

# Modeling exposure to airborne metals using moss biomonitoring in cemeteries in two urban areas around Paris and Lyon in France.

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## Supplementary methods

Categorization of Corine Land Cover subtypes into urban, agricultural, forest, natural and water area categories:

- urban area: “Continuous urban fabric”, “Discontinuous urban fabric”, “Industrial or commercial units”, “Road and rail networks and associated land”, “Port areas”, “Airports”, “Mineral extraction sites”, “Dump sites”, “Construction sites”, “Green urban areas”, “Sport and leisure facilities”;
- agricultural area: “Non-irrigated arable land”, “Permanently irrigated land”, “Rice fields”, “Vineyards”, “Fruit trees and berry plantations”, “Olive groves”, “Pastures”, “Annual crops associated with permanent crops”, “Complex cultivation patterns”, “Land principally occupied by agriculture, with significant areas of natural vegetation”, “Agro-forestry areas”;
- forest area: “Broad-leaved forest”, “Coniferous forest”, and “Mixed forest”;
- natural area: “Natural grasslands”, “Moors and heathland”, “Sclerophyllous vegetation”, “Transitional woodland-shrub”, “Beaches, dunes, sands”, “Bare rocks”, “Sparsely vegetated areas”, “Burnt areas”;
- water: “Glaciers and perpetual snow”, “Inland marshes”, “Peat bogs”, “Salt marshes”, “Salines”, “Intertidal flats”, “Water courses”, “Water bodies”, “Coastal lagoons”, “Estuaries”, and “Sea and ocean”.

## Supplementary tables

**Table S1: descriptive statistics of the metal concentrations in mosses in the two regions.** Mean, standard deviation (SD), 25<sup>th</sup> percentile (p25), 50<sup>th</sup> percentile (p50), and 75<sup>th</sup> percentile (p75). These values correspond to the graphics in Figure 2. All units are in  $\mu\text{g.g}^{-1}$  of dry matter. N=77 in Paris and N=51 in Lyon.

Metal	Region	Mean	SD	p25	p50	p75
Al	Lyon	8746	3820	6320	7440	9615
	Paris	6735	1790	5470	6590	8040
As	Lyon	2.7	1.7	1.6	2.3	3.0
	Paris	1.8	0.6	1.4	1.8	2.2
Ca	Lyon	15894	1565	14700	15900	16950
	Paris	16832	1536	16100	17000	18000
Cd	Lyon	0.4	0.3	0.2	0.3	0.5
	Paris	1.0	0.6	0.6	0.9	1.3
Cr	Lyon	13	6	9	11	15
	Paris	15	7	10	13	20
Cu	Lyon	34	28	18	26	37
	Paris	71	52	31	60	94
Fe	Lyon	5243	2594	3755	4540	5435
	Paris	5569	2038	4040	5550	6930
Hg	Lyon	0.22	0.15	0.09	0.16	0.30
	Paris	0.13	0.12	0.08	0.10	0.13
Na	Lyon	1123	812	626	864	1215
	Paris	629	230	473	595	697
Ni	Lyon	8	4	5	7	9
	Paris	9	4	6	8	12
Pb	Lyon	25	22	11	19	28
	Paris	82	53	41	68	112
Sb	Lyon	1.5	1.5	0.7	1.0	1.8
	Paris	3.2	2.3	1.4	2.7	4.5
V	Lyon	18	7	13	16	20
	Paris	16	4	13	16	18
Zn	Lyon	98	70	55	76	117
	Paris	233	121	144	209	310

**Table S2: R2 of the models yielded by the forward- and backward stepwise selection approaches for each metal in the two study areas separately.**

Metal	Lyon		Paris	
	Forward	Backward	Forward	Backward
Al	0.26	0.10	0.24	0.23
As	0.37	0.12	0.25	0.23
Ca	0.14	0.14	0.28	0.20
Cd	0.46	0.58	0.57	0.67
Cr	0.31	0.31	0.59	0.63
Cu	0.41	0.55	0.67	0.65
Fe	0.20	0.20	0.46	0.50
Hg	0.23	0.23	0.23	0.34
Na	0.12	0.12	0.29	0.22
Ni	0.26	0.32	0.62	0.69
Pb	0.33	0.49	0.22	0.59
Sb	0.54	0.62	0.81	0.84
V	0.00	0.06	0.43	0.43
Zn	0.58	0.65	0.43	0.56

**Table S3: Akaike Information Criterion (AIC) for each metal in each study region for empty and final models.**

Metal	Lyon		Paris	
	Intercept-only model	Final model	Intercept-only model	Final model
Al	49	41	1375*	1356*
As	80	60	130*	109*
Ca	899*	893*	1351*	1334*
Cd	81	43	129	50
Cr	59	42	106	34
Cu	105	68	176	95
Fe	59	49	1395*	1348*
Hg	109	98	104	54
Na	90	86	61	38
Ni	62	46	101	20
Pb	111	81	167	104
Sb	110	64	181	45
V	38	37	431*	394*
Zn	94	47	136	78

\*: not natural log-transformed metal concentrations.

**Table S4: Variance inflation factor (VIF) for all predictors included in the final models in the two study regions.**

Lyon			Paris		
Metal	Predictor	VIF	Metal	Predictor	VIF
Al	forest_2500	1.24	Ca	agri_5000	1.97
Al	I(d_routesMaj <sup>-0.05</sup> )	1.06	Ca	density	1.75
Al	altitude	1.23	Ca	forest_1000:I(forest_1000 < 0.25)	1.67
As	forest_25001	1.22	Cd	urb_5000	1.94
As	altitude1	1.22	Cd	density1	2.00
Cd	urb_1000	2.26	Cd	Support	1.04
Cd	I(forest_5000 <sup>0.3</sup> )	2.23	Cr	altitude	1.27
Cd	Support	1.03	Cr	urb_50001	2.11
Cu	urb_10001	1.76	Cr	forest_2500	1.79
Cu	forest_25002	1.76	Cu	urb_50002	1.16
Ni	urb_10002	1.76	Cu	water_5000	1.16
Ni	forest_25003	1.76	Fe	altitude1	1.31
Pb	urb_500	1.03	Fe	urb_50003	6.76
Pb	Support1	1.03	Fe	agri_50001	6.96
Sb	agri_1000	1.55	Hg	altitude2	1.32
Sb	I(forest_5000 <sup>0.2</sup> )	1.55	Hg	urb_2500	6.01
Zn	I(forest_5000 <sup>0.3</sup> )1	2.25	Hg	agri_50002	6.11
Zn	agri_500	2.44	Hg	Support1	1.03
Zn	log(density)	3.67	Na	forest_25001	1.08
			Na	agri_2500	1.08
			Ni	altitude3	1.28
			Ni	urb_500	1.59
			Ni	forest_25002	1.42
			Ni	density2	1.66
			Ni	Support2	1.06
			Pb	forest_1000	1.25
			Pb	density3	1.29
			Pb	Support3	1.05
			Sb	urb_50004	1.63
			Sb	forest_10001	1.63
			V	urb_50005	6.77
			V	agri_50003	6.91
			V	I(altitude <sup>-0.5</sup> )	1.27
			Zn	urb_50006	1.94
			Zn	density4	2.00
			Zn	Support4	1.04

**Table S5: frequency (n and %) of the types of variables (considering any buffer size for buffer variables) used in the final models in each region.**

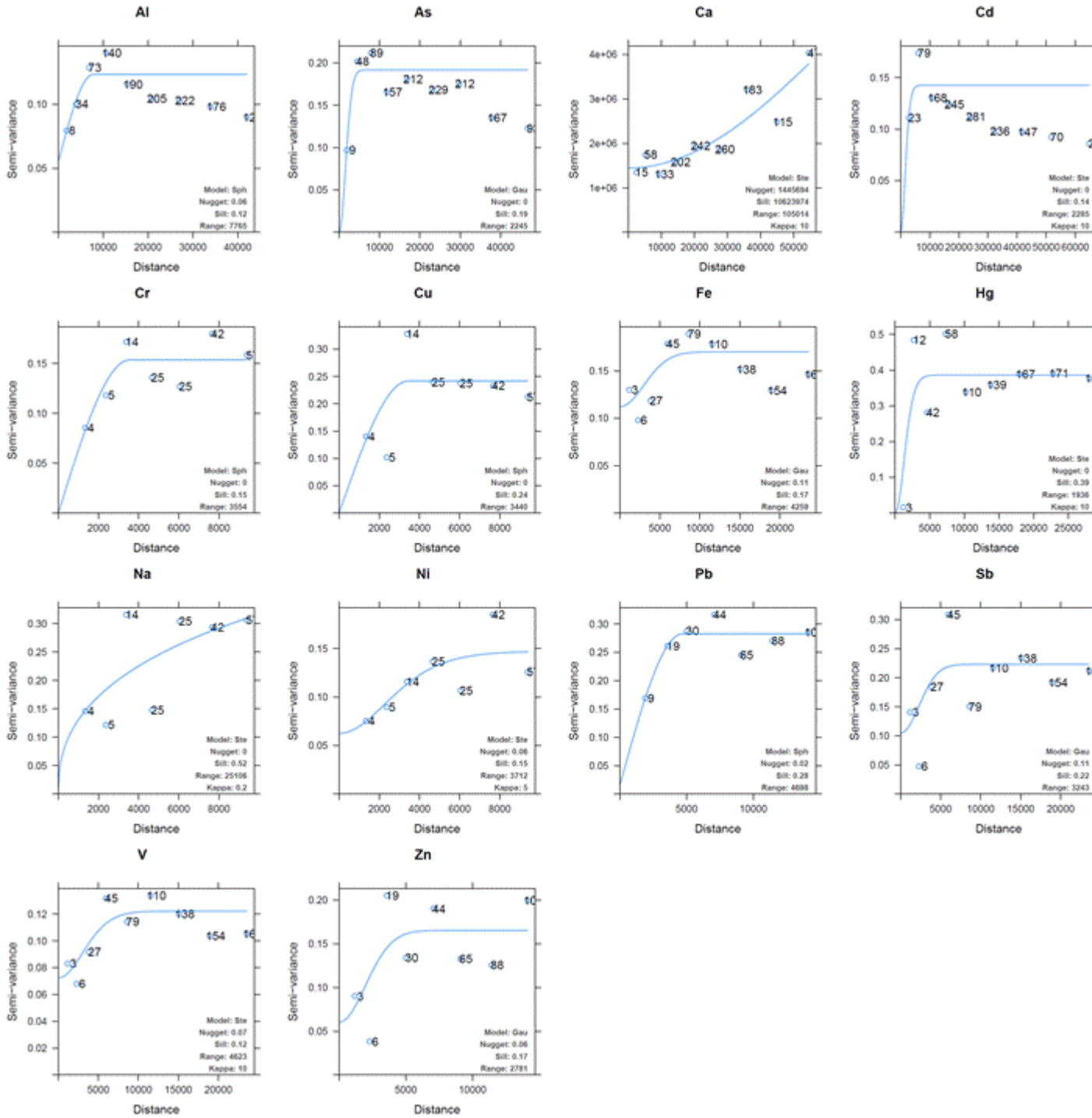
Type	Variable	Lyon		Paris	
Point	Altitude	2	14%	5	36%
	Distance to the road	1	7%	0	0%
	Population density	1	7%	5	36%
Buffer (all buffer sizes pooled)	Agricultural area	2	14%	5	36%
	Forest area	11	79%	8	57%
	Urban area	6	43%	9	64%
	Water area	0	0%	1	7%



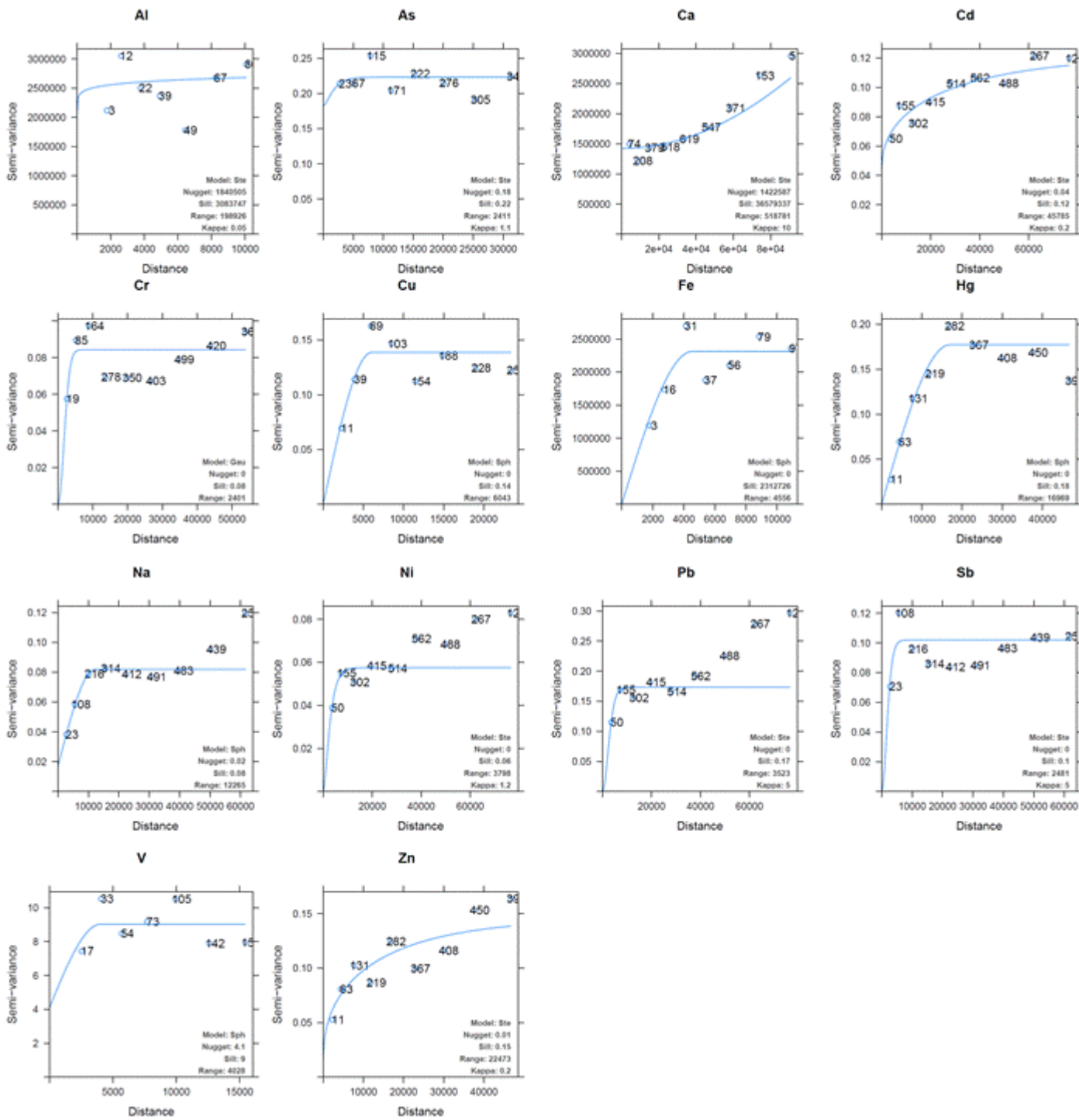
# Supplementary Figures

**Figure S1: variograms obtained for the KED approach in Lyon (panel A) and Paris (panel B).**

A: Lyon

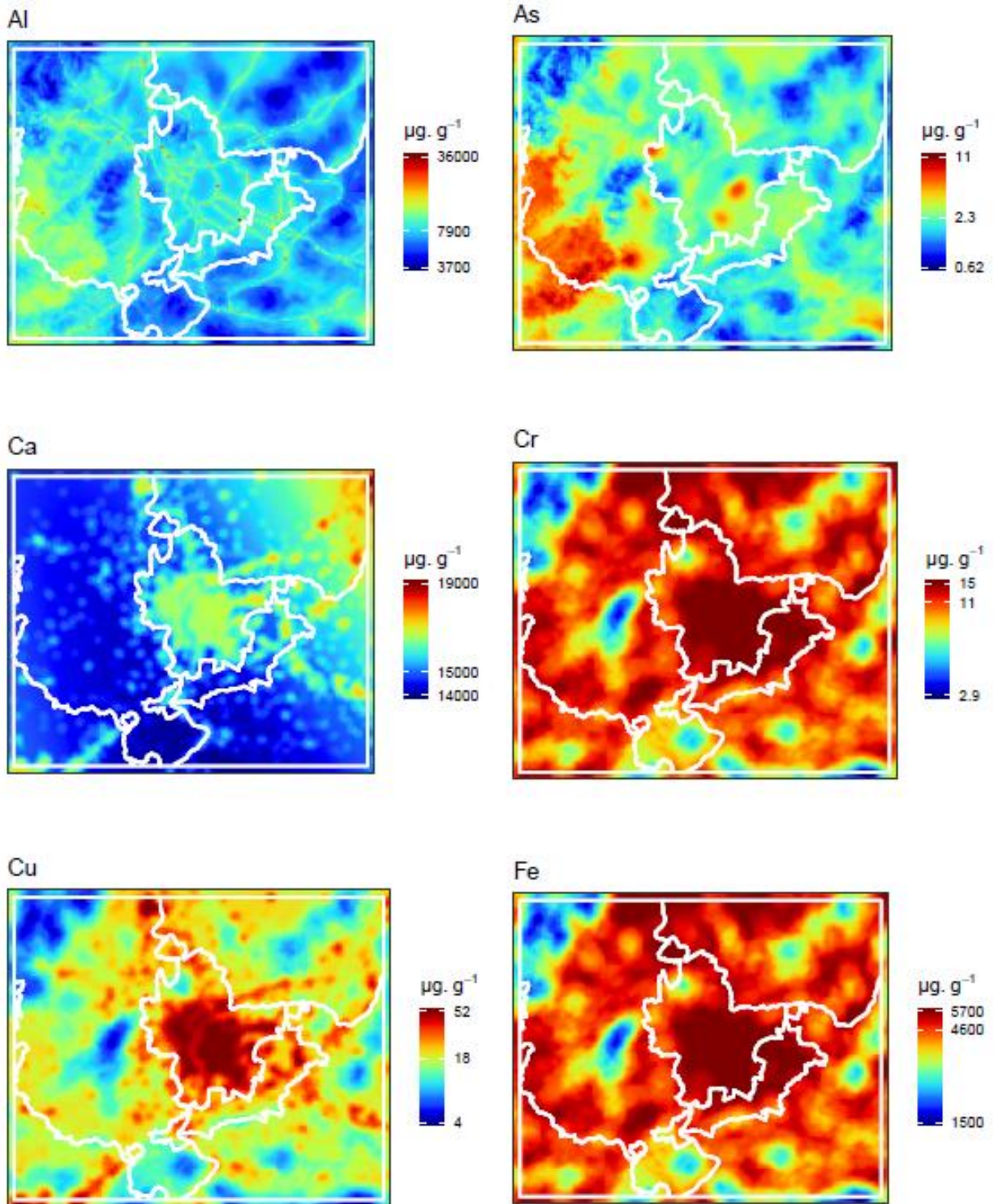


B: Paris

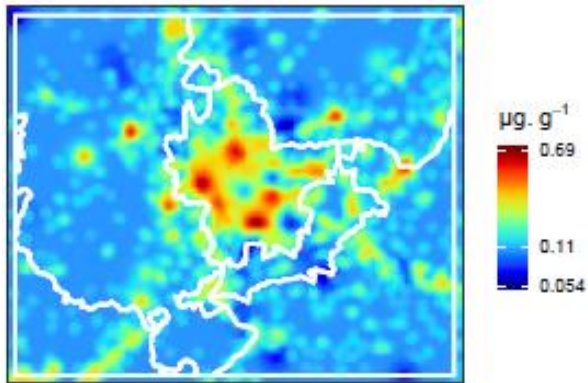


**Figure S2: exposure surfaces for Al, As, Ca, Cr, Cu, Fe, Hg, Na, Ni, V, and Zn in Lyon (A) and Paris (B).**

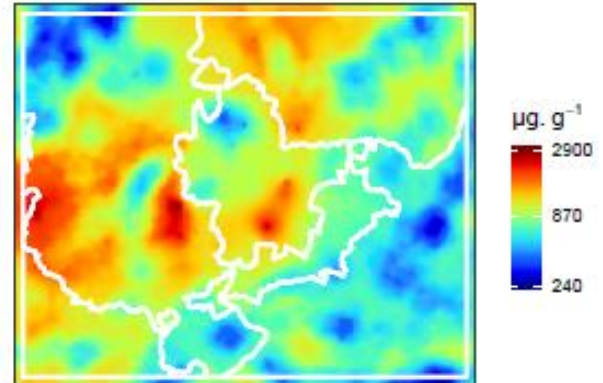
A: Lyon



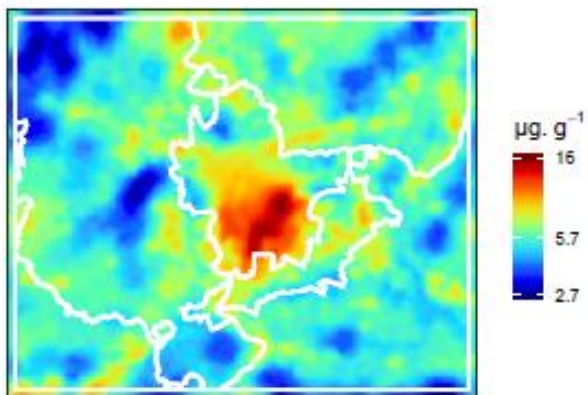
Hg



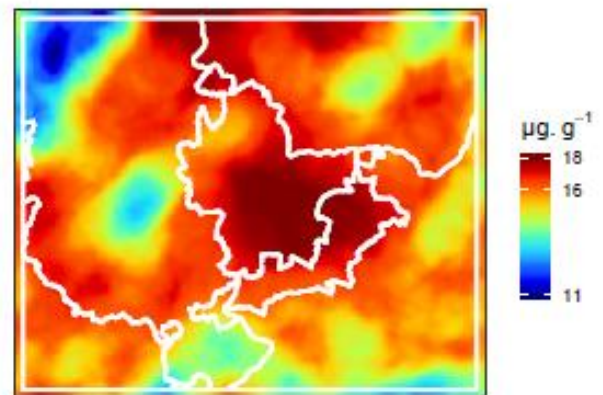
Na



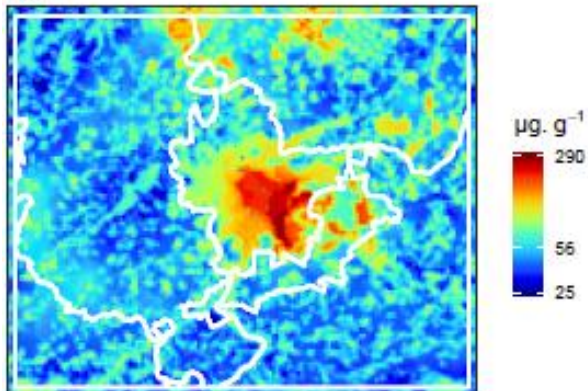
Ni



V

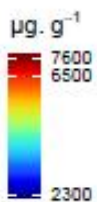
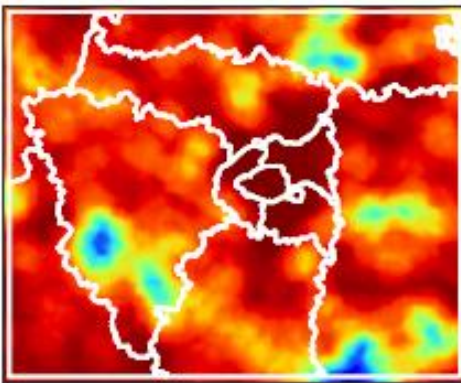


Zn

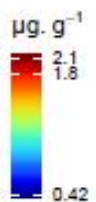
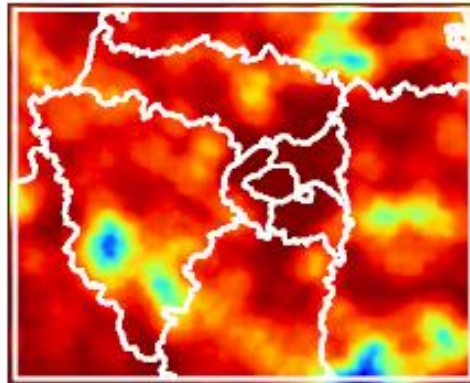


B: Paris

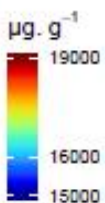
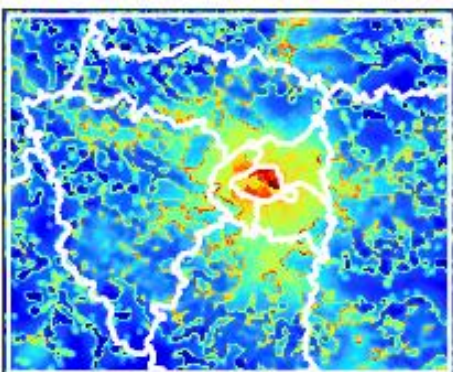
Al



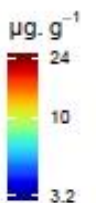
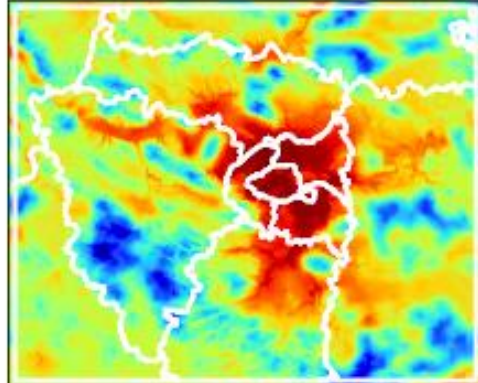
As



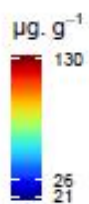
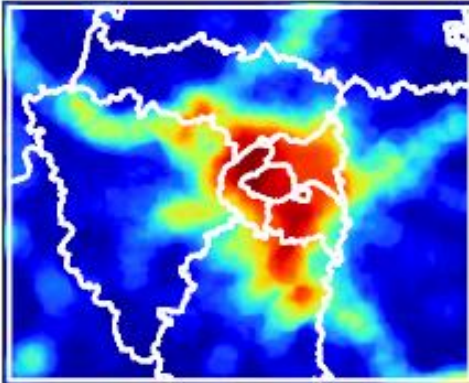
Ca



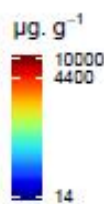
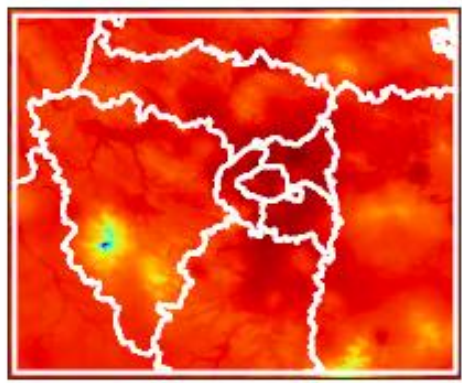
Cr



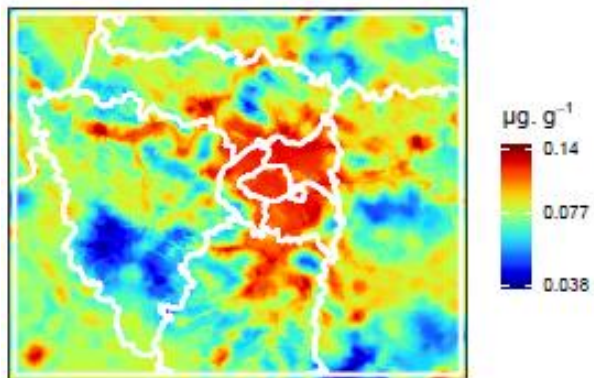
Cu



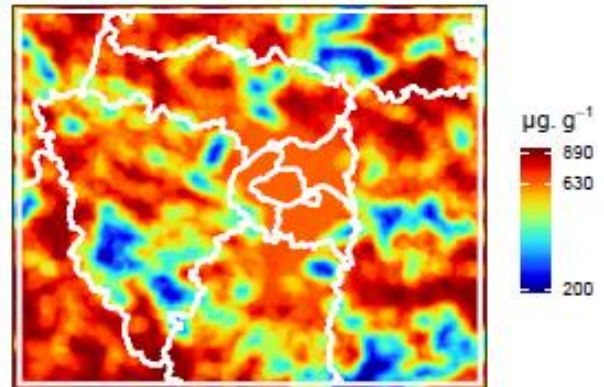
Fe



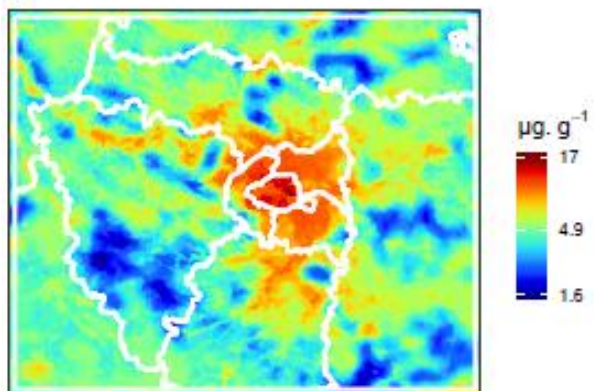
Hg



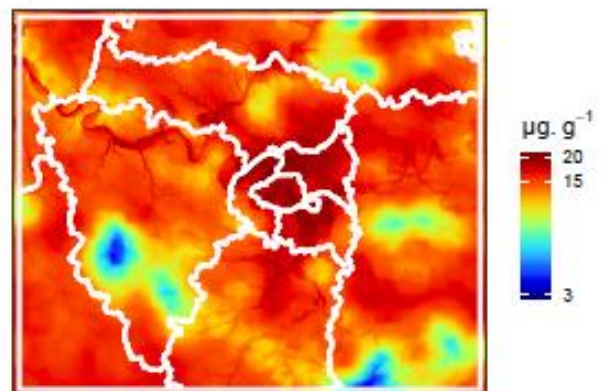
Na



Ni



V



Zn

