Springer
SPRINGER NATURE

Paper number:
285

3RD EURO-MEDITERRANEAN CONFERENCE
FOR ENVIRONMENTAL INTEGRATION
ONLINE | 10–13 JUNE 2021
www.emcei.net

$PM_{2.5}$ PAHs in large urban agglomerations in Bulgaria

Stela Naydenova (1), Anife Veli (1), Zilya Mustafa (1), Elena Hristova (2), Lenia Gonsalvesh-Musakova (1)

1. Prof. Dr Assen Zlatarov University, Burgas, Bulgaria
2. National Institute of Meteorology and Hydrology, Sofia, Bulgaria

1. Today's presentation

1. Background – Environment, Air Pollution

2. Motivation - Particulate Matter (PM), Polycyclic Aromatic Hydrocarbons (PAHs)

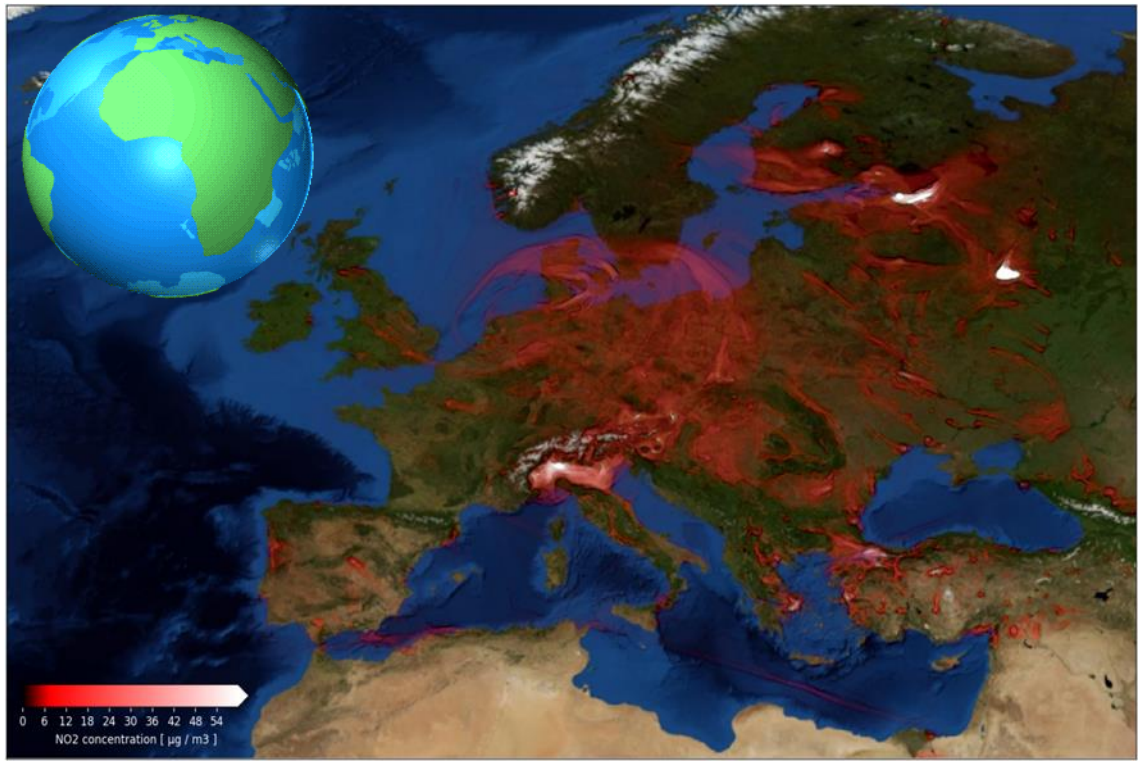
3. Goals – PAHs in $PM_{2.5}$

4. Materials and methods – $PM_{2.5}$ sampling and PAHs analysis

5. Results and discussion

6. Conclusions

1. Background



Source: CAMS, 2019

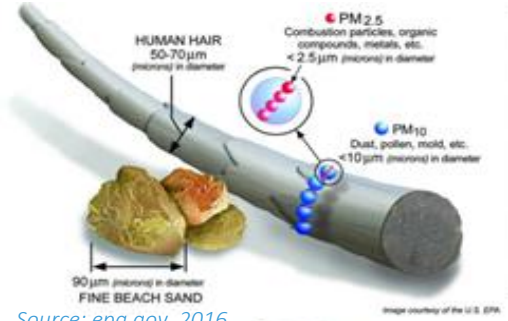
ENVIRONMENT

- Clean environment - normal existence;
- Population, industrial and energy production, pollution growth;
- Deteriorated environmental condition;
- Serious problems about human health and biosphere.

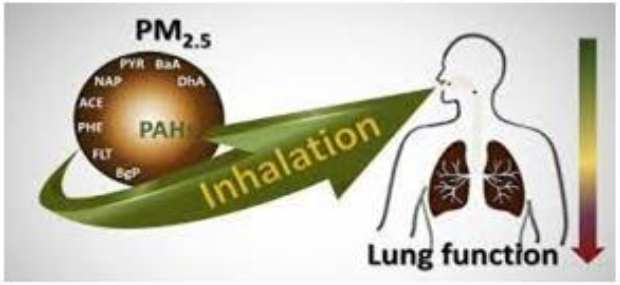
AIR POLLUTION

- The biggest environmental health risk in Europe;
- Levels of air pollutants still exceed;
- Huge impact on human health and the environment.

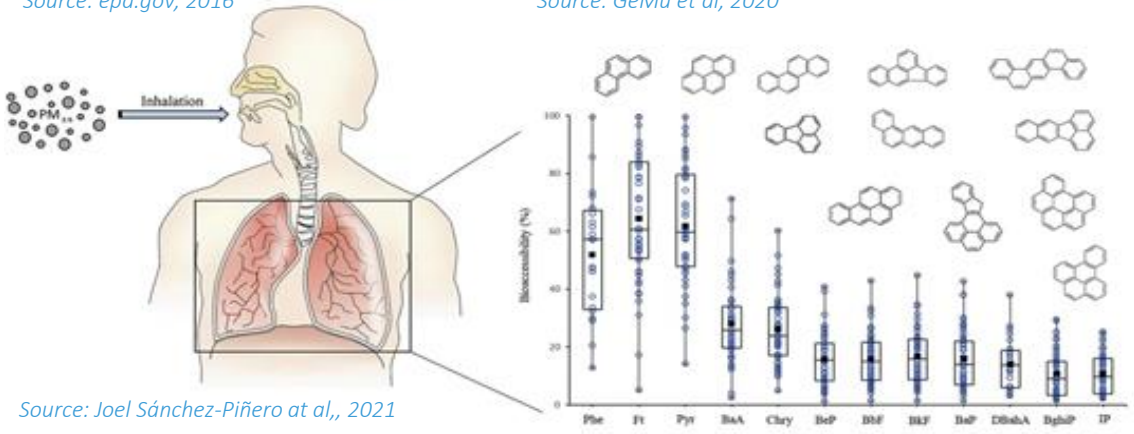
2. Motivation



Source: epa.gov, 2016



Source: GeMu et al, 2020

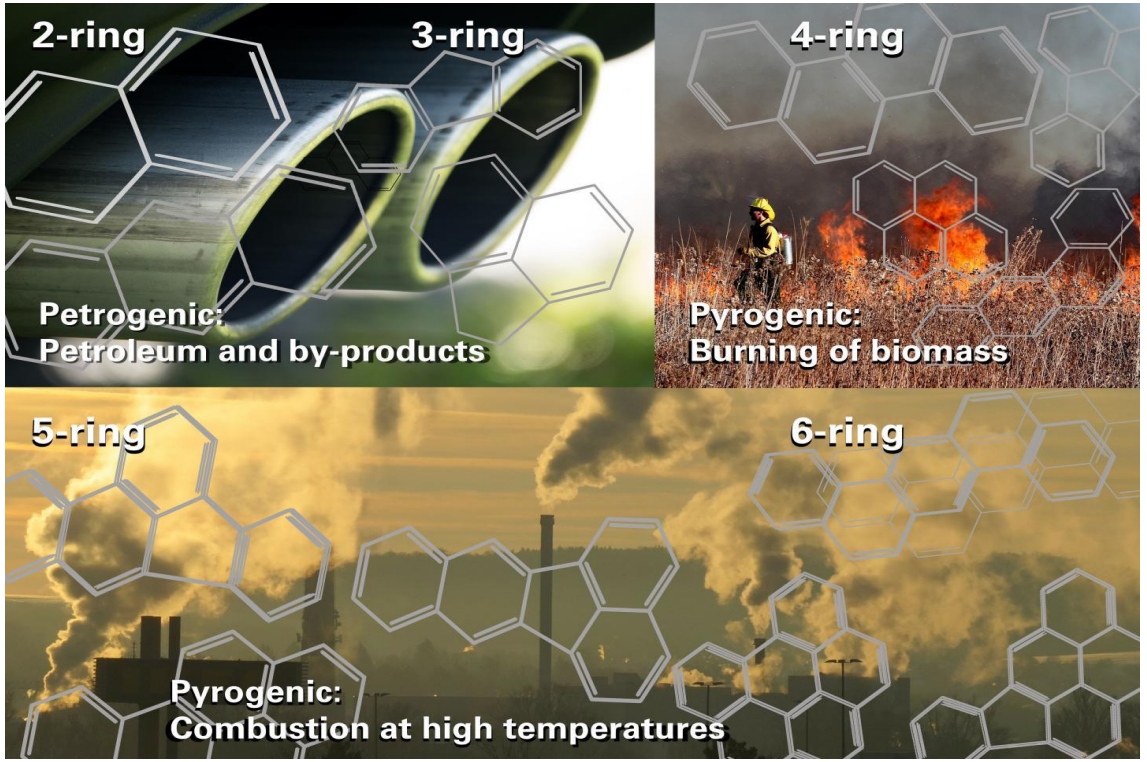


Source: Joel Sánchez-Piñero at al,, 2021

AIR

- The most used environmental resource ;
- 55 m^3 air per 24 hours for a human;
- 430 000 premature deaths in Europe because of air pollution;
- The impact of individual pollutant is well known;
- The impact of PM depends of their size and content;
- PAHs cause carcinogenesis and mutagenesis.

3. Goals

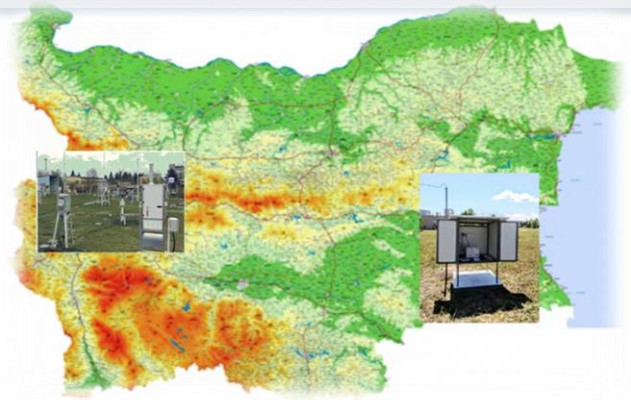


Source: Therese van Wyk,, 2021

PAHs in $PM_{2.5}$

- PAHs content in $PM_{2.5}$;
- Percentage of PAHs in $PM_{2.5}$;
- Identification of pollution sources at local area level.

4. Materials and methods

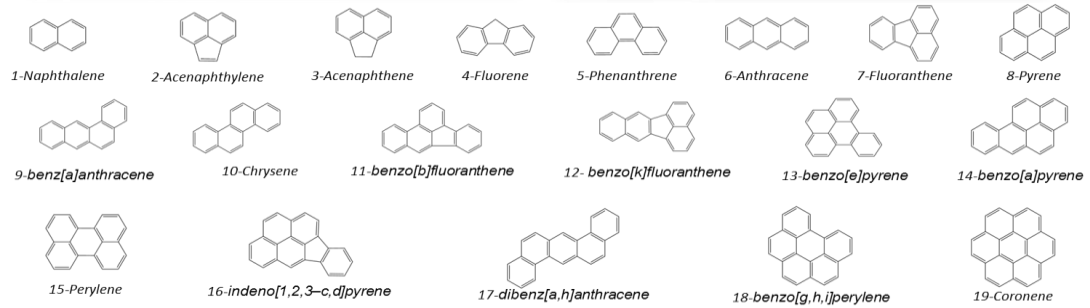


Sampling

- $PM_{2.5}$ sampling in accordance to EN 12341:2014;
- October 2020;
- Sofia and Burgas (Bulgaria).

Sample preparation

- Spiked filters with recovery standards;
- Ultrasonicated extraction with dichloromethane;
- Extracts purification and concentration.



Analysis

19 PAHs were analyzed by GC–MS/MS, Thermo Scientific Trace 1300/TSQ 8000 in the selected reaction monitoring (SRM);

Internal standard calibration technique.

5. Results and discussion

Total concentrations of PAHs and [*BaP*]eq in $PM_{2.5}$

Date	Sofia		Burgas	
	Σ PAH $PM_{2,5}$ ng m^{-3} (%)*	Σ $[BaP]_{eq}$ ng m^{-3}	Σ PAH $PM_{2,5}$ ng m^{-3} (%)*	Σ $[BaP]_{eq}$ ng m^{-3}
5.10.2020	1.389 (0.010)	0.019	0.828 (0.004)	0.039
7.10.2020	1.075 (0.011)	0.054	0.515 (0.004)	0.006
9.10.2020	1.844 (0.023)	0.107	0.380 (0.006)	0.002
11.10.2020	1.620 (0.013)	0.136	0.634 (0.005)	0.013
12.10.2020	0.760 (0.006)	0.036	0.361 (0.002)	0.001
14.10.2020	1.881 (0.021)	0.140	0.709 (0.011)	0.029
16.10.2020	1.398 (0.017)	0.083	0.489 (0.003)	0.004
18.10.2020	2.039 (0.027)	0.173	0.884 (0.027)	0.031
19.10.2020	5.176 (0.054)	0.563	2.001 (0.019)	0.180
21.10.2020	5.721 (0.048)	0.665	-	-
23.10.2020	6.934 (0.037)	0.799	1.166 (0.005)	0.087
25.10.2020	11.331 (0.045)	1.524	1.226 (0.005)	0.067
26.10.2020	3.927 (0.035)	0.418	0.759 (0.003)	0.025
28.10.2020	5.367 (0.024)	0.697	-	-
Mean value	3.604 (0.027)	0.387	0.829 (0.008)	0.040
RSD, %	84.5	110.6	55.6	127.6

RSD - Relative Standard Deviation

*Sum of PAHs as a part of $PM_{2.5}$, %.

5. Results and discussion

Meteorological conditions

	Sofia		Burgas	
	Mean value*	RSD, %	Mean value*	RSD, %
WS, m s^{-1}	2.6	55.2	3.6	17.0
RH, %	76.1	13.3	76.8	15.2
Temp, °C	12.2	33.3	17.9	15.6
DewP, °C	7.6	46.9	13.4	33.4
Vis, km	8.9	12.2	9.6	6.4
Press, mbar	1017.3	0.5	1015.4	0.4

*Mean value for the sampling period of the average values for 24h; RSD - relative standard deviation; WS - wind speed; RH - relative humidity; Temp – temperature; DewP - dew point; Vis - visibility; Press – pressure.

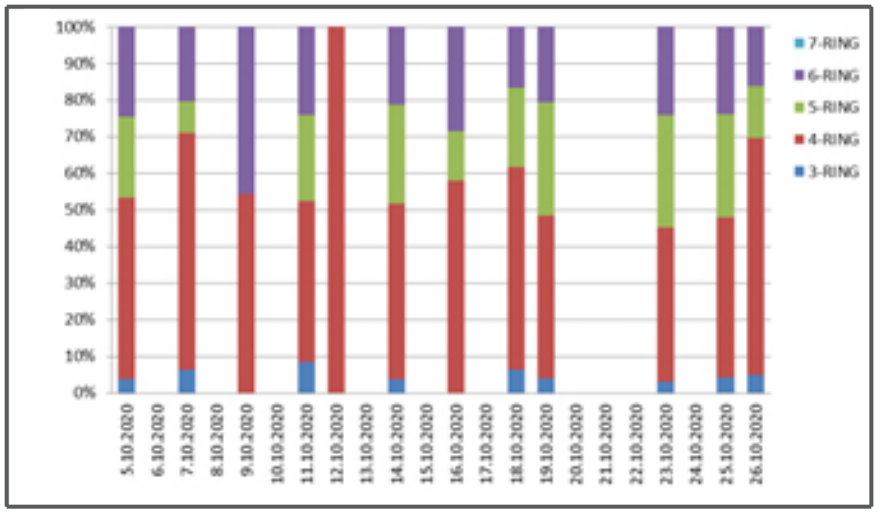
Correlation coefficients

	Sofia	Burgas
$PM_{2.5}$	**0.77**	0.08
WS	**-0.52**	0.00
RH	0.40	**-0.54**
TEMP	**-0.59**	**-0.57**
DEWP	-0.42	**-0.67**
VIS	**-0.49**	0.04
PRESS	0.38	**0.81**

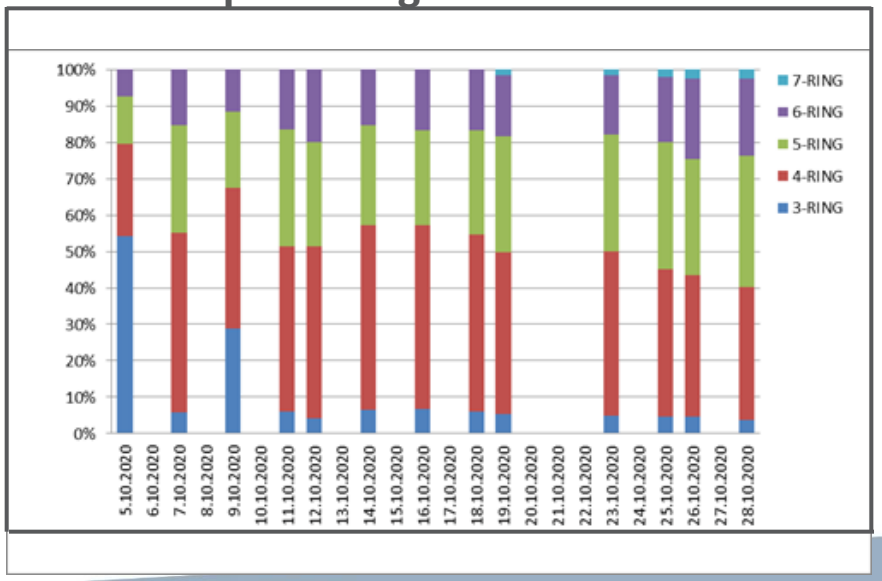
Statistically significant correlation coefficients (sign. $p < 0.05$) are in bold.

5. Results and discussion

Relative percentages of PAHs - Burgas



Relative percentages of PAHs - Sofia



Diagnostic ratios

	Sofia	Burgas	Reference source emission
	MV (RSD, %)	MV (RSD, %)	
IndP /(*IndP* +*BghiP*)	0.52 (9.9)	0.49 (10.2)	0.56 (coal)
			0.60 (wood burning)
			0.35 – 0.70 (Diesel emission)
BaP /(*BaP* +*Chr*)	0.34 (22.2)	0.28 (29.1)	0.5 (Diesel)
BbF /*BkF*	0.98 (8.8)	0.74 (39.2)	>0.5 (Diesel)
BaP /*BghiP*	0.82 (32.9)	0.45 (38.9)	<0.5 (non-Traffic emission)
			>0.5 (Traffic emission)
			0.9 – 6.6 (Coal combustion)
IndP /*BghiP*	1.08 (19.0)	0.99 (17.6)	<0.4 (Gasoline)
			≈ 1 (Diesel)
BaA /(*BaA* +*Chr*)	0.37 (6.8)	0.36 (8.9)	>0.35 (Combustion)

MV – Mean Value

Source: Khan, M.B. et al, 2018

6. Conclusions

- The study thoroughly assessed the content and pattern of distribution of **PAHs** in fine particulate matter, sampled in **two large Bulgarian cities** - Sofia and Burgas.
- Results reveal that PAHs concentrations in Sofia are higher than those in Burgas, but none of the averaged $\Sigma[BaP]_{eq}$ **does not exceed the annual limit value of 1 ng m^{-3}** set for *BaP*.
- Linear regression analysis of total PAHs concentrations with $PM_{2.5}$ and some meteorological parameters described a significant correlation. For Sofia between PAHs and $PM_{2.5}$, wind speed and temperature, and for Burgas - relative humidity, temperature, dew point and atmospheric pressure.
- Establishment of the PAHs composition in PM helps **to identify the pollution source**;
- **PAHs bound to $PM_{2.5}$** originate from pollution sources which are rather **pyrogenic**.
- The obtained results may trigger competent management decisions by the authorities, which may lead to improved air quality.

Thank you!

Stela Naydenova

steltion@gmail.com

Sponsors / Partners: This study was performed with the financial support from the Bulgarian National Science Fund through contract № КП-06-Н 34/9 -19.12.2019.

CARBOAEROSOL

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