MARMARA UNIVERSITY

10th BAQ Better Air Quality Conference Kuching, Malaysia 14-16 Nov 2018

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PM2.5 Analysis and the Determination of PAH Constituents at a Densely Populated Area of Istanbul

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BACKGROUND – PAH, $PM_{2.5}$

- According to World Health Organization (WHO), outdoor and indoor air pollution are responsible for premature death of seven million people every year as follows: 43% chronic obstructive pulmonary disease, 29% lung cancer, 25% stroke, and 24% heart disease.
- WHO **annual** standard PM2.5 = 10 μg/m^3
- US-EPA **annual** standard PM2.5 = 12 μg/m^3. **24h average** PM2.5: 35 μg/m^3.
- Australian EPA recommendations for **hourly** PM2.5: very good (<13.1 μg/m^3), good (13.2-26.3 μg/m3), fair (26.4-39.9 μg/m3), poor (40-59.9 μg/m3), very poor (>60 μg/m^3)
- PAHs are emitted by anthropogenic sources, generally as by-products of incomplete combustion of organic matter.
- PAHs are carcinogenic and mutagenic. EC establishes annual average of 1 ng/m^3 as BaP in PM10.
- Benzo[a]pyrene (BaP), the most toxic of the parent PAHs, is widely considered a key marker PAH for environmental assessments.

METHODS

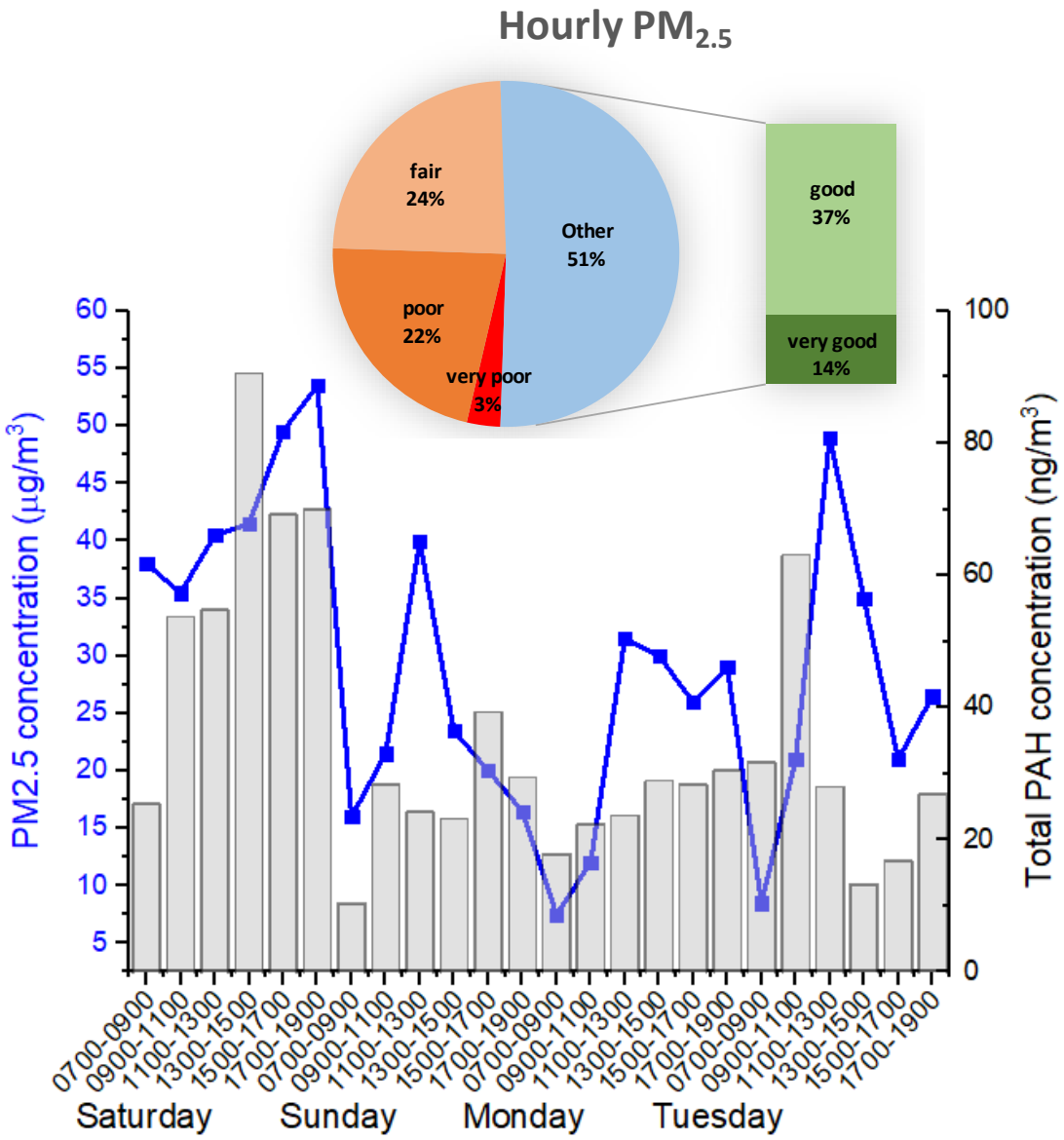
Sampling

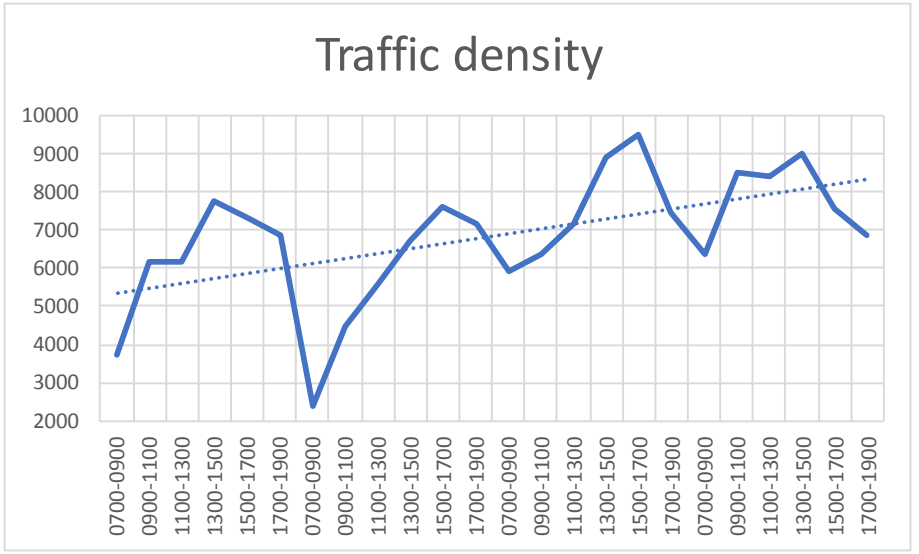
- high time resolved $PM_{2.5}$ every 2h
- 7:00 am - 7:00 pm
- 28 Jan – 31 Jan 2017

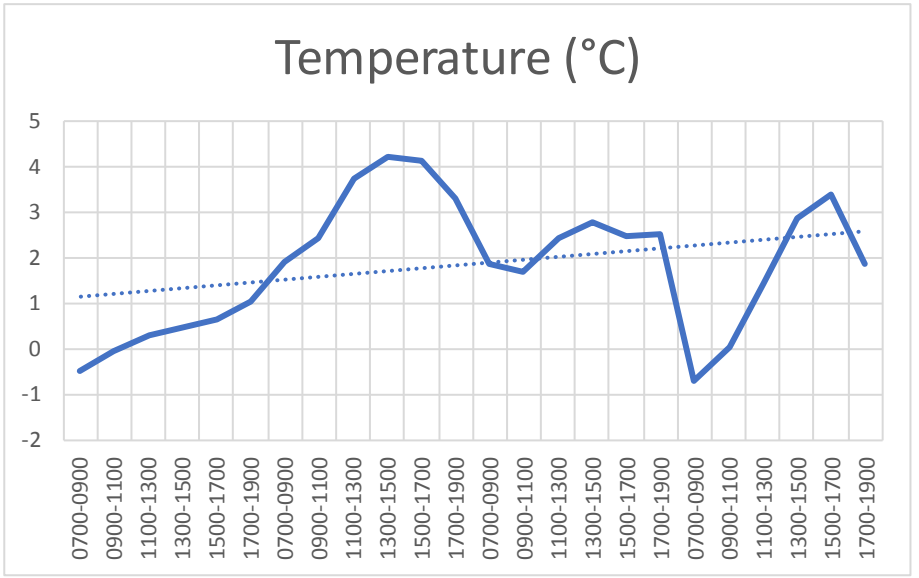
Analysis of PAH

- Thermal desorption – gas chromatography (TD-GC-MS)

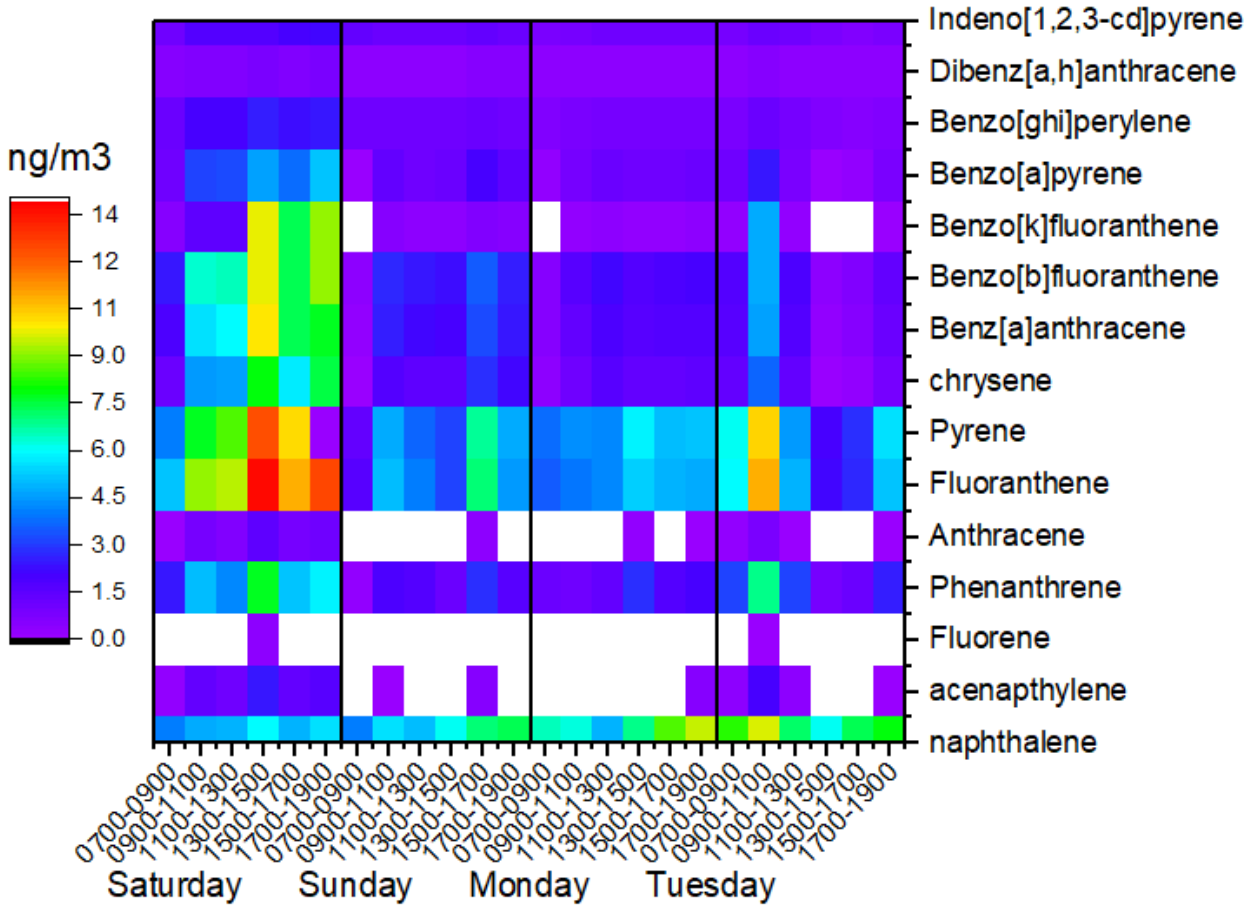
RESULTS


Hourly PM2.5
fair 24%
Other 51%
poor 22%
very poor 3%
good 37%
very good 14%
PM2.5 concentration (µg/m3)
Total PAH concentration (ng/m3)
Saturday
Sunday
Monday
Tuesday

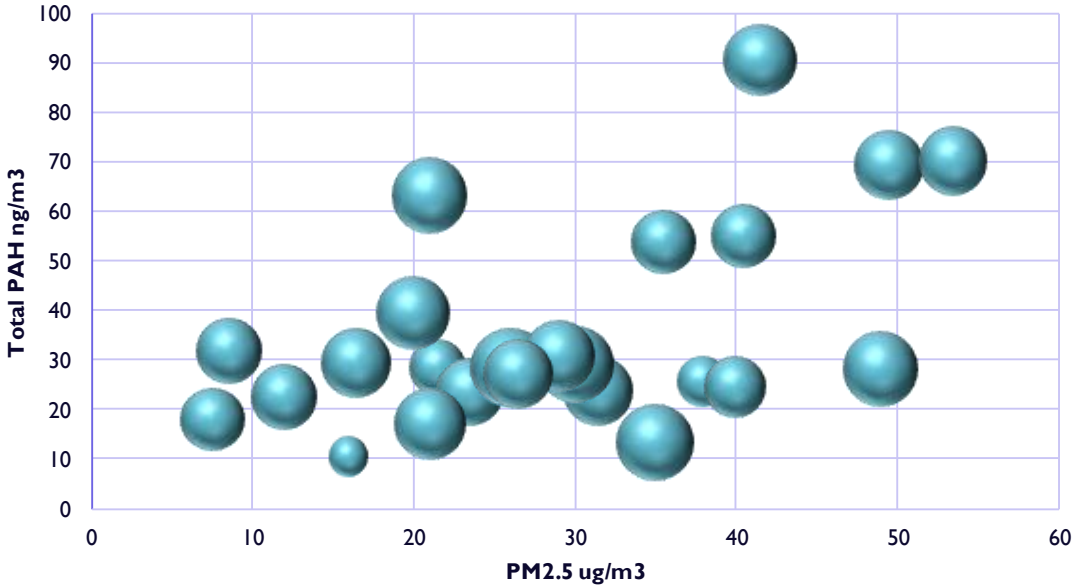

Traffic density


Temperature (°C)

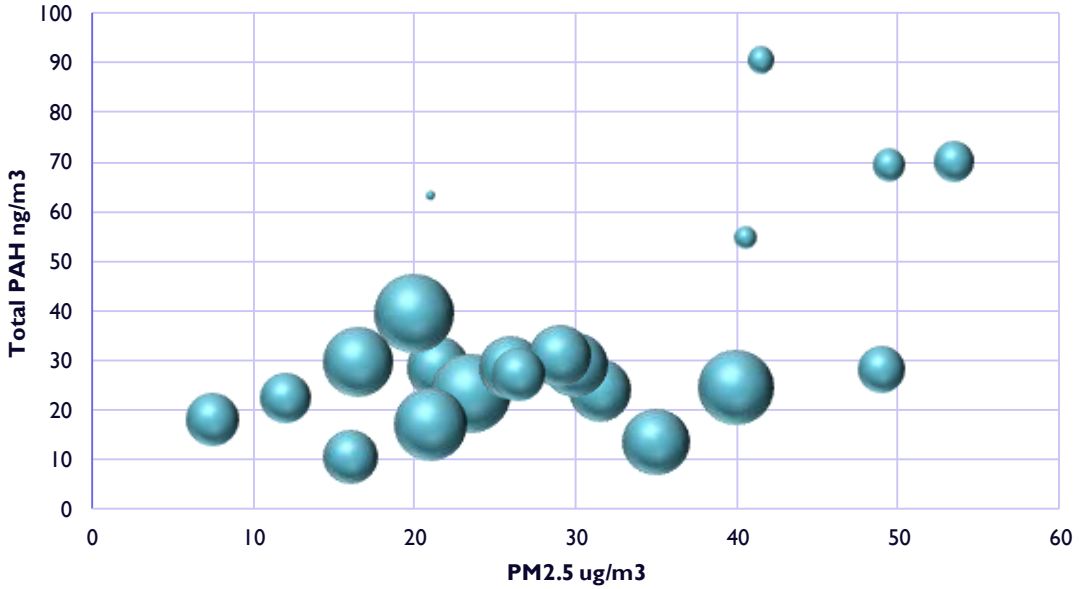
Diurnal variation of PAHs



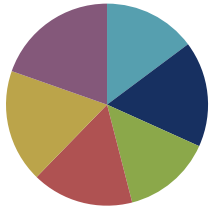
Effect of traffic on PM2.5 and total PAH



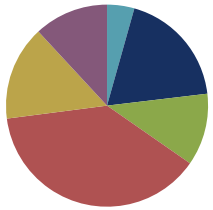
Effect of temperature on PM2.5 and total PAH



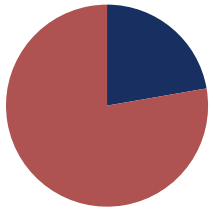
naphthalene



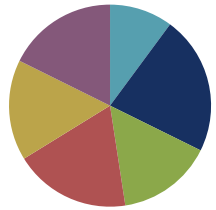
acenapthylene

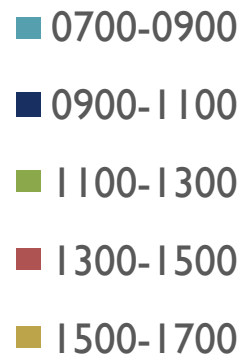


Fluorene

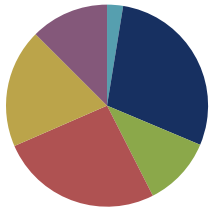


Phenanthrene

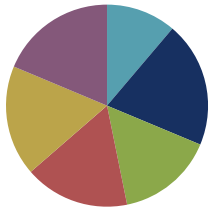




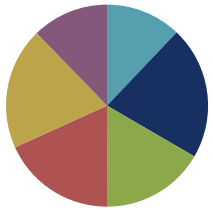
Anthracene



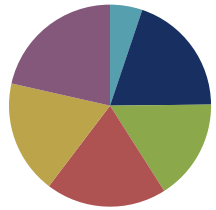
Fluoranthene



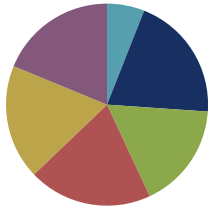
Pyrene



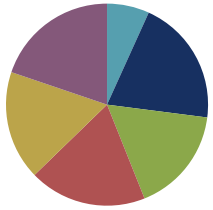
chrysene



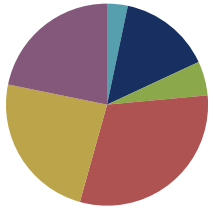
Benz[a]anthracene



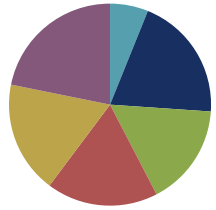
Benzo[b]fluoranthene



Benzo[k]fluoranthene

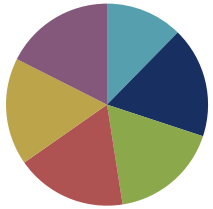


Benzo[a]pyrene

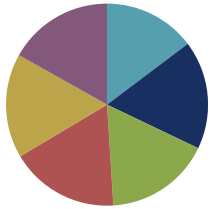


Hour	Traffic flow
0700-0900	4,609
0900-1100	6,386
1100-1300	6,839
1300-1500	8,112
1500-1700	7,996
1700-1900	7,089

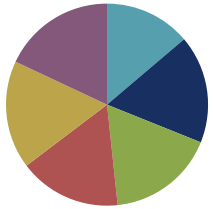
Benzo[ghi]perylene



Dibenz[a,h]anthracene



Indeno[1,2,3-cd]pyrene



Saturday	38,043	20% less than weekday
Sunday	33,941	~ 25% less than weeeekday
Monday	45,339	Mon and Tue equal
Tuesday	46,800	Mon and Tue equal

Pearson correlation coefficients: Individual PAH, Meteorology, and Traffic

	Acenapthylene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Chrysene	Benz[a]anthracene	Benzo[b]fluoranthene	Benzo[k]fluoranthene	Benzo[a]pyrene	Benzo[ghi]perylene	Dibenz[a,h]anthracene	Indeno[1,2,3-cd]pyrene
PM2.5	0.38	0.50	0.42	0.52	0.14	0.59	0.59	0.61	0.55	0.60	0.64	0.63	0.61
Traffic	0.45	0.25	0.14	0.21	0.28	0.15	0.12	0.10	0.16	0.12	-0.05	-0.10	-0.09
Temperature °C	-0.36	-0.61	-0.31	-0.57	-0.45	-0.43	-0.46	-0.47	-0.41	-0.44	-0.46	-0.50	-0.38
Pressure hPa	-0.14	0.11	-0.13	-0.05	-0.02	-0.15	-0.14	-0.16	-0.05	-0.18	-0.21	-0.22	-0.20
Wind Direction	0.42	0.25	0.52	0.27	0.03	0.30	0.27	0.30	0.19	0.30	0.27	0.28	0.27
Solar radiation w/m²	-0.06	-0.17	-0.18	-0.31	-0.20	-0.30	-0.28	-0.30	-0.20	-0.34	-0.34	-0.34	-0.37
Humidity %	0.47	0.24	0.70	0.39	0.21	0.49	0.50	0.51	0.36	0.52	0.60	0.59	0.63
Wind speed (m/s)	-0.46	-0.41	-0.65	-0.47	-0.15	-0.55	-0.57	-0.59	-0.48	-0.56	-0.66	-0.70	-0.65
Boundary Layer (m)	-0.31	-0.47	-0.50	-0.51	-0.11	-0.49	-0.48	-0.51	-0.45	-0.50	-0.52	-0.57	-0.49
Mixing coefficient (m2/s)	-0.46	-0.53	-0.59	-0.57	-0.24	-0.57	-0.58	-0.60	-0.51	-0.58	-0.61	-0.67	-0.56

Regression Parameters for Multiple regression analysis

	Total PAH	Acenapthylen	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Chrysene	Benz[a]anthra	Benzo[b]fluor	Benzo[k]fluor	Benzo[a]pyre	Benzo[ghi]per	Dibenz[a,h]ar	Indeno[1,2,3-
PM2.5	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Traffic	1.81	10.29	10.33	9.32	6.30	7.45	7.10	7.02	6.40	9.96	6.20	2.87	1.88	2.14
Temperature °C	-0.21	-0.53	-0.54	-0.46	-0.35	-0.37	-0.28	-0.29	-0.29	-0.40	-0.27	-0.14	-0.11	-0.05
Pressure hPa	24.92	10.83	43.73	-63.83	-8.10	69.94	-60.53	-49.80	-84.42	-17.01	-84.83	-67.36	-74.72	-8.21
Humidity %	1.60	1.08	1.08	1.06	1.17	1.82	2.17	2.01	1.60	2.41	1.89	0.89	0.17	1.10
Wind Speed m/s	-0.77	-1.23	-0.97	-1.57	-0.82	-0.13	-1.85	-1.82	-1.76	-3.04	-1.66	-1.10	-0.77	-0.66
R2	0.81	0.80	0.83	0.82	0.83	0.52	0.81	0.81	0.82	0.64	0.81	0.80	0.82	0.73

CONCLUSIONS

- PM2.5 and 16 PAH were studied in short-time 2h samples during the winter (28-31 Jan 2017) in Istanbul
- According to Australian EPA recommendations, hourly PM2.5 concentrations were used as indicators of air quality: 49% fair, poor, and very poor, 37% good, and 14% very good.
- Diurnal average concentrations of total PAH (∑14 PAH) ranged 21.75 ng/m3 (7-9am) to 42.35 ng/m3 (13-15h). With Benzo(a)pyrene ranging 0.59-2.1 ng/m3
- Pearson correlations showed positive correlations between PAH and PM2.5 (R^2=0.5-0.64), and negative correlations with wind speed (R^2=0.55-0.70) and boundary layer height (R^2=0.5-0.57).
- Multiple regression analysis determined PM2.5, traffic, Temperature, Pressure, Humidity, and Wind speed resolved **52-83%** of the total variance of individual PAH concentrations.
- The study of diurnal variations of PM2.5 and PAH is helpful for understanding the fate and transport in the atmosphere and their effects on human health, ecosystems, and climate change. Their variations depend on sources, meteorology, and atmospheric reactivity.

Thank you

Acknowledgements:

- TUBITAK 115Y625; BAPKO FEN-C-YLP-090217-0060
- IETT (Beşiktaş) for use of their facilities.
- Ministry of Environment and Urbanization, Department of Transportation, Turkish State Meteorological Center, and Weather Underground for data provided.