

Supplementary Materials: Spatio-Temporal Representativeness of Air Quality Monitoring Stations in Mexico City

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¹ **1. Supplementary tables**

² *Monitoring stations distributed in the Valley of Mexico Metropolitan Area (VMMA).*

Table S1. Location coordinates for monitoring stations in the Valley of Mexico Metropolitan Area (VMMA).

Station ID	Station code	Station name	Longitude	Latitude	Altitude	Comment
1	484150020109	ACO	-98.912003	19.635501	2198	
2	484090120609	AJM	-99.207744	19.272161	2548	
3	484150130101	ATI	-99.254133	19.576963	2341	
4	484090140201	BJU	-99.159596	19.370464	2249	Ended in 2005
5	484090020301	CAM	-99.169794	19.468404	2233	
6	484090030501	CCA	-99.176111	19.326111	2294	
7	484150250109	CHO	-98.886088	19.266948	2253	
8	484090040109	CUA	-99.291705	19.365313	2704	
9	484150570109	FAC	-99.243524	19.482473	2299	
10	484090150409	HGM	-99.152207	19.411617	2234	
11	484090050209	IMP	-99.147294	19.487561	2250	Ended in 2010
12	484150620109	INN	-99.38052	19.291968	3082	
13	484090060101	IZT	-99.117641	19.384413	2238	
14	484090150101	LAG	-99.135183	19.44242	2223	Ended in 2010
15	484150330201	LLA	-99.039644	19.578792	2230	
16	484151040203	LPR	-99.11772	19.534727	2302	
17	484090170127	MER	-99.119594	19.42.461	2245	
18	484090160609	MGH	-99.20266	19.40405	2327	
19	484150990113	MON	-98.902853	19.460415	2252	
20	484090090104	MPA	-98.990189	19.1769	2594	
21	484150580115	NEZ	-99.028212	19.393734	2235	
22	484090100127	PED	-99.204136	19.325146	2326	
23	484090100209	PLA	-99.200109	19.365869	2345	Ended in 2010
24	484150330327	SAG	-99.030324	19.532968	2241	
25	484090040309	SFE	-99.262865	19.357357	2599	
26	484090050701	SJA	-99.086095	19.452592	2258	
27	484090030109	SUR	-99.149994	19.31448	2279	
28	484090160309	TAC	-99.202455	19.453907	2275	Ended in 2010
29	484090130309	TAH	-99.010564	19.246459	2297	
30	484090030201	TAX	-99.123204	19.335689	2242	Ended in 2010
31	484151040115	TLA	-99.204597	19.529077	2311	
32	484151090101	TLI	-99.177173	19.602542	2313	

Station ID	Station code	Station name	Longitude	Latitude	Altitude	Comment
33	484090120209	TPN	Tlalpan	-99.184177	19.257041	2522
34	484090030401	UAX	UAM Xochimilco	-99.103629	19.304441	2246
35	484090070219	UIZ	UAM Iztapalapa	-99.07388	19.360794	2221
36	484090050501	VAL	Vallejo	-99.165702	19.522437	2248 Ended in 2010
37	484150200109	VIF	Villa de las Flores	-99.09659	19.658223	2242
38	484150330415	XAL	Xalostoc	-99.0824	19.525995	2160
39	484090020201	AZC	Azcapotzalco	-99.198657	19.487728	2279 Ended in 2010
40	484090070111	CES	Cerro de la Estrella	-99.074678	19.334731	2219 Ended in 2010
41	484090030303	COY	Coyoacán	-99.157101	19.350258	2260
42	484150950109	CUT	Cuautitlán	-99.198602	19.722186	2263
43	484090120400	AJU	Ajusco	-99.162611	19.154286	2942
44	484090050809	GAM	Gustavo A. Madero	-99.094517	19.4827	2227
45	484090050101	LVI	La Villa	-99.117749	19.46789	2228 Ended in 2010
46	484150580303	PER	La Perla	-98.991858	19.38286	2237 Ended in 2011
47	484090050301	ARA	Aragón	-99.074549	19.470218	2200 Ended in 2010
48	484800150584	FAR	FES Aragón	-99.046176	19.473692	2230
49	484800090073	SAC	Santiago Acahualtepec	-99.009381	19.34561	2293

3 Real time and historical data for pollutant concentrations and meteorological variables can be downloaded using the R package `aire.zmvm` for active and inactive stations.

4 *Spatio-temporal modeling***Table S2. Initial variogram parameter values for air pollutants.**

		Time	Space	Joint		Time	Space	Joint
CO	nugget	0.06	0.03	0.04	NO ₂	30.08	27.07	28.57
	sill	0.07	0.07	0.07		51.09	59.95	55.52
	range	12.00	20.73	16.36		12.00	20.04	16.02
	stAni	0.20	0.20	0.20		0.30	0.30	0.30
O ₃	nugget	29.36	44.52	36.94	SO ₂	7.30	7.29	7.30
	sill	64.54	55.29	59.91		10.60	10.94	10.77
	range	12.00	21.40	16.70		12.00	21.40	16.70
	stAni	1.31	1.31	1.31		0.90	0.90	0.90
PM _{2.5}	nugget	26.79	41.57	34.18	PM ₁₀	151.42	101.85	126.63
	sill	56.65	47.81	52.23		264.57	264.96	264.76
	range	12.00	20.73	16.36		12.00	21.40	16.70
	stAni	1.49	1.49	1.49		0.51	0.51	0.51
NO	nugget	91.85	53.94	72.90	NO _x	178.67	125.15	151.91
	sill	134.66	143.15	138.90		288.20	336.27	312.24
	range	12.00	20.04	16.02		12.00	20.04	16.02
	stAni	0.17	0.17	0.17		0.21	0.21	0.21
PM _{CO}	nugget	55.79	42.85	49.32				
	sill	86.17	96.60	91.38				
	range	12.00	15.15	13.57				
	stAni	0.23	0.23	0.23				

stAni: spatio-temporal anisotropy

Table S3. Weighted Mean Squared Error (wMSE) for the tested covariance models.

Variogram model type: temporal + spatial										
Model	Joint	Exp+Exp	Sph+Sph	Gau+Gau	Exp+Gau	Exp+Sph	Gau+Exp	Gau+Sph	Sph+Exp	Sph+Gau
NO										
	metric	314.32251	464.49668	320.77210						
	separable	227.29274	267.19351	223.27802	218.93799	227.45143	228.41019	332.39790	238.98087	224.69833
	productSum	998.05200	1003.7673	1004.2407	997.54517	1006.2720	999.47112	1007.2452	1019.3748	1004.1995
simpleSumMetric	sumMetric	Exp	223.65028	229.25265	222.33345	219.14968	219.93966	217.79853	221.95089	237.60784
		Gau	218.41711	228.49110	219.51056	220.07645	221.93173	220.38515	219.47318	223.67573
		Sph	224.55070	223.98598	224.78247	218.43059	219.30839	218.53857	221.33537	223.16202
		Exp	251.47818	251.84904	251.22780	261.28988	262.41332	260.69236	250.97997	251.47600
		Gau	249.67680	289.37639	254.66438	250.05371	275.91811	263.48996	252.56001	291.14505
		Sph	251.37048	255.90646	255.02151	260.57654	265.68344	267.31847	251.58737	255.22089
NO _x										
	metric	1216.2399	1215.8008	1255.7962						
	separable	783.89513	823.63824	924.78019	782.54520	809.71588	770.71427	781.20906	1319.5791	815.85242
	productSum	5500.8853	5534.3305	5508.4015	5515.9607	5554.1369	5512.5675	5483.0362	5521.7044	5473.9558
simpleSumMetric	sumMetric	Exp	811.09989	852.74722	773.49901	807.50987	1028.0700	762.12053	796.50774	965.96022
		Gau	762.32740	797.58761	756.12147	761.97337	800.26970	763.33415	772.35853	790.17162
		Sph	785.29970	794.28077	777.47023	775.57787	783.13504	770.92203	809.17473	780.19179
		Exp	901.63339	894.10510	897.27721	980.04353	993.26101	968.35391	902.79395	897.97592
		Gau	889.57147	1076.5107	901.19040	820.13383	1145.2760	931.71713	894.79796	1040.1277
		Sph	897.35755	905.11647	898.36671	969.51013	993.98581	970.00722	899.30342	903.66063
PM _{CO}										
	metric	644.62111	644.03842	643.45868						
	separable	623.71605	607.71669	610.39054	616.96630	604.77784	614.93006	612.03043	632.08639	793.09965
	productSum	950.07066	951.46203	942.46674	951.04700	952.21029	944.12622	1061.7258	942.02212	895.38683
simpleSumMetric	sumMetric	Exp	609.97906	609.29677	607.78059	614.03327	614.83170	611.33476	610.85005	611.61747
		Gau	603.57826	599.57778	602.80172	606.53313	603.43250	603.50454	601.47158	596.46374
		Sph	607.76432	608.52111	606.79730	612.11267	612.54121	611.14899	608.07712	608.12503
		Exp	608.83922	612.20342	606.55306	612.76328	627.74877	606.69545	610.48604	609.94741
		Gau	603.55459	607.78308	603.88012	605.75264	609.40062	604.36625	603.01894	607.90093
		Sph	606.93907	606.86581	612.94685	613.81471	616.68362	633.30340	609.15736	612.67814

Table S4. Final variogram parameter values for air pollutants.

	Time	Space	Joint	Time	Space	Joint
CO				NO ₂		
		sumMetric			sumMetric	
	Exp	Gau	Gau	Sph	Exp	Gau
nugget	0.00988	0.02448	0.00597	9.83256	6.04587	0.14808
sill	0.00715	0.00100	0.02858	8.32812	48.98035	59.93512
range	12.00172	20.72637	16.36296	27.48596	43.37174	34.37637
stAni			0.32459			0.31863
O ₃				SO ₂		
		sumMetric			simpleSumMetric	
	Gau	Gau	Sph	Gau	Exp	Gau
nugget	17.39906	8.17109	0.997322			0.19818
sill	56.57224	60.82626	12.19842	2.29675	3.35601	5.96559
range	73.3575	57.82687	97.79145	37.47534	5.92587	35.92549
stAni			3.61389			25.58136
PM _{2.5}				PM ₁₀		
		simpleSumMetric			sumMetric	
	Gau	Sph	Exp	Sph	Gau	Gau
nugget			3.84173	61.16633	0.0010	13.48901
sill	26.15424	9.60075	22.41689	172.35015	155.2557	246.47684
range	36.65058	13.0008	128.6212	178.9469	12.9828	176.4812
stAni			65.67073			0.63066
NO				NO _x		
		sumMetric			sumMetric	
	Gau	Sph	Exp	Exp	Sph	Gau
nugget	23.37486	23.82696	4.82430	46.04706	50.46123	16.25752
sill	107.66649	171.11593	149.16515	230.64259	338.27802	317.65596
range	133.497	77.15998	123.2927	175.6062	84.44737	38.76529
stAni			0.39323			0.24669
PM _{CO}						
		sumMetric				
	Sph	Gau	Gau			
nugget	8.15818	13.60533	9.42787			
sill	18.96224	98.58390	93.12793			
range	21.24231	28.04363	33.89663			
stAni			0.25065			

stAni: spatio-temporal anisotropy

2. Supplementary figures

Data capture per contaminant and monitoring station

Sample variogram and fitted covariance models

The winner permutations taken by one, two or three variograms (Exponential, Gaussian and/or Spherical) for independent spatio, temporal and joint spatio-temporal models according to the covariance structure (metric, separable, productSum, sumMetric and simpleSumMetric) are presented for carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), sulphur dioxide (SO₂), particulate matter (PM_{2.5} and PM₁₀), nitrogen oxide (NO), other nitrogen oxides (NO_x) and coarse particulate matter (PM_{CO}) in Supplementary Figures ??-?? respectively.

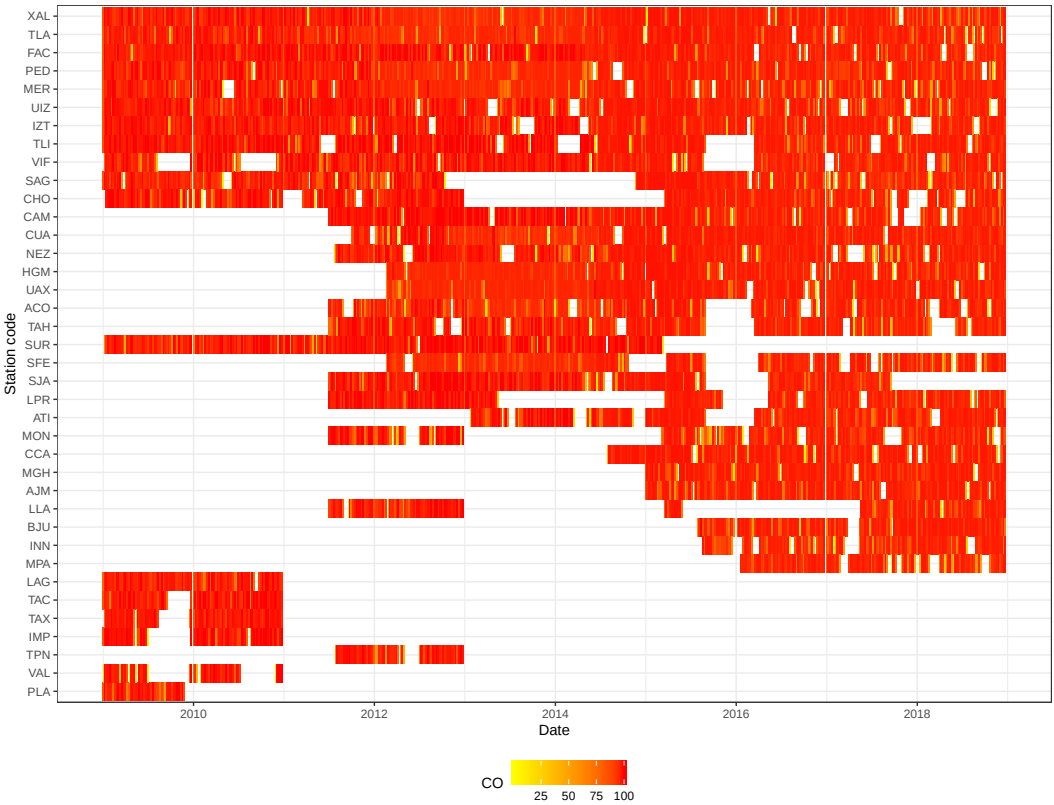


Figure S1. Carbon monoxide (CO) data capture. The color bar indicates the percentage of available data.



Figure S2. Ozone (O₃) data capture. The color bar indicates the percentage of available data.



Figure S3. Sulphur dioxide (SO₂) data capture. The color bar indicates the percentage of available data.



Figure S4. Particulate matter PM_{2.5} data capture. The color bar indicates the percentage of available data.



Figure S5. Particulate matter PM₁₀ data capture. The color bar indicates the percentage of available data.



Figure S6. Nitrogen oxide (NO) data capture. The color bar indicates the percentage of available data.

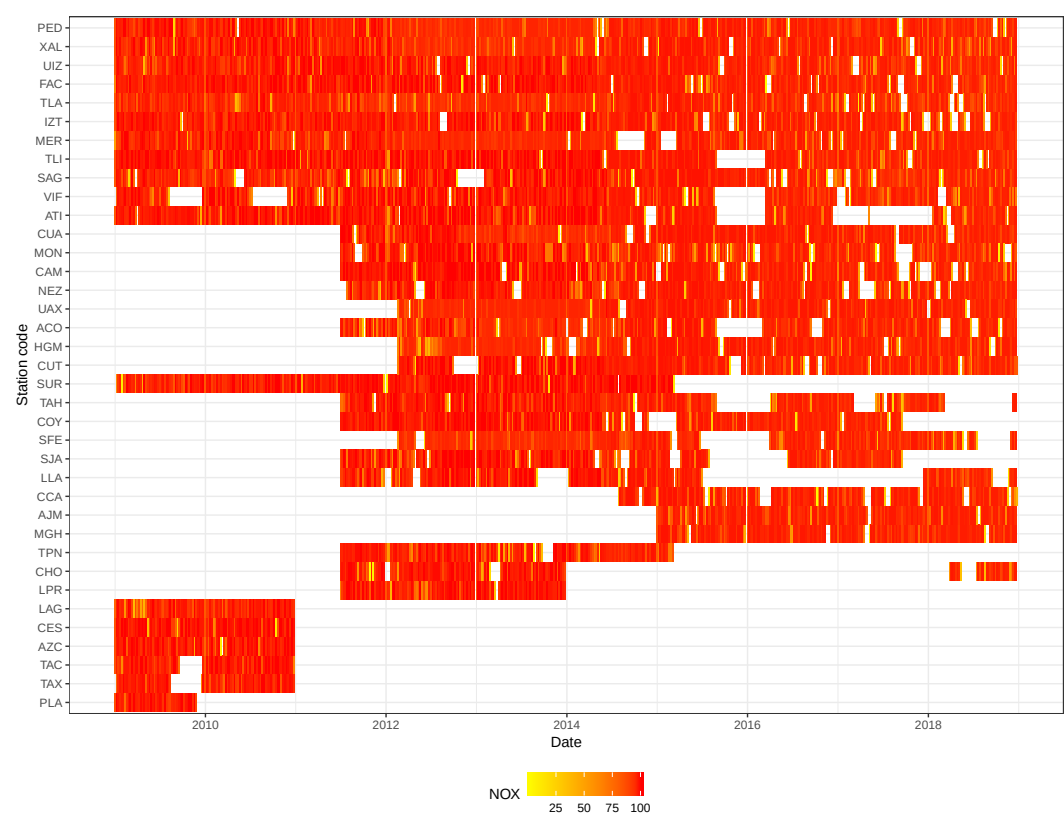


Figure S7. Nitrogen oxides (NO_x) data capture. The color bar indicates the percentage of available data.

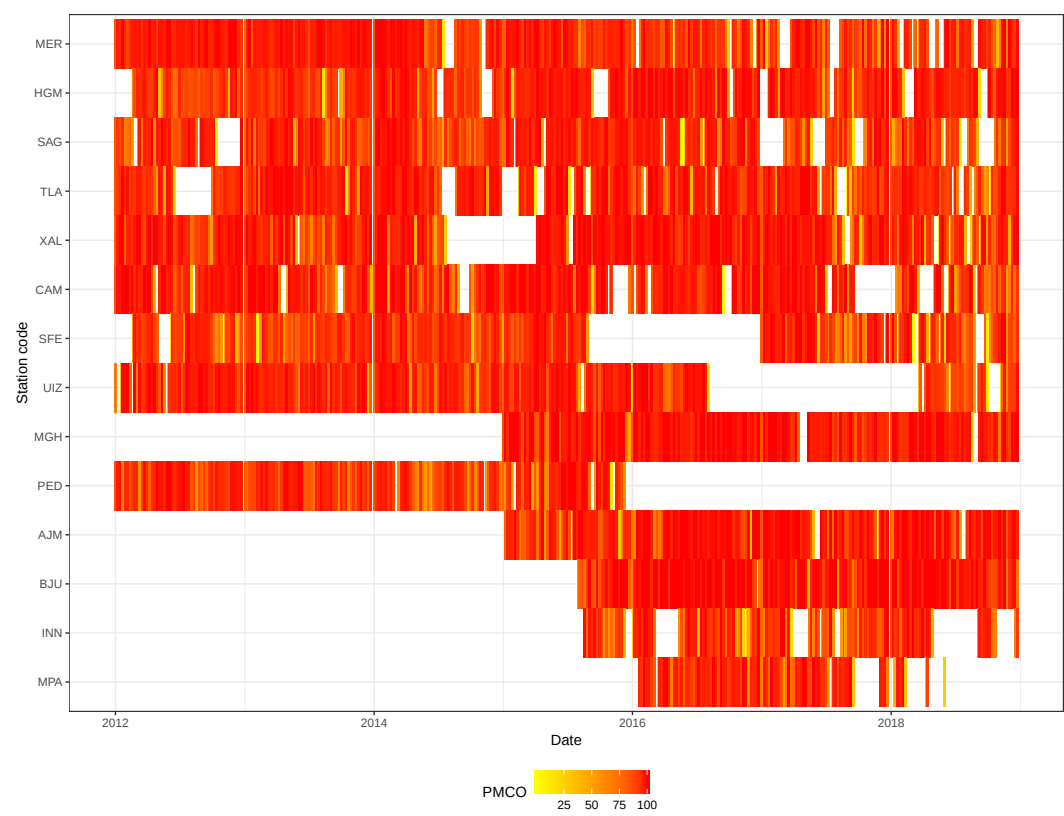


Figure S8. Coarse particulate matter PM_{CO} data capture. The color bar indicates the percentage of available data.

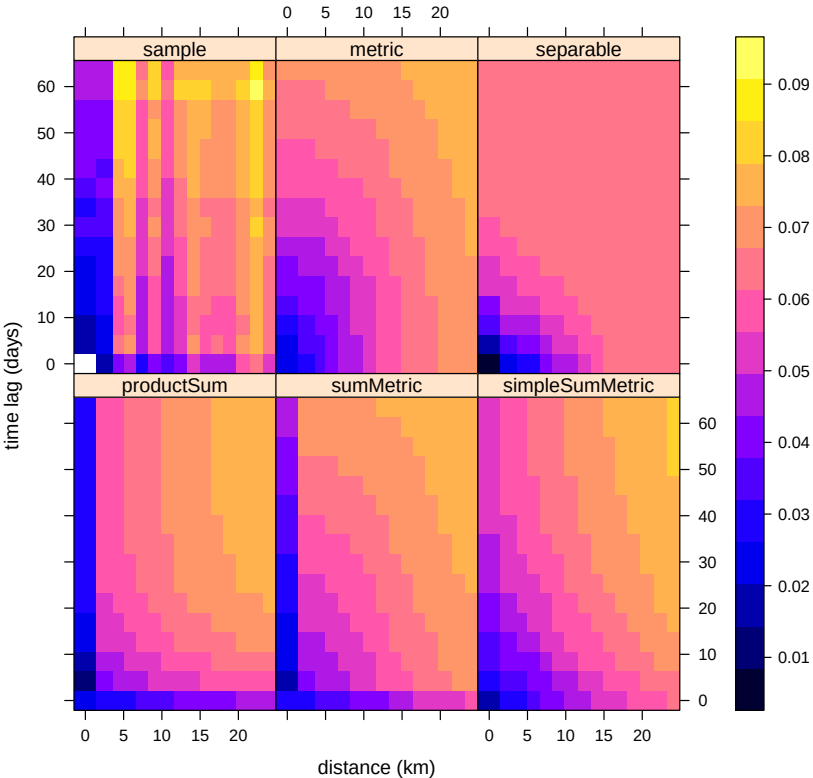


Figure S9. Sample variogram and fitted covariance models for carbon monoxide (CO).

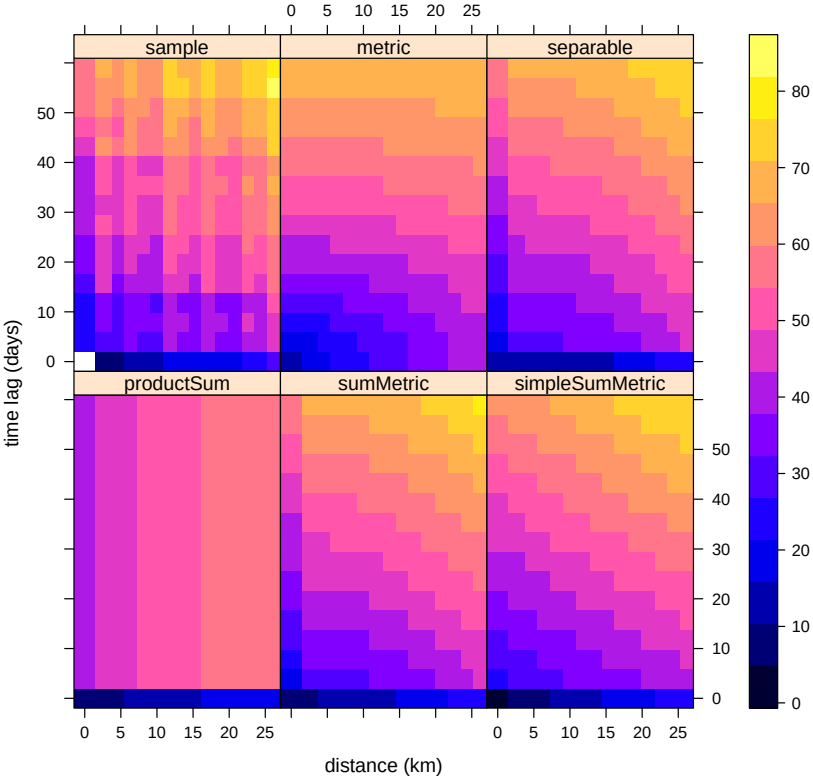


Figure S10. Sample variogram and fitted covariance models for ozone (O₃).

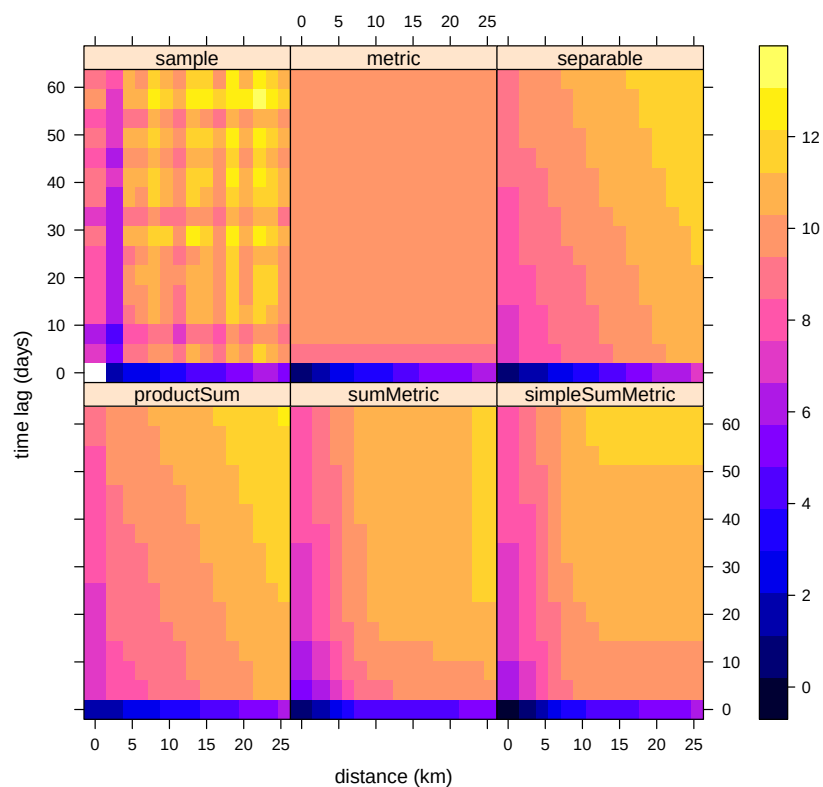


Figure S11. Sample variogram and fitted covariance models for sulphur dioxide (SO_2).

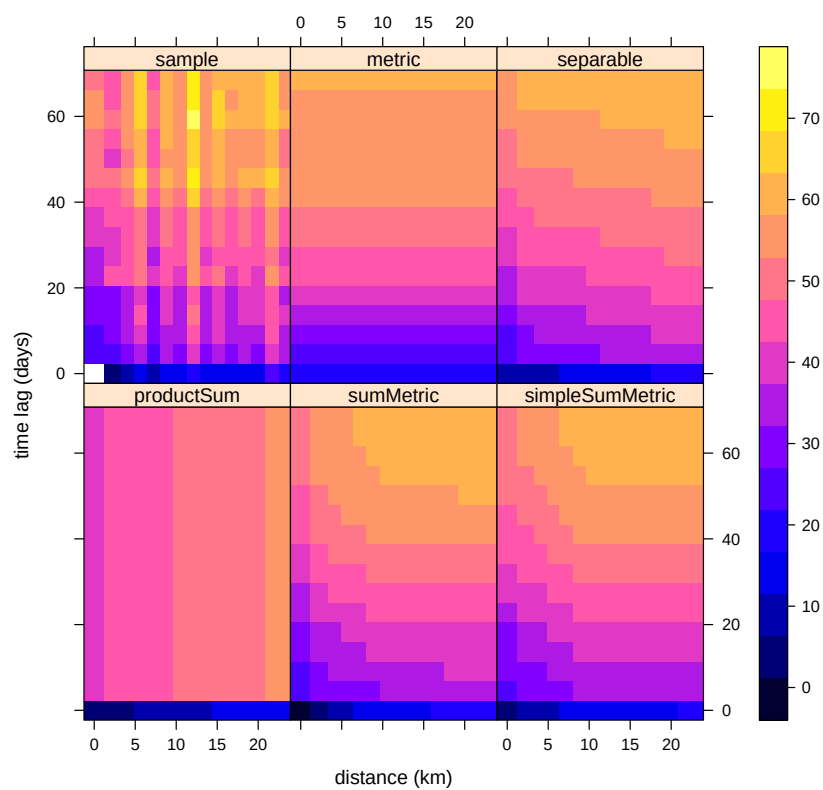


Figure S12. Sample variogram and fitted covariance models for particulate matter $\text{PM}_{2.5}$.

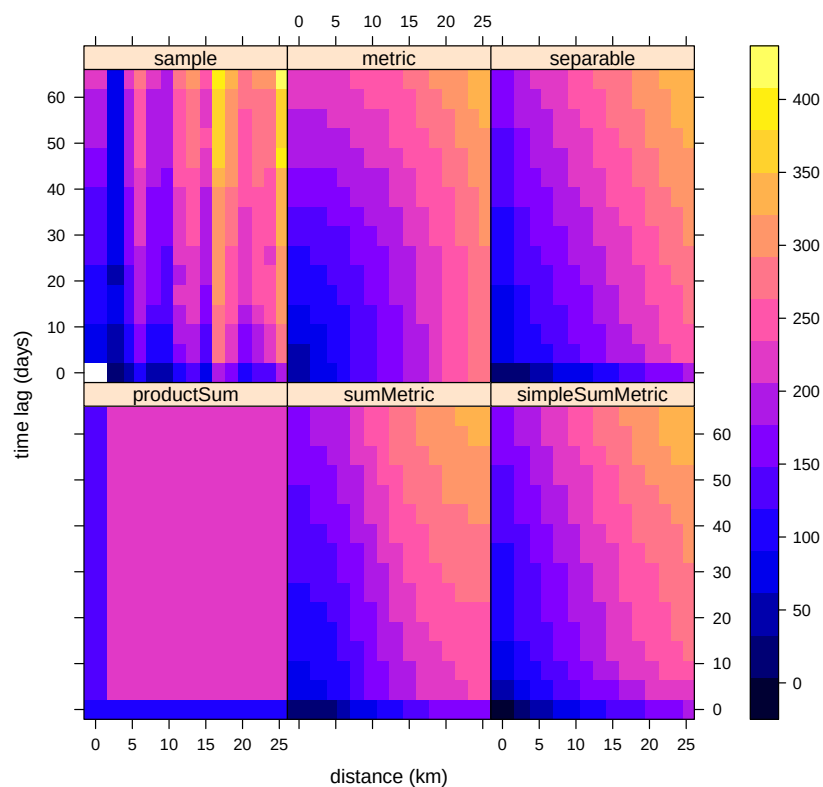


Figure S13. Sample variogram and fitted covariance models for particulate matter PM_{10} .

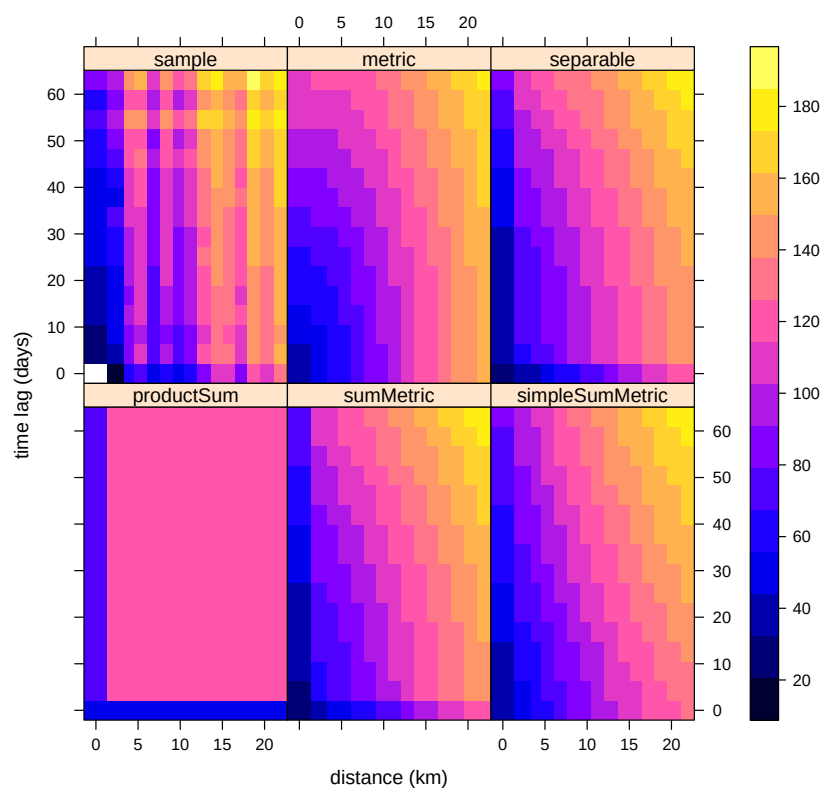


Figure S14. Sample variogram and fitted covariance models for nitrogen oxide (NO).

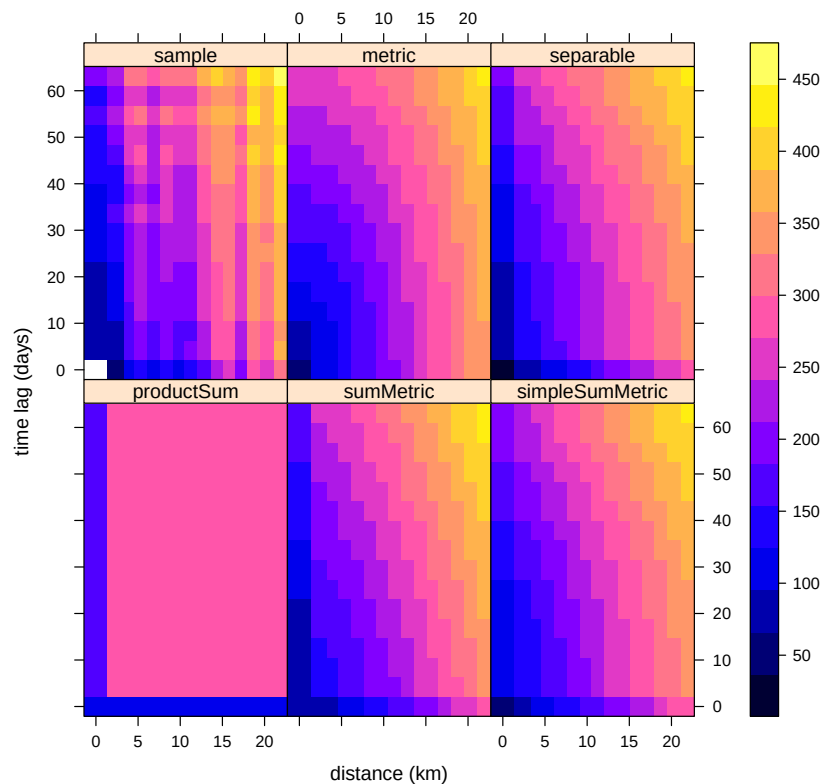


Figure S15. Sample variogram and fitted covariance models for nitrogen oxides (NO_x).

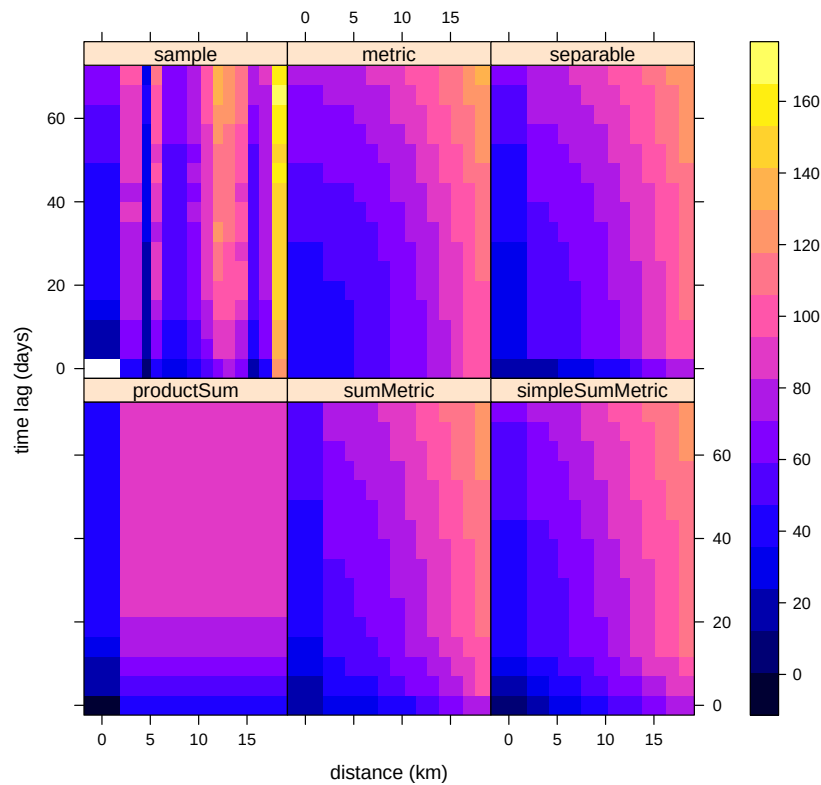


Figure S16. Sample variogram and fitted covariance models for coarse particulate matter (PM_{10}).

