02-2.05)	0.51 (0.14-0.86-1.87)	0.35 (0.10-0.61-1.34)	0.28 (0.10-0.49-1.14)			
1.48	2.15	2.85 (1.94-3.23-5.00)	1.72 (1.08-2.01-3.14)	1.37 (0.80-1.69-2.93)	0.74 (0.28-1.11-2.24)	0.56 (0.16-0.93-2.04)	0.37 (0.10-0.65-1.42)	0.30 (0.10-0.52-1.21)			
1.48	2.50	3.07 (2.08-3.48-5.50)	1.84 (1.17-2.17-3.44)	1.46 (0.86-1.82-3.17)	0.78 (0.30-1.19-2.42)	0.59 (0.16-0.99-2.19)	0.39 (0.10-0.69-1.51)	0.31 (0.10-0.54-1.27)			
1.49	1.80	2.61 (1.80-2.95-4.50)	1.55 (1.00-1.83-2.88)	1.23 (0.74-1.54-2.65)	0.66 (0.26-1.01-2.03)	0.51 (0.14-0.85-1.87)	0.35 (0.10-0.61-1.34)	0.28 (0.10-0.49-1.14)			
1.49	2.15	2.83 (1.94-3.20-5.00)	1.69 (1.08-1.99-3.14)	1.35 (0.80-1.67-2.92)	0.73 (0.28-1.10-2.23)	0.55 (0.15-0.92-2.03)	0.37 (0.10-0.65-1.42)	0.30 (0.10-0.52-1.22)			
1.49	2.50	3.03 (2.06-3.44-5.00)	1.83 (1.16-2.15-3.40)	1.45 (0.86-1.80-3.15)	0.78 (0.30-1.18-2.40)	0.59 (0.16-0.99-2.18)	0.39 (0.10-0.69-1.51)	0.31 (0.10-0.55-1.27)			
1.50	1.80	2.59 (1.79-2.92-4.50)	1.53 (0.98-1.81-2.81)	1.22 (0.72-1.52-2.60)	0.65 (0.26-1.00-2.00)	0.51 (0.14-0.84-1.82)	0.34 (0.10-0.60-1.33)	0.28 (0.10-0.49-1.14)			
1.50	2.15	2.80 (1.92-3.17-5.00)	1.67 (1.07-1.97-3.08)	1.33 (0.78-1.65-2.87)	0.72 (0.28-1.09-2.21)	0.55 (0.15-0.91-1.99)	0.37 (0.10-0.65-1.41)	0.30 (0.10-0.52-1.21)			
1.50	2.50	3.00 (2.04-3.41-5.00)	1.81 (1.14-2.12-3.36)	1.44 (0.84-1.78-3.11)	0.78 (0.30-1.17-2.37)	0.59 (0.16-0.98-2.15)	0.39 (0.10-0.68-1.50)	0.32 (0.10-0.54-1.28)			
1.51	1.80	2.57 (1.78-2.89-4.50)	1.53 (0.98-1.79-2.77)	1.21 (0.72-1.51-2.57)	0.66 (0.26-0.99-2.00)	0.51 (0.14-0.84-1.81)	0.34 (0.10-0.60-1.33)	0.28 (0.10-0.49-1.14)			
1.51	2.15	2.78 (1.90-3.14-4.50)	1.65 (1.06-1.95-3.07)	1.31 (0.78-1.64-2.85)	0.71 (0.28-1.08-2.19)	0.54 (0.14-0.91-1.97)	0.37 (0.10-0.65-1.41)	0.30 (0.10-0.52-1.21)			
1.51	2.50	2.98 (2.02-3.38-5.00)	1.79 (1.13-2.11-3.30)	1.43 (0.84-1.77-3.08)	0.77 (0.30-1.16-2.36)	0.59 (0.16-0.97-2.14)	0.39 (0.10-0.68-1.50)	0.32 (0.10-0.55-1.28)			
1.52	1.80	2.52 (1.74-2.86-4.25)	1.52 (0.96-1.77-2.72)	1.21 (0.72-1.49-2.53)	0.65 (0.26-0.99-1.98)	0.51 (0.14-0.83-1.80)	0.34 (0.10-0.60-1.31)	0.28 (0.10-0.49-1.13)			
1.52	2.15	2.75 (1.88-3.11-4.50)	1.64 (1.05-1.93-2.95)	1.31 (0.78-1.62-2.78)	0.71 (0.28-1.07-2.15)	0.55 (0.14-0.90-1.96)	0.37 (0.10-0.64-1.41)	0.30 (0.10-0.52-1.20)			
1.52	2.50	2.96 (2.00-3.35-5.00)	1.76 (1.13-2.08-3.22)	1.40 (0.84-1.75-3.00)	0.76 (0.30-1.15-2.33)	0.57 (0.16-0.97-2.10)	0.39 (0.10-0.68-1.49)	0.31 (0.10-0.55-1.27)			
1.53	1.80	2.49 (1.72-2.83-4.00)	1.50 (0.96-1.76-2.71)	1.19 (0.70-1.48-2.52)	0.65 (0.26-0.98-1.98)	0.49 (0.14-0.82-1.80)	0.34 (0.10-0.60-1.31)	0.28 (0.10-0.48-1.13)			
1.53	2.15	2.73 (1.86-3.07-4.50)	1.62 (1.04-1.92-3.01)	1.29 (0.76-1.61-2.78)	0.70 (0.28-1.07-2.13)	0.54 (0.14-0.90-1.96)	0.37 (0.10-0.64-1.42)	0.30 (0.10-0.52-1.20)			
1.53	2.50	2.92 (1.98-3.30-5.00)	1.75 (1.12-2.07-3.26)	1.39 (0.82-1.74-3.02)	0.76 (0.30-1.15-2.33)	0.57 (0.16-0.96-2.12)	0.39 (0.10-0.68-1.51)	0.31 (0.10-0.55-1.28)			
1.54	1.80	2.46 (1.71-2.80-4.00)	1.49 (0.94-1.74-2.67)	1.18 (0.70-1.46-2.50)	0.64 (0.25-0.97-1.96)	0.49 (0.14-0.82-1.78)	0.34 (0.10-0.60-1.31)	0.28 (0.10-0.48-1.12)			
1.54	2.15	2.69 (1.84-3.04-4.50)	1.61 (1.04-1.90-2.97)	1.29 (0.76-1.60-2.75)	0.69 (0.28-1.06-2.11)	0.53 (0.14-0.89-1.94)	0.36 (0.10-0.64-1.42)	0.30 (0.10-0.52-1.20)			
1.54	2.50	2.89 (1.96-3.27-5.00)	1.73 (1.11-2.04-3.21)	1.38 (0.81-1.72-2.99)	0.74 (0.30-1.14-2.31)	0.57 (0.16-0.95-2.10)	0.39 (0.10-0.68-1.50)	0.31 (0.10-0.55-1.28)			
1.55	1.80	2.43 (1.70-2.77-4.00)	1.47 (0.94-1.72-2.64)	1.17 (0.70-1.45-2.48)	0.63 (0.25-0.96-1.94)	0.49 (0.13-0.81-1.76)	0.34 (0.10-0.59-1.30)	0.28 (0.10-0.48-1.12)			
1.55	2.15	2.65 (1.82-3.01-4.50)	1.60 (1.02-1.88-2.94)	1.27 (0.76-1.58-2.71)	0.69 (0.28-1.05-2.10)	0.53 (0.14-0.88-1.92)	0.36 (0.10-0.64-1.41)	0.30 (0.10-0.52-1.20)			
1.55	2.50	2.86 (1.94-3.24-5.00)	1.70 (1.10-2.02-3.18)	1.36 (0.80-1.70-2.97)	0.73 (0.30-1.13-2.29)	0.57 (0.16-0.95-2.09)	0.39 (0.10-0.68-1.50)	0.31 (0.10-0.55-1.27)			

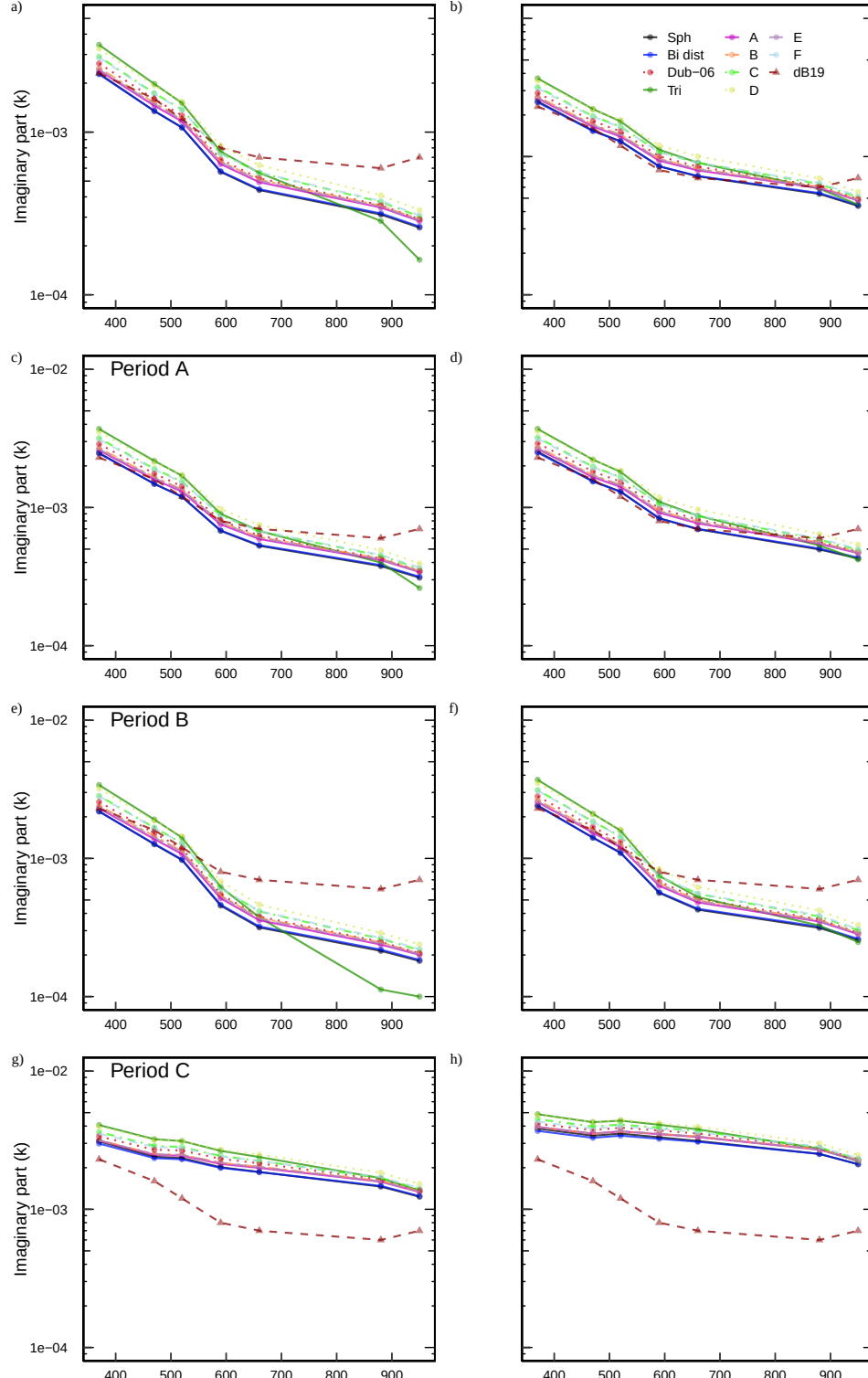


Figure S8: Retrieved k as in Fig. 8 of the main manuscript for the retrieval of the averages (left column, a,c, and e), and the average of the retrievals (right column, b,d, and f). The upper panel shows the whole dataset (upper panel) and then the different periods are shown: Period A: local emission, Period B: haboob event, and Period C: anthropogenic-influenced period.

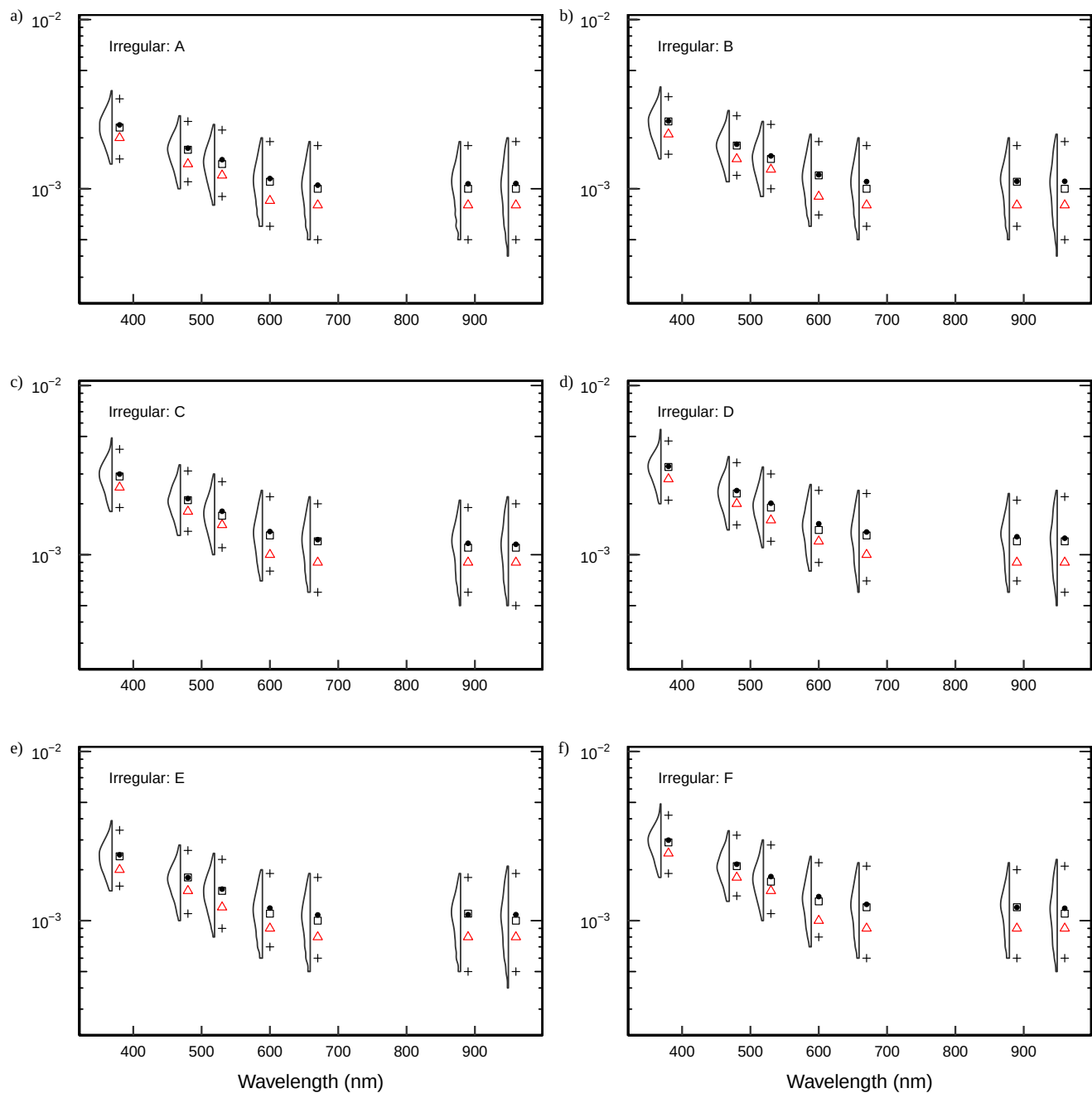


Figure S9: Retrieved k as in Fig. 8 of the main manuscript for the irregular shapes from the MOPSMAP database: A, B, C, D, E and F

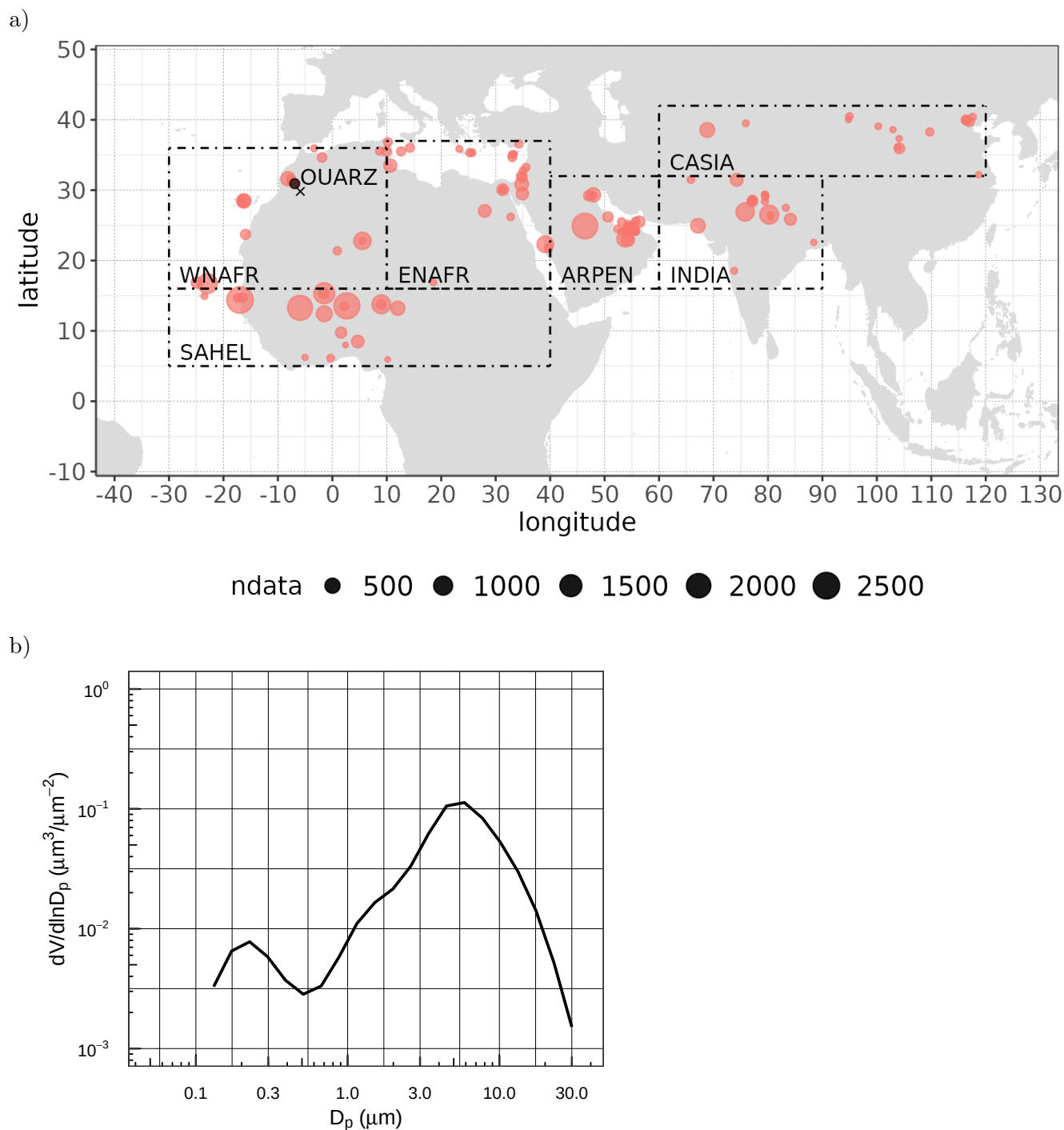


Figure S10: a) Map of the AERONET stations selected after filtering dust events, located within dust regions: northwestern Africa (WNAFR), northeastern Africa (ENAFR), Sahel, Arabian Peninsula (ARPEN), India, central Asia (CASIA). The dots represent all the AERONET stations within the regions, with symbol size proportional to the number of dust-filtered retrievals. The dark point indicates the Ouarzazate AERONET station and the cross marks the specific location of the measurement site. b) AERONET-derived volume size distribution, $dV/d\ln D_p$, for dust-filtered retrievals at the Ouarzazate station between 2000–2020.

Synthetic observation experiments

We performed an Observing System Simulation Experiment (OSSE) to assess the robustness and sensitivity of the k retrieval method to input perturbations and methodological choices. The OSSEs use prescribed “true” values of the particle size distribution (PSD), absorption coefficient, truncated scattering coefficient, particle density, particle shape, and refractive index. Synthetic observations are then generated by perturbing these true values, and the retrieval is applied to test how accurately k can be recovered.

The true PSD was prescribed as the campaign-average particle size distribution. The true absorption and truncated scattering coefficients were computed assuming spherical particles, a particle density of 2.5 g cm^{-3} and a refractive index of $1.52 + 0.0015i$, so $k = 0.0015$ is the target value to retrieve in the synthetic experiments.

Five sets of 50 synthetic samples were generated. The first set perturbs only the truncated scattering ($tsca$), while keeping the PSD and absorption coefficient fixed at their true values. The second set perturbs only the absorption coefficient, (abs), while keeping $tsca$ and the PSD fixed. The third set perturbs both $tsca$ and abs , while keeping the PSD fixed. The fourth set perturbs only the PSD, while keeping $tsca$ and abs fixed. The fifth set perturbs the PSD, $tsca$, and abs simultaneously.

The perturbations in $tsca$ and abs were drawn independently from a uniform distribution within ($\pm 10\%$) of the prescribed true value. This range is used as a controlled sensitivity test of measurement-level uncertainty in the optical variables, rather than as a complete probabilistic uncertainty model.

The PSD perturbations were designed to explore both changes in the shape of the PSD and changes in the absolute particle number concentration. First, the campaign-average PSD was approximated as the sum of eight log-normal modes. The total number concentration of each log-normal mode was then independently perturbed using a uniform distribution within ($\pm 50\%$) of its prescribed value. The resulting PSD was first normalized to preserve the true total particle number; this step isolates changes in PSD shape while keeping the integrated particle number constant. In a second step, the total number concentration of the full PSD was also perturbed using a uniform distribution within ($\pm 50\%$) of the true total number. This procedure allows the OSSEs to explore both size-dependent PSD-shape distortions and uniform particle-number changes.

Figure S11 shows the prescribed true values and the perturbed synthetic observations for the PSD, abs , $tsca$, and $tssa$. Figure S12 to Figure S15 show the retrieved k , together with the simulated $tsca$, abs , and $tssa$ obtained using the retrieved k .

Figure S12 shows the results for an inversion assumption of spherical shapes, i.e., the same particle shape used to generate the synthetic truth. The first column shows the sensitivity to perturbations in $tsca$: lower $tsca$, and therefore lower $tssa$, requires larger retrieved k , whereas higher $tsca$ leads to smaller retrieved k . The second column shows that higher absorption leads to higher retrieved k , as expected. The third column shows the combined effect of perturbing $tsca$ and abs , which directly modifies $tssa$. The fourth column shows the effect of perturbing the PSD. In this case, the simulated absolute values of $tsca$ and abs can differ substantially from the true values, but the retrieved k remains comparatively stable because the cost function is based on $tssa$. The fifth column shows that, when all perturbations are applied simultaneously, the retrieved k remains distributed around the true value, although with increased dispersion.

Figure S12 also illustrates the sensitivity of retrieved k and the simulated $tsca$ and abs to the prescribed real part of the refractive index (n) and the density of the particle (ρ_p). The sensitivity to n is relatively small compared with the effect of k , whereas ρ_p has a clearer effect because it controls the aerodynamic-to-geometric diameter conversion and therefore the effective PM2.5 size range included in the retrieval.

Figure S13 shows the corresponding experiment when the inversion assumes spheroids with the [1] aspect-ratio distribution, while the synthetic truth was generated using spherical particles. This experiment illustrates the effect of particle-shape mismatch. In this case, the main consequence is a systematic positive bias in retrieved k relative to the baseline spherical experiment in Figure S12. This result high-

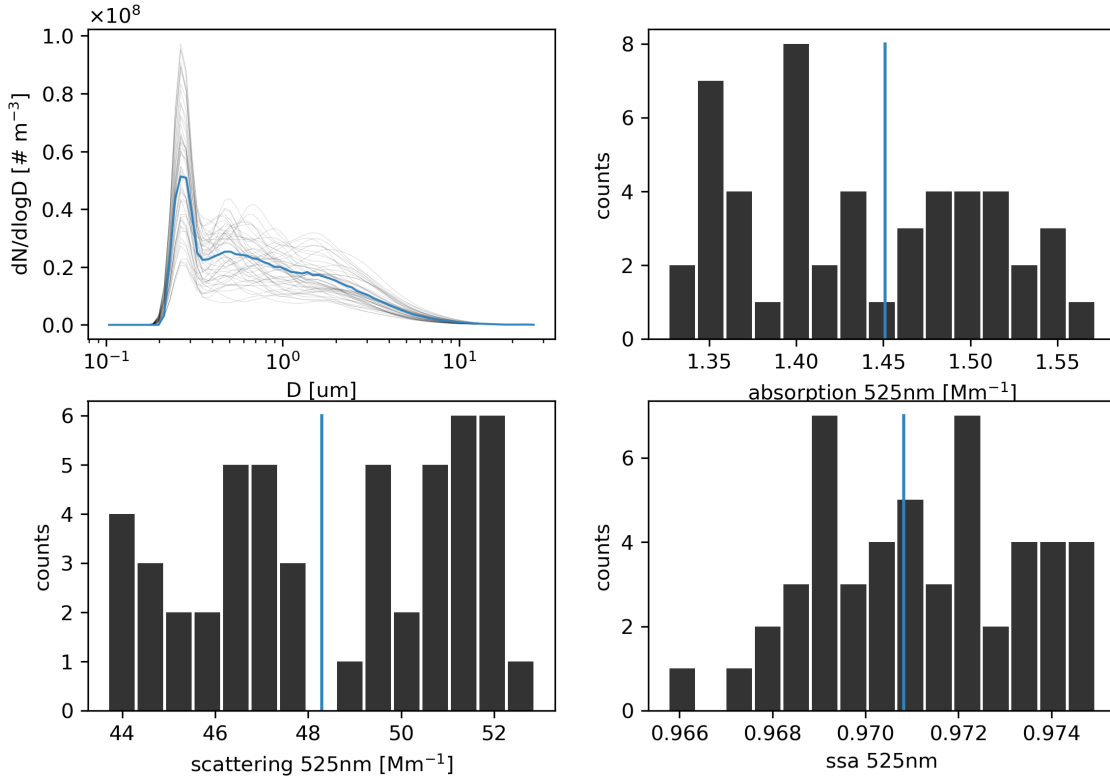


Figure S11: True values and perturbed synthetic observations used in the OSSEs. The panels show the prescribed PSD (lef-top panel), absorption coefficient (*abs*; right-top panel), truncated scattering coefficient (*tsca*; bottom-left panel), and truncated single scattering albedo (*tssa*; bottom-right panel). Blue lines in the PSD plot indicate the true values, whereas grey lines or points indicate the perturbed samples.

lights that particle-shape assumptions can lead to systematic biases in retrieved k when the assumed shape differs from the shape controlling the synthetic observations.

We also tested two methodological alternatives within the OSSE framework. FigureS14 shows the equivalent of Figure S12, but using an OPC optical-to-geometric diameter conversion similar to that of dB19. In this alternative, the OPC conversion is computed as an average over a prescribed set of plausible refractive indices, with ($n = \{1.48, 1.5, 1.53\}$ and $k = \{0.001, 0.002, 0.003, 0.004, 0.005\}$), instead of being coupled to the retrieved k . The cost function remains based on *tssa*. The retrieved k , simulated *tsca*, and simulated *abs* are very similar to the baseline approach shown in Figure S12. This suggests that the DB19-type OPC conversion produces similar results when the assumed particle shape is consistent.

Figure S15 uses the same OPC conversion as Figure S14, but replaces the *tssa*-based cost function with a cost function based on extensive optical properties, closer to the approach of DB19. In our field-based adaptation, the full scattering coefficient is replaced by the truncated scattering coefficient, *tsca*, to avoid introducing an additional correction to complete the scattering phase function. The cost function is defined as

$$J(k) = \left(\frac{tsca_{\text{measured}} - tsca(k)}{tsca(k)} \right)^2 + \left(\frac{abs_{\text{measured}} - abs(k)}{abs(k)} \right)^2$$

with *tsca* and *abs*

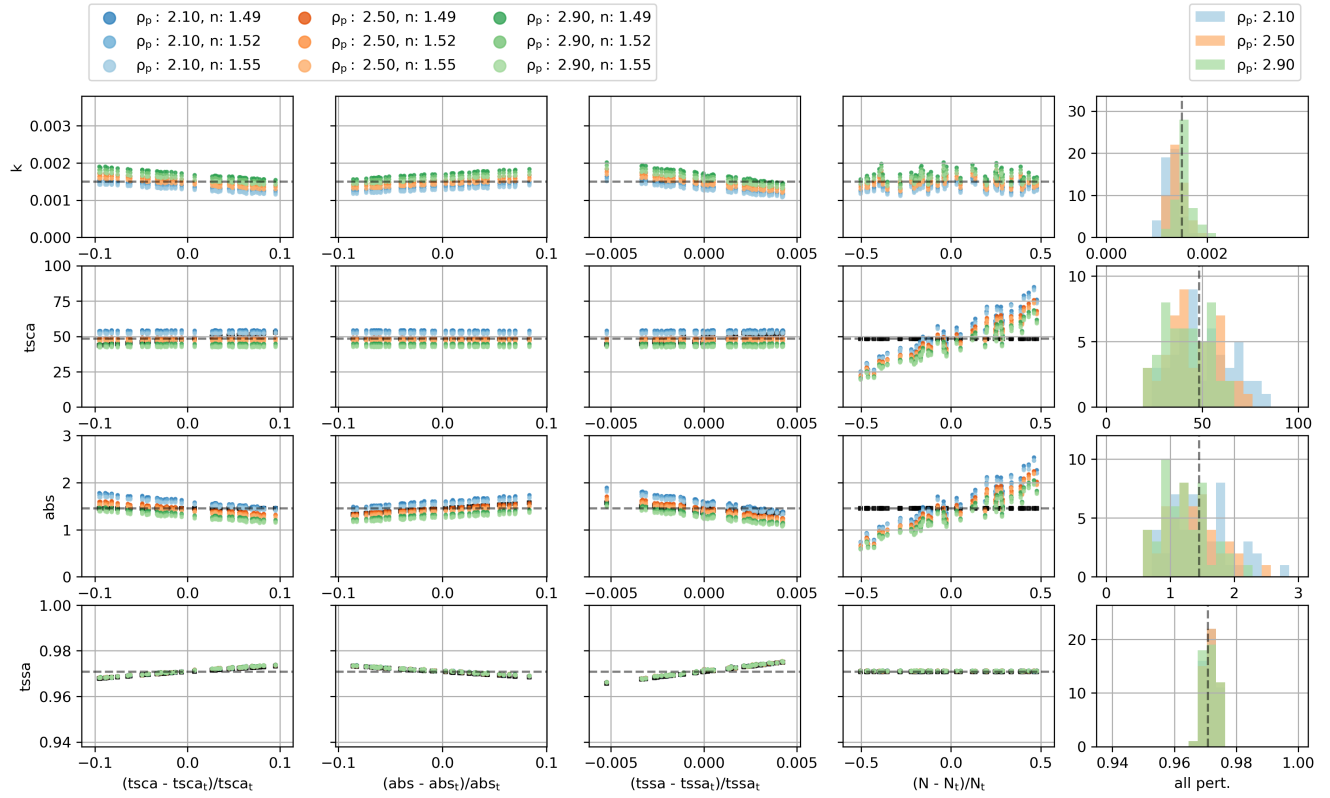


Figure S12: Synthetic experiment results for spheres. Estimates of the imaginary part of the refractive index (k), the simulated truncated scattering coefficient ($tsca$), the simulated absorption coefficient (abs) and the truncated single scattering albedo ($tssa$) for inversions using the perturbations shown in Figure S11. Computation of values of $tsca$, abs and $tssa$ use the k estimated in the inversion (shown in the first row). This Figure shows the variables k , $tsca$, abs and $tssa$ as function of the relative error of the perturbed variables (true values are notated with the under-script t) for perturbations only in the truncated scattering (first column), only in the absorption coefficient (second column), only in the truncated single scattering albedo (third column), and only in the particle size distribution (fourth column). Last column shows histograms of k , $tsca$, abs , and $tssa$ for the case where all variables (PSD, $tsca$ and abs) are jointly perturbed. Values used as observations in the last three rows are shown in black. True values are shown with a dashed grey line.

The main difference between this cost function and the one used in the main manuscript is that it fits the absolute extensive optical properties rather than their ratio. As a result, it is more sensitive to PSD and particle number perturbations. When the PSD underestimates the true particle number, the inversion can compensate by retrieving a larger k , improving the fit to absorption but leaving $tsca$ and $tssa$ underestimated. Conversely, when the PSD overestimates the true particle number, the inversion can compensate by retrieving a smaller k , improving the fit to absorption but overestimating $tsca$ and $tssa$. This behaviour shows that, when the PSD and optical measurements are affected by sampling mismatches, extensive-property-based inversions can translate PSD biases into biased estimates of k .

Although the cost function (J) used in Figure S15 combines residuals in both abs and $tsca$, the fit is, in practice, controlled mainly by abs . This occurs because k directly controls absorption, whereas the simulated truncated scattering coefficient is more strongly affected by the PSD, particle density, particle shape, and the inlet-efficiency mapping. A suitable combination of n , particle density, and particle shape can also improve the fit to $tsca$, but in most cases shown in columns 2, 3, and 4 this occurs only when the prescribed particle density is equal to 2.5 g cm^{-3} , i.e., the true density used to generate the synthetic

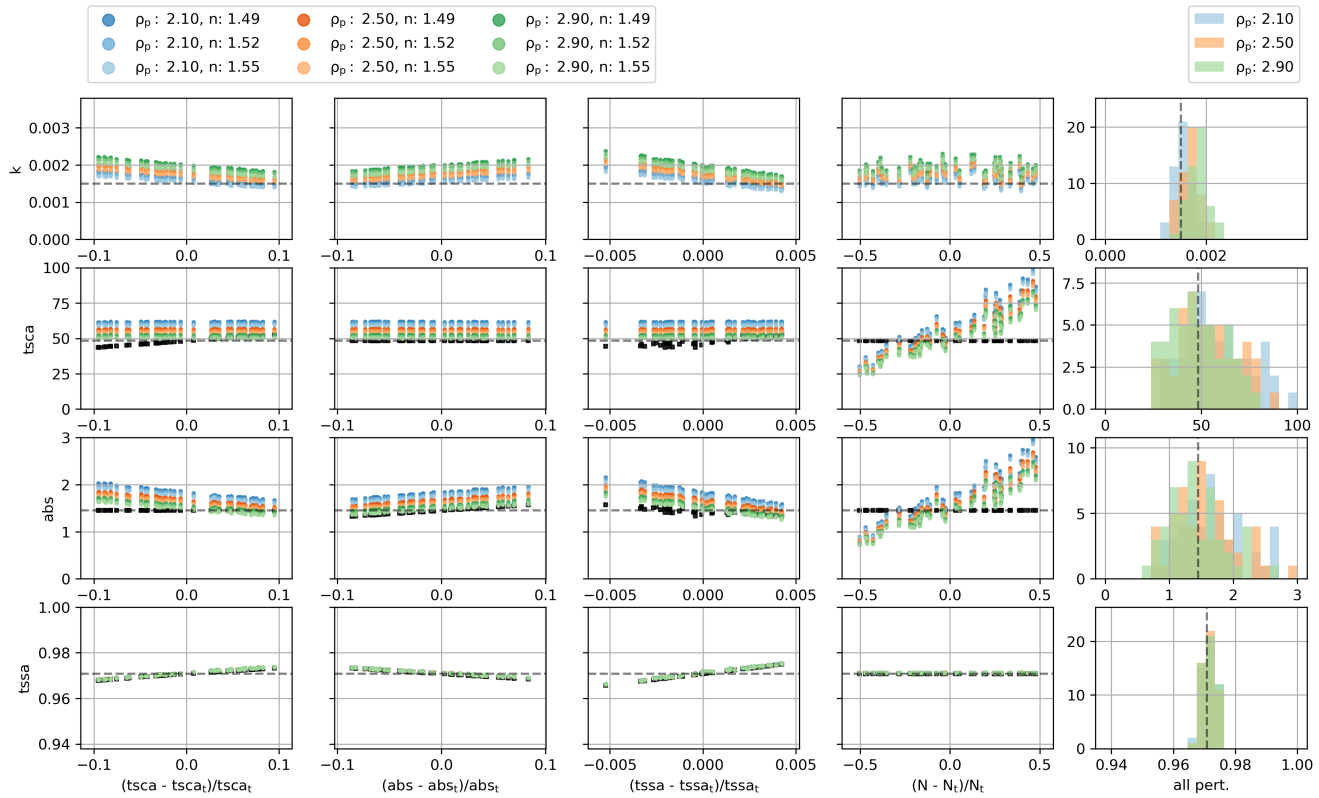


Figure S13: Synthetic experiment results for spheroids with aspect ratio distribution from [1]. Please refer to S12 for the explanation of the panels.

observations. This behaviour is linked to the dependence of the simulated PM_{2.5} inlet cut-off on particle density and dynamic shape factor, which determines the effective PSD used in the inversion.

The fourth column of Figure S15 illustrates this behaviour more clearly. When the PSD underestimates the true particle number concentration, corresponding to the negative side of the x-axis, the retrieved k is overestimated. In this case, the simulated absorption coefficient is fitted well, but the simulated $tsca$ and $tssa$ remain underestimated. This indicates that the lack of particles in the PSD is compensated in the inversion by retrieving more absorbing particles. Conversely, when the PSD overestimates the true particle number concentration, corresponding to the positive side of the x-axis, the retrieved k is underestimated. In that case, the fit to abs remains good, but $tsca$ and $tssa$ are overestimated, indicating that the excess number of particles is compensated by retrieving less absorbing particles.

The range of values induced by varying n within the tested interval is relatively small compared with the changes induced by variations in (k) . Therefore, when the extensive-property cost function (J) is used, biases in the PSD or in the relative sampling of the OPC and optical instruments are translated primarily into biases in the retrieved k , at least for n values within the range 1.48–1.55 considered here, which is close to the range used in DB19.

In experimental configurations where the PSD and optical properties are measured from the same aerosol population, and where no relevant systematic PSD–optical sampling bias is present, an extensive-property cost function such as that of DB19 can be more appropriate. Under such conditions, the inversion can exploit the independent information contained in absorption and scattering and may support the simultaneous retrieval of both n and k , provided that particle density, inlet transmission, and particle shape are sufficiently well characterized. However, if particle shape is unknown or poorly represented, shape-related biases may still propagate into the retrieved n and k .

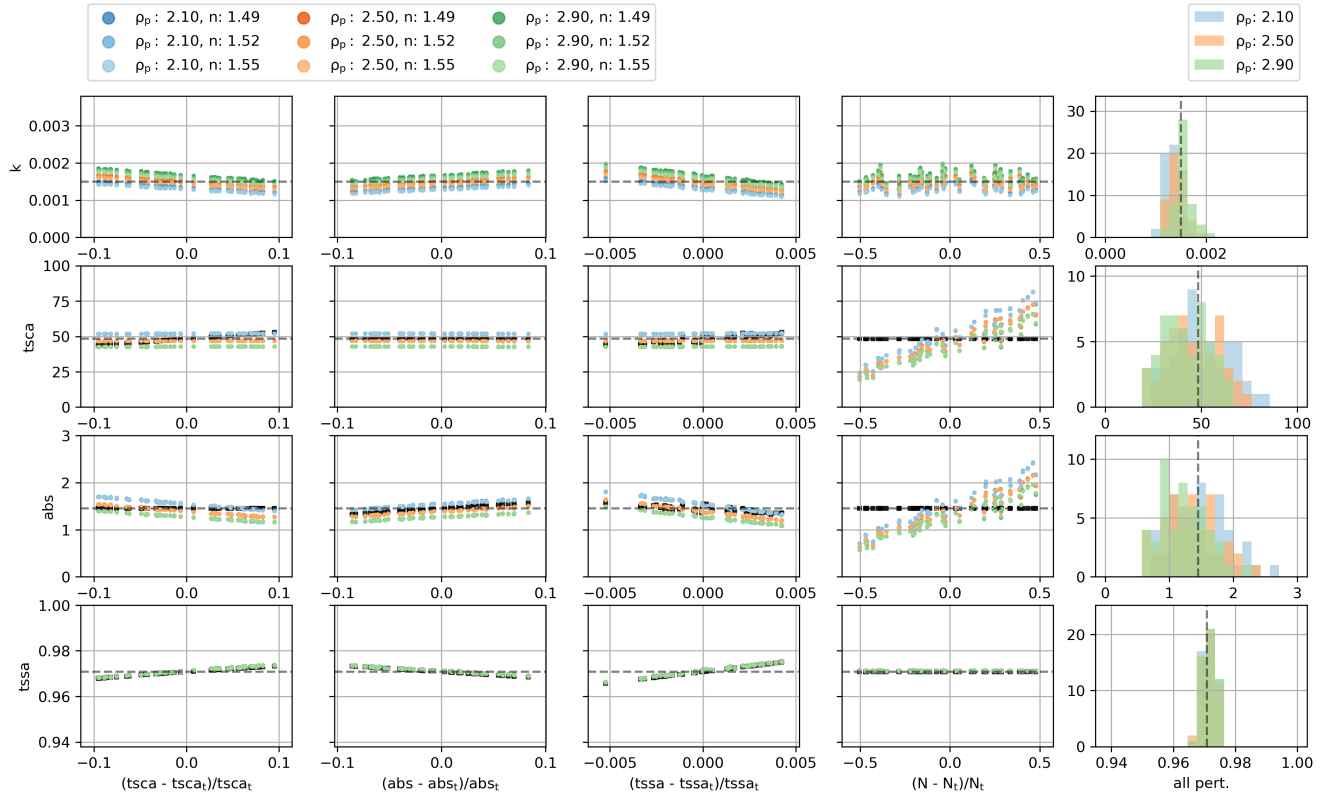


Figure S14: Synthetic experiment results for spheres but with OPC diameter conversion similar to DB19. Please refer to S12 for the explanation of the panels.

For the present field campaign, the OPC and optical instruments sampled through different inlet systems, and the available measurements indicate possible systematic differences between the PSD measured by the Fidas and the aerosol population sampled by the nephelometer and aethalometer. Because the available data do not allow these differences to be robustly corrected, the *tssa*-based cost function is more appropriate for estimating k in this study. This choice reduces sensitivity to absolute particle-number mismatches, while the OSSEs also show that size-dependent PSD-shape distortions can still introduce systematic uncertainty. For this reason, the retrieved k values in the main manuscript are interpreted as conditional estimates under prescribed assumptions for PSD, particle shape, particle density, n , and AE33 absorption correction.

Overall, the OSSEs show that the *tssa*-based retrieval is appropriate for estimating k under the constraints of the present field campaign, where the OPC and optical instruments sampled through different inlet systems and a robust absolute PSD–optical closure cannot be guaranteed. The use of *tssa* reduces sensitivity to approximately uniform particle-number mismatches because it is based on a ratio. However, it does not fully remove the possible impact of size-dependent PSD-shape distortions. Such distortions can change the relative contribution of different particle sizes to absorption and scattering and may therefore introduce systematic biases in retrieved k . For this reason, the retrievals in the main manuscript are interpreted as conditional estimates under prescribed assumptions for PSD, particle shape, density, n , and AE33 absorption correction.

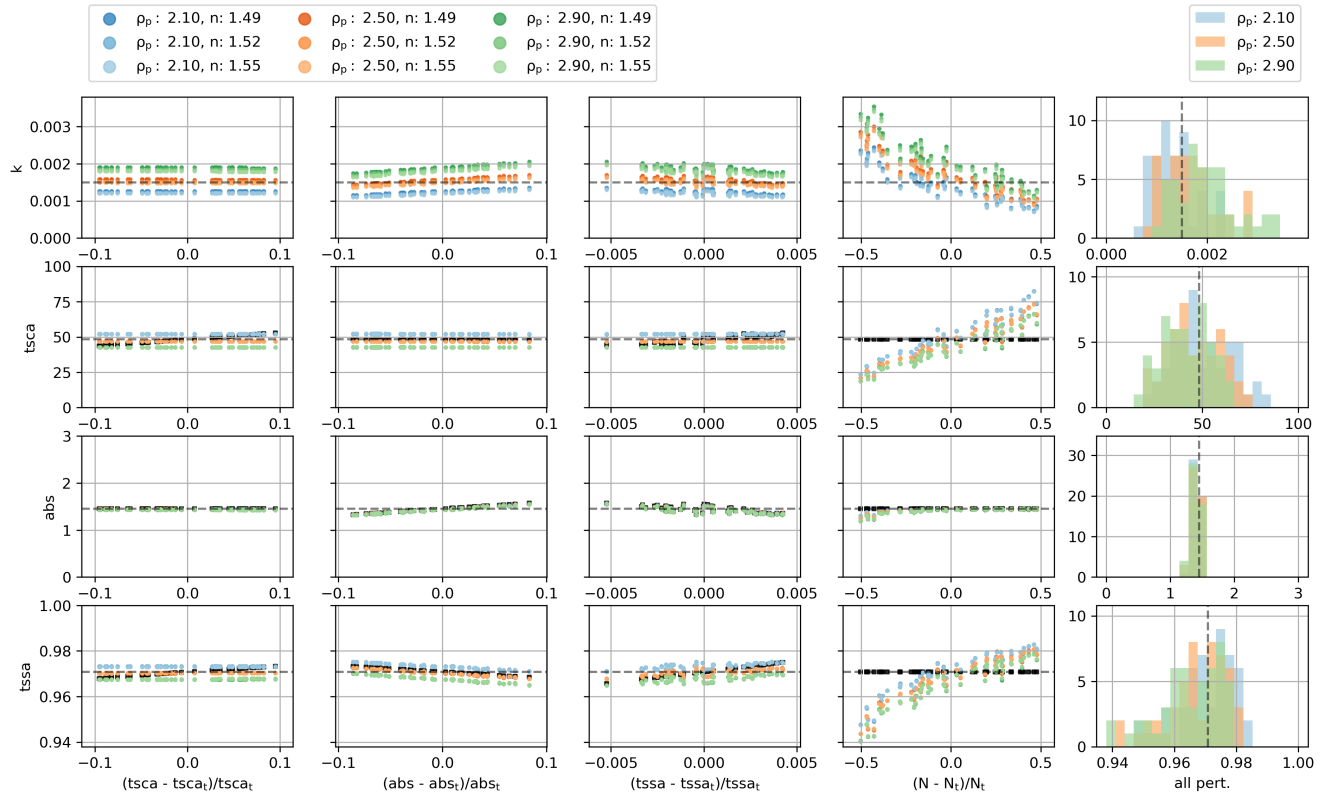


Figure S15: Synthetic experiment results for spheres but with OPC diameter conversion similar to DB19 and cost function similar to DB19. Please, refer to S12 for the explanation of the panels.

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