PM-ASSOCIATED PAHs DURING WINTER IN BURGAS, BULGARIA

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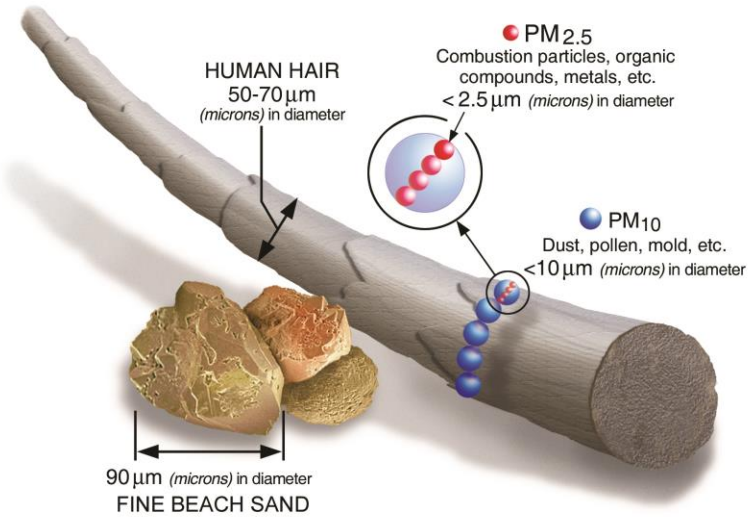
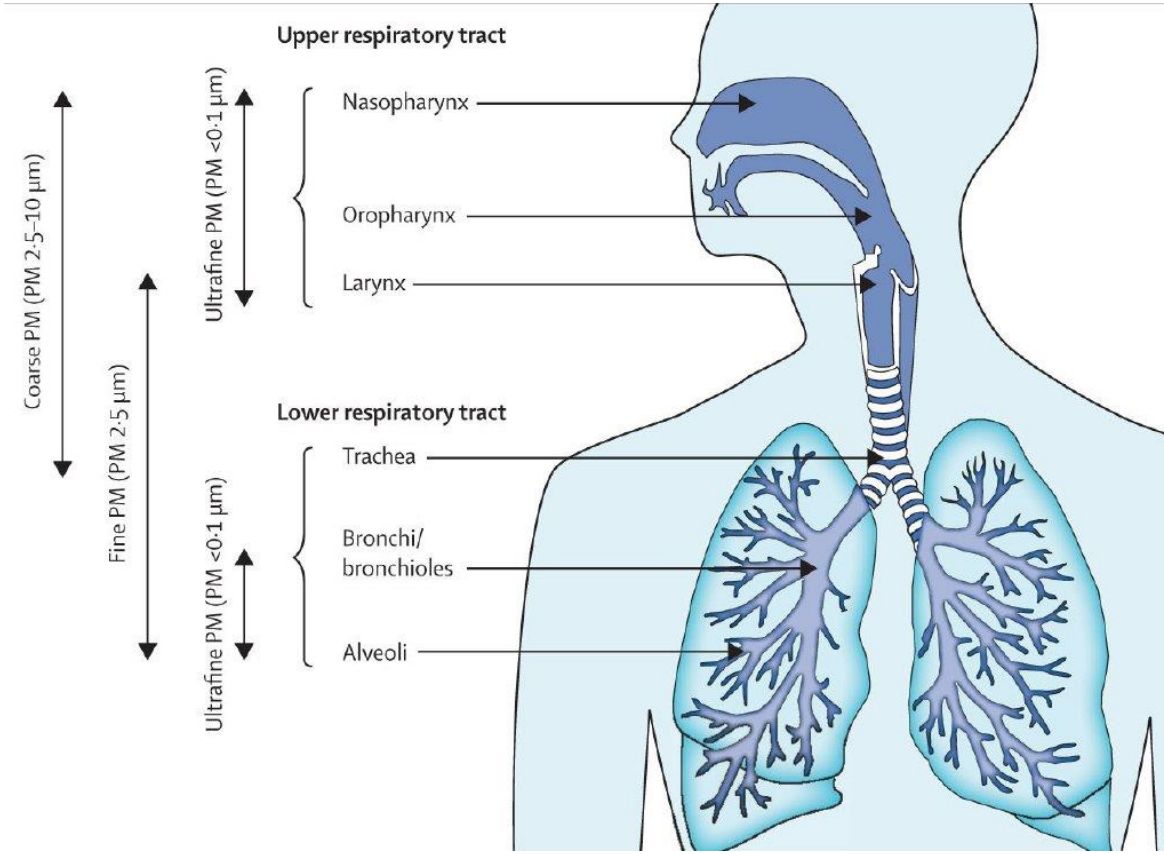
Particulate matter (PM)

How does the pollution affects health?



https://mycanyonlake-rochen.netdna-ssl.com/wp-content/uploads/2019/05/pm2.5_scale_graphic-color_2.jpg



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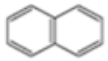
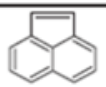
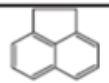
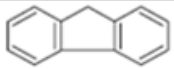
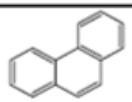
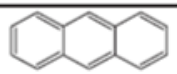
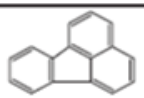
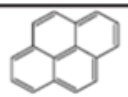
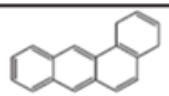
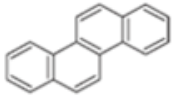
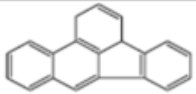
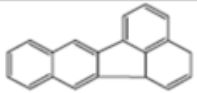
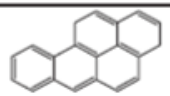
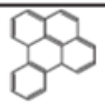
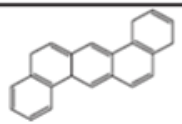
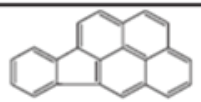
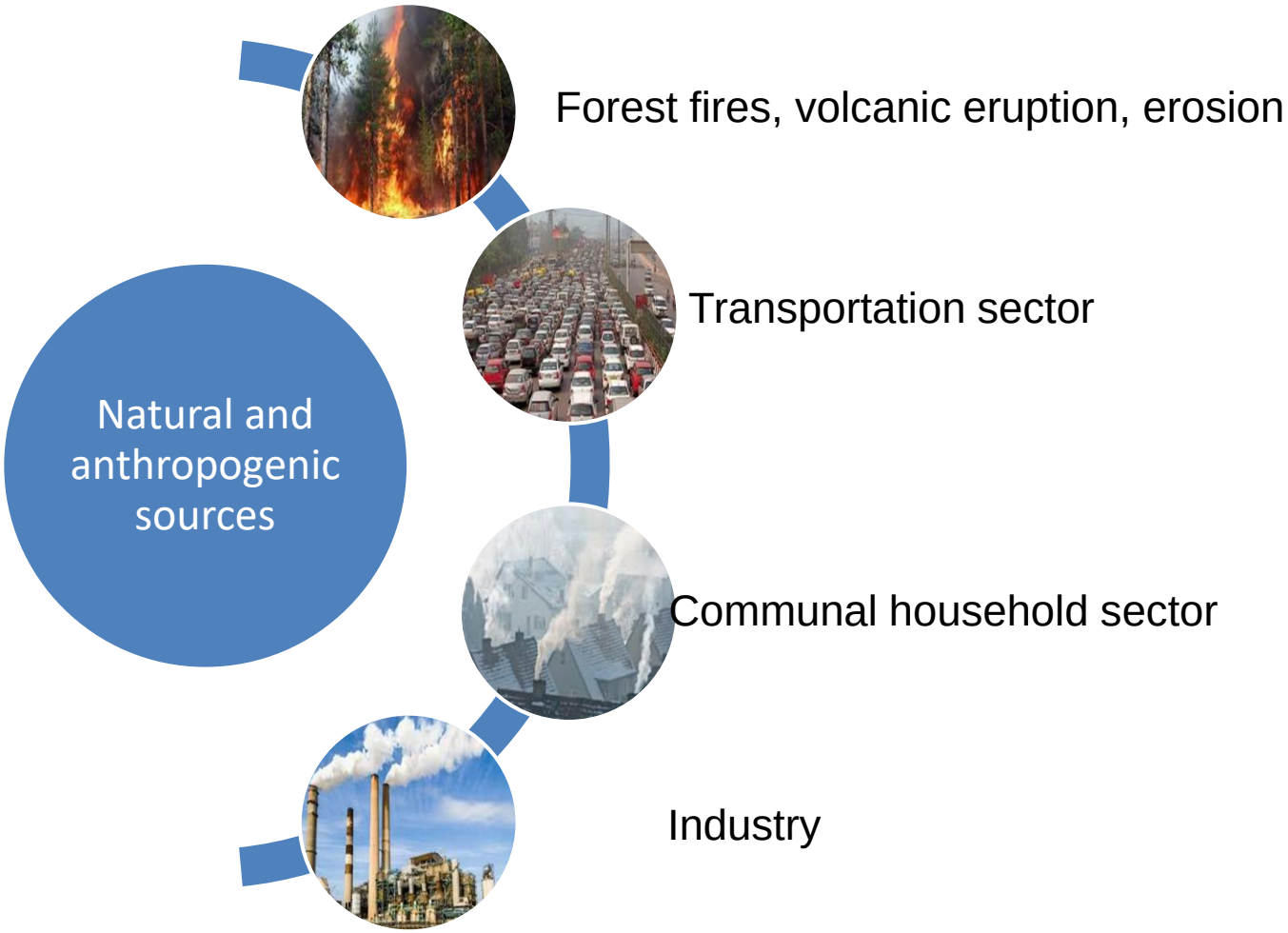
Priority polycyclic aromatic hydrocarbons (PAHs)

 *naphthalene* $C_{10}H_8$	 *acenaphthylene* $C_{12}H_8$	 *acenaphthene* $C_{12}H_{10}$
 *fluorene* $C_{13}H_{10}$	 *phenanthrene* $C_{14}H_{10}$	 *anthracene* $C_{14}H_{10}$
 *fluoranthene* $C_{16}H_{10}$	 *pyrene* $C_{16}H_{10}$	 *benzo[a]anthracene* $C_{18}H_{12}$
 *chrysene* $C_{18}H_{12}$	 *benzo[b]fluoranthene* C_2H_{12}	 *benzo[k]fluoranthene* $C_{20}H_{12}$
 *benzo[j]fluoranthene* $C_{20}H_{12}$	 *benzo[a]pyrene* $C_{20}H_{12}$	 *benzo[e]pyrene* $C_{20}H_{12}$
 *dibenz[a,h]anthracene* $C_{22}H_{14}$	 *benzo[g,h,i]perylene* $C_{22}H_{12}$	 *indeno[1,2,3-c,d]pyrene* $C_{22}H_{12}$

Sources of PM and PAHs pollution



Objectives of study:

- to determine the concentration of 19 polycyclic aromatic hydrocarbons (PAHs) in airborne $PM_{2.5}$ and PM_{10} collected in the urban area of Burgas, Bulgaria and to investigate the PAH relationship between these two particle fractions and correlation of their concentrations with meteo-rological parameters.

Sampling site location

Sampling site location (red point) in Burgas city and possible industrial PM pollution sources: 1) The largest oil-processing company on the Balkan Peninsula; 2) Wood processing plant; 3) Airport Burgas; 4) Sea Port Burgas; 5) Sea Port Burgas - Oil Terminal.

Experiment

Sampling

Sampling – between 14th and 27th of January, 2020; Whatman® QM–A quartz filters, 47 mm for 24 h, using air sampler OPSIS SM200 with flow rate about 2.3 N m^3 h^{-1}.

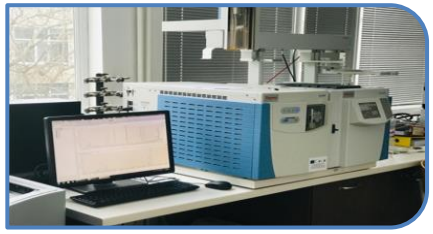
Extraction

Extraction - miniaturized ultrasonic extraction (10 ml) with dichloromethane;

Purification

Purification - dried and cleaned via column chromatography and further concentrated by nitrogen purging to about 300-500 µL;

GC/MS



Analysis – GC–MS/MS, Thermo Scientific Trace 1300/TSQ 8000 was employed in SIM mode at following conditions:

GC: Temperature program – $T_{initial}$ 100°C, 10°C/min, 300°C, 15 min hold; Gas flow rate (He) = 1.2 ml/min; Injection temperature 280°C, Injection volume 1µl.

MS: Electron impact ionization; Ion source temperature 220°C; MS transfer line temperature 250°C.

- **Meteorological data were measured at sampling site by the Mobile station for Air quality control of Burgas Municipality.**

Meteorological conditions during the sampling period

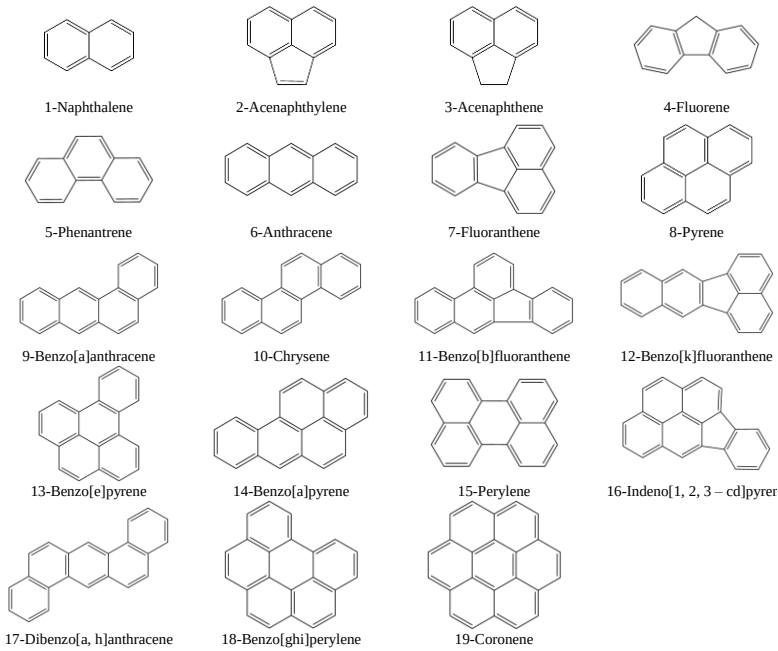
Date	WS m s^{-1}	RH %	TEMP ° C	RADST W m^{-2}	PRESS mbar
14.01.2020	0.52	99.9	2.9	31.6	1022.7
15.01.2020	0.29	99.6	4.2	32.5	1026.7
16.01.2020	0.45	90.3	7.6	41.1	1025.8
17.01.2020	1.39	89.8	5.7	10.7	1026.0
18.01.2020	1.03	96.2	5.7	21.7	1024.3
19.01.2020	1.00	96.6	5.7	17.8	1022.5
20.01.2020	0.85	75.5	3.4	25.8	1034.3
21.01.2020	0.40	76.8	3.7	35.0	1035.4
22.01.2020	1.20	69.4	4.4	36.3	1023.8
23.01.2020	1.10	45.2	6.7	39.7	1024.0
24.01.2020	0.71	64.7	4.2	34.8	1027.4
25.01.2020	0.85	71.7	6.4	36.4	1020.6
26.01.2020	0.60	88.0	8.4	36.3	1019.7
27.01.2020	0.08	99.9	9.6	45.6	1013.2

WS – wind speed; RH – relative humidity; TEMP – temperature; RADST – sun radiation; PRESS - atmospheric pressure.

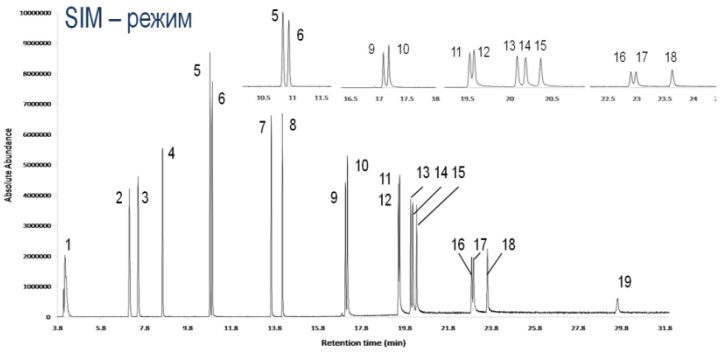
Concentrations of $PM_{2.5}$, PM_{10}, sum of PAHs and sum of [BaP]eq in both PM fractions

Date	$PM_{2.5}$	PAH $PM_{2.5}$	$[BaP]_{eq}$ $PM_{2.5}$	PM_{10}	PAH PM_{10}	$[BaP]_{eq}$ PM_{10}
	$\mu g\ m^{-3}$	$ng\ m^{-3}$ (%)*	$ng\ m^{-3}$	$\mu g\ m^{-3}$	$ng\ m^{-3}$ (%)*	$ng\ m^{-3}$
14.01.2020	10.58	29.57 (0.28)	4.03	30.02	28.26 (0.09)	3.59
15.01.2020	10.51	13.95 (0.13)	1.44	35.25	16.48 (0.05)	1.81
16.01.2020	10.42	12.37 (0.12)	1.43	25.23	12.28 (0.05)	1.41
17.01.2020	9.60	4.91 (0.05)	0.46	8.89	4.92 (0.06)	0.43
18.01.2020	10.17	5.81 (0.06)	0.64	16.22	5.93 (0.04)	0.63
19.01.2020	10.11	6.25 (0.06)	0.68	15.47	6.71 (0.04)	0.72
20.01.2020	10.21	7.00 (0.07)	0.79	10.65	5.28 (0.05)	0.56
21.01.2020	10.70	12.31 (0.12)	1.56	22.68	13.30 (0.06)	1.62
22.01.2020	10.68	15.08 (0.14)	1.68	19.60	15.84 (0.08)	1.80
23.01.2020	10.05	15.22 (0.15)	1.63	12.03	11.80 (0.10)	1.28
24.01.2020	10.49	19.29 (0.18)	2.24	19.29	15.38 (0.08)	1.77
25.01.2020	10.32	14.81 (0.14)	1.74	18.31	15.28 (0.08)	1.76
26.01.2020	10.58	16.75 (0.16)	2.01	21.40	15.08 (0.07)	1.73
27.01.2020	11.15	29.76 (0.27)	3.62	49.81	26.85 (0.05)	3.54
Mean value	10.40	14.51 (0.14)	1.71	21.77	13.81 (0.06)	1.62

Analyzed PAHs



GC-MS chromatogram of $PM_{2.5}$ extract



Linear correlation coefficients between $PM_{2.5}$, PM_{10}, PAHs in both PM fractions and meteorological parameters

	$PM_{2.5}$	PAH $PM_{2.5}$	PM_{10}	PAH PM_{10}	WS	RH	TEMP	RADST	PRESS
$PM_{2.5}$	**1.00**								
PAH $PM_{2.5}$	**0.74**	**1.00**							
PM_{10}	**0.82**	**0.75**	**1.00**						
PAH PM_{10}	**0.78**	**0.97**	**0.81**	**1.00**					
WS	**-0.78**	**-0.61**	**-0.85**	**-0.66**	**1.00**				
RH	0.18	0.09	0.51	0.20	-0.41	**1.00**			
TEMP	0.19	0.17	0.32	0.11	-0.20	0.12	**1.00**		
RADST	**0.77**	**0.68**	**0.59**	**0.66**	**-0.63**	-0.28	0.37	**1.00**	
PRESS	-0.30	-0.52	-0.49	-0.51	0.14	-0.29	**-0.72**	-0.29	**1.00**

Statistically significant correlation coefficients (significance $F < 0.05$) are in bold.

In conclusion…

- *Analyzed data revealed a relatively similar pattern of distribution of PAHs in both PM fractions, a strong correlation between $PM_{2.5}$, PM_{10} and PAHs bound to $PM_{2.5}$ and PM_{10} concentrations and most probably common source of pollution;*
- *A significant correlation between wind speed (inverse correlation, R = 0.61 – 0.85) and solar radiation (positive correlation, R = 0.59 – 0.77) with the concentration of $PM_{2.5}$ and PM_{10} and the associated PAHs was found as well assuming that their sources of pollution are rather local;*
- *The averaged concentrations of $[BaP]_{eq}$ in both PM fractions do not exceed significantly the annual limit value of 1 ng m^{-3} set for BaP – 1.7 ng m^{-3} $[BaP]_{eq}$ in $PM_{2.5}$ and 1.6 ng m^{-3} $[BaP]_{eq}$ in PM_{10}.*

Acknowledgements

The study is performed in the frame of the Project КП-06-Н34/9, National Science Fund, Ministry of Education and Science, Bulgaria, entitled…

"Study of black CARBOn and some important hydrocarbons in the atmospheric AEROSOL in an urban environment"

Thank you for the attention!

Efforts to improve air quality will improve the quality of life!