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**Supplemental Materials**2 Table S1. Summary of field blank values ( $\mu\text{g}/\text{m}^3$ ) for each of chemical compounds.

Chemical species	Field blanks ( $\mu\text{g}/\text{m}^3$ )
OC	0.4837 ( $\pm$ 0.0244)
EC	0.0090 ( $\pm$ 0.0022)
SO <sub>4</sub> <sup>2-</sup>	1.7088 ( $\pm$ 0.2049)
NO <sub>3</sub> <sup>-</sup>	1.8571 ( $\pm$ 0.0496)
Cl <sup>-</sup>	0.7626 ( $\pm$ 0.0228)
NH <sub>4</sub> <sup>+</sup>	0.1145 ( $\pm$ 0.0378)
Na <sup>+</sup>	0.0000 ( $\pm$ 0.0315)
K <sup>+</sup>	0.0000 ( $\pm$ 0.0166)
Na	0.0226 ( $\pm$ 0.0070)
Mg	0.0096 ( $\pm$ 0.0017)
Al	0.0049 ( $\pm$ 0.0013)
Si	0.0065 ( $\pm$ 0.0029)
P	0.0019 ( $\pm$ 0.0005)
S	0.0118 ( $\pm$ 0.0095)
Cl	0.0051 ( $\pm$ 0.0046)
K	0.0017 ( $\pm$ 0.0010)
Ca	0.0082 ( $\pm$ 0.0041)
Ti	0.0004 ( $\pm$ 0.0001)
V	0.0001 ( $\pm$ 0.0000)
Cr	0.0004 ( $\pm$ 0.0001)
Mn	0.0008 ( $\pm$ 0.0002)
Fe	0.0024 ( $\pm$ 0.0013)
Co	0.0000 ( $\pm$ 0.0000)
Ni	0.0005 ( $\pm$ 0.0001)
Cu	0.0005 ( $\pm$ 0.0002)
Zn	0.0014 ( $\pm$ 0.0004)
Br	0.0004 ( $\pm$ 0.0002)
Sr	0.0005 ( $\pm$ 0.0001)
Pb	0.0012 ( $\pm$ 0.0002)

3 Table S2. Annual average concentrations of inorganic water soluble ions across eleven  
 4 sites (unit: microgram per cubic meter).

Site		PM <sub>2.5</sub> mass	SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Na <sup>+</sup>	K <sup>+</sup>
All Sites	Min	5.64	N.D	N.D	N.D	0.01	N.D	N.D
	Mean	28.66	4.65	1.06	0.23	1.83	0.33	0.09
	Std	17.75	2.58	0.87	0.29	1.03	0.29	0.09
	Max	161.97	14.93	8.14	2.78	6.79	3.09	1.22
E. Jerusalem	Min	9.72	0.88	0.18	N.D	0.33	N.D	N.D
	Mean	26.84	4.45	0.98	0.20	1.78	0.25	0.08
	Std	17.10	2.42	0.67	0.16	0.93	0.22	0.10
	Max	117.92	10.71	3.58	0.60	4.07	1.00	0.68
Hebron	Min	8.10	1.09	0.22	0.04	0.37	N.D	N.D
	Mean	23.06	3.98	0.93	0.22	1.67	0.26	0.08
	Std	10.85	2.35	0.55	0.17	0.90	0.22	0.07
	Max	64.99	12.99	3.20	0.78	4.26	0.86	0.32
Nablus	Min	13.29	0.98	0.39	0.01	0.32	0.01	0.02
	Mean	30.89	4.44	1.08	0.25	1.69	0.30	0.11
	Std	12.43	2.49	0.67	0.20	0.92	0.22	0.06
	Max	85.13	10.99	3.73	0.78	3.98	0.99	0.31
Aqaba	Min	10.33	0.77	0.15	N.D	0.01	N.D	N.D
	Mean	25.37	3.81	0.90	0.17	1.42	0.35	0.08
	Std	16.48	1.57	0.53	0.23	0.75	0.25	0.05
	Max	114.16	7.69	3.38	1.27	4.28	1.06	0.25
Rahma	Min	8.34	0.93	0.23	0.02	0.31	0.01	0.02
	Mean	24.98	4.13	0.87	0.14	1.63	0.29	0.11
	Std	18.73	2.07	0.58	0.15	0.89	0.19	0.06
	Max	131.97	11.48	2.95	0.61	4.31	0.83	0.27
Amman	Min	12.37	1.64	0.33	N.D	0.62	N.D	N.D
	Mean	40.29	4.93	1.19	0.15	2.03	0.20	0.09
	Std	25.44	2.31	0.73	0.17	1.05	0.17	0.10
	Max	161.97	11.52	3.88	0.83	5.82	0.75	0.68
Zarqa	Min	12.63	1.33	0.08	0.01	0.47	N.D	N.D
	Mean	37.52	5.37	1.44	0.32	2.06	0.29	0.11
	Std	19.42	2.52	1.25	0.32	1.13	0.22	0.08
	Max	113.01	11.83	7.55	1.77	5.92	0.78	0.30
Eilat	Min	5.64	N.D	N.D	0.01	0.40	0.02	0.02
	Mean	20.56	3.72	0.77	0.30	1.54	0.34	0.11
	Std	9.60	1.78	0.79	0.49	0.85	0.22	0.06
	Max	53.65	7.22	4.81	2.78	4.88	0.97	0.31
W.	Min	10.29	0.85	0.18	0.01	0.34	0.01	N.D

Jerusalem	Mean	25.72	4.93	1.14	0.19	1.97	0.27	0.08
	Std	18.19	2.83	0.68	0.21	1.03	0.24	0.18
	Max	116.62	14.15	2.99	1.05	4.69	1.13	1.22
	Min	13.04	1.24	N.D	N.D	0.38	0.02	N.D
Tel Aviv	Mean	32.25	5.48	1.44	0.38	2.22	0.58	0.09
	Std	12.47	3.25	1.56	0.53	1.32	0.54	0.06
	Max	80.65	14.90	8.14	2.39	6.79	3.09	0.31
	Min	7.84	0.73	N.D	N.D	0.03	N.D	N.D
Haifa	Mean	24.44	5.44	0.83	0.26	1.91	0.42	0.09
	Std	16.98	3.28	0.64	0.26	1.15	0.28	0.09
	Max	106.81	14.93	3.09	0.95	5.60	1.39	0.59

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\*not detected, min=minimum, Std=Standard deviation, Max=Maximum

6 Table S3. Annual average concentrations of each trace metal across eleven sites (unit: microgram per cubic meter).

Site	Statistics	Al	Si	P	S	Cl	K	Ca	Ti	V	Mn	Fe	Ni	Cu	Zn	Br	Sr	Pb
All sites	Min	N.D*	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
	Mean	0.445	0.932	0.071	1.770	0.178	0.267	1.131	0.041	0.005	0.007	0.450	0.001	0.004	0.031	0.012	0.003	0.072
	Std	0.782	1.634	0.045	0.954	0.299	0.284	1.649	0.071	0.005	0.013	0.700	0.003	0.006	0.053	0.023	0.007	0.359
	Max	6.431	13.707	0.346	5.720	2.585	2.360	15.284	0.590	0.043	0.120	6.534	0.052	0.056	0.516	0.266	0.060	4.748
E. Jerusalem	Min	N.D	N.D	N.D	0.266	0.008	0.040	0.136	N.D	N.D	N.D	0.054	N.D	N.D	N.D	N.D	N.D	N.D
	Mean	0.394	0.816	0.067	1.766	0.117	0.247	0.808	0.037	0.004	0.005	0.414	0.001	0.004	0.024	0.005	0.002	0.010
	Std	0.758	1.551	0.037	0.905	0.162	0.316	1.367	0.072	0.003	0.012	0.704	0.001	0.009	0.037	0.006	0.006	0.017
Hebron	Max	4.857	9.852	0.150	3.973	0.726	2.020	9.577	0.470	0.015	0.077	4.672	0.005	0.056	0.270	0.025	0.038	0.072
	Min	N.D	N.D	N.D	0.173	0.006	0.045	0.085	N.D	N.D	N.D	0.022	N.D	N.D	N.D	N.D	N.D	N.D
	Mean	0.272	0.574	0.062	1.571	0.088	0.200	0.675	0.025	0.003	0.004	0.264	0.000	0.003	0.025	0.005	0.001	0.008
Nablus	Std	0.386	0.831	0.039	0.905	0.108	0.144	0.552	0.035	0.003	0.007	0.350	0.001	0.003	0.058	0.007	0.003	0.011
	Max	1.943	4.148	0.168	4.400	0.546	0.802	3.098	0.181	0.014	0.032	1.750	0.006	0.013	0.356	0.032	0.015	0.042
	Min	N.D	N.D	N.D	0.273	0.010	0.078	0.060	N.D	N.D	N.D	0.052	N.D	N.D	0.011	N.D	N.D	N.D
Aqaba	Mean	0.330	0.684	0.074	1.791	0.135	0.253	1.017	0.031	0.005	0.004	0.352	0.001	0.003	0.044	0.005	0.002	0.009
	Std	0.643	1.317	0.042	0.960	0.160	0.218	0.948	0.058	0.003	0.010	0.564	0.001	0.004	0.063	0.005	0.005	0.016
	Max	3.653	7.462	0.181	4.306	0.576	1.491	6.517	0.334	0.014	0.050	3.200	0.007	0.017	0.423	0.021	0.023	0.085
Rahma	Min	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D
	Mean	0.552	1.183	0.080	1.481	0.080	0.278	1.159	0.051	0.004	0.007	0.480	0.000	0.001	0.016	0.013	0.005	0.019
	Std	0.848	1.789	0.065	0.755	0.180	0.288	1.808	0.074	0.004	0.014	0.735	0.001	0.002	0.011	0.014	0.009	0.027
Amman	Max	5.080	10.847	0.346	3.781	0.584	1.944	11.455	0.446	0.017	0.083	4.474	0.005	0.010	0.042	0.049	0.045	0.154
	Min	0.037	N.D	N.D	0.253	N.D	0.074	0.110	N.D	0.001	N.D	0.034	N.D	N.D	N.D	N.D	N.D	N.D
	Mean	0.618	1.270	0.075	1.641	0.117	0.311	1.176	0.053	0.005	0.007	0.511	0.001	0.001	0.019	0.013	0.005	0.013
Zarqa	Std	1.043	2.118	0.041	0.792	0.181	0.342	2.096	0.091	0.004	0.015	0.866	0.001	0.002	0.015	0.012	0.010	0.025
	Max	6.431	13.138	0.168	3.973	0.671	2.360	14.173	0.570	0.020	0.097	5.539	0.005	0.009	0.078	0.047	0.060	0.157
	Min	0.030	N.D	N.D	0.575	0.015	0.050	0.075	N.D	N.D	N.D	0.020	N.D	N.D	0.004	0.005	N.D	N.D
Zarqa	Mean	0.772	1.633	0.073	1.933	0.220	0.405	2.842	0.075	0.005	0.013	0.790	0.001	0.005	0.026	0.033	0.007	0.085
	Std	1.189	2.593	0.039	0.878	0.256	0.418	2.756	0.113	0.004	0.022	1.149	0.002	0.006	0.018	0.045	0.011	0.125
Zarqa	Max	5.972	13.707	0.193	4.386	1.025	2.359	15.284	0.590	0.024	0.120	6.534	0.013	0.033	0.091	0.266	0.058	0.488
	Min	0.037	0.028	N.D	0.363	0.009	0.057	0.177	N.D	N.D	N.D	0.034	N.D	N.D	0.004	N.D	N.D	N.D

	Mean	0.525	1.085	0.068	1.838	0.227	0.303	1.690	0.047	0.006	0.012	0.517	0.001	0.005	0.086	0.031	0.003	0.593
	Std	0.879	1.814	0.043	0.945	0.302	0.294	1.715	0.076	0.005	0.015	0.747	0.002	0.007	0.112	0.040	0.007	1.046
	Max	5.376	10.960	0.183	4.695	1.830	2.046	10.996	0.464	0.016	0.074	4.563	0.007	0.025	0.516	0.255	0.042	4.748
	Min	N.D	0.053	N.D	0.334	0.007	0.060	0.069	N.D	N.D	N.D	0.056	N.D	N.D	N.D	N.D	N.D	N.D
Eilat	Mean	0.419	0.880	0.063	1.549	0.153	0.238	0.908	0.038	0.005	0.006	0.386	0.002	0.002	0.020	0.010	0.003	0.012
	Std	0.494	1.023	0.034	0.742	0.190	0.147	0.887	0.044	0.003	0.008	0.422	0.002	0.003	0.016	0.011	0.006	0.026
	Max	2.074	4.476	0.141	3.809	0.678	0.641	4.354	0.206	0.015	0.033	2.006	0.006	0.013	0.084	0.042	0.025	0.145
	Min	N.D	N.D	N.D	0.238	N.D	0.046	0.083	N.D	N.D	N.D	0.034	N.D	N.D	N.D	N.D	N.D	N.D
W. Jerusalem	Mean	0.400	0.841	0.069	1.830	0.117	0.243	0.706	0.037	0.004	0.005	0.402	0.001	0.003	0.024	0.004	0.002	0.010
	Std	0.747	1.522	0.039	0.952	0.197	0.331	1.207	0.067	0.003	0.011	0.655	0.001	0.004	0.053	0.007	0.006	0.019
	Max	4.741	9.540	0.176	4.680	0.922	1.853	8.440	0.424	0.014	0.061	4.155	0.005	0.018	0.403	0.042	0.034	0.109
	Min	N.D	N.D	N.D	N.D	0.018	0.073	0.117	N.D	N.D	N.D	0.080	N.D	N.D	0.008	N.D	N.D	N.D
Tel Aviv	Mean	0.332	0.707	0.076	2.080	0.497	0.256	0.861	0.035	0.008	0.007	0.524	0.002	0.008	0.032	0.004	0.003	0.010
	Std	0.374	0.767	0.052	1.261	0.626	0.163	0.705	0.034	0.005	0.008	0.356	0.002	0.011	0.017	0.004	0.005	0.012
	Max	1.822	3.593	0.198	5.720	2.585	0.775	4.006	0.175	0.023	0.026	1.719	0.007	0.043	0.089	0.020	0.017	0.058
	Min	N.D	N.D	N.D	0.309	N.D	0.033	0.064	N.D	N.D	N.D	0.026	N.D	N.D	N.D	N.D	N.D	N.D
Haifa	Mean	0.274	0.572	0.071	1.881	0.177	0.189	0.464	0.025	0.009	0.002	0.280	0.005	0.004	0.019	0.002	0.001	0.010
	Std	0.654	1.336	0.048	1.103	0.265	0.256	1.108	0.059	0.007	0.009	0.565	0.008	0.007	0.037	0.004	0.005	0.020
	Max	4.594	9.337	0.225	5.497	1.046	1.770	8.032	0.409	0.043	0.061	3.974	0.052	0.046	0.240	0.025	0.031	0.110

\*not detected, min=minimum, Std=Standard deviation, Max=Maximum

8 Table S4. Inter-correlation among each pair of ion for each site

Site			SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Na <sup>+</sup>	
E. Jerusalem	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	-0.06					
		p-value	0.67					
	Cl <sup>-</sup>	Pearson Correlation	-0.37	0.37				
		p-value	0.01	0.01				
	NH <sub>4</sub> <sup>+</sup>	Pearson Correlation	0.91	-0.01	-0.32			
		p-value	0.00	0.92	0.02			
	Na <sup>+</sup>	Pearson Correlation	0.13	0.26	0.30	-0.14		
		p-value	0.40	0.07	0.04	0.36		
	K <sup>+</sup>	Pearson Correlation	0.19	0.29	0.14	-0.03	0.30	
		p-value	0.19	0.04	0.34	0.82	0.04	
	Palestine Hebron	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.21				
			p-value	0.12				
Cl <sup>-</sup>		Pearson Correlation	-0.36	0.37				
		p-value	0.01	0.01				
NH <sub>4</sub> <sup>+</sup>		Pearson Correlation	0.88	0.39	-0.29			
		p-value	0.00	0.00	0.04			
Na <sup>+</sup>		Pearson Correlation	-0.23	0.20	0.43	-0.18		
		p-value	0.11	0.16	0.00	0.21		
K <sup>+</sup>		Pearson Correlation	-0.09	0.06	0.07	-0.13	0.39	
		p-value	0.53	0.69	0.63	0.37	0.01	
Noblus		NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.08				
			p-value	0.54				
	Cl <sup>-</sup>	Pearson Correlation	-0.35	0.44				
		p-value	0.01	0.00				
	NH <sub>4</sub> <sup>+</sup>	Pearson Correlation	0.93	0.05	-0.30			
		p-value	0.00	0.71	0.02			
	Na <sup>+</sup>	Pearson Correlation	0.04	0.27	0.44	-0.15		
		p-value	0.77	0.06	0.00	0.27		
	K <sup>+</sup>	Pearson Correlation	0.39	0.39	-0.06	0.17	0.31	
		p-value	0.00	0.00	0.68	0.22	0.02	

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11 Table S4. Continued

Site			SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Na <sup>+</sup>	
Jordan	Aqaba	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.32				
			p-value	0.02				
		Cl <sup>-</sup>	Pearson Correlation	-0.20	0.24			
			p-value	0.16	0.08			
		NH <sub>4</sub> <sup>+</sup>	Pearson Correlation	0.83	0.44	-0.23		
			p-value	0.00	0.00	0.11		
	Na <sup>+</sup>	Pearson Correlation	-0.12	0.24	0.75	-0.29		
		p-value	0.39	0.09	0.00	0.04		
	K <sup>+</sup>	Pearson Correlation	0.41	0.55	-0.06	0.32	0.00	
		p-value	0.00	0.00	0.66	0.02	0.98	
	Rahma	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.16				
			p-value	0.27				
Cl <sup>-</sup>		Pearson Correlation	-0.40	0.33				
		p-value	0.01	0.03				
NH <sub>4</sub> <sup>+</sup>		Pearson Correlation	0.93	0.28	-0.49			
		p-value	0.00	0.04	0.00			
Na <sup>+</sup>	Pearson Correlation	-0.22	0.19	0.84	-0.38			
	p-value	0.14	0.21	0.00	0.01			
K <sup>+</sup>	Pearson Correlation	0.27	0.47	-0.02	0.30	-0.10		
	p-value	0.06	0.00	0.92	0.03	0.51		
Amman	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.54					
		p-value	0.00					
	Cl <sup>-</sup>	Pearson Correlation	-0.03	0.47				
		p-value	0.80	0.00				
	NH <sub>4</sub> <sup>+</sup>	Pearson Correlation	0.88	0.65	0.06			
		p-value	0.00	0.00	0.64			
	Na <sup>+</sup>	Pearson Correlation	-0.11	0.15	0.51	-0.26		
		p-value	0.46	0.31	0.00	0.06		
	K <sup>+</sup>	Pearson Correlation	0.18	0.04	0.00	-0.05	0.26	
		p-value	0.19	0.78	0.98	0.70	0.07	
	Zarqa	NO <sub>3</sub> <sup>-</sup>	Pearson Correlation	0.35				
			p-value	0.01				
Cl <sup>-</sup>		Pearson Correlation	0.08	0.72				
		p-value	0.55	0.00				
NH <sub>4</sub> <sup>+</sup>		Pearson Correlation	0.89	0.58	0.28			
		p-value	0.00	0.00	0.04			
Na <sup>+</sup>		Pearson Correlation	-0.25	0.08	0.22	-0.39		
		p-value	0.09	0.57	0.13	0.01		
K <sup>+</sup>		Pearson Correlation	0.06	-0.17	-0.09	-0.03	0.09	
		p-value	0.66	0.24	0.52	0.81	0.56	

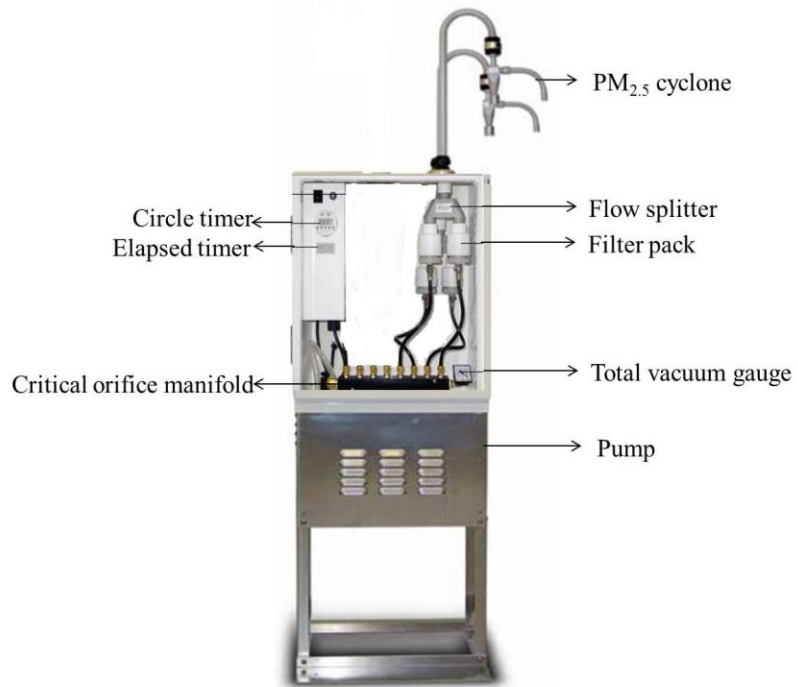
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14 Table S4. Continued

Site			SO <sub>4</sub> <sup>2-</sup>	NO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>	NH <sub>4</sub> <sup>+</sup>	Na <sup>+</sup>
Israel	Eilat	NO <sub>3</sub> <sup>-</sup> Pearson Correlation	-0.34				
		p-value	0.03				
		Cl <sup>-</sup> Pearson Correlation	-0.38	0.23			
		p-value	0.03	0.20			
		NH <sub>4</sub> <sup>+</sup> Pearson Correlation	0.48	0.51	-0.10		
		p-value	0.00	0.00	0.57		
	Na <sup>+</sup> Pearson Correlation	-0.22	0.40	0.35	-0.13		
	p-value	0.17	0.01	0.05	0.44		
	K <sup>+</sup> Pearson Correlation	-0.07	0.58	0.14	0.44	0.10	
	p-value	0.66	0.00	0.43	0.00	0.54	
	W. Jerusalem	NO <sub>3</sub> <sup>-</sup> Pearson Correlation	0.20				
		p-value	0.15				
		Cl <sup>-</sup> Pearson Correlation	-0.03	0.42			
		p-value	0.84	0.00			
		NH <sub>4</sub> <sup>+</sup> Pearson Correlation	0.92	0.16	-0.22		
		p-value	0.00	0.25	0.12		
	Na <sup>+</sup> Pearson Correlation	0.05	0.44	0.64	-0.20		
	p-value	0.74	0.00	0.00	0.16		
Tel Aviv	NO <sub>3</sub> <sup>-</sup> Pearson Correlation	0.08					
	p-value	0.55					
	Cl <sup>-</sup> Pearson Correlation	-0.19	0.41				
	p-value	0.18	0.00				
	NH <sub>4</sub> <sup>+</sup> Pearson Correlation	0.90	0.35	-0.21			
	p-value	0.00	0.01	0.12			
Na <sup>+</sup> Pearson Correlation	0.10	0.42	0.91	0.03			
p-value	0.45	0.00	0.00	0.83			
Haifa	K <sup>+</sup> Pearson Correlation	0.39	0.49	0.34	0.40	0.45	
	p-value	0.00	0.00	0.01	0.00	0.00	
	NO <sub>3</sub> <sup>-</sup> Pearson Correlation	0.06					
	p-value	0.67					
	Cl <sup>-</sup> Pearson Correlation	-0.27	0.17				
	p-value	0.07	0.26				
Haifa	NH <sub>4</sub> <sup>+</sup> Pearson Correlation	0.93	0.09	-0.44			
	p-value	0.00	0.51	0.00			
	Na <sup>+</sup> Pearson Correlation	0.20	0.36	0.63	0.13		
	p-value	0.15	0.01	0.00	0.35		
	K <sup>+</sup> Pearson Correlation	0.52	0.42	0.09	0.52	0.44	
	p-value	0.00	0.00	0.58	0.00	0.00	

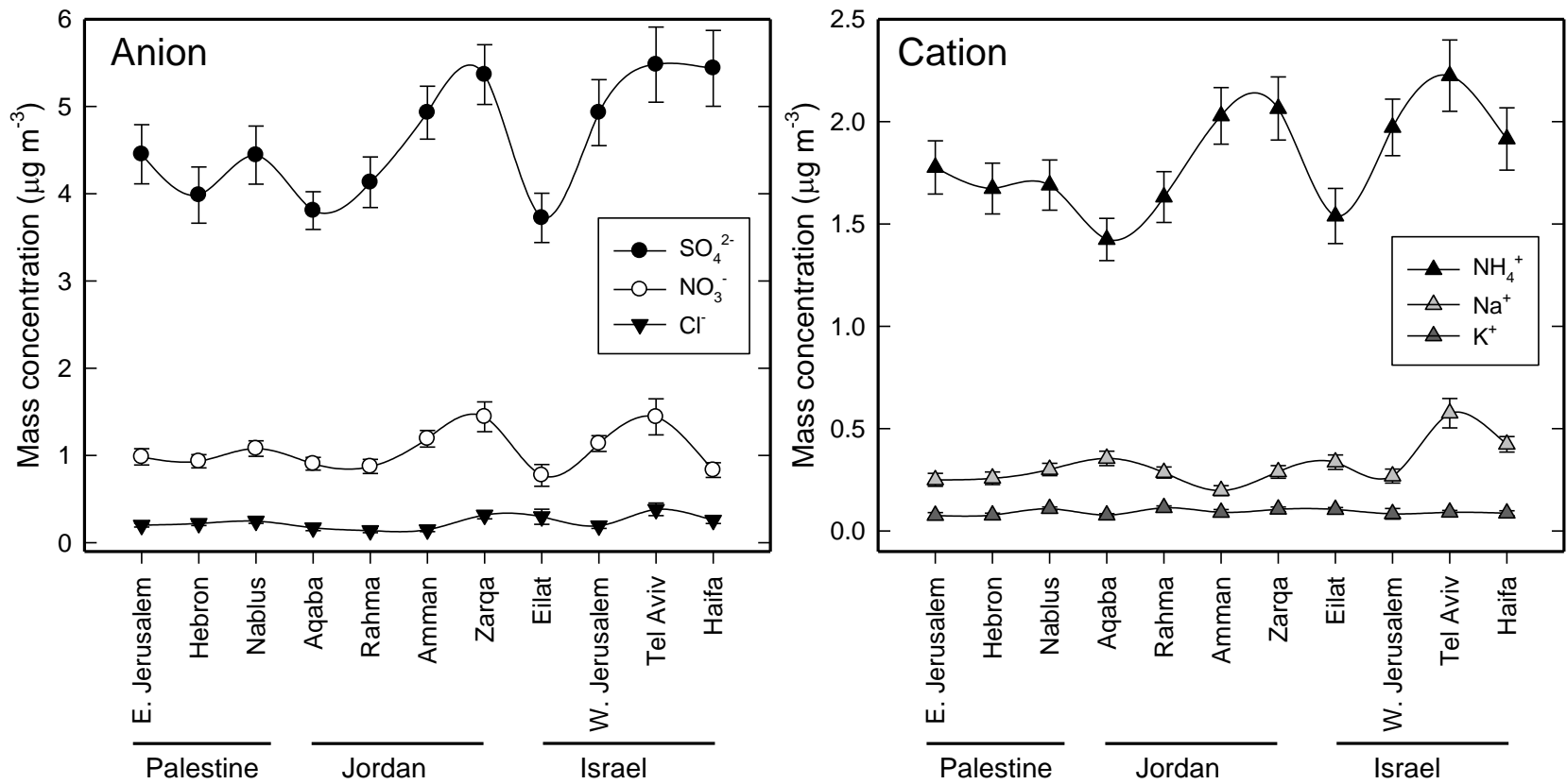




16

17 **Fig. S1.** PM<sub>2.5</sub> sampling system modified from URG-3000ABC (Chapel Hill, NC, USA;

18 [www.urgcorp.com](http://www.urgcorp.com)).

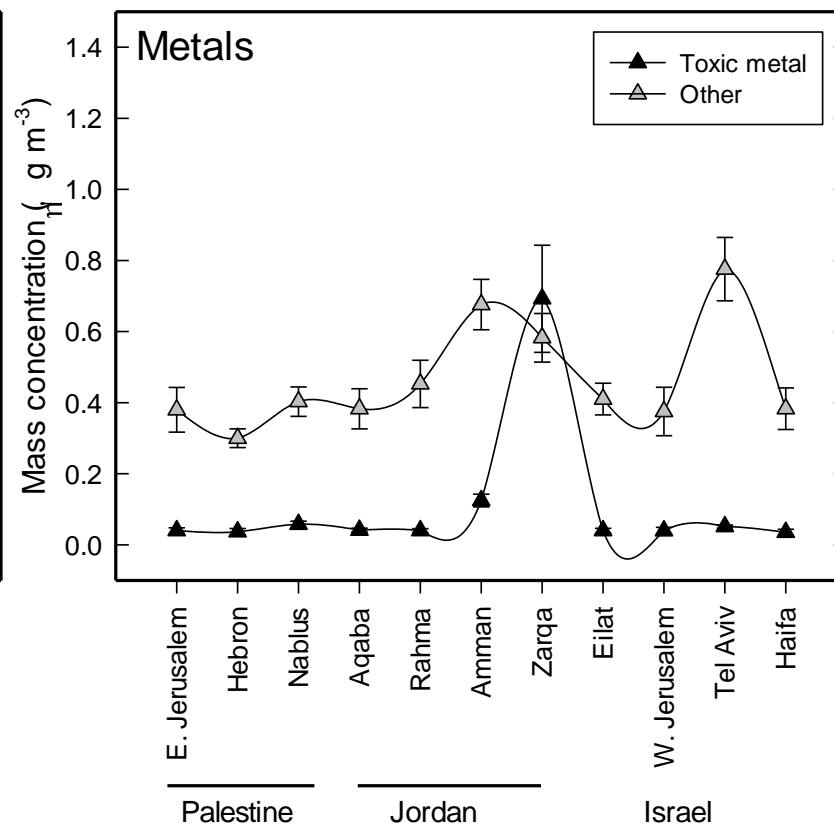
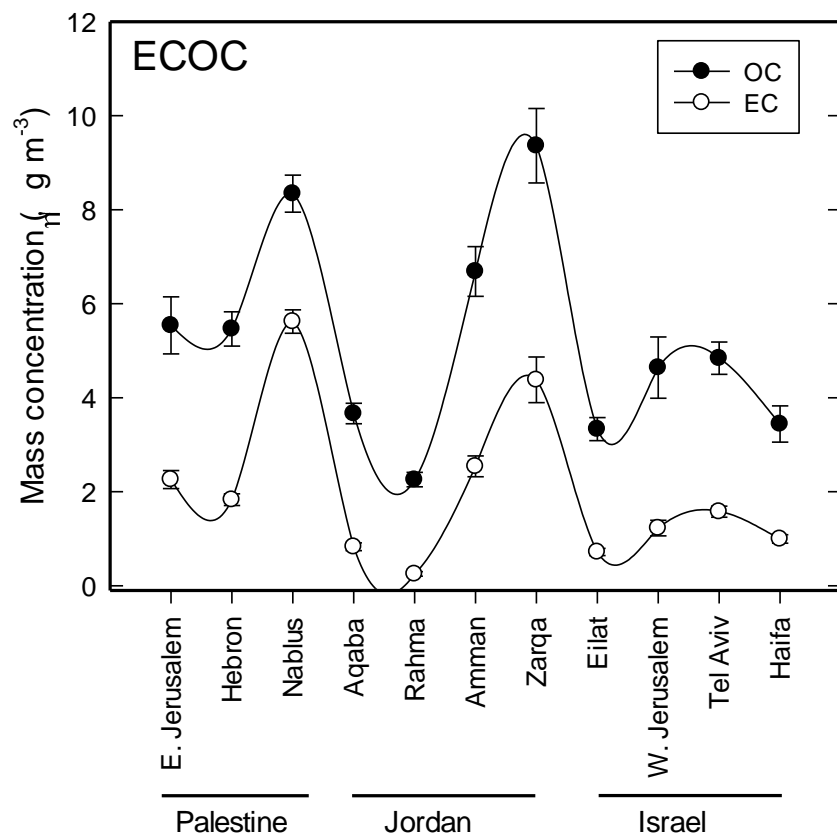


19

20 **Fig. S2.** Annual trends for inorganic water soluble ions at each site.

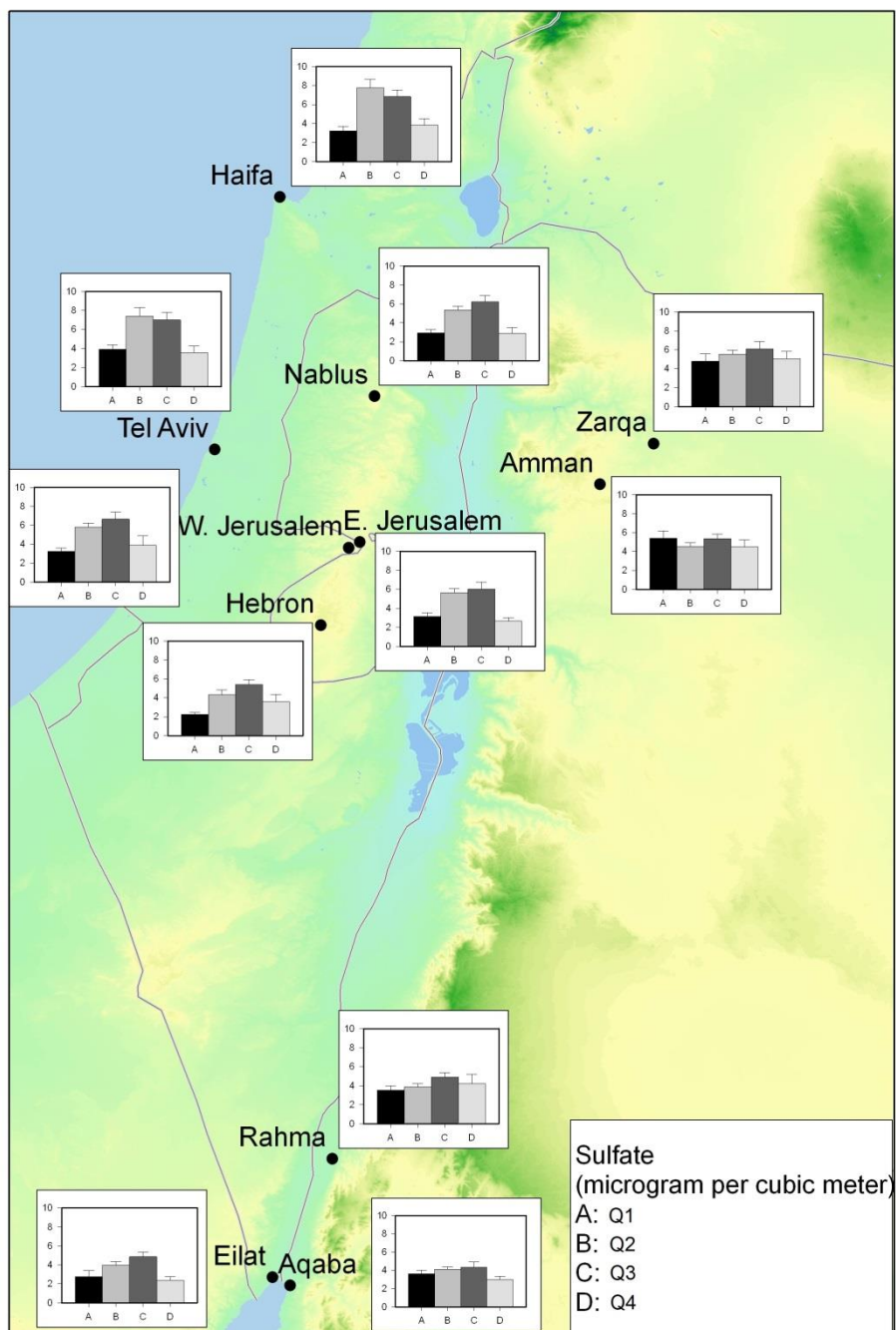
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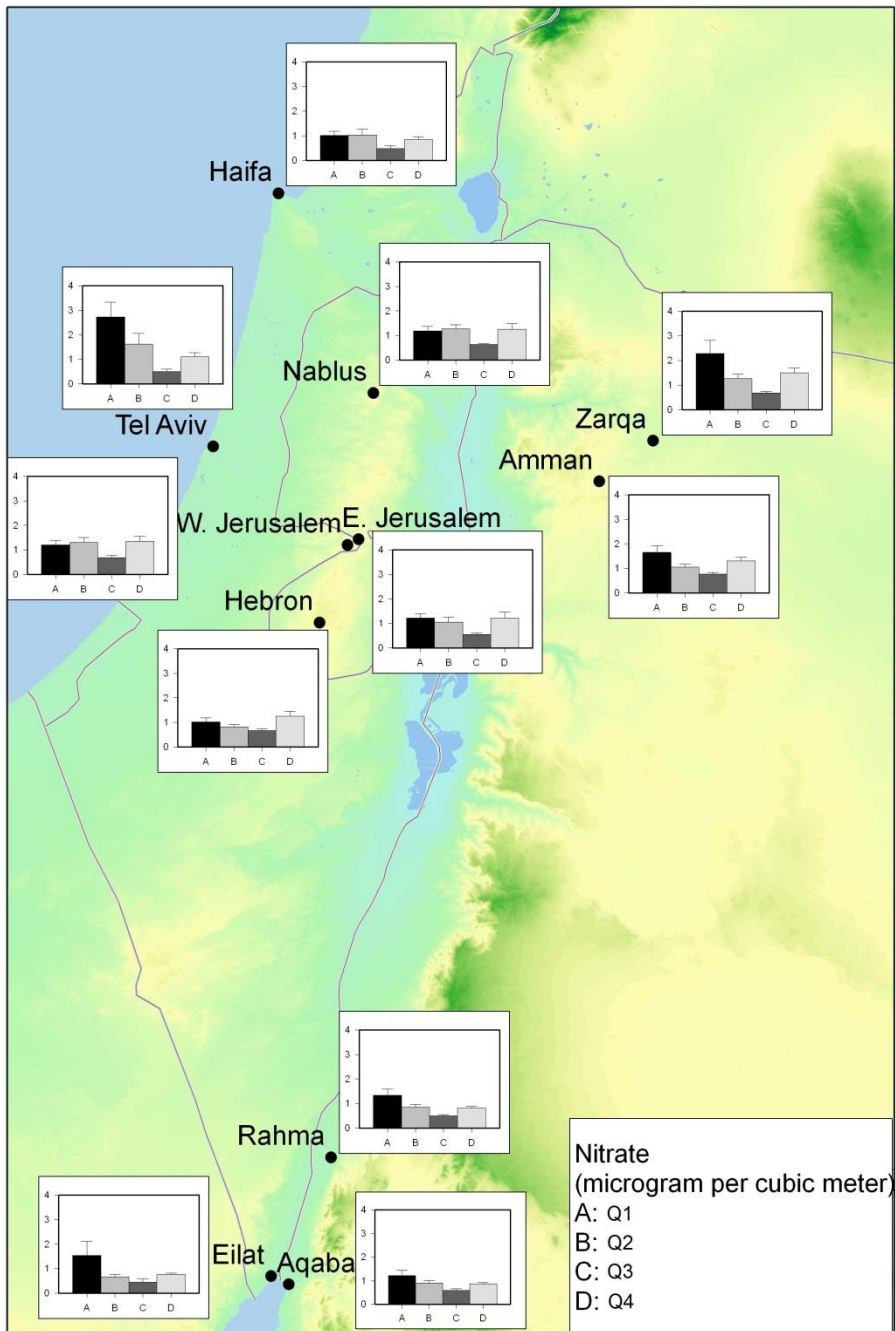
24 **Fig. S3.** Annual trends for ECOC and metals at each site.



25

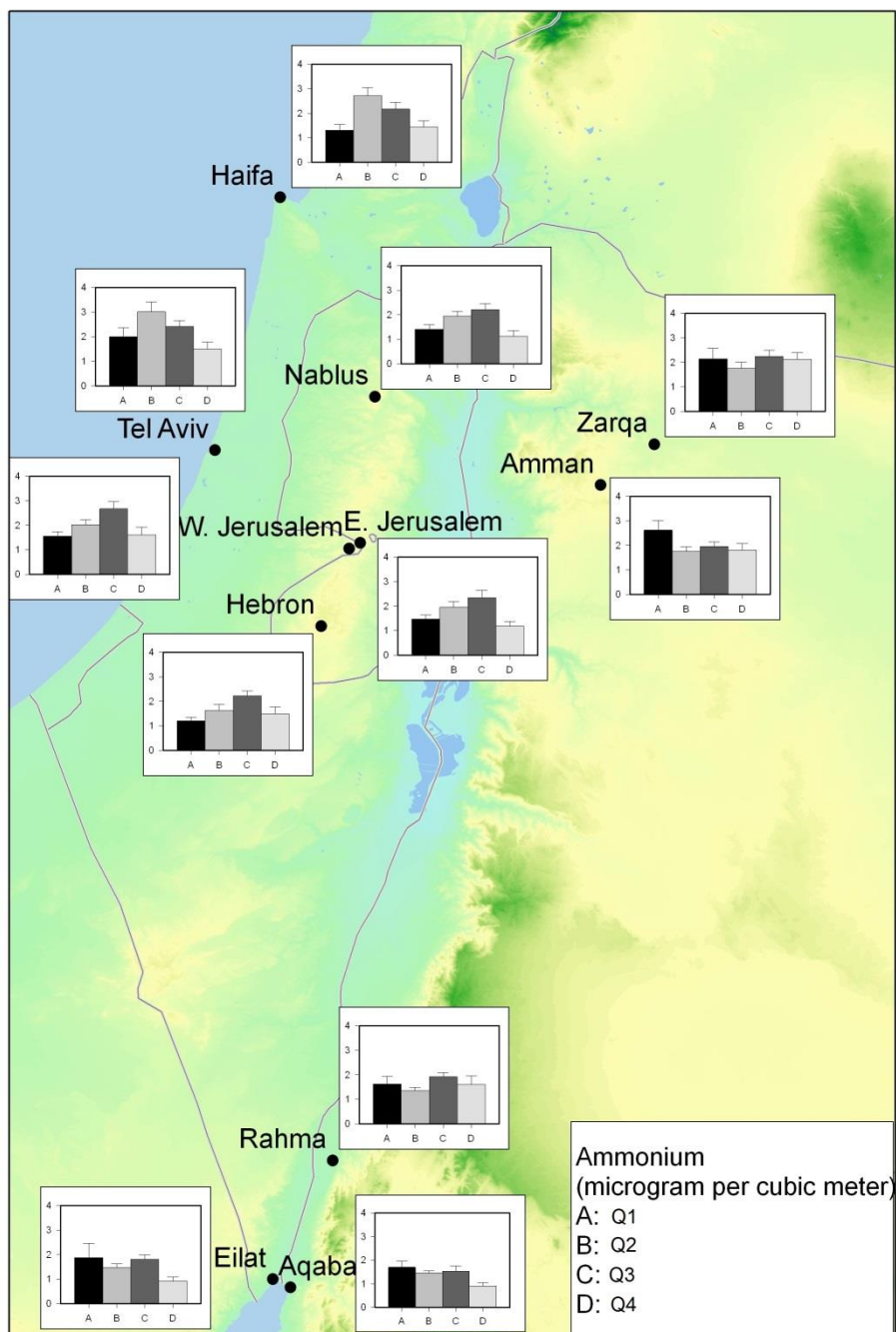
26 **Fig. S4.** Spatial and seasonal trends of PM<sub>2.5</sub> sulfate concentrations at each site.

27



28

29 **Fig. S5.** Spatial and seasonal trends of PM<sub>2.5</sub> nitrate concentrations at each site.



30

31 **Fig. S6.** Spatial and seasonal trends of PM<sub>2.5</sub> ammonium concentrations at each site.

32