

Supplement of Atmos. Chem. Phys., 19, 11235–11252, 2019
<https://doi.org/10.5194/acp-19-11235-2019-supplement>
© Author(s) 2019. This work is distributed under
the Creative Commons Attribution 4.0 License.



Supplement of

Exploiting multi-wavelength aerosol absorption coefficients in a multi-time resolution source apportionment study to retrieve source-dependent absorption parameters

Alice Corina Forello et al.

Correspondence to: Roberta Vecchi (roberta.vecchi@unimi.it)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

SUPPLEMENTAL MATERIAL

	<i>Low time resolution samples</i>				<i>High time resolution samples</i>			
$\mu\text{g m}^{-3}$	<i>mean</i>	<i>median</i>	<i>10th perc</i>	<i>90th perc</i>	<i>mean</i>	<i>median</i>	<i>10th perc</i>	<i>90th perc</i>
PM10 Mass	38.4	30.9	16.2	76.6	NA	NA	NA	NA
EC	1.39	1.18	0.54	2.63	NA	NA	NA	NA
OC	8.1	6.2	3.4	14.7	NA	NA	NA	NA
NO ₃ ⁻	5.19	2.63	0.71	13.9	NA	NA	NA	NA
SO ₄ ⁻	2.95	2.55	0.89	5.56	NA	NA	NA	NA
Levoglucosan	0.68	0.63	0.33	1.15	NA	NA	NA	NA

ng m^{-3}	<i>mean</i>	<i>median</i>	<i>10th perc</i>	<i>90th perc</i>	<i>mean</i>	<i>median</i>	<i>10th perc</i>	<i>90th perc</i>
Na	89	70	27	165	89	60	21	196
Mg	59	59	24	94	44	40	20	73
Al	178	161	78	287	111	91	38	218
Si	700	635	331	1104	413	340	146	737
S	1320	1004	411	2908	696	630	167	1246
K	467	349	198	871	318	257	80	611
Ca	912	954	418	1475	512	420	211	948
Cr	10	9	4	15	7	7	4	11
Mn	14	12	5	24	8	7	4	13
Fe	1120	940	577	2040	794	692	335	1363
Cu	45	36	21	92	34	29	12	63
Zn	90	83	35	148	66	56	16	133
Pb	24	17	10	50	20	13	6	35

Table S1: Basic statistics on mass and chemical species concentrations at different time resolution. Note that high time resolution samples were collected during shorter periods (about two weeks) respect to low time resolution ones (about two months). NA represents Not Available data.

	$\lambda=405\text{ nm}$	$\lambda=532\text{ nm}$	$\lambda=635\text{ nm}$	$\lambda=780\text{ nm}$
<i>Summer campaign - low resolution samples</i>				
mean	11.4	10.3	8.9	7.7
max	20.9	19.8	16.3	15.1
min	5.5	5.5	4.6	2.9
<i>Winter campaign - low resolution samples</i>				
mean	37.2	26.3	23.5	18.9
max	63.1	49.4	45.3	37.1
min	9.1	4.6	7.3	4.4

Table S2: Basic statistics on b_{ap} data (in Mm^{-1}) from PTFE optical measurements.

Factors	Total [$\mu\text{g m}^{-3}$]
Nitrate	10.4 (31 %)
Sulphate	6.2 (19 %)
Resuspended dust	5.5 (16 %)
Biomass burning	3.5 (11 %)
Construction works	3.6 (11 %)
Traffic	1.7 (5 %)
Industry	1.1 (3 %)
Aged sea salt	1.3 (4 %)

Table S3: Absolute and relative average source contributions to PM10 mass in the 8-factor base case solution.

<i>Measured in atmosphere</i>	$\lambda = 405 \text{ nm}$			$\lambda = 532 \text{ nm}$			$\lambda = 635 \text{ nm}$			$\lambda = 780 \text{ nm}$		
	b_{ap}/EC	σ	R^2	b_{ap}/EC	σ	R^2	b_{ap}/EC	σ	R^2	b_{ap}/EC	σ	R^2
Summer	14.2	± 0.5	0.61	12.9	± 0.5	0.61	11.1	± 0.4	0.64	9.8	± 0.4	0.67
Winter	17.8	± 0.4	0.89	12.8	± 0.3	0.90	11.2	± 0.3	0.87	8.9	± 0.3	0.79
All data	17.3	± 0.3	0.94	12.8	± 0.2	0.94	11.2	± 0.2	0.93	9.0	± 0.2	0.87
<i>Multi-time resolution model</i>	b_{ap}/EC	25 th -75 th percentile		b_{ap}/EC	25 th -75 th percentile		b_{ap}/EC	25 th -75 th percentile		b_{ap}/EC	25 th -75 th percentile	
Biomass burning	23.1	21.1 - 24.8		14.3	13.2 – 16.0		10.6	9.9 – 11.7		6.4	6.0 – 7.3	
Fossil fuel	13.7	12.7 – 14.2		10.2	9.6 – 10.4		8.8	8.2-9.1		8.6	7.6-8.9	

Table S4: b_{ap} -to-EC ratios for biomass burning and fossil fuel emission sources as measured in atmosphere and assessed by the multi-time resolution model. Values measured in atmosphere (b_{ap}/EC , σ and R^2) result from a linear regression between experimental b_{ap} and EC concentrations. Results from multi-time resolution model are retrieved considering the b_{ap} and EC apportioned in each source; the 25th and 75th percentile is estimated by the bootstrap analysis.

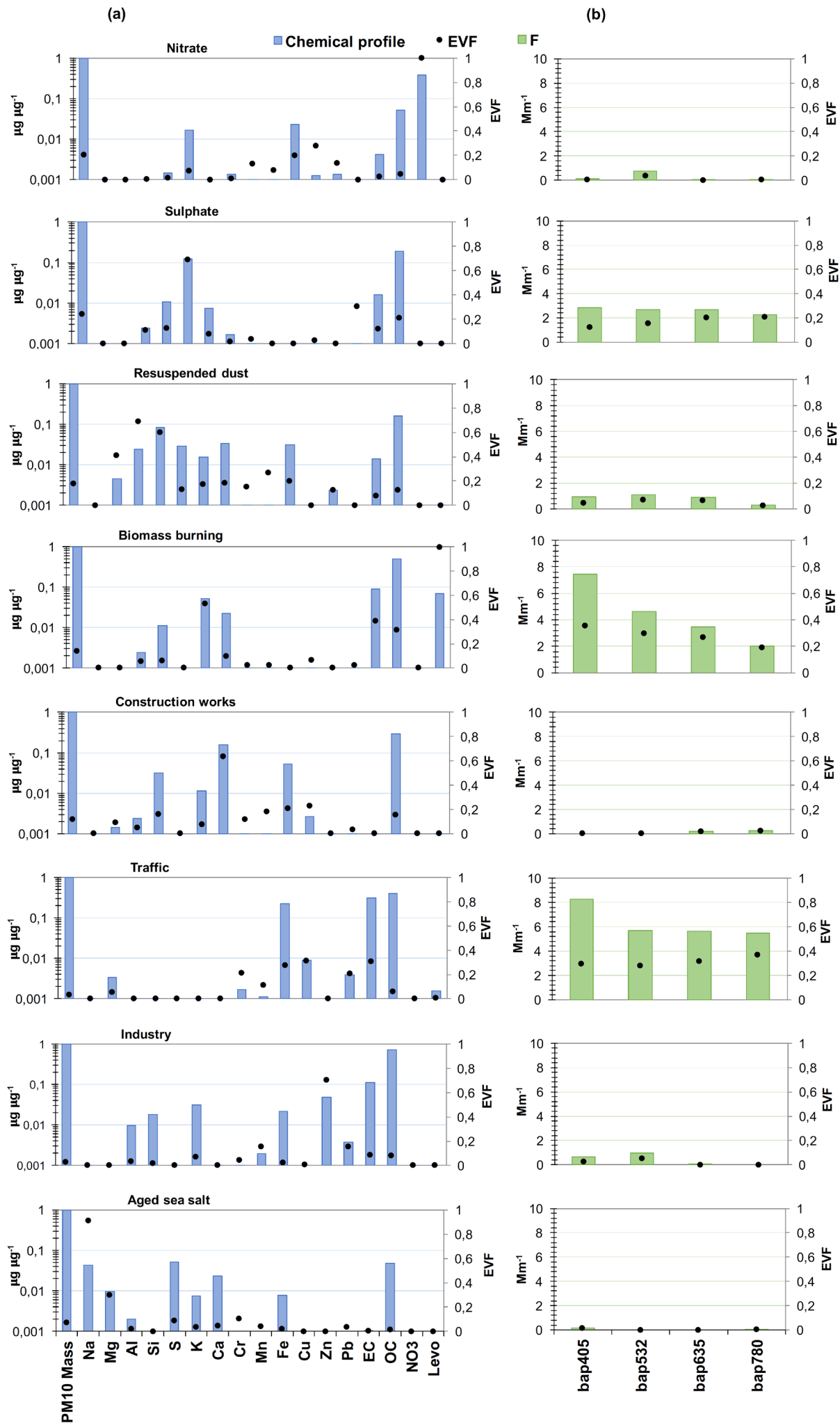


Figure S1: (a) Chemical profiles of the 8-factor base case solution (b) b_{ap} apportionment of the 8-factor base case solution. The blue bars represent the chemical profile (output of the matrix F normalised on mass), the green bars the output values of the matrix F, and the black dots the EVF.

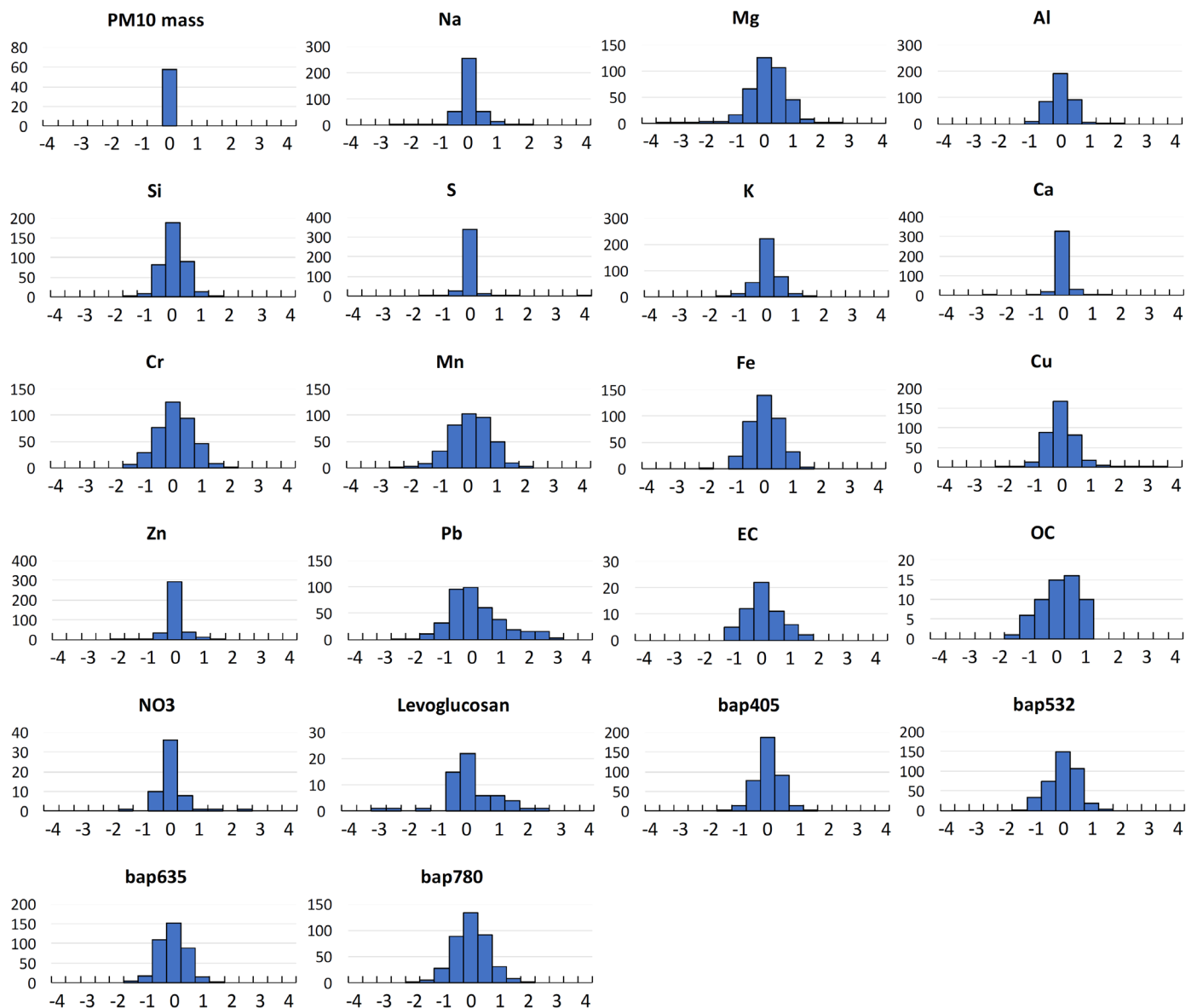


Figure S2: Uncertainty-scaled residuals (residuals divided by input data uncertainties) of the 8-factor base case solution. The x-axis represents the scaled residuals values, while the y-axis represents the frequency of occurrence.

Aged_sea_salt

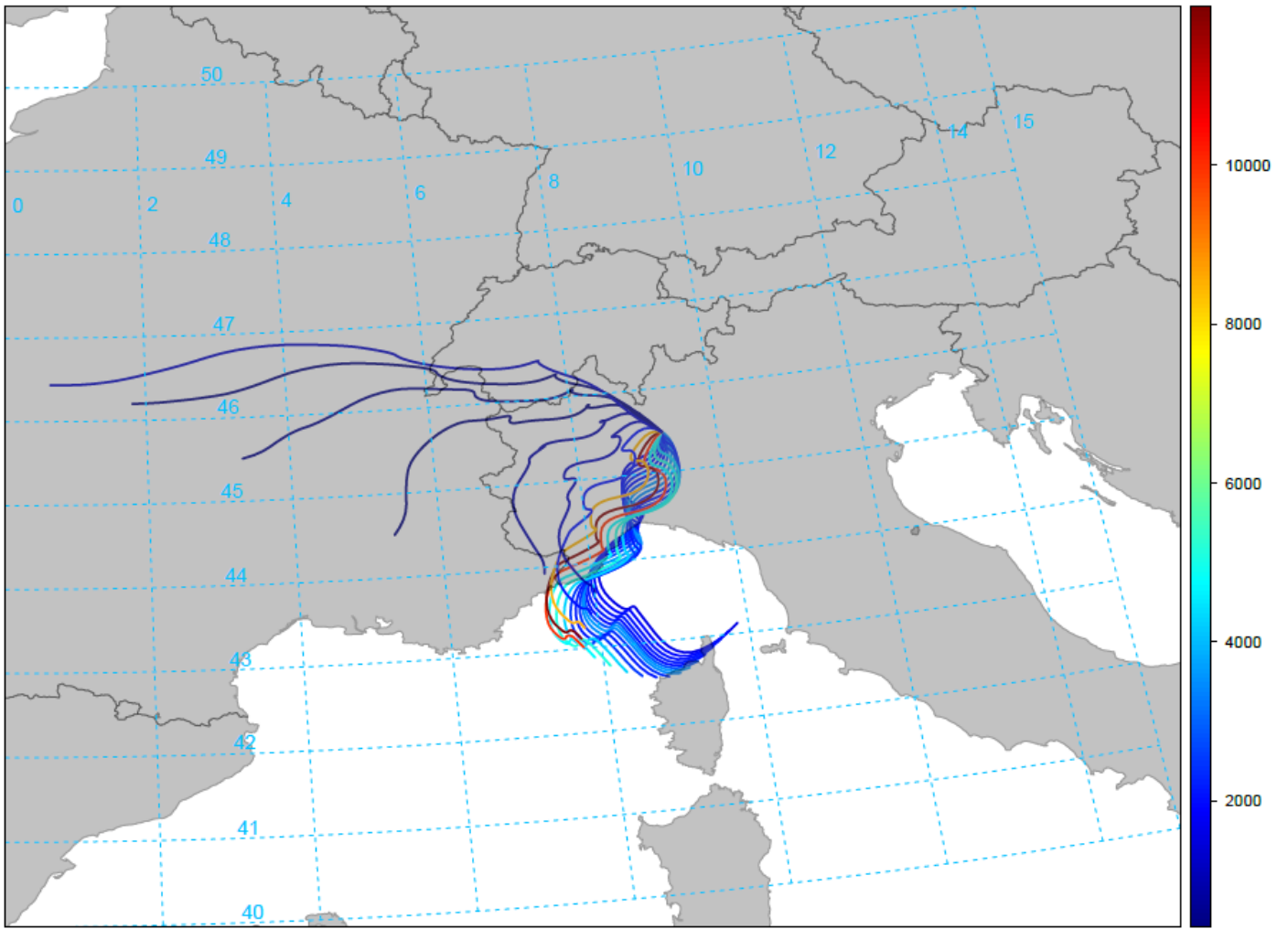


Figure S3: 72h Hysplit back-trajectories coloured by the aged sea salt concentration (in ng m^{-3}) on July 13th, 2016.

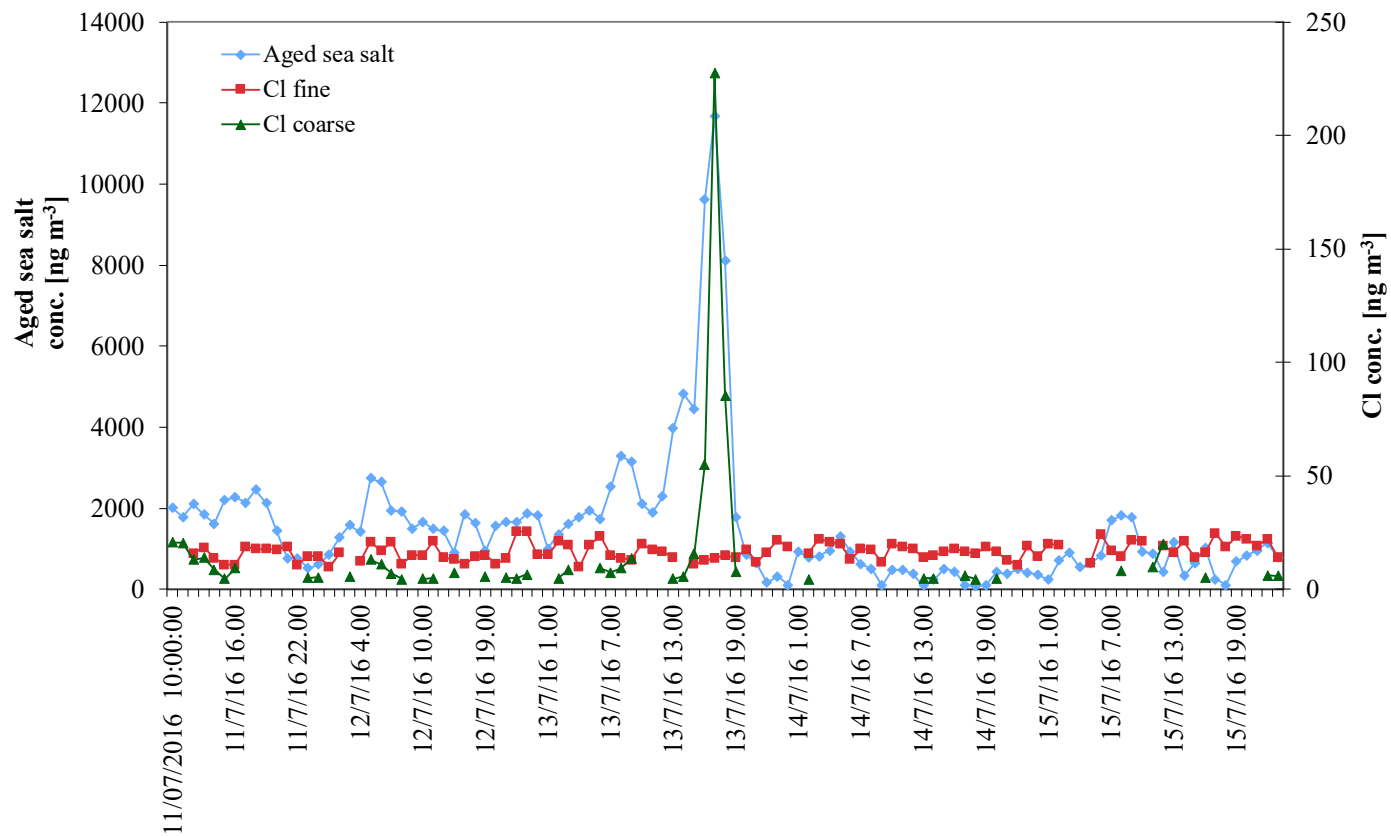


Figure S4: Temporal patterns of aged sea salt source retrieved from the multi-time resolution model and Cl concentrations measured in atmosphere in the fine and coarse fractions.

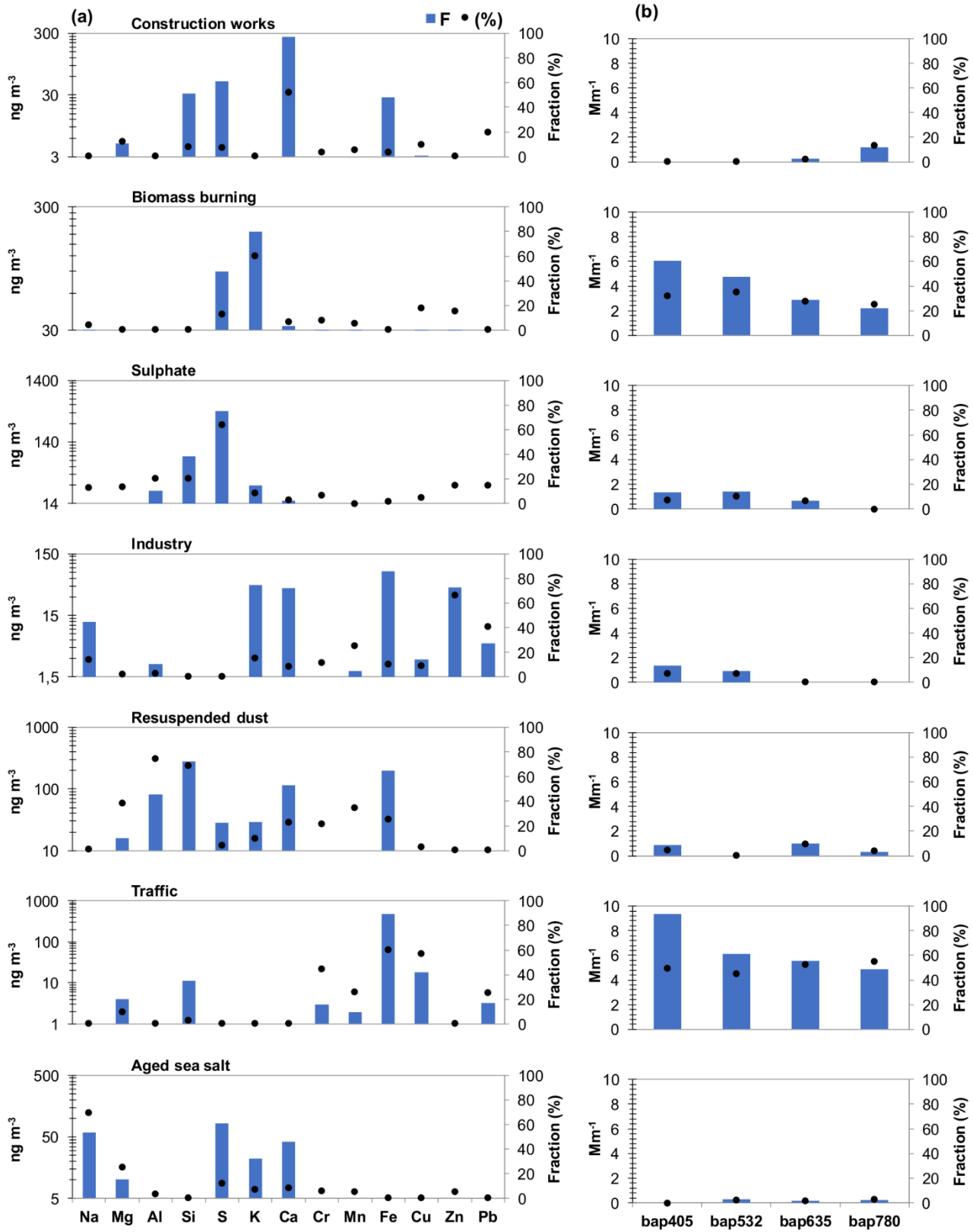


Figure S5: Source apportionment study performed with EPA PMF 5.0 on elemental concentrations and absorption coefficients at four wavelengths, both measured on high-time resolution samples collected by streaker sampler. The blue bars represent the output values of the matrix F, and the black dots the percentage of species in each factor.