

Supplementary Material

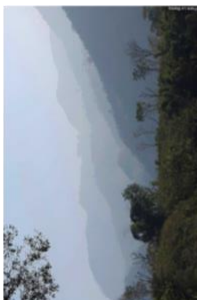
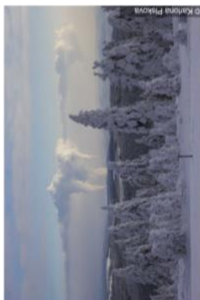
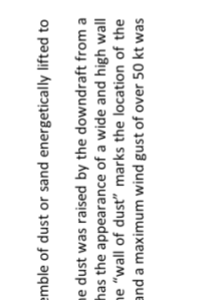
LITHOMETEORS		SUSPENSION of particles in the atmosphere		DRIFTING or BLOWING of particles LIFTED by the wind		
Haze Dust haze Smoke Drifting dust or sand: Duststorm or sandstorm Dust/sand whirl (dust devil)						
	Haze Haze is a suspension in the air of extremely small, dry particles that are invisible to the naked eye and sufficiently numerous to give the air an opalescent appearance. In this picture, haze progressively obscures the detail of successive hill slopes further from the camera. The haze was caused by general pollution and smoke from small bonfires which stagnated over successive days in the sheltered central valley of Nepal during the winter. © Frank Le Blanca Kurnihar, Darchok, Nepal	Dust haze Dust haze is a suspension in the air of dust or small sand particles, raised from the ground prior to the time of the observation by a dust storm or sandstorm that occurred either at or near the location, or far away from it. In this picture, the visibility is significantly reduced to about 1 200 m by a large amount of dust in the atmosphere that has been blown from afar on a strong shamal wind. The surface wind was from the north-north-west at 19 kt. © Frank Le Blanca Doha International Airport, Doha, Qatar	Smoke This picture shows Cumulus flammagenitus, generated as a result of rising thermals from a wildfire. The top of the cloud displays strong sproutings with sharp outlines and indicates the species congestus. Furthermore, the rising thermals have penetrated an elevated moist layer of air, generating a pileus accessory cloud. South-westerly low-level winds have caused a plume of smoke from the wildfire to drift to the north-east, obscuring the base of the Cumulus from the observer. © Irene Ho Vancouver, Canada	Drifting dust or sand: In the image, a strong and gusty wind from the sea (blowing from right to left on the picture) is causing sand to drift from the beach with some force along the ground, but mainly to a height of less than 1.8 m. Near the ground, the sand begins to veil the objects some mt away, but the horizontal visibility at normal observation level is not reduced	Duststorm or sandstorm A dust storm or sandstorm (commonly known as a haboob) is an ensemble of dust or sand energetically lifted to great height by a strong and turbulent wind. This picture shows a dust storm in Helmand Province, Afghanistan. The dust was raised by the downdraft from a high-based thunderstorm. The forward portion of a dust storm often has the appearance of a wide and high wall that advances fairly rapidly, as in this picture. The leading edge of the "wall of dust" marks the location of the advancing gust front. This dust storm reduced visibility to about 10 m and a maximum wind gust of over 50 kt was recorded. Conditions improved after about an hour. © Mike Baker Camp Bastion, near Nad-e-Ali, Helmand Province, Afghanistan	Dust/sand whirl (dust devil) A dust devil (dust whirl or sand whirl) is an ensemble of particles of dust or sand, sometimes accompanied by small litter, raised from the ground in the form of a whirling column about an approximately vertical axis. Dust devils occur when the air near the ground is very unstable, such as when the soil is strongly heated by the Sun. © Stan Cretorian near Glendale, Arizona, United States of America
						
	Haze The dry north-east monsoon brought generally fine but hazy weather to the coastal areas of Guangdong, China. Haze reduced the visibility at Hong Kong International Airport to 1 900 m at the time this photograph was taken. As light is scattered by haze particles, distant bright objects (in this case, the Sun and the surrounding bright sky) appear yellowish or reddish in colour. © Alan Yik Mak Chek Lap Kok, Hong Kong, China	Cumulus congestus and dust Clearance of an area of convection seen from 10 400 m (34 000 ft) over southern Iraq. The cloud is mainly Cumulus congestus, identified by sharp outlines and a lumpy cauliflower appearance. Some behind the front the sky is cloudless, but there is widespread thick dust haze in the lower atmosphere. Nasirya, Iraq (WMO 40676) reported 200 m visibility in a dust storm at 1500 hours and 5 km in dust haze at 1800 hours. © Frank Le Blanca Southern Iraq	Stratocumulus cumulonimbus homogenitus Rising thermals from the power plants Prunéřov, Tusiřice and Počeradý (Czech Republic) generated Cumulus congestus homogenitus clouds at 1, 2 and 3. Cumulonimbus because the stratocumulus has formed by the spreading of Cumulus; homogenitus because it formed as a consequence of human activity. There is a slight reduction of visibility on the horizon due to haze and additional particulate matter from the chimneys. © Karolína Plíšková Jáchymov, Czech Republic	Foehn wall and drifting dust The large band of cloud over the mountains is known as a foehn wall. The foehn wall is a cloud formation which, during an episode of foehn winds, lies over and along a mountain ridge and which appears to an observer downwind from the mountains as a wall or bank of cloud. The warm, dry downslope foehn wind (known locally in Argentina as the Zonda wind) is strong enough here to raise dust to a small height above the ground. This is known as drifting dust. © Moviliana Vile Barriles Blancas, Mendoza, Argentina	Dust whirls (dust devils) and mirage Dust whirls (dust devils) occur when the air near the ground is very unstable, such as when the soil is strongly heated by the Sun. The same conditions are also conducive to the appearance of an inferior mirage, as seen in this photograph taken over the Black Rock Desert in Nevada, USA. Mirages are an optical phenomenon caused by the curving of light rays passing through layers of air with changing refractive index due to differences in temperature and density. In an inferior mirage, the image of a distant object is displaced downwards. © Steve Anderson Gerlach, Nevada, United States of America	

Figure S1. Lithometeors Classification of the World Meteorological Organization: figures and descriptions directly from <https://cloudatlas.wmo.int/>

Table S1

Averaged descriptive statistics for primary and remobilised samples.

Type of deposit	Median $Md\phi^*$	Median (μm)	Sorting# ($\sigma\phi$)	Mode (μm)	2.5 th – 97.5 th percentile difference (μm)
Primary deposit – Unit III					
Primary proximal	-2 – 4.71	4×10^3 – 38	1.20 – 3.54	1.1×10^3 and 40	$6 - 22 \times 10^3$
Primary distal	5.06 – 5.26	26 – 30	1.50 – 1.59	45	2 – 91
Remobilised-associated material					
Plant - windward	4.29 – 4.83	35 – 51	1.24 – 1.49	45	3 – 114
Plant – leeward	2.88 – 3.96	64 – 135	0.80 – 0.88	90	11 – 250
Interpatch	5.39 – 5.35	23 – 25	1.59 – 1.60	30	2 – 72
Rock - leeward	5.05 – 5.06	29 - 30	1.63 – 1.64	35	1 – 125
Fine – ash lens	5.05 – 5.26	26 – 30	1.63 – 1.65	30	1 – 103
Coarse – ash mound layers	2.99 – 4.42	47 – 126	0.83 – 1.61	95	5 – 255
Airborne – 0.15m	3.44 – 4.29	51 – 92	0.93 – 1.47	65	3 – 250
Airborne – 0.50m	3.75 – 4.62	41 - 74	0.98 – 1.13	65	3 – 150
Airborne – 1.50m	3.63 – 4.50	44 – 81	0.79 – 1.09	65	2 – 144

* $\phi = -\log_2 D/D_0$, where $D_0 = 1$ mm.#Sorting, calculated as the Inman graphic standard deviation in phi units, $\alpha_\phi = (P_{84} - P_{16})/2$ where P_{16} and P_{84} correspond to 16th and 84th percentiles respectively (Inman 1952).

Table S2

Comparison of primary (black) and remobilized (magenta) shape descriptors for the 3 size classes. Outliers correspond to points larger than $P75 + w(P75 - P25)$; where P25 and P75 correspond to the 25th and 75th percentiles respectively, and w corresponds to the whisker width, fixed at 1.5. This width corresponds to approximately $\pm 2.7\sigma$ and 99.3 coverage if the data is normally distributed.

SOLIDITY			
Statistics	Class 1: <63 μ m	Class 2: 63 – 125 μ m	Class 3: > 125 μ m
Median	0.806 0.828	0.767 0.828	0.844 0.832
Minimum	0.271 0.328	0.272 0.099	0.347 0.395
Maximum	0.924 0.963	0.927 0.942	0.924 0.940
N (number of particles)	215 804	180 602	342 461
75 th percentile	0.849 0.881	0.831 0.872	0.873 0.871
25 th percentile	0.746 0.759	0.704 0.779	0.811 0.787
Number of outliers	10 40	17 27	22 15
CONVEXITY			
Statistics	Class 1: <63 μ m	Class 2: 63 – 125 μ m	Class 3: > 125 μ m
Median	0.849 0.788	0.741 0.829	0.752 0.738
Minimum	0.567 0.335	0.317 0.523	0.378 0.391
Maximum	0.991 0.998	0.966 0.996	0.962 0.970
N (number of particles)	215 804	180 602	342 461
75 th percentile	0.917 0.867	0.828 0.881	0.818 0.820
25 th percentile	0.772 0.654	0.598 0.736	0.641 0.647
Number of outliers	6 10	0 25	7 7
CIRCULARITY			
Statistics	Class 1: <63 μ m	Class 2: 63 – 125 μ m	Class 3: > 125 μ m
Median	0.806 0.828	0.767 0.828	0.844 0.832
Minimum	0.271 0.328	0.272 0.099	0.347 0.395
Maximum	0.924 0.963	0.927 0.942	0.924 0.940
N (number of particles)	215 804	180 602	342 461
75 th percentile	0.849 0.881	0.831 0.872	0.873 0.871
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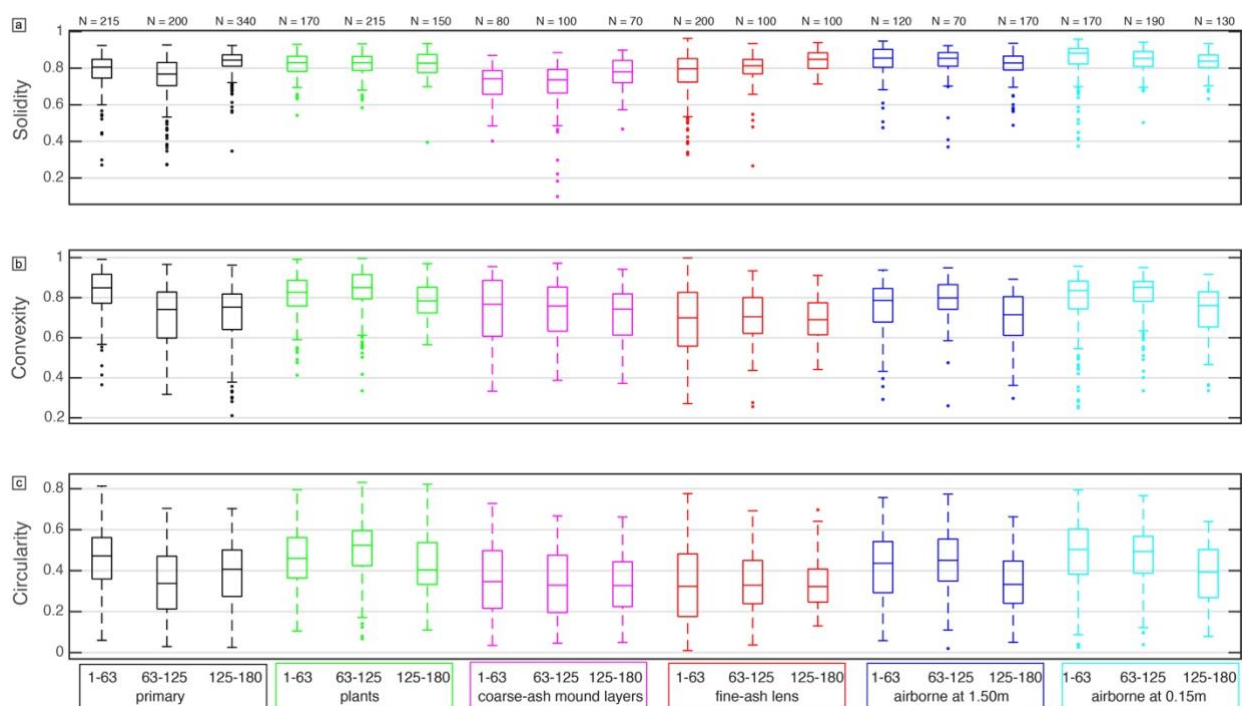


Figure S2. Box and whisker plots showing a) solidity, b) convexity and c) circularity for primary and remobilised ash. Remobilised material is discriminated into ground samples (plants, coarse-ash mound layers and fine-ash lenses) and airborne material collected at different heights (0.15m and 1.50m). Each shape parameter is dimensionless and scaled from zero to one, with one being a perfect . N is the number of particles analysed per sample.