Supplementary Materials

Transport Pathways Versus Dust Sources: A Negative-Control Test of Trajectory-Statistical Attribution in Riyadh, Saudi Arabia

Saleh A. Aloraini and Abdullah S. Alnasser

Table S1. Regional mean enrichment, with one-sided permutation p in parentheses (1000 day-block permutations within strata; ≤0.025, enriched; ≥0.975, depleted), for (a) PSCF, (b) PSCF of the mutually exclusive classes, and class-conditional CWT with (c) daily maximum extinction and (d) class dust-code hours; (e) between-class correlations of weighted and unweighted (W ≥ 0.70) fields, observed (null mean). S: "suspension-dominated"; L: locally raised. Unmatched: all months of 2016–2022; season- and wind-matched: March–June 2016–2022.

	Unmatched		Season-matched		Wind-matched	
Region	**S**	**L**	**S**	**L**	**S**	**L**
(a) PSCF						
Syrian Desert	1.03 (0.370)	1.51 (0.002)	0.99 (0.531)	1.15 (0.153)	0.98 (0.597)	1.08 (0.250)
An Nafud	1.00 (0.470)	1.04 (0.401)	1.00 (0.491)	1.03 (0.430)	1.06 (0.263)	1.23 (0.092)
Rub al Khali	1.40 (≤0.001)	1.62 (≤0.001)	1.10 (0.031)	1.52 (≤0.001)	0.90 (0.443)	1.02 (0.137)
Mesopotamia / Fertile Crescent	0.68 (1.000)	0.84 (0.765)	0.66 (1.000)	0.69 (0.961)	0.69 (0.997)	0.77 (0.793)
Ad-Dahna corridor	1.13 (0.024)	0.84 (0.965)	0.99 (0.372)	0.94 (0.582)	0.94 (0.654)	0.88 (0.853)
Northeast Africa	0.87 (≤0.001)	1.03 (≤0.001)	0.65 (≤0.001)	0.71 (≤0.001)	0.55 (≤0.001)	0.52 (0.013)
Eastern Arabia / Gulf	0.65 (1.000)	0.43 (1.000)	0.70 (0.998)	0.48 (1.000)	0.72 (0.996)	0.55 (1.000)
Iranian plateau / Sistan	0.04 (0.595)	0.04 (0.626)	0.02 (0.663)	0.00 (1.000)	0.01 (0.481)	0.00 (1.000)
All eight regions	**0.84 (≤0.001)**	**0.96 (≤0.001)**	**0.73 (≤0.001)**	**0.82 (≤0.001)**	**0.66 (0.056)**	**0.68 (0.028)**
(b) PSCF, mutually exclusive classes (suspension-only / local-only)						
Syrian Desert	0.88 (0.859)	1.61 (≤0.001)	0.91 (0.770)	1.06 (0.402)	0.91 (0.787)	0.97 (0.557)
An Nafud	1.01 (0.436)	1.11 (0.293)	0.94 (0.648)	0.87 (0.673)	0.98 (0.567)	1.07 (0.355)
Rub al Khali	1.38 (0.005)	1.79 (≤0.001)	1.02 (0.185)	1.83 (0.004)	0.89 (0.459)	1.18 (0.093)
Mesopotamia / Fertile Crescent	0.63 (1.000)	0.90 (0.491)	0.65 (0.997)	0.73 (0.800)	0.68 (0.992)	0.85 (0.486)
Ad-Dahna corridor	1.28 (0.003)	0.95 (0.630)	1.06 (0.132)	1.15 (0.161)	1.01 (0.288)	1.00 (0.401)
Northeast Africa	0.76 (≤0.001)	0.91 (0.004)	0.57 (≤0.001)	0.47 (0.217)	0.51 (0.006)	0.30 (0.802)
Eastern Arabia / Gulf	0.73 (0.996)	0.42 (1.000)	0.78 (0.930)	0.46 (0.996)	0.79 (0.918)	0.56 (0.963)
Iranian plateau / Sistan	0.05 (0.474)	0.05 (0.467)	0.02 (0.528)	0.00 (1.000)	0.02 (0.393)	0.00 (1.000)
All eight regions	**0.79 (≤0.001)**	**0.96 (≤0.001)**	**0.68 (0.025)**	**0.78 (0.005)**	**0.64 (0.340)**	**0.62 (0.447)**
(c) CWT, daily maximum extinction						
Syrian Desert	0.66 (0.959)	0.95 (0.521)	0.58 (0.966)	0.73 (0.750)	0.57 (0.963)	0.70 (0.795)
An Nafud	0.92 (0.532)	0.98 (0.454)	0.99 (0.435)	1.08 (0.353)	1.09 (0.331)	1.24 (0.220)
Rub al Khali	2.48 (0.002)	2.43 (0.005)	1.82 (0.020)	2.15 (0.011)	1.39 (0.074)	1.46 (0.069)
Mesopotamia / Fertile Crescent	0.41 (1.000)	0.50 (0.996)	0.37 (1.000)	0.39 (0.999)	0.40 (0.999)	0.43 (0.990)
Ad-Dahna corridor	1.16 (0.167)	1.08 (0.305)	1.06 (0.270)	1.09 (0.257)	0.97 (0.417)	0.97 (0.422)
Northeast Africa	0.86 (0.013)	1.04 (0.005)	0.71 (0.009)	0.88 (0.006)	0.56 (0.087)	0.61 (0.071)
Eastern Arabia / Gulf	0.64 (0.982)	0.39 (1.000)	0.79 (0.642)	0.35 (1.000)	0.82 (0.619)	0.38 (0.995)
Iranian plateau / Sistan	0.04 (0.380)	0.02 (0.620)	0.00 (0.689)	0.00 (1.000)	0.00 (0.599)	0.00 (1.000)
All eight regions	**0.95 (0.002)**	**1.02 (≤0.001)**	**0.83 (0.004)**	**0.94 (0.003)**	**0.69 (0.115)**	**0.72 (0.080)**
(d) CWT, class dust-code hours						
Syrian Desert	0.99 (0.538)	1.66 (≤0.001)	0.87 (0.872)	1.31 (0.035)	0.87 (0.890)	1.21 (0.084)
An Nafud	1.03 (0.389)	1.05 (0.399)	1.06 (0.325)	1.06 (0.365)	1.10 (0.223)	1.31 (0.043)
Rub al Khali	1.27 (0.027)	1.40 (0.016)	1.13 (0.051)	1.30 (0.034)	0.97 (0.226)	0.83 (0.622)
Mesopotamia / Fertile Crescent	0.65 (1.000)	0.85 (0.680)	0.62 (1.000)	0.72 (0.900)	0.64 (0.997)	0.83 (0.536)
Ad-Dahna corridor	1.14 (0.046)	0.70 (1.000)	1.04 (0.191)	0.80 (0.915)	1.00 (0.360)	0.76 (0.982)
Northeast Africa	0.88 (≤0.001)	1.15 (≤0.001)	0.65 (≤0.001)	0.81 (≤0.001)	0.57 (≤0.001)	0.55 (0.006)
Eastern Arabia / Gulf	0.59 (1.000)	0.37 (1.000)	0.65 (0.996)	0.37 (1.000)	0.66 (0.998)	0.45 (1.000)
Iranian plateau / Sistan	0.03 (0.724)	0.02 (0.781)	0.01 (0.651)	0.00 (1.000)	0.01 (0.501)	0.00 (1.000)
All eight regions	**0.81 (≤0.001)**	**0.98 (≤0.001)**	**0.72 (≤0.001)**	**0.83 (≤0.001)**	**0.66 (0.061)**	**0.67 (0.078)**

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	Unmatched		Season-matched		Wind-matched	
(e) Field and classes	**Weighted**	**Unweighted**	**Weighted**	**Unweighted**	**Weighted**	**Unweighted**
PSCF, overlapping	0.87 (0.80)	0.72 (0.33)	0.85 (0.79)	0.64 (0.29)	0.83 (0.81)	0.44 (0.21)
PSCF, exclusive	0.64 (0.55)	0.26 (−0.05)	0.58 (0.51)	0.11 (−0.10)	0.52 (0.54)	−0.09 (−0.14)
CWT, max. extinction, overlapping	0.86 (0.65)	0.81 (0.50)	0.78 (0.64)	0.68 (0.49)	0.77 (0.66)	0.67 (0.48)
CWT, max. extinction, exclusive	0.36 (0.19)	0.18 (−0.01)	0.27 (0.16)	0.10 (−0.01)	0.26 (0.17)	0.05 (−0.02)
CWT, dust-code hours, overlapping	0.78 (0.71)	0.58 (0.20)	0.80 (0.70)	0.58 (0.15)	0.78 (0.74)	0.40 (0.11)
CWT, dust-code hours, exclusive	0.59 (0.48)	0.22 (−0.04)	0.58 (0.45)	0.18 (−0.06)	0.55 (0.48)	0.01 (−0.08)

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