Supplementary information - Dispersion normalisation method for improved long-term trend evaluation: Heavy Metals in ambient air in the Czech Republic, Central Europe (2010–2021)

Adéla Holubová Šmejkalová[1], Radek Lhotka[1], Hana Škáchová[1], Jan Pacner[1]

[1]Air Quality Division, Czech Hydrometeorological Institute, Prague, 143 06, Czech Republic

Correspondence to: Adéla Holubová Šmejkalová (adela.holubova@chmi.cz)

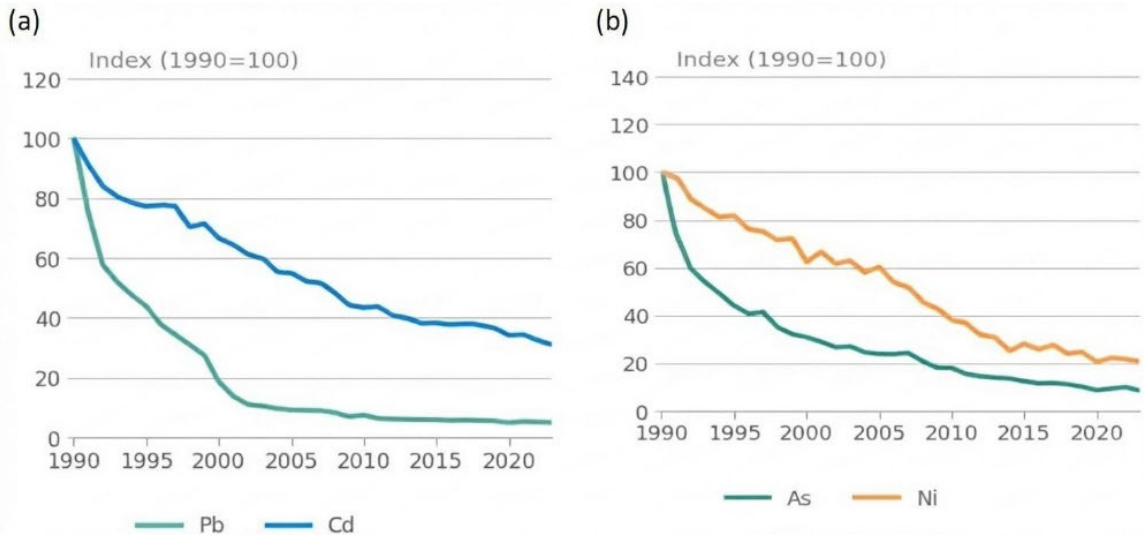

Figure S1: Indexed EU-27 emission trends for HMs. Reworked from (EEA, 2025).

Table S1: Basic characteristic of selected stations.

Station name	Station abbreviation	Station type according EOI	Coordiantes	Altitute [m] a.s.l.	Category
Brno-Líšeň	BBN	background/urban/residental	49° 12′ 47.6" N 16° 40′ 40.9" E	340	BU
Bílý Kříž	BKR	background/rural/natural	49° 30′ 9.4" N 18° 32′ 18.8" E	890	BRM
Červená hora	CER	background/rural/natural	49° 46′ 37.7" N 17° 32′ 31.0" E	749	BRL

Churáňov	CHU	background/rural/natural	49° 4′ 6.4" N 13° 36′ 53.3" E	1118	BRM
Jizerka	JIZ	background/rural/natural	50° 49′ 11.8" N 15° 20′ 40.2" E	830	BRM
Kladno-Švermov	SKL	background/urban/residental, industrial	50° 10′ 2.7" N 14° 6′ 21.7" E	219	BU
Košetice	KOS	background/rural/natural, agricultural	49° 34′ 24.2" N 15° 4′ 49.0" E	535	BRL
Kuchařovice	KUCH	background/rural/agricultural	48° 52′ 52.9" N 16° 5′ 8.9" E	334	BRL
Lom	LOM	background/rural/industrial	50° 35′ 8.8" N 13° 40′ 24.3" E	265	BRL
Ostrava-Poruba	OPR	background/sub-urban/residental	49° 49′ 31.1" N 18° 9′ 33.4" E	242	BS
Ostrava-Přívoz	POP	industrial/urban/industrial	49° 51′ 22.5" N 18° 16′ 11.1" E	207	I
Pardubice Dukla	EPA	background/urban/residental	50° 1′ 26.5" N 15° 45′ 48.8" E	239	BU
Plzeň-Slovany	PLL	dopravní/urban/commercial	49° 43′ 56.8" N 13° 24′ 8.3" E	340	T
Praha 4-Libuš	LIB	background/sub-urban/residental	50° 0′ 26.3" N 14° 26′ 45.4" E	301	BS
Svratouch	ESV	background/rural/natural	49° 44′ 6.3" N 16° 2′ 3.1" E	735	BRL
Ústí n.L.-Kočkov	ULK	background/sub-urban/residental; natural	50° 41′ 0.7" N 14° 2′ 28.3" E	367	BS

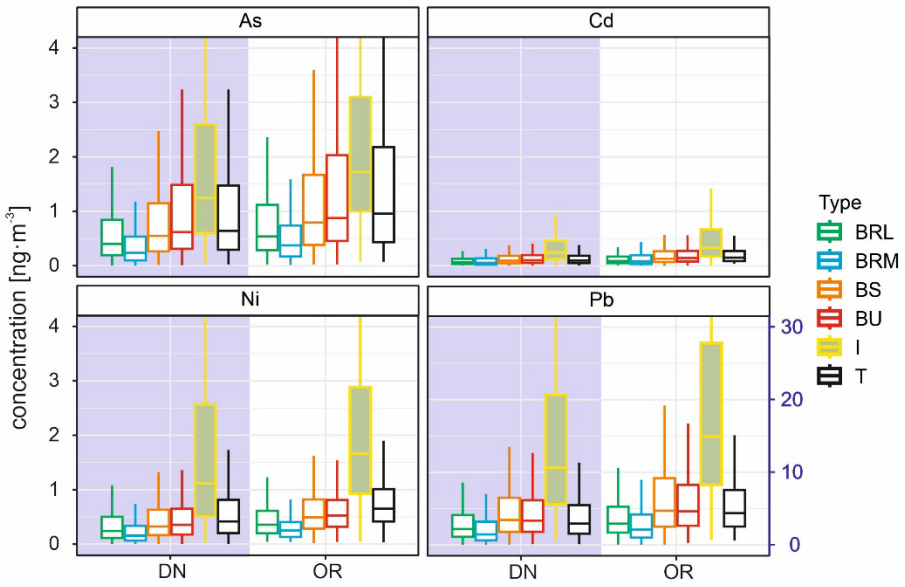

Figure S2: HMDN and HMOR concentration overview at all station type, 2010–2021. Colours representing particular station type. Background Rural Lowland stations - BRL green, Background Rural Mountain stations - BRM are coloured lightblue, Background Suburban stations – BS orange, Background Urban stations - BU red, Industrial station I – yellow and Traffic station – T black. The violet background indicates HMDN concentration, and the white background indicates HMOR concentration. The Y-axis does not reach the maximum values.

Table S2: Correlation coefficient (R_s) of As_{DN} concentrations. The R_s values > 0.7 are highlighted in blue.

	type	BRL	BRL	BRL	BRL	BRL	BRM	BRM	BRM	BS	BS	BS	BU	BU	BU	I	T
	station	CER	KOS	KUCH	LOM	ESV	BKR	CHU	JIZ	OPO	LIB	ULK	BBN	SKL	EPA	OPR	PLL
BRL	CER	1.00	0.54	0.60	0.41	0.56	0.66	0.38	0.39	0.67	0.47	0.36	0.64	0.38	0.53	0.43	0.44
BRL	KOS	0.54	1.00	0.69	0.54	0.61	0.37	0.60	0.48	0.45	0.75	0.55	0.60	0.55	0.63	0.35	0.64
BRL	KUCH	0.60	0.69	1.00	0.43	0.64	0.41	0.44	0.33	0.46	0.54	0.35	0.77	0.40	0.63	0.36	0.48
BRL	LOM	0.41	0.54	0.43	1.00	0.38	0.30	0.42	0.48	0.47	0.74	0.66	0.36	0.76	0.48	0.49	0.76
BRL	ESV	0.56	0.61	0.64	0.38	1.00	0.43	0.35	0.40	0.46	0.47	0.33	0.65	0.35	0.65	0.39	0.41
BRM	BKR	0.66	0.37	0.41	0.30	0.43	1.00	0.26	0.32	0.60	0.31	0.22	0.51	0.28	0.66	0.20	0.31
BRM	CHU	0.38	0.60	0.44	0.42	0.35	0.26	1.00	0.40	0.23	0.52	0.42	0.41	0.34	0.40	0.22	0.53
BRM	JIZ	0.39	0.48	0.33	0.48	0.40	0.32	0.40	1.00	0.27	0.45	0.58	0.33	0.36	0.44	0.30	0.44
BS	OPO	0.67	0.45	0.46	0.47	0.46	0.60	0.23	0.27	1.00	0.50	0.36	0.48	0.54	0.40	0.82	0.47
BS	LIB	0.47	0.75	0.54	0.74	0.47	0.31	0.52	0.45	0.50	1.00	0.64	0.45	0.80	0.54	0.17	0.83
BS	ULK	0.36	0.55	0.35	0.66	0.33	0.22	0.42	0.58	0.36	0.64	1.00	0.30	0.59	0.38	0.36	0.61
BU	BBN	0.64	0.60	0.77	0.36	0.65	0.51	0.41	0.33	0.48	0.45	0.30	1.00	0.32	0.59	0.39	0.40

BU	SKL	0.38	0.55	0.40	0.76	0.35	0.28	0.34	0.36	0.54	0.80	0.59	0.32	1.00	0.41	0.32	0.79
BU	EPA	0.53	0.63	0.63	0.48	0.65	0.66	0.40	0.44	0.40	0.54	0.38	0.59	0.41	1.00	0.39	0.48
I	OPR	0.61	0.35	0.36	0.49	0.39	0.20	0.22	0.30	0.82	0.17	0.36	0.39	0.32	0.39	1.00	0.46
T	PLL	0.44	0.64	0.48	0.76	0.41	0.31	0.53	0.44	0.47	0.83	0.61	0.40	0.79	0.48	0.46	1.00

Table S3: Correlation coefficient (R_s) of Cd_{DN} concentrations. The R_s values > 0.7 are highlighted in blue.

	type	BRL	BRL	BRL	BRL	BRL	BRM	BRM	BRM	BS	BS	BS	BU	BU	BU	I	T
	station	CER	KOS	KUCH	LOM	ESV	BKR	CHU	JIZ	OPO	LIB	ULK	BBN	SKL	EPA	OPR	PLL
BRL	CER	1.00	0.57	0.65	0.50	0.64	0.66	0.45	0.25	0.69	0.49	0.54	0.72	0.40	0.55	0.66	0.44
BRL	KOS	0.57	1.00	0.71	0.68	0.76	0.44	0.66	0.33	0.54	0.75	0.73	0.68	0.65	0.76	0.56	0.69
BRL	KUCH	0.65	0.71	1.00	0.61	0.69	0.52	0.51	0.18	0.56	0.59	0.59	0.81	0.52	0.71	0.54	0.57
BRL	LOM	0.50	0.68	0.61	1.00	0.62	0.37	0.55	0.41	0.45	0.70	0.76	0.56	0.70	0.70	0.48	0.73
BRL	ESV	0.64	0.76	0.69	0.62	1.00	0.49	0.53	0.40	0.55	0.61	0.64	0.71	0.57	0.75	0.58	0.57
BRM	BKR	0.66	0.44	0.52	0.37	0.49	1.00	0.36	0.15	0.58	0.36	0.38	0.59	0.27	0.44	0.60	0.35
BRM	CHU	0.45	0.66	0.51	0.55	0.53	0.36	1.00	0.30	0.37	0.62	0.60	0.49	0.52	0.54	0.42	0.63
BRM	JIZ	0.25	0.33	0.18	0.41	0.40	0.15	0.30	1.00	0.23	0.36	0.37	0.23	0.39	0.34	0.29	0.42
BS	OPO	0.69	0.54	0.56	0.45	0.55	0.58	0.37	0.23	1.00	0.50	0.49	0.63	0.51	0.53	0.85	0.44
BS	LIB	0.49	0.75	0.59	0.70	0.61	0.36	0.62	0.36	0.50	1.00	0.73	0.56	0.77	0.70	0.50	0.76
BS	ULK	0.54	0.73	0.59	0.76	0.64	0.38	0.60	0.37	0.49	0.73	1.00	0.58	0.66	0.67	0.49	0.66
BU	BBN	0.72	0.68	0.81	0.56	0.71	0.59	0.49	0.23	0.63	0.56	0.58	1.00	0.48	0.70	0.63	0.53
BU	SKL	0.40	0.65	0.52	0.70	0.57	0.27	0.52	0.39	0.51	0.77	0.66	0.48	1.00	0.65	0.49	0.72
BU	EPA	0.55	0.76	0.71	0.70	0.75	0.44	0.54	0.34	0.53	0.70	0.67	0.70	0.65	1.00	0.55	0.67
I	OPR	0.66	0.56	0.54	0.48	0.58	0.60	0.42	0.29	0.85	0.50	0.49	0.63	0.49	0.55	1.00	0.46
T	PLL	0.44	0.69	0.57	0.73	0.57	0.35	0.63	0.42	0.44	0.76	0.66	0.53	0.72	0.67	0.46	1.00

Table S4: Correlation coefficient (R_s) of Ni_{DN} concentrations. The R_s values > 0.7 are highlighted in blue.

	type	BRL	BRL	BRL	BRL	BRL	BRM	BRM	BRM	BS	BS	BS	BU	BU	BU	I	T
	station	CER	KOS	KUCH	LOM	ESV	BKR	CHU	JIZ	OPO	LIB	ULK	BBN	SKL	EPA	OPR	PLL
BRL	CER	1.00	0.41	0.34	0.36	0.54	0.30	0.40	0.44	0.33	0.31	0.45	0.27	0.40	0.31	0.25	0.29
BRL	KOS	0.33	1.00	0.49	0.44	0.43	0.29	0.47	0.44	0.31	0.48	0.47	0.45	0.47	0.49	0.28	0.47
BRL	KUCH	0.41	0.49	1.00	0.40	0.45	0.38	0.35	0.35	0.31	0.36	0.35	0.51	0.29	0.46	0.22	0.38
BRL	LOM	0.34	0.44	0.40	1.00	0.40	0.29	0.44	0.53	0.25	0.47	0.52	0.41	0.49	0.45	0.25	0.56
BRL	ESV	0.36	0.43	0.45	0.40	1.00	0.37	0.37	0.44	0.33	0.38	0.36	0.45	0.35	0.53	0.30	0.36

BRM	BKR	0.54	0.29	0.38	0.29	0.37	1.00	0.26	0.33	0.44	0.28	0.24	0.44	0.26	0.41	0.31	0.28
BRM	CHU	0.30	0.47	0.35	0.44	0.37	0.26	1.00	0.39	0.24	0.44	0.43	0.31	0.44	0.39	0.29	0.50
BRM	JIZ	0.40	0.44	0.35	0.53	0.44	0.33	0.39	1.00	0.30	0.44	0.48	0.35	0.35	0.51	0.32	0.47
BS	OPO	0.44	0.31	0.31	0.25	0.33	0.44	0.24	0.30	1.00	0.29	0.28	0.37	0.27	0.34	0.53	0.26
BS	LIB	0.33	0.48	0.36	0.47	0.38	0.28	0.44	0.44	0.29	1.00	0.49	0.37	0.51	0.48	0.25	0.50
BS	ULK	0.31	0.47	0.35	0.52	0.36	0.24	0.43	0.48	0.28	0.49	1.00	0.36	0.47	0.44	0.29	0.49
BU	BBN	0.45	0.45	0.51	0.41	0.45	0.44	0.31	0.35	0.37	0.37	0.36	1.00	0.33	0.48	0.33	0.40
BU	SKL	0.27	0.47	0.29	0.49	0.35	0.26	0.44	0.35	0.27	0.51	0.47	0.33	1.00	0.42	0.28	0.50
BU	EPA	0.40	0.49	0.46	0.45	0.53	0.41	0.39	0.51	0.34	0.48	0.44	0.48	0.42	1.00	0.32	0.50
I	OPR	0.31	0.28	0.22	0.25	0.30	0.31	0.29	0.32	0.53	0.25	0.29	0.33	0.28	0.31	1.00	0.31
T	PLL	0.25	0.47	0.38	0.56	0.36	0.28	0.50	0.47	0.26	0.50	0.49	0.40	0.50	0.49	0.31	1.00

Table S5: Correlation coefficient (R_s) of Pb_{DN} concentrations. The R_s values > 0.7 are highlighted in blue.

	type	BRL	BRL	BRL	BRL	BRL	BRM	BRM	BRM	BS	BS	BS	BU	BU	BU	I	T
	station	CER	KOS	KUCH	LOM	ESV	BKR	CHU	JIZ	OPO	LIB	ULK	BBN	SKL	EPA	OPR	PLL
BRL	CER	1.00	0.59	0.66	0.46	0.67	0.68	0.43	0.53	0.68	0.46	0.52	0.72	0.39	0.58	0.61	0.45
BRL	KOS	0.59	1.00	0.72	0.66	0.77	0.43	0.67	0.60	0.52	0.73	0.74	0.67	0.64	0.78	0.49	0.67
BRL	KUCH	0.66	0.72	1.00	0.57	0.71	0.51	0.47	0.49	0.55	0.55	0.57	0.79	0.48	0.71	0.48	0.56
BRL	LOM	0.46	0.66	0.57	1.00	0.60	0.33	0.57	0.68	0.39	0.69	0.78	0.54	0.69	0.68	0.44	0.73
BRL	ESV	0.67	0.77	0.71	0.60	1.00	0.49	0.54	0.66	0.54	0.58	0.64	0.74	0.54	0.77	0.56	0.58
BRM	BKR	0.68	0.43	0.51	0.33	0.49	1.00	0.35	0.37	0.58	0.36	0.36	0.57	0.27	0.45	0.53	0.36
BRM	CHU	0.43	0.67	0.47	0.57	0.54	0.35	1.00	0.53	0.32	0.63	0.62	0.46	0.55	0.54	0.37	0.66
BRM	JIZ	0.53	0.60	0.49	0.68	0.66	0.37	0.53	1.00	0.42	0.56	0.69	0.53	0.59	0.65	0.46	0.58
BS	OPO	0.68	0.52	0.55	0.39	0.54	0.58	0.32	0.42	1.00	0.42	0.46	0.60	0.46	0.52	0.77	0.42
BS	LIB	0.46	0.73	0.55	0.69	0.58	0.36	0.63	0.56	0.42	1.00	0.71	0.52	0.70	0.68	0.42	0.73
BS	ULK	0.52	0.74	0.57	0.78	0.64	0.36	0.62	0.69	0.46	0.71	1.00	0.56	0.68	0.68	0.46	0.68
BU	BBN	0.72	0.67	0.79	0.54	0.74	0.57	0.46	0.53	0.60	0.52	0.56	1.00	0.47	0.70	0.59	0.53
BU	SKL	0.39	0.64	0.48	0.69	0.54	0.27	0.55	0.59	0.46	0.70	0.68	0.47	1.00	0.63	0.49	0.71
BU	EPA	0.58	0.78	0.71	0.68	0.77	0.45	0.54	0.65	0.52	0.68	0.68	0.70	0.63	1.00	0.54	0.67
I	OPR	0.61	0.49	0.48	0.44	0.56	0.53	0.37	0.46	0.77	0.42	0.46	0.59	0.49	0.54	1.00	0.44
T	PLL	0.45	0.67	0.56	0.73	0.58	0.36	0.66	0.58	0.42	0.73	0.68	0.53	0.71	0.67	0.44	1.00

Table S6: Correlation coefficient (R_s) of HM_{DN} concentrations at BRL stations.

	CER_As	CER_Cd	CER_Ni	CER_Pb	KOS_As	KOS_Cd	KOS_Ni	KOS_Pb	KUCH_As	KUCH_Cd	KUCH_Ni	KUCH_Pb	LOM_As	LOM_Cd	LOM_Ni	LOM_Pb	ESV_As	ESV_Cd	ESV_Ni	ESV_Pb
CER_As	1	0.69	0.52	0.76																
CER_Cd	0.69	1	0.51	0.92																
CER_Ni	0.52	0.51	1	0.56																
CER_Pb	0.76	0.92	0.56	1																
KOS_As					1	0.8	0.5	0.82												
KOS_Cd					0.8	1	0.54	0.9												
KOS_Ni					0.5	0.54	1	0.6												
KOS_Pb					0.82	0.9	0.6	1												
KUCH_As									1	0.85	0.49	0.87								
KUCH_Cd									0.85	1	0.51	0.94								
KUCH_Ni									0.49	0.51	1	0.52								
KUCH_Pb									0.87	0.94	0.52	1								
LOM_As													1	0.78	0.48	0.78				
LOM_Cd													0.78	1	0.61	0.9				
LOM_Ni													0.48	0.61	1	0.68				
LOM_Pb													0.78	0.9	0.68	1				
ESV_As																	1	0.65	0.44	0.71
ESV_Cd																	0.65	1	0.51	0.91
ESV_Ni																	0.44	0.51	1	0.52
ESV_Pb																	0.71	0.91	0.52	1

Table S7: Correlation coefficient (R_s) of HM_{DN} concentrations at BRM stations.

	BKR_As	BKR_Cd	BKR_Ni	BKR_Pb	CHU_As	CHU_Cd	CHU_Ni	CHU_Pb	JIZ_As	JIZ_Cd	JIZ_Ni	JIZ_Pb
BKR_As	1	0.7	0.52	0.7								
BKR_Cd	0.7	1	0.62	0.93								
BKR_Ni	0.51	0.59	1	0.61								
BKR_Pb	0.7	0.93	0.62	1								
CHU_As					1	0.81	0.45	0.82				
CHU_Cd					0.81	1	0.55	0.9				
CHU_Ni					0.41	0.52	1	0.57				
CHU_Pb					0.82	0.9	0.6	1				
JIZ_As									1	0.59	0.57	0.85
JIZ_Cd									0.59	1	0.4	0.62
JIZ_Ni									0.54	0.4	1	0.59
JIZ_Pb									0.85	0.62	0.63	1

35

Table S8: Correlation coefficient (R_s) of HM_{DN} concentrations at BS stations.

	OPO_As	OPO_Cd	OPO_Ni	OPO_Pb	LIB_As	LIB_Cd	LIB_Ni	LIB_Pb	ULK_As	ULK_Cd	ULK_Ni	ULK_Pb
OPO_As	1	0.67	0.59	0.7								
OPO_Cd	0.67	1	0.6	0.9								
OPO_Ni	0.59	0.6	1	0.64								
OPO_Pb	0.7	0.9	0.64	1								
LIB_As					1	0.78	0.46	0.72				
LIB_Cd					0.78	1	0.55	0.87				
LIB_Ni					0.46	0.55	1	0.63				
LIB_Pb					0.72	0.87	0.63	1				
ULK_As									1	0.74	0.43	0.78
ULK_Cd									0.74	1	0.57	0.9
ULK_Ni									0.43	0.57	1	0.61
ULK_Pb									0.78	0.9	0.61	1

Table S9: Correlation coefficient (Rs) of HMDN concentrations at BU, I and T stations.

	BBN_As	BBN_Cd	BBN_Ni	BBN_Pb	SKL_As	SKL_Cd	SKL_Ni	SKL_Pb	EPA_As	EPA_Cd	EPA_Ni	EPA_Pb	OPR_As	OPR_Cd	OPR_Ni	OPR_Pb	PLL_As	PLL_Cd	PLL_Ni	PPL_Pb
BBN_As	1	0.76	0.54	0.79																
BBN_Cd	0.76	1	0.59	0.93																

BBN_Ni	0.54	0.59	1	0.62																
BBN_Pb	0.79	0.93	0.62	1																
SKL_As					1	0.81	0.32	0.75												
SKL_Cd					0.81	1	0.49	0.88												
SKL_Ni					0.32	0.49	1	0.55												
SKL_Pb					0.75	0.88	0.55	1												
EPA_As									1	0.72	0.6	0.76								
EPA_Cd									0.72	1	0.63	0.92								
EPA_Ni									0.6	0.63	1	0.65								
EPA_Pb									0.76	0.92	0.65	1								
OPR_As													1	0.67	0.73	0.74				
OPR_Cd													0.67	1	0.52	0.88				
OPR_Ni													0.73	0.52	1	0.62				
OPR_Pb													0.74	0.88	0.62	1				
PLL_As																	1	0.74	0.36	0.72
PLL_Cd																	0.74	1	0.46	0.72
PLL_Ni																	0.36	0.46	1	0.48
PLL_Pb																	0.72	0.72	0.48	1

Table S10: The results of long-term trend analyses of HM_{DN} and HM concentrations for the individual stations.The overall trend is mentioned as a percentage increase/decrease per year, and the 95% confidence intervals in the slope are listed in [ ] %/year. Significance level: p < 0.001 = ∗ ∗ ∗, p < 0.01 = ∗∗, p < 0.05 = ∗ and p < 0.1 = +.

	As %/year	Cd %/year	Pb %/year	Ni %/year
BRL				
KOS_{DN}	−4.42[−5.53, −2.63] ***	−4.87 [−5.91, −3.75] ***	−4.57 [−5.68, −3.43] ***	−3.33[−34.92, -1.67] ***

KOS	−4.92 [−5.95, −3.42] ***	−5.12 [−6.75, −3.5] ***	−5.44 [−6.62, −4] ***	−3.75[−4.94, −2.06] ***
BKU_{DN}	−4.09 [−5.21, −2.81] ***	−4.72 [−6.1, −3.34] ***	−4.85 [−5.95, −3.61] ***	−2.67 [−3.99, −0.34] *
BKU	−5.05[−6.11, −3.5] ***	−5.72 [−7.06, −3.84] ***	−5.86 [−6.97, −4.68] ***	−3.15 [−4.4, -1.16] **
LOM_{DN}	−1.89 [−4.12, 1.2]	−4.43 [−5.52, −3.13] ***	−5.14 [−6.01, −3.93] ***	−1.81 [−3, 0.02] +
LOM	−2.16 [−3.99, −0.11] *	−5.37 [−6.68, −3.68] ***	−5.44 [−6.62, −4.00] ***	−2.04 [−3.12, -0.41] **
ESV_{DN}	−0.88 [−2.97, 1.66]	−3.97 [−5.10, −2.43] ***	−4.01 [−4.95, −2.58] ***	−0.99[−3.31, 12.3]
ESV	−3.23 [−4.83, −1.19] ***	−5.33 [−6.79, −3.87] ***	−5.22 [−6.49, −4.00] ***	−1.73 [−3.43, 0.58]
CER_{DN}	−4.76 [−5.73, −3.62] ***	−5.88 [−6.79, −4.53] ***	−4.83 [−5.75, −3.83] ***	−3.5[−4.82, -1.53] ***
CER	−5.34 [−6.37, −4.43] ***	−6.52 [−7.11, −5.54] ***	−5.78 [−6.51, −4.86] ***	−3.95 [−5.15, −2.35] ***
BRM				
BKR_{DN}	−7.41 [−7.86, −6.97] ***	−5.84 [−6.42 −5.16] ***	−5.17 [−5.94, −4.48] ***	−3.15 [−4.48, −1.06]**
BKR	−7.61 [−8.34, −6.81] ***	−6.48 [−7.19, −5.7] ***	−6.12 [−6.87, −5.31] ***	−4.00 [−4.91, -2.1] ***
CHU_{DN}	−4.59 [−5.59, −3.39] ***	−5.58 [−7.13, −4.46] ***	−4.93 [−6.13, −3.75] ***	-3.39 [−5, -1.49] **
CHU	−5.94[−7.07, −4.51] ***	−6.35 [−8.17, −4.57] ***	−6.00 [−6.82, −4.81] ***	-4.27[−5.52, -2.31] ***
JIZ_{DN}	−3.20 [−4.58, −1.62] ***	−7.3[−8.15, −5.91] ***	−5.23 [−6.09, −4.14J] ***	−3.42 [−4.74, −1.74]***
JIZ	−4.27 [−5.31, −2.89] ***	−8.07 [−9.54, −6.68] ***	−5.60 [−652, −4.68] ***	−4.17[−5.41, −2.64] ***
BS				
ULK_{DN}	−3.98 [−5.68, −2.32] ***	−5.67 [−6.7, −4.79] ***	−5.36 [−6.38, −4.33] ***	−3.45 [−4.71, −1.49] **
ULK	−3.96 [−5.35, −2.14] ***	−6.04 [−7.04, −4.87] ***	−5.32 [−6.22, −4.25] ***	−3.47 [−4.55, −2] ***
LIB_{DN}	−5.07 [−6.72, −3.25] ***	−5.66 [−6.55, −4.67] ***	−6 [−6.72, −4.96] ***	−3.42 [−4.53, −2.1] ***
LIB	−4.9 [−6.61, −3.21] ***	−6.22 [−7.59, −482] ***	−6.53 [−7.22, −5.49] ***	−3.65 [−4.76, −2.31] ***
OPO_{DN}	−3.03 [−4.68, −1.34] ***	−5.91 [−6.86, −4.65] ***	−5.31 [−6.31, −4.32] ***	−0.47 [−2.57, 2.41]
OPO	−3.61 [−5.31, −1.89] ***	−6.04 [−7.19, −4.98] ***	−5.81 [−7.05, −5.04] ***	−2.05 [−3.74, -0.05] *
BU				
BBN_{DN}	−4.33 [−5.36, −3.22] ***	−5.5 [−6.35, −4.21] ***	−5.07 [−5.85, −4.25] ***	−4.64 [−5.42, −3.71] ***
BBN	−4.79 [−5.82, −3.75] ***	−5.83 [−7.03, −4.58] ***	−5.67 [−6.38, −4.53] ***	−4.94 [−5.71, −3.76]r ***
EPA_{DN}	−1.72 [−3.12, −0.04] *	−4.99 [−6.1, −3.89] ***	−4.97 [−6.12, −3.68] ***	−3.33 [−4.56, −1.78] ***
EPA	−3.62 [−4.82, −1.94] ***	−5.84 [−6.92, −4.24] ***	−5.88 [−7.1, −4.46] ***	−4.01 [−5.19, −2.77] ***
SKL_{DN}	−4.69 [−6.73, −1.94] ***	−5.28 [−6.4, −4.06] ***	−6.51 [−7.21, −5.21] ***	−3.45 [−4.57, −2.14] ***
SKL	−5.03 [−7.54, −2.84] ***	−5.63 [−6.67, −3.99] ***	−6.85 [−7.64, −5.8] ***	−4.28[−5.23, −3.03] ***
I				
OPR_{DN}	−3.73 [−4.87, −2.63] ***	−5.73 [−6.60, −4.73] ***	−4.95 [−5.82, −4.01] ***	0.74[−1.68, 4.14]
OPR	−4.41 [−5.66 −3.42] ***	−6.19 [−7.44, −5.26] ***	−5.85 [−6.54, −5.09] ***	0.23[−1.8, 3.31]
T				

PLL_{DN}	−4.54 [−6.31, −2.54] ***	−5.36 [−6.89, −4.08] ***	−5.86 [−6.77, −5.5] ***	−5.02 [−5.92, −3.97] ***
PLL	−5.09 [−6.41, −3] ***	−6.04 [−7.16, −4.72] ***	−6.52 [−7.34, −5.49] ***	−4.81 [−5.84, −3.78] ***

Table S11: The maximal and minimal percentage difference between HM OR–DN yearly average concentration.

HM	Station type	BRL	BRM	BS	BU	I	T
As OR–DN [%]	max	36	51	44	41	46	44
	min	12	19	10	20	7	9
Cd OR–DN [%]	max	36	47	40	44	39	52
	min	13	21	11	8	8	20
Ni OR–DN [%]	max	39	49	46	40	47	50
	min	23	20	20	20	18	27
Pb OR–DN [%]	max	35	43	39	43	46	50
	min	13	19	18	9	15	8

45

Figure S3: Dispersion conditions evaluated by ventilation coefficient value according to method CHMI (2026) at individual stations 2011–2021.