Supplementary Information for

Spatial and seasonal dynamics of gaseous elemental mercury concentrations over Switzerland observed by a passive air sampler network

Stefan Osterwalder[1], Ron Schibler[2], Christoph Hüglin[3], Beat Schwarzenbach[3], Geoff Stupple[4], Katrina MacSween[4], Kevin Bishop[5], Christine Alewell[2], Nina Buchmann[1]

[1] Institute of Agricultural Sciences, Department of Environmental Systems Science, ETH Zurich, 8092 Zurich, Switzerland

[2] Environmental Geosciences, University of Basel, 4056 Basel, Switzerland

[3] Empa, Swiss Federal Laboratories for Materials Science and Technology, 8600 Dübendorf, Zürich, Switzerland

[4] Air Quality Research Division, Environment and Climate Change Canada, M3H 5T4 Toronto, ON, Canada

[5] Department of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, 75007 Uppsala, Sweden

Contents

S1: Photo-documentation of MerPAS® at NABEL and Swiss FluxNet sites

a) BER: Bern-Bollwerk

b) LAU: Lausanne-César-Roux

c) LUG: Lugano-Università

d) CH-BAS: Basel Klingelbergstr.

e) ZUE: Zürich-Kaserne

f) BAS: Basel-Binningen

g) DUE: Dübendorf-Empa

h) HAE: Härkingen-A1

i) CH-OE2: Oensingen

j) SIO: Sion-Aéroport-A9

k) MAG: Magadino-Cadenazzo

l) CH-CHA: Chamau

m) PAY: Payerne

n) TAE: Tänikon

o) CH-LAE: Lägeren

p) BRM: Beromünster

q) CH-FRU: Früebüel

r) RIG: Rigi-Seebodenalp

s) CHA: Chaumont

t) DAV: Davos-Seehornwald

u) CH-AWS: Alp Weissenstein

v) JUN: Jungfraujoch

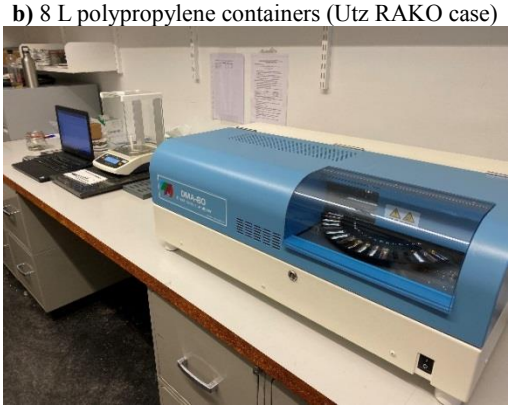
Figure S1: Photo-documentation of MerPAS® installations at the 16 National Air Pollution Monitoring Network (NABEL; a-c, e-h, j, k, m, n, p, r-t, v) and six Swiss FluxNet sites (d, i, l, o, q, u).

S2: Photo-documentation of MerPAS® preparation and lab work

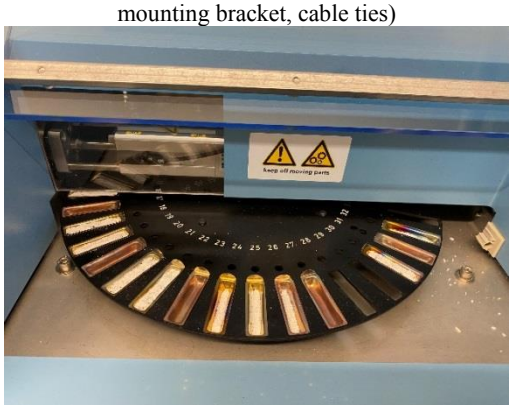
a) 2 L clear glass jar with lid (IKEA, Korken)

b) 8 L polypropylene containers (Utz RAKO case)

c) MerPAS® kit (samples, blank, marker, tape, gloves, mounting bracket, cable ties)

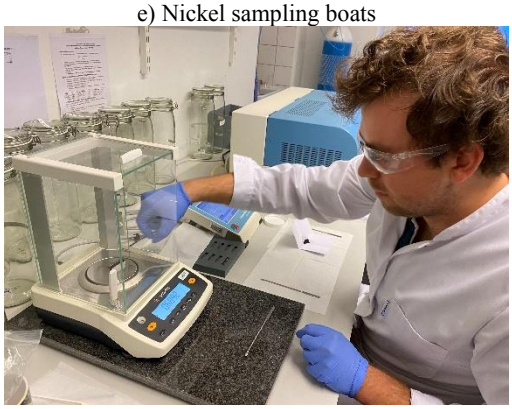


d) DMA-80 Mercury Analyzer

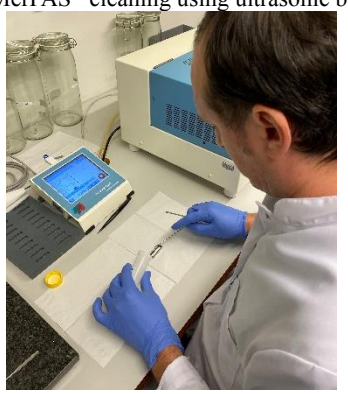


e) Nickel sampling boats

f) MerPAS® cleaning using ultrasonic bath



g) Weighing in of sulfur-impregnated activated carbon



h) Covering of samples with sodium carbonate

Figure S2: Photo-documentation of MerPAS® handling during transport and impressions from lab work.

S3: MerPAS® cleaning protocol

Radiello

1 Blow zero air or argon through the Radiello to remove particles
2 Put the Radiello into an Alconox sonicate bath for 15 min
3 Rinse Radiello with ultrapure water (Milli-Q)
4 Put the Radiello into a Milli-Q sonicate bath for 15 min
5 Blow through Radiello with Hg-free air (zero air) to remove excess water
6 Leave Radiello in fume hood to dry over night
7 Blow Radiello with zero air
8 Double bag and store

Mesh screens

1 Put the mesh screens into an Alconox sonicate bath for 15 min
2 Rinse mesh screens with Milli-Q water
3 Put the mesh screens into a Milli-Q sonicate bath for 15 min
4 Dry mesh screens in oven @ 120°C for 2 -3 hours (until dry)
5 Double bag and store

Plugs

1 Put the plugs into an Alconox sonicate bath for 20 min
2 Put the plugs into a Milli-Q sonicate bath for 15 min
3 Leave the plugs in a 10% nitric acid bath over night
4 Rinse plugs with Milli-Q water
5 Dry over night - double bag and store

Blue shields and lids

1 Remove previous labels and save for records (do not remove ECCC barcode)
2 Clean shields and lids manually with Alconox, brush to clean and rinse with Milli-Q water
3 Dry overnight - store in clean container with lid

Passive sampler preparation

1 Fill mesh screens to the top with sulfur-impregnated activated carbon (90-Hg 410-40 bulk carbon)
2 Insert plug
3 Place mesh screens in the Radiello
4 Properly screw Radiello into blue shield
5 Place lid and seal it with white electrical tape (2x around)
6 Add new label
7 Place MerPAS® in plastic bag with carbon sorbent drier bag
8 Double bag - ready for deployment

S4: Statistical overview of seasonal atmospheric Hg^0 measurements

Table S1: Analytical results from the **autumn** MerPAS® deployment.

Code	Station type	Start date	End date	Depl. (days)	AC (g)	Hg (ng)	TA (°C)	WS ($m\ s^{-1}$)	$SR_{adj.}$ ($m^3\ day^{-1}$)	Hg^0 ($ng\ m^{-3}$)
BER	urban roadside	30.09.2022	23.11.2022	54.00	0.805	9.09	11.66	1.62	0.107	1.40
LAU		14.09.2022	07.12.2022	84.04	0.711	14.23	11.96	2.75	0.111	1.33
LUG	urban center	06.09.2022	29.11.2022	84.13	0.644	12.25	14.26	1.41	0.109	1.24
CH-BAS		31.08.2022	30.11.2022	91.19	0.660	15.59	13.80	2.04	0.110	1.38
ZUE		13.09.2022	06.12.2022	84.03	0.645	14.16	11.79	1.96	0.108	1.38
BAS	suburban	14.09.2022	07.12.2022	83.99	0.683	12.42	9.77	1.69	0.106	1.17
DUE		22.08.2022	16.11.2022	85.81	0.681	15.61	14.00	1.82	0.110	1.37
HAE	rural motorway	13.09.2022	06.12.2022	84.08	0.691	14.48	10.50	1.67	0.106	1.48
CH-OE2		12.09.2022	13.12.2022	92.04	0.716	16.10	9.23	1.44	0.104	1.70
SIO		14.09.2022	07.12.2022	84.04	0.649	14.14	10.15	1.53	0.106	1.41
MAG	rural low (< 1000 m a.s.l.)	06.09.2022	29.11.2022	84.06	0.662	13.90	12.70	1.16	0.107	1.35
CH-CHA		07.09.2022	30.11.2022	84.17	0.671	12.40	10.84	0.79	0.104	1.24
PAY		21.09.2022	14.12.2022	83.97	0.676	11.88	7.53	1.94	0.104	1.24
TAE		31.08.2022	23.11.2022	84.00	0.662	14.70	11.72	1.31	0.106	1.39
CH-LAE		16.08.2022	23.09.2022	38.18	0.656	5.92	16.41	0.45	0.108	1.26
BRM		08.09.2022	30.11.2022	83.15	0.805	13.96	10.43	3.41	0.111	1.35
CH-FRU	rural high (> 1000 m a.s.l.)	07.09.2022	30.11.2022	84.08	0.676	13.18	9.17	1.24	0.104	1.33
RIG		07.09.2022	30.11.2022	83.68	0.682	12.72	9.98	2.10	0.107	1.28
CHA		31.08.2022	23.11.2022	84.06	0.605	15.10	9.73	2.60	0.108	1.51
DAV		21.09.2022	30.11.2022	70.04	0.662	9.66	5.41	1.78	0.102	1.17
CH-AWS		15.09.2022	03.11.2022	48.97	0.640	8.04	6.82	1.74	0.103	1.28
JUN	high altitude	25.08.2022	24.11.2022	91.02	0.716	16.27	-3.89	5.23	0.104	1.58

Table S2: Analytical results from the **winter** MerPAS® deployment.

Code	Station type	Start date	End date	Depl. (days)	AC (g)	Hg (ng)	TA (°C)	WS ($m\ s^{-1}$)	$SR_{adj.}$ ($m^3\ day^{-1}$)	Hg^0 ($ng\ m^{-3}$)
BER	urban roadside	23.11.2022	15.02.2023	84.05	0.609	11.09	2.84	2.02	0.100	1.13
LAU		07.12.2022	01.03.2023	83.98	0.609	10.92	4.64	1.53	0.101	1.15
LUG	urban center	29.11.2022	21.02.2023	83.96	0.630	11.15	5.71	1.47	0.101	1.12
CH-BAS		30.11.2022	03.03.2023	92.71	0.620	15.20	4.63	2.13	0.102	1.45
ZUE		06.12.2022	28.02.2023	84.01	0.646	13.77	4.44	2.32	0.103	1.46
BAS	suburban	07.12.2022	28.02.2023	83.03	0.627	13.72	4.27	2.21	0.102	1.41
DUE		16.11.2022	23.02.2023	99.10	0.644	15.97	3.89	2.23	0.102	1.46
HAE	rural motorway	-	-	-		-	-	-	-	-
CH-OE2		13.12.2022	06.03.2023	83.03	0.607	15.18	3.07	2.16	0.101	1.81
SIO		07.12.2022	01.03.2023	84.00	0.617	13.12	2.17	1.39	0.098	1.44
MAG	rural low (< 1000 m a.s.l.)	29.11.2022	21.02.2023	83.96	0.614	10.56	3.37	1.20	0.099	1.09
CH-CHA		30.11.2022	04.03.2023	94.08	0.609	12.85	2.12	1.05	0.097	1.26
PAY		14.12.2022	08.03.2023	84.04	0.648	12.56	3.38	2.14	0.101	1.34
TAE		23.11.2022	23.02.2023	92.25	0.653	14.53	2.86	1.66	0.099	1.39
CH-LAE		04.12.2022	04.03.2023	89.98	0.636	12.88	2.33	2.96	0.103	1.39
BRM		30.11.2022	21.02.2023	83.01	0.613	12.37	1.65	3.62	0.104	1.30
CH-FRU	rural high (> 1000 m a.s.l.)	30.11.2022	04.03.2023	94.08	0.635	13.95	0.52	1.63	0.097	1.37
RIG		30.11.2022	21.02.2023	82.98	0.600	12.15	1.19	2.27	0.100	1.29
CHA		23.11.2022	15.02.2023	84.00	0.605	11.84	0.02	3.14	0.101	1.27
DAV		30.11.2022	02.03.2023	91.98	0.638	12.41	-2.22	1.68	0.095	1.28
CH-AWS		03.11.2022	06.05.2023	184.11	0.656	21.33	-1.21	1.89	0.096	1.12
JUN	high altitude	24.11.2022	02.03.2023	97.98	0.695	12.43	-11.51	6.70	0.102	1.06

Table S3: Analytical results from the **spring** MerPAS® deployment.

Code	Station type	Start date	End date	Depl. (days)	AC (g)	Hg (ng)	TA (°C)	WS ($m\ s^{-1}$)	$SR_{adj.}$ ($m^3\ day^{-1}$)	Hg^0 ($ng\ m^{-3}$)
BER	urban roadside	15.02.2023	10.05.2023	83.99	0.646	11.37	8.60	2.43	0.107	1.16
LAU		01.03.2023	24.05.2023	83.96	0.664	14.98	10.65	1.43	0.106	1.48
LUG	urban center	21.02.2023	16.05.2023	84.02	0.577	13.44	11.76	1.96	0.108	1.33
CH-BAS		03.03.2023	30.05.2023	88.23	0.603	14.16	11.73	2.16	0.109	1.31
ZUE		28.02.2023	23.05.2023	83.84	0.668	17.36	10.56	2.45	0.109	1.62
BAS	suburban	28.02.2023	23.05.2023	83.96	0.687	17.25	10.34	2.06	0.107	1.50
DUE		23.02.2023	31.05.2023	97.03	0.603	16.16	10.12	2.04	0.107	1.39
HAE	rural motorway	01.03.2023	24.05.2023	84.06	0.680	15.80	9.60	2.42	0.108	1.61
CH-OE2		06.03.2023	05.06.2023	90.90	0.639	15.19	10.72	2.16	0.108	1.39
SIO		01.03.2023	24.05.2023	83.96	0.618	12.63	10.64	2.54	0.109	1.31
MAG	rural low (< 1000 m a.s.l.)	21.02.2023	16.05.2023	83.96	0.629	14.47	11.56	2.05	0.108	1.33
CH-CHA		04.03.2023	31.05.2023	88.02	0.612	13.14	9.79	1.29	0.105	1.26
PAY		08.03.2023	31.05.2023	83.96	0.614	12.82	10.51	2.50	0.109	1.21
TAE		23.02.2023	09.05.2023	75.22	0.657	11.17	7.59	1.92	0.104	1.19
CH-LAE		04.03.2023	13.06.2023	101.21	0.614	11.43	10.17	2.81	0.109	0.89
BRM		21.02.2023	31.05.2023	98.79	0.643	14.92	7.58	3.97	0.111	1.28
CH-FRU	rural high (> 1000 m a.s.l.)	04.03.2023	31.05.2023	87.98	0.637	12.65	6.83	1.79	0.103	1.22
RIG		21.02.2023	30.05.2023	97.98	0.648	13.16	6.33	2.55	0.105	1.09
CHA		15.02.2023	10.05.2023	84.01	0.694	12.99	4.42	3.36	0.106	1.33
DAV		02.03.2023	17.05.2023	76.00	0.679	11.12	2.14	2.03	0.100	1.23
CH-AWS		06.05.2023	18.07.2023	73.01	0.572	10.48	10.36	1.61	0.106	1.15
JUN	high altitude	02.03.2023	07.06.2023	97.02	0.605	14.61	-8.24	6.11	0.103	1.34

Table S4: Analytical results from the **summer** MerPAS® deployment.

Code	Station type	Start date	End date	Depl. (days)	AC (g)	Hg (ng)	TA (°C)	WS ($m\ s^{-1}$)	$SR_{adj.}$ ($m^3\ day^{-1}$)	Hg^0 ($ng\ m^{-3}$)
BER	urban roadside	10.05.2023	30.08.2023	111.94	0.712	20.51	20.00	2.28	0.117	1.46
LAU		24.05.2023	13.09.2023	112.02	0.698	21.41	22.29	1.27	0.116	1.53
LUG	urban center	16.05.2023	05.09.2023	111.96	0.620	21.47	21.95	1.71	0.117	1.51
CH-BAS		30.05.2023	05.09.2023	98.04	0.575	16.94	21.90	2.06	0.118	1.30
ZUE		23.05.2023	13.09.2023	112.94	0.649	23.39	22.07	2.30	0.119	1.58
BAS	suburban	23.05.2023	12.09.2023	111.96	0.619	22.96	20.93	1.68	0.116	1.53
DUE		31.05.2023	19.09.2023	110.77	0.656	16.52	20.93	2.10	0.117	1.18
HAE	rural motorway	24.05.2023	13.09.2023	111.92	0.669	19.64	20.63	2.01	0.116	1.33
CH-OE2		05.06.2023	05.09.2023	92.04	0.595	28.81	20.20	1.51	0.115	2.56
SIO		24.05.2023	13.09.2023	112.00	0.692	22.51	21.35	2.66	0.119	1.51
MAG	rural low (< 1000 m a.s.l.)	16.05.2023	05.09.2023	112.00	0.633	20.03	21.69	1.88	0.117	1.21
CH-CHA		31.05.2023	12.09.2023	103.92	0.602	17.14	19.62	1.05	0.113	1.29
PAY		31.05.2023	06.09.2023	98.08	0.612	16.24	20.36	1.89	0.116	1.29
TAE		09.05.2023	20.09.2023	134.07	0.591	21.10	18.19	1.40	0.112	1.22
CH-LAE		13.06.2023	16.09.2023	94.70	0.667	15.33	19.16	2.36	0.116	1.22
BRM		31.05.2023	06.09.2023	98.13	0.614	15.06	19.01	3.14	0.118	1.22
CH-FRU	rural high (> 1000 m a.s.l.)	31.05.2023	12.09.2023	103.96	0.591	17.10	17.28	1.40	0.112	1.30
RIG		30.05.2023	06.09.2023	98.96	0.654	14.82	17.77	2.17	0.114	1.18
CHA		10.05.2023	30.08.2023	111.97	0.681	17.66	15.55	2.70	0.114	1.23
DAV		17.05.2023	21.09.2023	127.06	0.583	18.14	12.86	2.21	0.110	0.97
CH-AWS		18.07.2023	16.09.2023	59.98	0.668	8.56	12.72	1.53	0.108	1.14
JUN	high altitude	07.06.2023	31.08.2023	84.98	0.649	14.60	0.93	4.90	0.107	1.41

S5: Linear relationship between Hg^0 and elevation

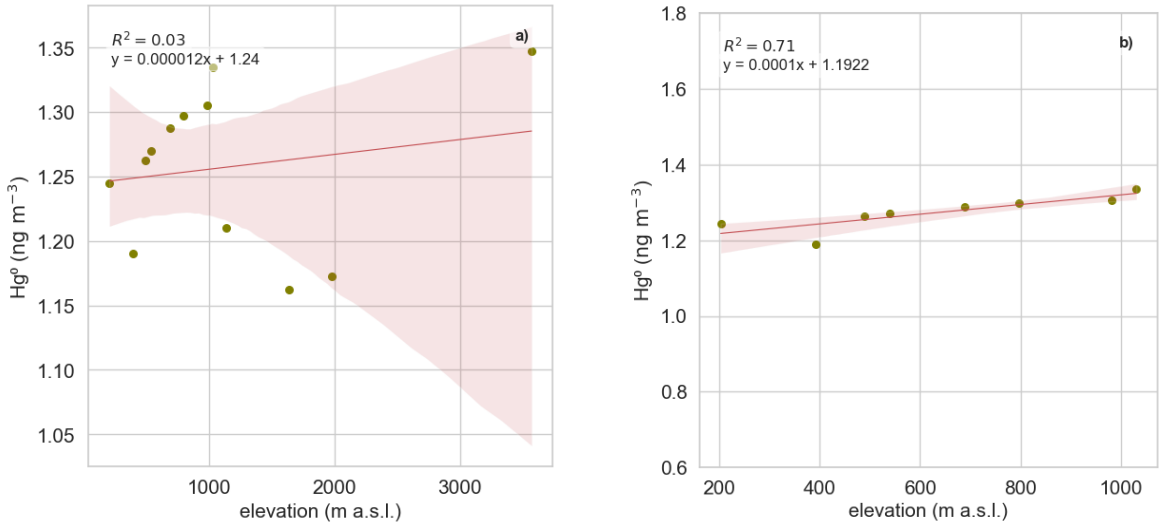


Figure S3: Liner relationships between atmospheric Hg^0 concentrations a) at all rural sites and b) at rural sites from MAG (203 m a.s.l.) to RIG (1031 m a.s.l.). The shaded areas indicate the 95% confidence interval for the slopes of the regression lines.

S6: Seasonal dynamics of atmospheric Hg^0 concentrations at all station types

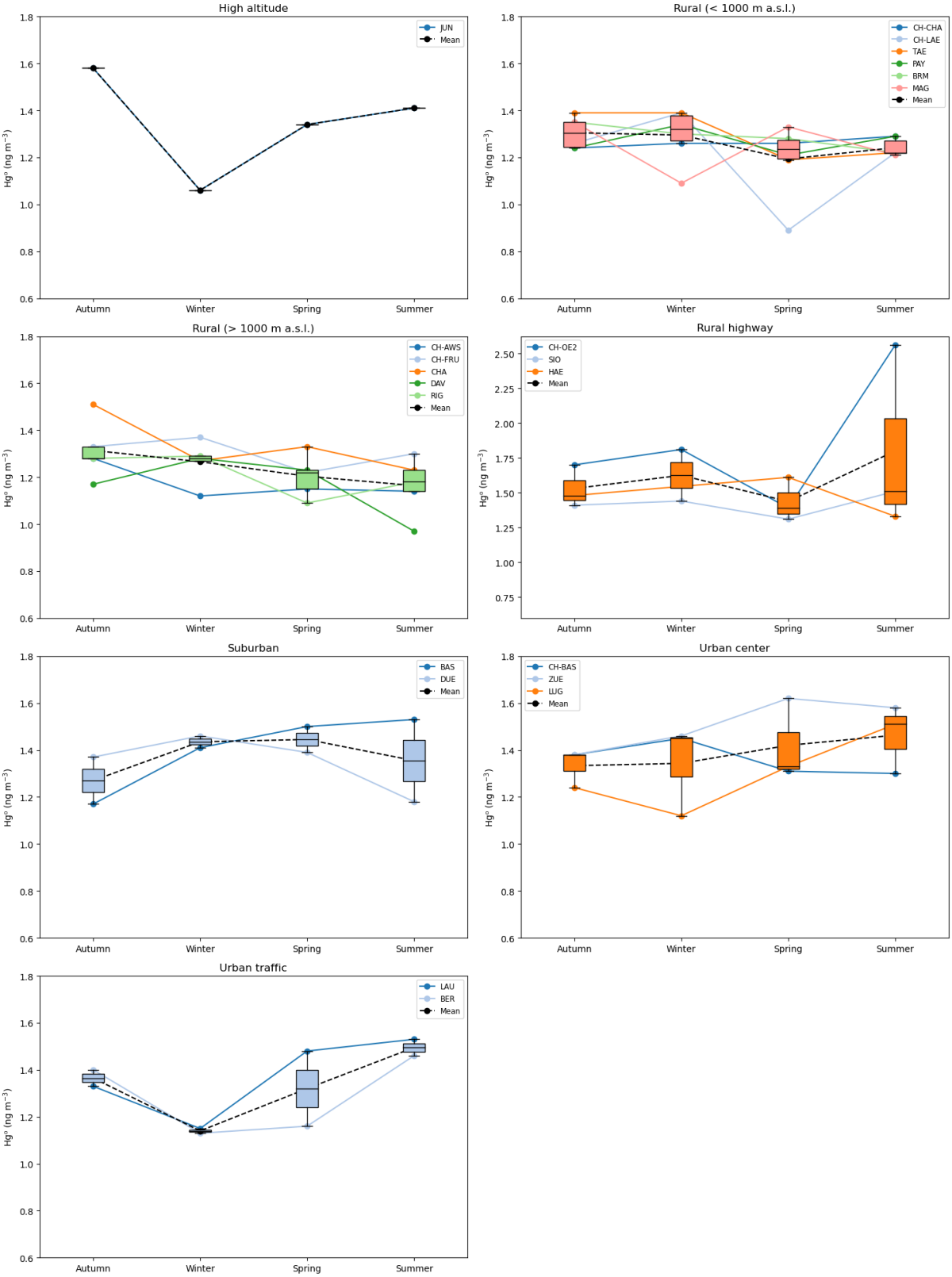


Figure S4: Seasonal dynamics of atmospheric Hg^0 concentrations at all station types rural low, rural high, suburban, urban center, urban traffic, high altitude and rural highway. The dashed line connects the seasonal means. The boxplots display the median (middle line) and the limits indicate the upper and lower quartiles. The whiskers represent 1.5 times the interquartile range.