

Supplementary Information for: Chemical characterization and source apportionment of PM₁₀ in Belgrade, Serbia: influence of local and regional anthropogenic and natural sources

Bojana Petrović¹, Andres Alastuey², Karl E. Yttri³, Marco Pandolfi², Maja Jovanović¹, Bojan Radović⁴, Renata Kovačević⁴, Danka B. Stojanović¹, Miloš Davidović¹, Stephen M. Platt³, Alena Bartonova³, Milena Jovasević-Stojanović¹

¹VIDIS Centre, Vinča Institute of Nuclear Sciences, National Institute of the Republic of Serbia, University of Belgrade, Belgrade, Serbia

² Institute of Environmental Assessment and Water Research, (IDAEA CSIC), Barcelona, Spain

³ NILU, Norway

⁴Mining and Metallurgy Institute Bor, Serbia

Correspondence to: Milena Jovasević-Stojanović (webiopat@vin.bg.ac.rs)

Table S1. Overview of the source apportionment studies conducted in Belgrade for the period 2003-2015.

PM fraction	Sampling site	Study period	Number of samples	Chemical components analyzed	Factors resolved	Model used	Reference
PM _{2.5} , PM ₁₀	1. Roof of Rector's Office building of University of Belgrade (urban background)	June 2003 – July 2005	PM _{2.5} : 64; PM ₁₀ : 209	Pb, Cu, Zn, Mn, Fe, Cd, Ni, V, Al, Cr	PM _{2.5} : resuspended road dust, traffic and oil refineries, oil combustion, diesel fuel and local industry PM ₁₀ : road dust, fuel oil, road traffic emission, traffic exhaust	Principal component analysis	Rajšić et al. 2008
	2. Faculty of Veterinary Medicine (urban traffic)						

PM₁₀	1. Roof of Rector's Office building of University of Belgrade (urban background)	July 2003 – December 2006	277	Al, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd, Pb	Fossil fuel combustion, traffic exhaust/regional transport from industril centers, traffic related particles/site specific sources, mineral/crustal matter	Unmix USEPA	Mijić et al. 2012
	2. Faculty of Vetrinary Medicine (urban traffic)						
<hr/>							
PM₁₀	D_p ≤ 0.49 μm 0.49 ≤ D_p ≤ 0.95; 0.95 ≤ D_p ≤ 1.5; 1.5 ≤ D_p ≤ 3.0; 3.0 ≤ D_p ≤ 7.2; D_p ≥ 7.2 μm	Knjeginje Ljubice 21	June – December 2008	Na ⁺ , NH ₄ ⁺ , K ⁺ , Mg ²⁺ , Ca ²⁺ , Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻	Ammonium sulphate; marine aerosol; construction activities; fertilizer plant; industrial zone; biomass burning	Principal component analysis	Đorđević et al. 2012
	<hr/>						
PM₁₀	1. Lazarevac (suburban industrial)			Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthen, Pyrene,	Diesel and gasoline exhaust (traffic 1), unburned petroleum from vehicles (traffic 2), stationary sources, wood combustion, coal combustion,	USEPA PMF 3.0	Cvetković et al. 2015
	2. Grabovac (rural industrial)	2010 – 2011		Benz[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Indeno(1.2.3-cd), pyrene,			
	3. Slavija (urban traffic)			Dibenz[ah]anthracene, Benzo[ghi]perylene			

PM₁₀	Institute of Public Health Belgrade	2011 – 2015	254	Benzo[a]pyrene, As, Cd, Cr, Mn, Ni, Pb, Cl ⁻ , Na ⁺ , Mg ²⁺ , Ca ²⁺ , K ⁺ , NO ₃ ⁻ , SO ₄ ²⁻ , NH ₄ ⁺ , OC, EC	Solid fuel burning, industrial emissions, secondary aerosols, vehicle derived and particle resuspension	Unmix USEPA	Stojic et al. 2016
PM_{2.5}	Zeleno brdo (suburban background)	May 2014 – May 2015		Al, S, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, As, Ba, Pb, NH ₄ ⁺ , NO ₃ ⁻ , SO ₄ ²⁻	Biomass burning, traffic, secondary sulphate from regional combustion sources, local combustion sources and ammonium nitrate, soil	USEPA PMF 5.0	Todorovic et al. 2020
PM_{2.5}	Zeleno brdo (suburban background)	April 2014 – August 2015	166	Al, Si, S, Cl, K, Ca, Ti, V, Mn, Fe, Cu, Zn, Pb, Ni	Soil, biomass burning, traffic, fuel oil combustion, secondary sulfate	USEPA PMF 5.0	Almeida et al. 2020

PMF modelling

To determine the optimal number of factors, we started by varying the number of factors in PMF from 3 to 9 with random seeds and no applied factor constrains. We selected the final solution with 7 factors based on next criteria: (1) all factors' chemical profile and temporal variability could have been interpreted, (2) Q_{true}/Q_{exp} (1.03) ratio lower than 1.5 which indicates a negligible influence of the outliers on the results (Glojek et al. 2024), (3) normal distribution of modelled species with uncertainty-scaled residuals within ± 3 , and (4) on displacement (DISP) and bootstrap (BS) analysis which confirmed the stability of the model. In case of DISP test, no factor swaps were reported while BS analysis based on 100 runs showed > 70 out of 100 mapped factors (Table 1) which is considered as appropriate solution (Glojek et al. 2024). The extra model uncertainty was 7%. The correlation between observed and modelled PM₁₀ concentrations was 0.92.

Table S2. Bootstrap values of the base run.

Factors	BS mapped factors
Biomass burning	100

NaCl/COMB	92
Mineral dust	100
PBAP	100
BSOAisoprene	100
Ammonium sulfate	88
TRA/IND	92

NaCl/COMB – long-range transport and road-salt/local combustion; PBAP – primary biological aerosol particles; BSOAisoprene – biological secondary organic aerosol from isoprene; TRA/IND – traffic/industry factor.

Table S3. Seasonal levels of analysed species (ng m⁻³) in Belgrade during WeBaSOOP campaign (N=84).

Species	N	Average (\pm SD)	Spring	Summer	Autumn	Winter	NH	H
PM ₁₀ *	84	23943 (\pm 14867)	20107	20289	23283	32537	19272	28189
OC	84	8185 (\pm 6489)	5288	6412	8441	12996	5936	10230
EC	84	1384 (\pm 1030)	927	933	1636	2140	955	1774
OM	84	11459 (\pm 9085)	7403	8977	11818	18194	8310	14322
Cl ⁻	84	135 (\pm 185)	70	25	178	285	26	234
NO ₃ ⁻	84	1294 (\pm 1498)	615	364	1647	2709	478	2035
SO ₄ ²⁻	84	2531 (\pm 1874)	2140	3201	2213	2532	2967	2135
NH ₄ ⁺	84	673 (\pm 541)	444	776	672	815	716	634
Na	83	158 (\pm 132)	156	74	196	211	82	225
Mg	84	109 (\pm 105)	128	82	107	117	79	135
Al	83	409 (\pm 426)	572	347	282	412	338	471
K	84	353 (\pm 385)	219	142	411	672	157	531
Ca	84	492 (\pm 413)	611	432	395	507	416	561
V	84	1.67 (\pm 1.48)	1.35	0.91	1.67	2.83	0.91	2.37
Cr	66	2.59 (\pm 2.41)	4.62	1.24	0.84	3.21	1.67	3.42
Mn	81	7.29 (\pm 5.20)	7.82	6.09	6.59	8.66	5.87	8.49

Fe	80	497 (\pm 375)	512	412	463	603	391	584
Co	80	0.12 (\pm 0.12)	0.14	0.10	0.12	0.13	0.08	0.15
Ni	84	2.07 (\pm 1.24)	2.49	1.43	1.94	2.42	1.67	2.44
Cu	64	6.00 (\pm 7.06)	2.67	2.66	9.38	8.49	2.40	8.46
Zn	54	19.17 (\pm 20.80)	3.52	6.93	26.38	24.48	9.22	23.00
Ga	71	0.10 (\pm 0.10)	0.17	0.07	0.07	0.09	0.08	0.11
As	80	1.01 (\pm 0.90)	0.59	0.57	1.28	1.63	0.62	1.34
Se	82	0.33 (\pm 0.17)	0.32	0.36	0.32	0.34	0.33	0.33
Rb	84	0.86 (\pm 0.88)	0.68	0.49	0.87	1.44	0.45	1.24
Sr	84	1.97 (\pm 2.13)	2.67	1.46	1.71	1.98	1.61	2.31
Cd	84	0.16 (\pm 0.15)	0.09	0.08	0.17	0.29	0.08	0.22
Ba	83	11.24 (\pm 8.38)	5.78	8.05	15.84	16.35	7.41	14.80
Pb	81	3.27 (\pm 2.90)	2.60	2.39	3.50	4.64	2.36	4.04
P	84	19.31 (\pm 12.32)	25.73	21.62	11.22	16.80	21.20	17.59
Ti	81	20.09 (\pm 27.58)	35.83	16.30	12.33	16.81	17.08	24.63
Zr	58	1.98 (\pm 1.60)	2.76	1.98	1.54	1.65	2.07	1.92
Mo	66	12.46 (\pm 12.25)	11.56	26.50	7.01	7.79	20.66	6.04
Sb	83	1.11 (\pm 0.92)	1.14	0.82	0.96	1.50	0.76	1.41
Sn	74	6.41 (\pm 6.79)	3.15	2.73	11.65	7.76	3.32	8.52
Galactosan	84	12.51 (\pm 22.34)	1.76	0.57	16.21	33.60	0.90	23.05
Mannosan	84	55.3 (\pm 103.3)	7.9	2.1	65.6	154.0	3.6	102.2
Levoglucosan	84	413.0 (\pm 682.3)	74.8	34.3	545.7	1066.4	48.4	744.4
2-methylerythritol	84	5.01 (\pm 7.97)	3.51	14.44	1.01	0.21	10.15	0.35
2-methylthreitol	84	2.05 (\pm 2.78)	1.43	5.51	0.78	0.21	3.97	0.31
Glucose	84	39.69 (\pm 25.93)	46.60	60.27	31.97	17.16	58.46	22.62
Fructose	84	10.16 (\pm 8.46)	15.37	15.09	6.41	2.51	16.32	4.57
Mannitol	84	39.50 (\pm 32.85)	45.73	74.03	24.81	9.12	66.68	14.80
Arabitol	84	34.84 (\pm 26.85)	43.67	57.73	25.02	9.63	56.75	14.93
Trehalose	84	16.17 (\pm 11.51)	20.41	25.17	11.07	6.48	24.51	8.59
Inositol	77	3.15 (\pm 2.16)	3.55	3.83	2.92	1.71	3.96	2.26

Erythritol 84 4.36 (\pm 5.17) 4.08 8.19 2.77 2.00 6.95 2.00

NH – non-heating season (April 15th – October 15th), H – heating season (October 15th – April 15th), N- number of samples, N – number of samples used for the source apportionment.

*A complete gravimetric PM₁₀ time series, aligned with co-measured species (EC, OC, ions, and trace elements), was unavailable. Missing PM₁₀ values were gap-filled using data from the GRIMM instrument when it agreed to within \pm 20% of aerosol mass closure derived from the other measured variables; when GRIMM PM₁₀ was outside this range, the mass-closure value was used instead. Mass closure (MC) was calculated as MC = Ions + Mineral Dust + OM + EC + Trace Elements, where OM = OC \times 1.4 and mineral dust was reconstructed as Dust = Ca \times 1.5 + Al/0.53 + Al \times 0.53 \times 2.5 + Na + Mg + K + Fe. This resulted in final PM₁₀ assignments for 40 samples from GRIMM, 25 from mass closure, and 19 from offline gravimetry.

Table S4. Relative contribution of the measured species in each factor and contribution of identified factors to PM₁₀ (showed in %).

	BB	NaCl/COMB	MD	PBAP	BSOA _{Isoprene}	SUL	TRA/IND
PM ₁₀	21	9	17	10	10	18	15
OC	33	9	5	14	11	12	17
EC	22	13	0	11	4	8	41
Cl ⁻	51	30	5	6	0	7	0
NO ₃ ⁻	16	51	0	4	0	17	12
SO ₄ ²⁻	12	0	6	1	24	54	2
NH ₄ ⁺	13	9	0	0	22	55	0
Na	0	61	28	0	0	11	0
Mg	0	11	60	0	0	7	22
Al	11	0	78	4	8	0	0
K	51	5	22	6	1	8	6
Ca	0	3	51	2	4	7	34
V	23	0	30	1	1	9	35
Mn	2	12	29	0	6	0	51
Fe	2	8	19	0	6	0	64
Cu	43	0	0	0	0	0	57
As	28	13	7	4	6	18	25
Rb	38	4	30	4	6	2	16
Sr	6	4	62	5	0	3	20

Cd	32	11	2	6	2	14	32
Pb	21	15	4	6	9	6	37
Ti	4	4	69	11	2	2	6
Sb	5	12	6	1	6	10	60
Sn	22	22	0	0	0	0	57
Galactosan	80	9	1	4	1	2	3
Mannosan	79	11	0	3	1	2	4
Levoglucozan	76	11	0	3	1	3	6
2-methylerythritol	0	0	2	7	84	7	0
2-methylthreitol	1	0	2	13	76	8	0
Glucose	4	2	4	72	17	0	1
Fructose	0	1	5	57	26	7	4
Mannitol	2	0	4	62	28	3	0
Arabitol	2	0	5	68	21	4	0
Trehalose	2	2	7	63	20	1	5

BB – biomass burning, NaCl/COMB – mixed regional and road salt/local combustion; MD - mineral dust; PBAP – primary biological aerosol particles; BSOAisoprene – biological secondary organic aerosol from isoprene; SUL – ammonium sulphate; TRA/IND – traffic/industry.

Table S5. Correlation coefficients between the species included in the PMF.

	PM ₁₀	OC	EC	Cl ⁻	NO ₃ ⁻	SO ₄ ²⁻	NH ₄ ⁺	Na	Mg	Al	K	Ca	V	Mn	Fe	Cu	As	Rb	Sr	Cd	Pb	Ti	Sb	Sn	Gala	Manno	Levo	2-ME	2-MT	Glu	Fru	Manni	Ara	Tre			
PM ₁₀	1.00																																				
OC	0.91	1.00																																			
EC	0.79	0.88	1.00																																		
Cl ⁻	0.61	0.63	0.58	1.00																																	
NO ₃ ⁻	0.75	0.77	0.72	0.76	1.00																																
SO ₄ ²⁻	0.56	0.48	0.30	0.11	0.27	1.00																															
NH ₄ ⁺	0.57	0.53	0.34	0.25	0.48	0.91	1.00																														
Na	0.50	0.42	0.46	0.75	0.51	-0.03	0.04	1.00																													
Mg	0.46	0.19	0.19	0.28	0.15	0.11	0.00	0.58	1.00																												
Al	0.36	0.09	0.04	0.19	0.13	0.10	0.07	0.45	0.81	1.00																											
K	0.87	0.93	0.85	0.69	0.76	0.32	0.38	0.53	0.34	0.19	1.00																										
Ca	0.54	0.26	0.26	0.21	0.17	0.20	0.04	0.48	0.94	0.77	0.36	1.00																									
V	0.76	0.70	0.73	0.48	0.59	0.27	0.27	0.49	0.56	0.40	0.81	0.61	1.00																								
Mn	0.73	0.55	0.60	0.35	0.39	0.31	0.20	0.56	0.82	0.65	0.62	0.88	0.78	1.00																							
Fe	0.74	0.58	0.65	0.36	0.40	0.30	0.19	0.53	0.76	0.55	0.64	0.81	0.81	0.97	1.00																						
Cu	0.57	0.66	0.67	0.47	0.55	0.15	0.20	0.36	0.09	0.00	0.67	0.14	0.47	0.38	0.42	1.00																					
As	0.67	0.75	0.76	0.53	0.68	0.35	0.45	0.38	0.26	0.16	0.74	0.27	0.66	0.52	0.53	0.52	1.00																				
Rb	0.90	0.86	0.78	0.65	0.68	0.33	0.33	0.61	0.59	0.43	0.94	0.62	0.86	0.81	0.81	0.59	0.70	1.00																			
Sr	0.42	0.19	0.16	0.23	0.08	0.11	-0.01	0.45	0.90	0.75	0.35	0.84	0.55	0.71	0.68	0.06	0.26	0.56	1.00																		
Cd	0.77	0.83	0.78	0.58	0.80	0.34	0.47	0.40	0.21	0.14	0.81	0.24	0.69	0.53	0.55	0.58	0.75	0.76	0.15	1.00																	
Pb	0.65	0.72	0.72	0.51	0.53	0.35	0.34	0.42	0.20	0.09	0.69	0.28	0.59	0.53	0.57	0.58	0.65	0.69	0.20	0.69	1.00																
Ti	0.28	0.02	0.01	0.07	-0.05	0.00	-0.13	0.44	0.86	0.82	0.17	0.82	0.43	0.66	0.59	-0.04	0.06	0.43	0.83	0.05	0.04	1.00															
Sb	0.70	0.66	0.74	0.46	0.51	0.30	0.27	0.52	0.40	0.34	0.64	0.52	0.68	0.71	0.71	0.50	0.60	0.72	0.34	0.62	0.68	0.30	1.00														
Sn	0.42	0.49	0.66	0.40	0.46	0.04	0.11	0.42	0.17	0.01	0.52	0.16	0.49	0.43	0.47	0.61	0.48	0.47	0.07	0.51	0.47	-0.01	0.49	1.00													
Gala	0.82	0.94	0.85	0.72	0.82	0.28	0.39	0.46	0.13	0.02	0.95	0.15	0.69	0.45	0.49	0.69	0.73	0.84	0.14	0.83	0.66	-0.04	0.58	0.51	1.00												
Manno	0.81	0.93	0.85	0.77	0.83	0.28	0.38	0.50	0.15	0.04	0.94	0.18	0.68	0.47	0.50	0.67	0.71	0.84	0.14	0.82	0.68	-0.03	0.62	0.52	0.98	1.00											
Levo	0.80	0.94	0.87	0.73	0.79	0.27	0.37	0.47	0.13	0.03	0.95	0.15	0.69	0.47	0.50	0.71	0.73	0.84	0.13	0.83	0.70	-0.04	0.60	0.54	0.99	0.98	1.00										
2-ME	-0.02	-0.10	-0.22	-0.38	-0.36	0.52	0.35	-0.37	-0.09	-0.02	-0.30	0.03	-0.24	-0.04	-0.04	-0.20	-0.20	-0.21	-0.08	-0.27	-0.02	-0.06	-0.08	-0.27	-0.32	-0.31	-0.33	1.00									
2-MT	-0.04	-0.12	-0.23	-0.40	-0.38	0.46	0.29	-0.37	-0.07	-0.02	-0.31	0.04	-0.26	-0.03	-0.03	-0.22	-0.21	-0.22	-0.07	-0.30	-0.07	-0.05	-0.10	-0.27	-0.34	-0.33	-0.35	0.97	1.00								
Glu	-0.31	-0.29	-0.33	-0.48	-0.47	0.06	-0.10	-0.49	-0.34	-0.30	-0.44	-0.27	-0.44	-0.35	-0.35	-0.37	-0.36	-0.43	-0.24	-0.45	-0.24	-0.21	-0.35	-0.32	-0.41	-0.41	-0.41	0.46	0.46	1.00							
Fru	-0.14	-0.23	-0.29	-0.50	-0.43	0.22	0.03	-0.40	-0.08	-0.02	-0.39	0.07	-0.30	-0.07	-0.12	-0.30	-0.31	-0.28	-0.03	-0.38	-0.20	0.02	-0.12	-0.36	-0.42	-0.41	-0.44	0.53	0.51	0.67	1.00						
Manni	-0.30	-0.30	-0.35	-0.53	-0.51	0.15	0.00	-0.50	-0.29	-0.23	-0.49	-0.23	-0.48	-0.30	-0.29	-0.39	-0.38	-0.45	-0.19	-0.49	-0.27	-0.18	-0.33	-0.35	-0.47	-0.46	-0.48	0.58	0.58	0.88	0.69	1.00					
Ara	-0.34	-0.34	-0.39	-0.54	-0.52	0.08	-0.05	-0.50	-0.30	-0.23	-0.48	-0.26	-0.50	-0.35	-0.36	-0.38	-0.39	-0.47	-0.21	-0.52	-0.35	-0.16	-0.39	-0.38	-0.48	-0.47	-0.49	0.48	0.48	0.82	0.70	0.92	1.00				
Tre	-0.21	-0.23	-0.26	-0.47	-0.46	0.19	0.01	-0.46	-0.25	-0.21	-0.41	-0.16	-0.37	-0.22	-0.21	-0.34	-0.33	-0.37	-0.15	-0.40	-0.20	-0.13	-0.24	-0.30	-0.41	-0.41	-0.42	0.57	0.55	0.81	0.68	0.88	0.80	1.00			

Correlation coefficients were interpreted according (Schober et al. 2018). Correlation coefficient between 0.40 and 0.69 was considered as moderate correlation (yellow), 0.70 to 0.89 strong correlation (green) and 0.90 to 1 very strong correlation (blue). Gala –galactosan, Manno – mannosan, levo – levoglucosan, 2-ME – 2-methylerythritol, 2-methylthreitol, Glu – glucose, Fru – fructose, Manni – mannitol, Ara – arabitol, Tre – trehalose.

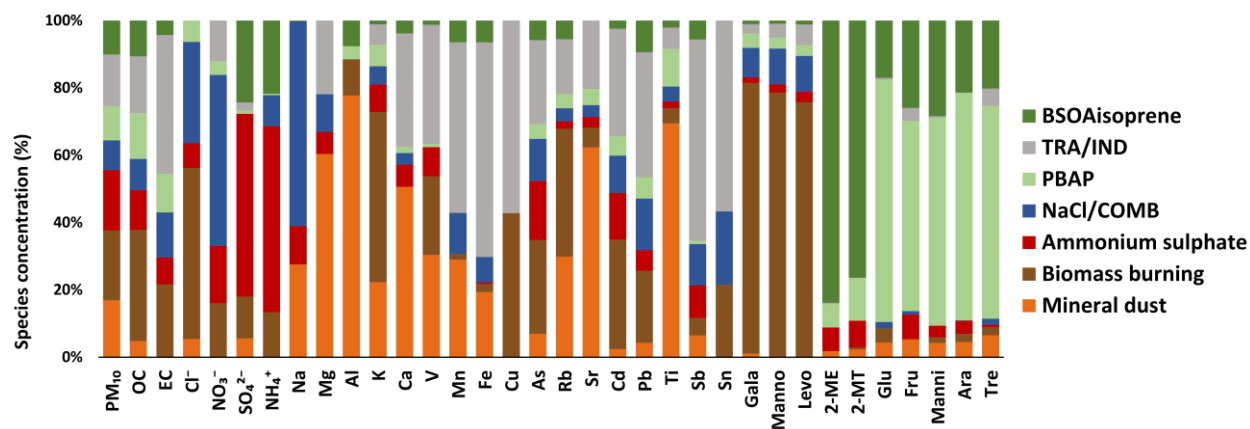


Figure S1. Fingerprints of identified factors in Belgrade; Biomass burning (BB); Long range transport and local combustion (NaCl/COMB); Mineral dust (MD); Primary biological aerosol (PBAP); Biogenic secondary organic (BSOA_{Isoprene}); ammonium sulfate; Traffic/ Industry (TRA/IND); Gala –galactosan, Manno – mannosan, levo – levoglucosan, 2-ME – 2-methylerythritol, 2-methylthreitol, Glu – glucose, Fru – fructose, Manni – mannitol, Ara – arabitol, Tre – trehalose.

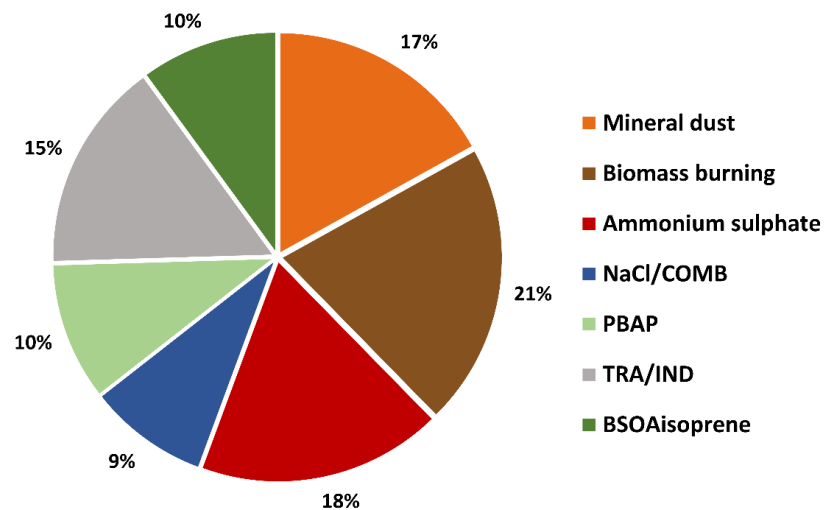


Figure S2. Factor contributions to total PM₁₀ mass concentration. Biomass burning (BB); Long range transport and local combustion (NaCl/COMB); Mineral dust (MD); Primary biological aerosol (PBAP); Biogenic secondary organic (BSOA_{Isoprene}); ammonium sulfate; Traffic/ Industry (TRA/IND).

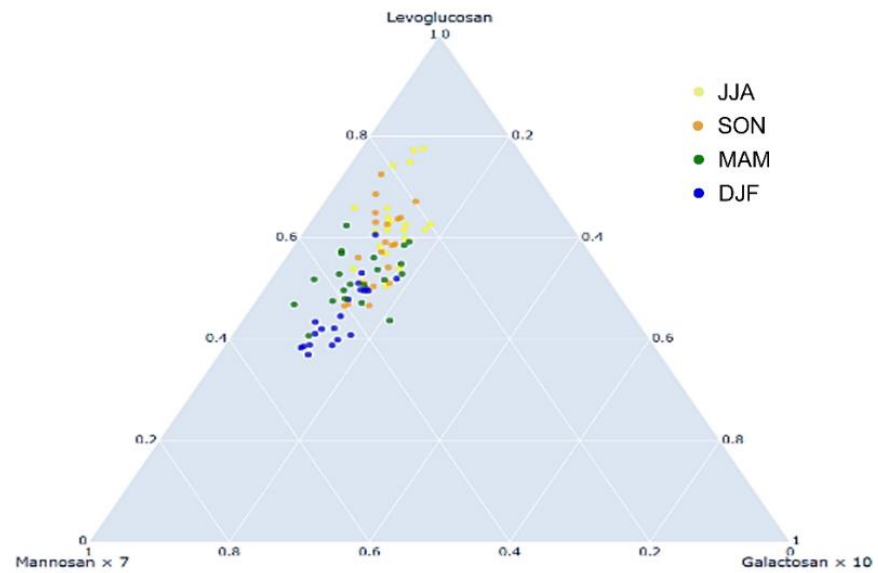


Figure S3. Ternary plot of levoglucosan, mannosan and galactosan concentrations during different seasons. JJA – June, July, August; SON – September, October, November; MAM – march, April, May; DJF – December, January, February.

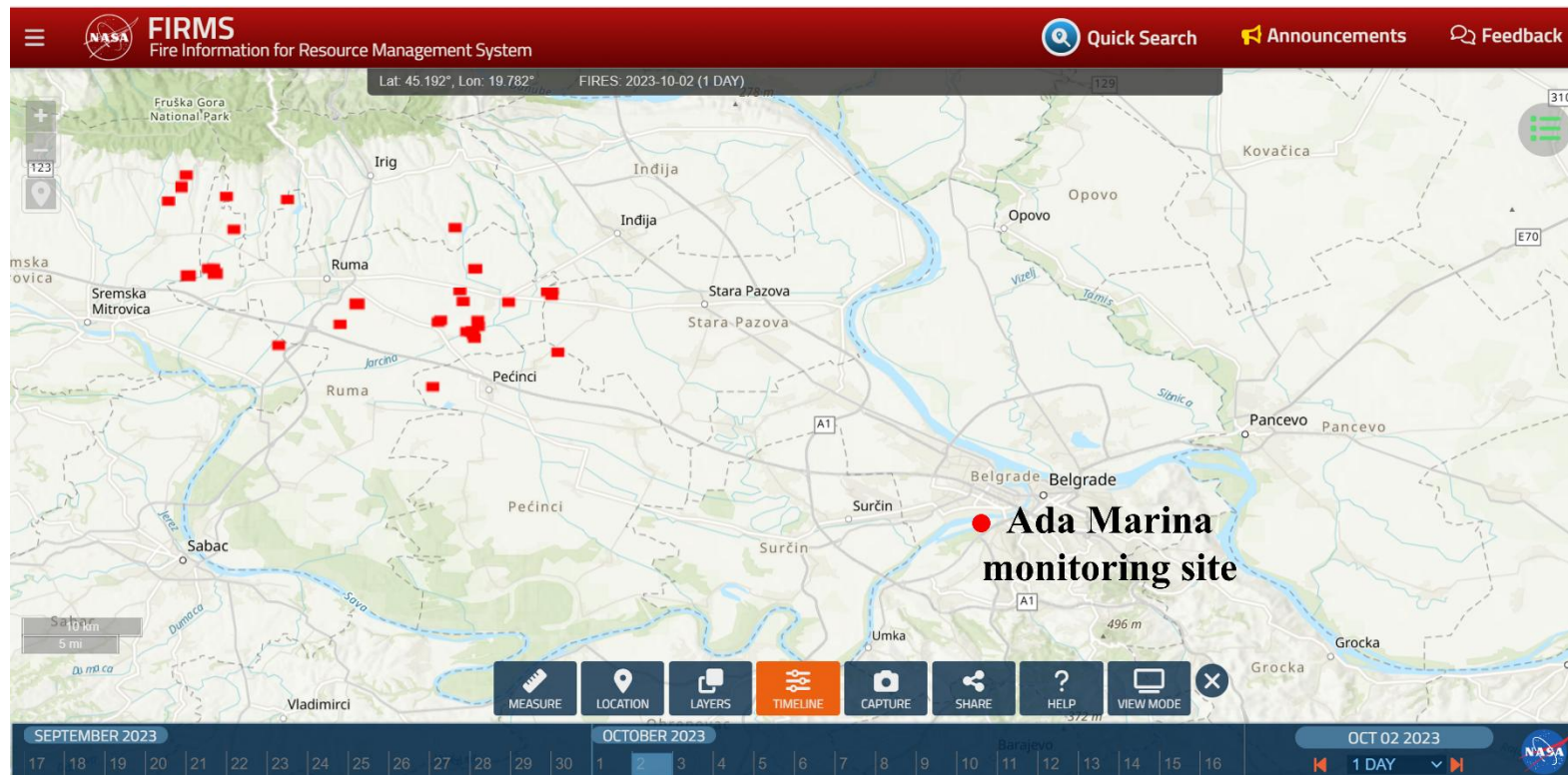


Figure S4. Open fire occurrence on day October 2nd (Source: https://firms.modaps.eosdis.nasa.gov/map/#d:2023-10-02;l:fires_all,topo:@20.24,44.87,10.32z).

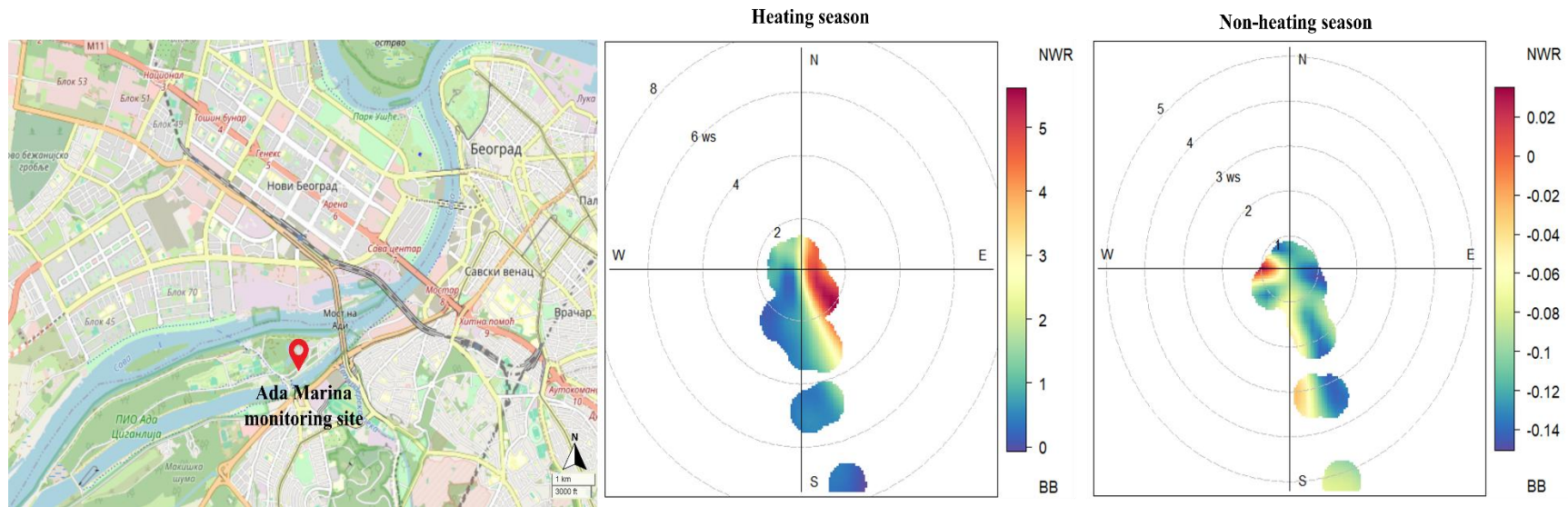


Figure S5. Location of the Ada Marina monitoring site and wind polar plots for heating and non-heating season (Source: © OpenStreetMap contributors).

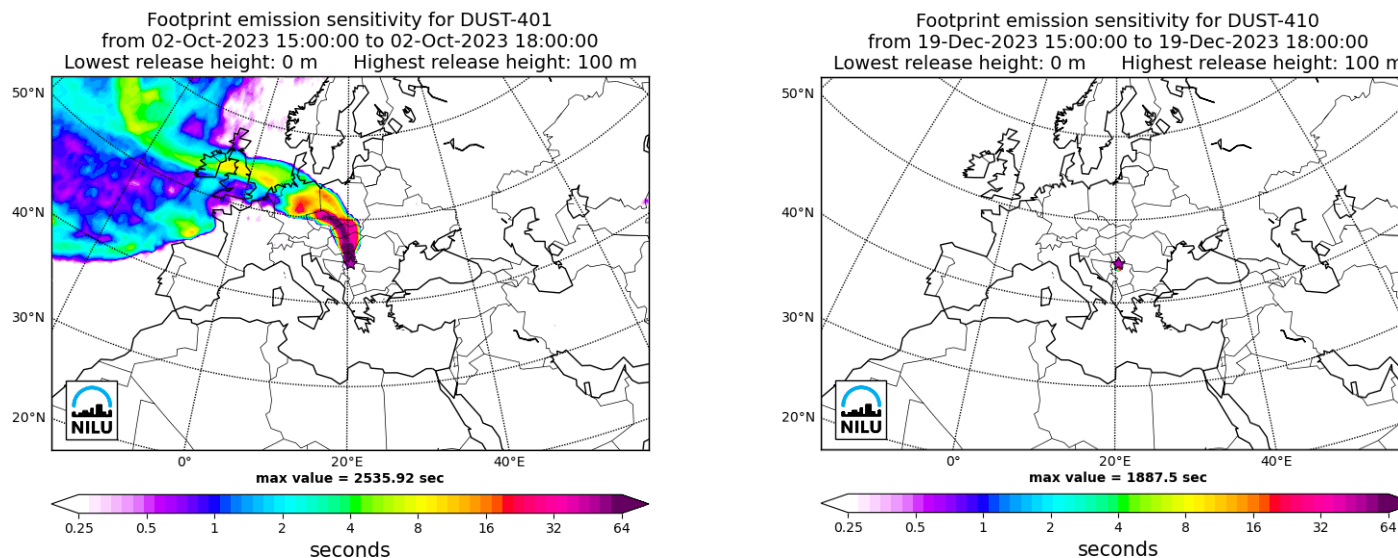


Figure S6. Mean surface footprint (residence time of an air mass over the surface before reaching the receptor) of the PMF factors for Ada Marina (to be added) and for the four peak days in the NaCl/COMB factor time series, obtained from FLEXPART model runs.

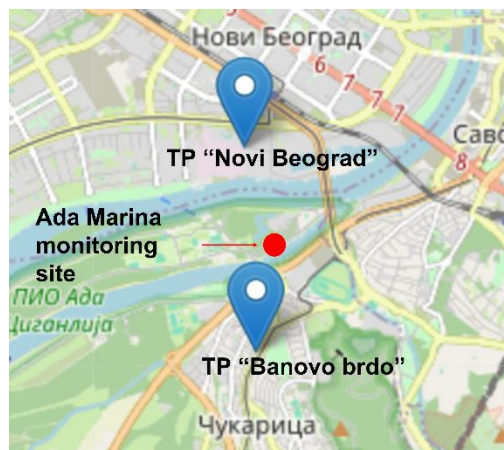


Figure S7. Locations of the thermal power plants closest to the Ada Marina monitoring station. TP – thermal power plant (Source: © OpenStreetMap contributors).

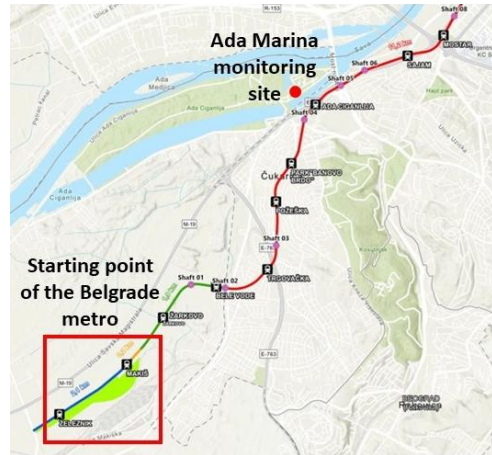


Figure S8. Location of the main depot of Belgrade metro that was being built during the sampling campaign (Makiš station); source: Belgrade metro and train (<https://bgmetro.rs/index.php/en/bg-metro/projects/line-1-phase-1>).



Figure S9. Location of the Košutnjak forest and Ada Marina monitoring site (Source: © OpenStreetMap contributors).

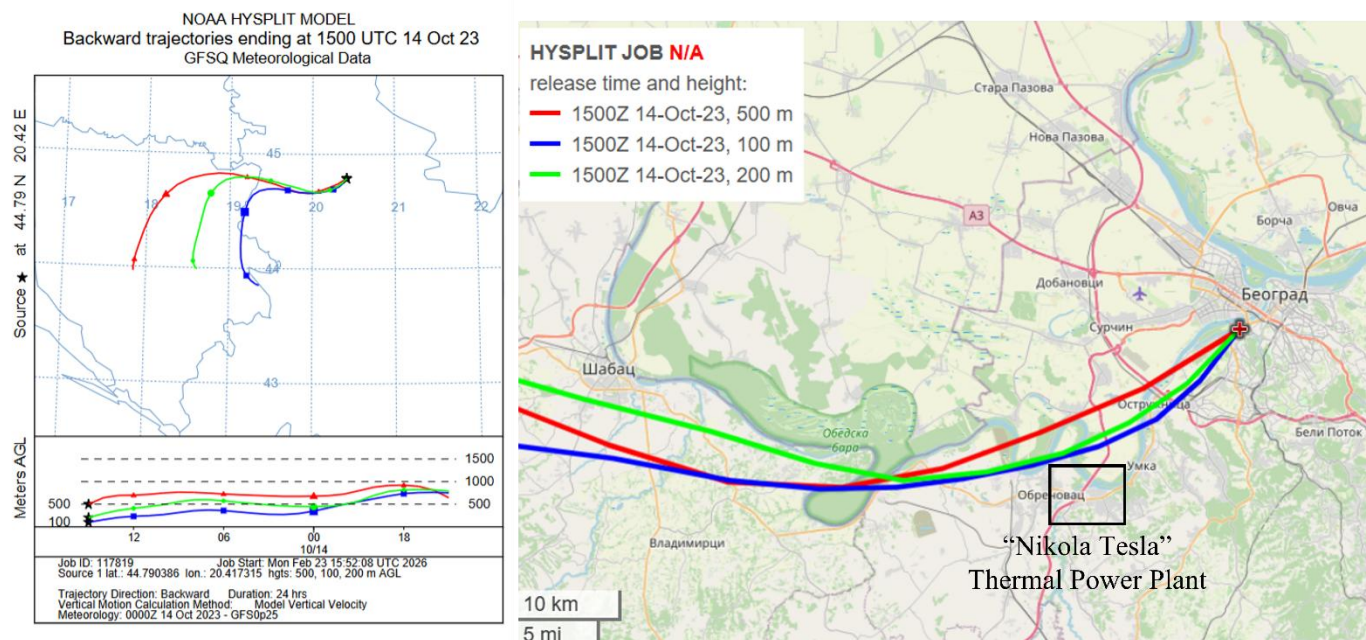


Figure S10. HYSPLIT model on 14th October 2023 and location of the monitoring site and “Nikola Tesla A” Power Plant (Source: © OpenStreetMap contributors).

References

- Almeida, S., M., Manousakas, M., Diapouli, E., Kertesz, Z., Samek, L., Hristova, E., Šega, K., Padilla Alvarez, R., Belis, C. A., Eleftheriadis, K., The IAEA European Region Study Group: Ambient particulate matter source apportionment using receptor modelling in European and Central Asia urban areas. *Environ. Pollut.* 266, 115199, <https://doi.org/10.1016/j.envpol.2020.115199>, 2020.
- Cvetković, A., Jovašević-Stojanović, M., Marković, D., and Ristovski, Z.: Concentration and source identification of polycyclic aromatic hydrocarbons in the metropolitan area of Belgrade, Serbia. *Atmos. Environ.*, 112, 335-343, <https://doi.org/10.1016/j.atmosenv.2015.04.034>, 2015.
- Đorđević, D., Mihajlidi-Zelić, A., Relić, D., Ignjatović, L., Huremović, J., Stortini, A. M., and Gambaro, A.: Size-segregated mass concentration and water soluble inorganic ions in an urban aerosol of the Central Balkans (Belgrade). *Atmos. Environ.* 46, 309-317, <https://doi.org/10.1016/j.atmosenv.2011.09.057>, 2012.
- Glojek, K., Thuy, V. D. N., Weber, S., Uzu, G., Manousakas, M., Elazzouzi, R., Džepina, K., Darfeuil, S., Ginot, P., Jaffrezo, J. L., Žabkar, R., Turšič, J., Podkoritnik, A., and Močnik, G.: Annual variation of source contributions to PM10 and oxidative potential in a mountainous area with traffic, biomass burning, cement-plant and biogenic influences. *Environ. Int.*, 189, 108787, <https://doi.org/10.1016/j.envint.2024.108787>, 2024.

- Mijić, Z., Stojić, A., Perišić, M., Rajšić, S., and Tasić, M.: Receptor modeling studies for the characterization of PM10 pollution sources in Belgrade. *CI&CEQ*, 18, 623-634, <https://doi.org/10.2298/CICEQ120104108M>, 2012.
- Rajšić, S., Mijić, Z., Tasić, M., Radenković, M., and Joksić, J.: Evaluation of the levels and sources of trace elements in urban particulate matter. *Environ. Chem. Lett.*, 6, 95-100, <https://doi.org/10.1007/s10311-007-0115-0>, 2008.
- Todorović, M. N., Radenković, M. B., Onjia, A. E., and Ignjatović, L. M.: Characterization of PM2.5 sources in a Belgrade suburban area: a multi-scale receptor-oriented approach. *Environ. Sci. Pollut. Res.*, 27, 41717-41730, <https://doi.org/10.1007/s11356-020-10129-z>, 2020.
- Schober, P., Boer, C., & Schwarte, L. A.: Correlation coefficients: appropriate use and interpretation. *Anesth. Analg.*, 126, 1763-1768, <https://doi.org/10.1213/ANE.0000000000002864>, 2018.