



45<sup>th</sup> NATIONALE-NEDERLANDEN  
WARSAW MARATHON

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**Environmental Report**  
WARSAW JUNE 2024

**RUNNING FOR CLEAN AIR**

# DISCLAIMER

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This report contains data from the Air Quality monitoring station installed at Park Pole Mokotowskie, Warsaw, POLAND, operating since May 7th, 2024.

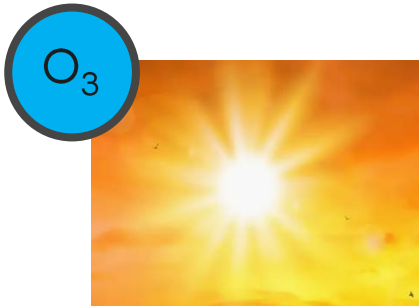
The data presented in this report is collected with sensor technologies which are not regulatory-grade instrumentation following Directive 2008/50/EC. Therefore, the results presented should be considered as informative and not be used for regulatory compliance checking purposes. Any communication of the data should include this statement. After deployment, the monitors are not routinely inter-compared with reference instruments at each destination.

# MAIN POLLUTANTS MEASURED



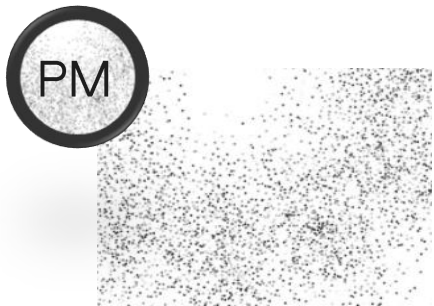
## Nitrogen Dioxide

Primarily gets in the air from the burning of fuel by cars, trucks and buses, power plants



## Ozone

Created by chemical reactions between (NOx) and (VOC) in the presence of sunlight



## Particulate matter

Mixture of solid particles and liquid droplets found in the air. Some are emitted directly from a source, such as heating in residential, construction sites, unpaved roads, fields, smokestacks, fires or transported by the wind



# EUROPEAN AQI INDEX

Help us understand data measured by the stations

<b>EXTREMELY POOR</b> 126-200	May cause respiratory issues in healthy people, and serious health issues in people with lung/heart disease.
<b>VERY POOR</b> 101-125	The pollution level has reached a critical level. Even healthy people may show symptoms for short exposures.
<b>POOR</b> 75-100	Effects can be immediately felt by individuals at risk. Everybody feels the effects of prolonged exposure.
<b>MODERATE</b> 51-75	The air has reached a high level of pollution. Higher than the maximum limit for 24 hours established by WHO.
<b>FAIR</b> 26-50	The air is moderately polluted. A long-term exposure constitutes a health risk.
<b>GOOD</b> 0-25	The air is pure, ideal for outdoor activities.

# EUROPEAN AQI LEVELS



Measurements of up to five key pollutants (O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>) determine the index level that describes the current air quality situation at the location of each Kunak device. The index corresponds to the poorest level for any of the five pollutants based on the following scheme:

Pollutant	Level index (based on pollutant concentrations in µg/m <sup>3</sup> )					
	Good	Fair	Moderate	Poor	Very poor	Extremely poor
	(0-25)	(26-50)	(51-75)	(76-100)	(101-125)	(126-200)
PM <sub>2.5</sub> (24h)	0-10	10-20	20-25	25-50	50-75	75-800
PM <sub>10</sub> (24h)	0-20	20-35	35-50	50-100	100-150	150-1200
NO <sub>2</sub>	0-40	40-90	90-120	120-230	230-340	340-1000
O <sub>3</sub>	0-50	50-100	100-130	130-240	240-380	380-800
SO <sub>2</sub>	0-100	100-200	200-350	350-500	500-750	750-1250

[https://www.kunak.es/doc/O8.Manuals/html/Kunak\\_Cloud\\_UserManual\\_EN.html#\\_Toc102586013](https://www.kunak.es/doc/O8.Manuals/html/Kunak_Cloud_UserManual_EN.html#_Toc102586013)

RECOMMENDED AIR QUALITY GUIDELINES LEVELS & INTERIM TARGETS

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	35	25	15	10	5
	24-hour <sup>a</sup>	75	50	37.5	25	15
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	70	50	30	20	15
	24-hour <sup>a</sup>	150	100	75	50	45
O <sub>3</sub> , µg/m <sup>3</sup>	Peak season <sup>b</sup>	100	70	-	-	60
	8-hour <sup>a</sup>	160	120	-	-	100
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	30	20	-	10
	24-hour <sup>a</sup>	120	50	-	-	25

AIR QUALITY GUIDELINES FOR NITROGEN DIOXIDE (SHORT AVERAGE TIME) REMAIN VALID

Pollutant	Averaging time	Air quality guidelines that remain valid
NO <sub>2</sub> , µg/m <sup>3</sup>	1-hour	200

Recommended 2021 AQG levels compared to 2005 air quality guidelines

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual	10	5
	24-hour <sup>a</sup>	25	15
PM <sub>10</sub> , µg/m <sup>3</sup>	Annual	20	15
	24-hour <sup>a</sup>	50	45
O <sub>3</sub> , µg/m <sup>3</sup>	Peak season <sup>b</sup>	-	60
	8-hour <sup>a</sup>	100	100
NO <sub>2</sub> , µg/m <sup>3</sup>	Annual	40	10
	24-hour <sup>a</sup>	-	25
SO <sub>2</sub> , µg/m <sup>3</sup>	24-hour <sup>a</sup>	20	40
CO, mg/m <sup>3</sup>	24-hour <sup>a</sup>	-	4

<https://apps.who.int/iris/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y>



# METHODOLOGY

## Meteo sensors

Temperature

(WBGT) Wet bulb globe temperature

Relative Humidity

## Gas sensors (ug/m3)

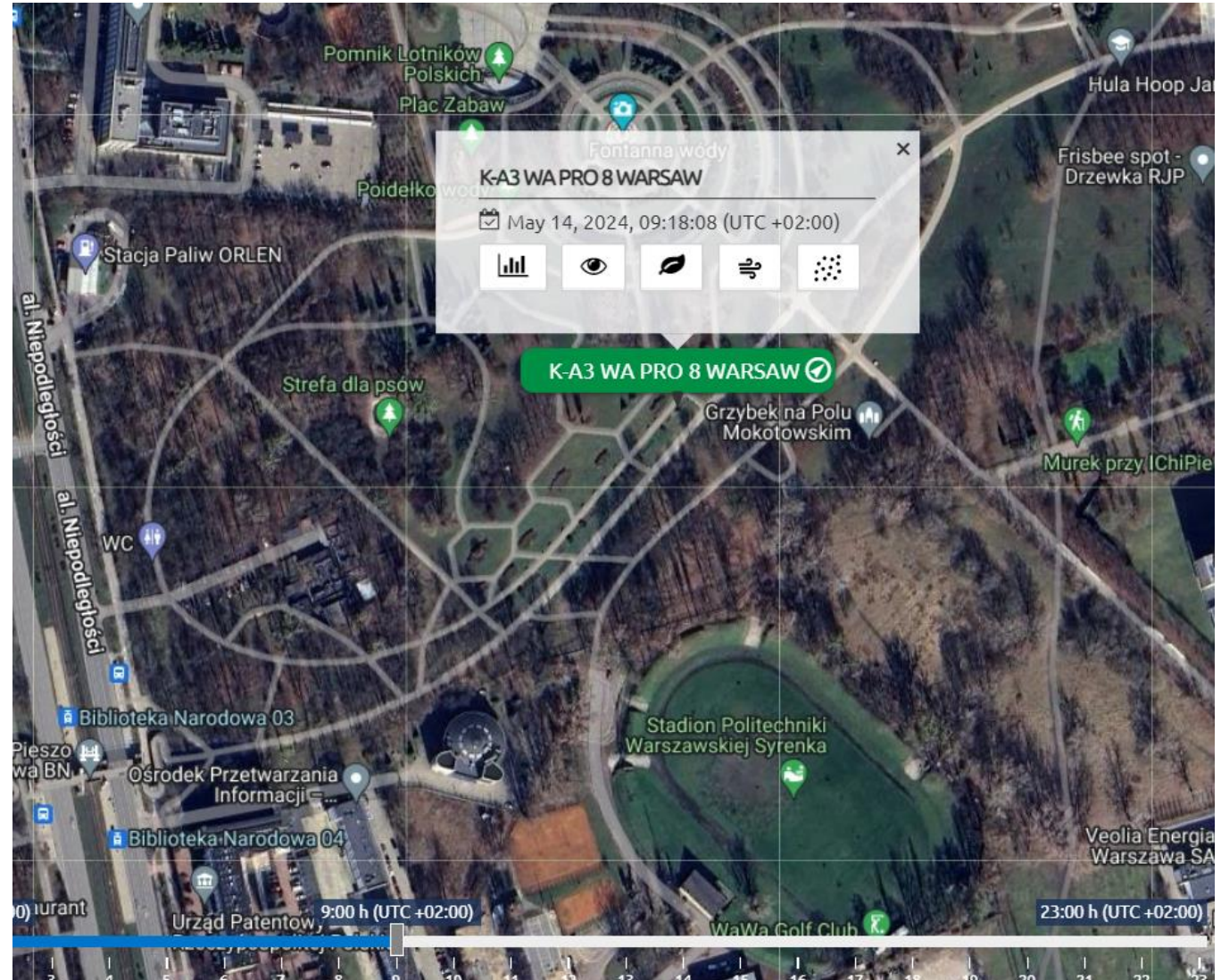
NO, NO2, O3

## Particulate Matter sensor (ug/m3)

PM2.5, PM10

## Positioning

GPS





**AGGREGATED DATA June 1st to June 30th**

**ENVIRONMENTAL DATA & AIR QUALITY INDEX**

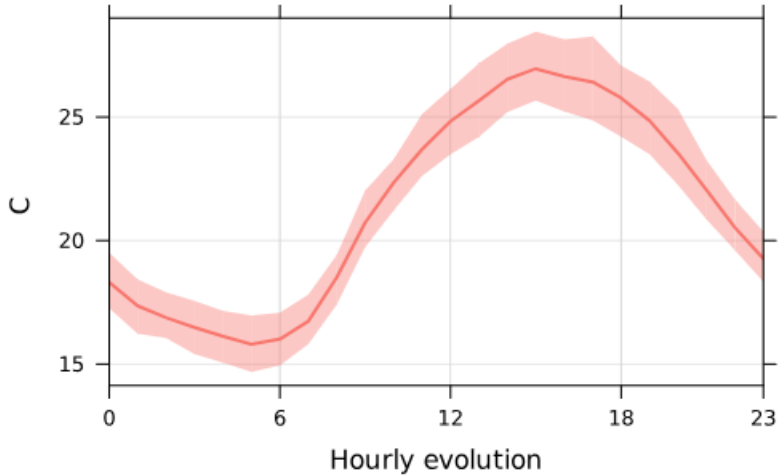
**DEVICE LOCATED AT**

**Park Pole Mokotowskie**



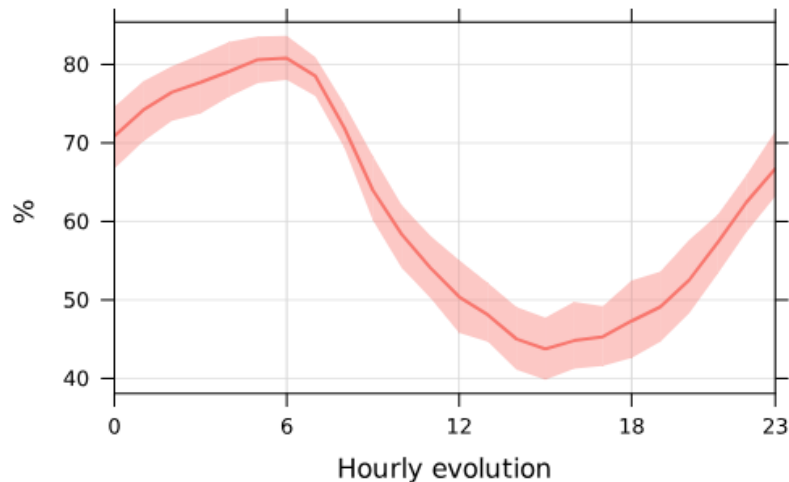
# TEMPERATURE & HUMIDITY – Time variation - June 1st to June 30th

## Air Temperature



Aggregated data of the temperature hourly evolution indicate that the lowest temperature is measured at 05:00 and the highest between 14:00 and 16:00

## Relative Humidity



Aggregated data of the humidity hourly evolution indicate that the lowest humidity is measured at 14:00 and the highest between 05:00 and 07:00

# WET BULB GLOBE TEMPERATURE - Time variation - June 1st to June 30th



WBGT is a measure of heat stress in direct sunlight.

It is a comprehensive measure of all the weather-related factors

(i) air temperature;

(ii) humidity;

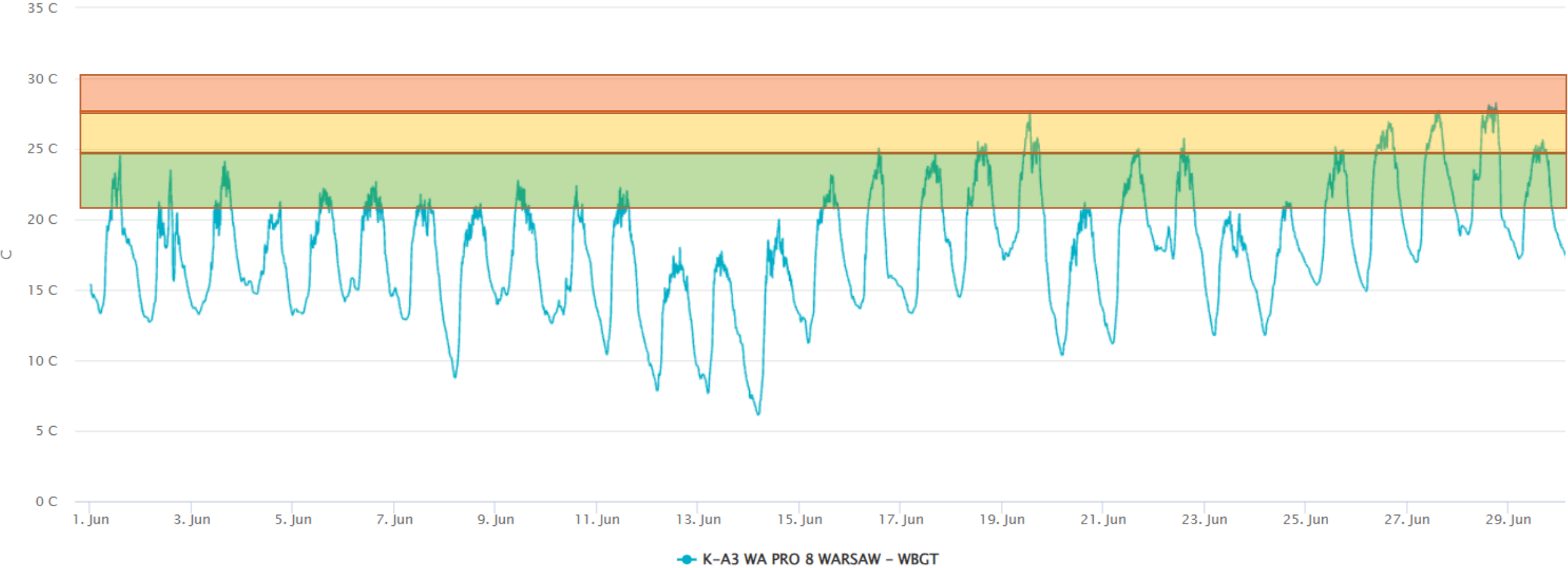
(iii) wind speed;

(iv) solar radiation

that impact the health and performance of athletes.

# WBGT - Time variation June 1st to June 30th

WBGT index increases during this period and starts to become a significant level of heat stress for training athletes.



**WBGT**

Almost safe <21°C	Caution 21-25°C	Warning 25-28°C	Severe warning 28-30°C	Danger > 30°C
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# AQI EU - June 1st to June 30th

AQI EU of K-A3 WA PRO 8 WARSAW in 2024

June-2024						
26	27	28	29	30	31	
						44
47	59	59	56	40	50	52
49	48	48	38	38	76	59
43	43	43	63	40	58	47
46	28	41	42	48	57	65
54	1	2	3	4	5	6
S	M	T	W	T	F	S

EXTREMELY POOR

126-200

VERY POOR

101-125

POOR

75-100

MODERATE

51-75

FAIR

26-50

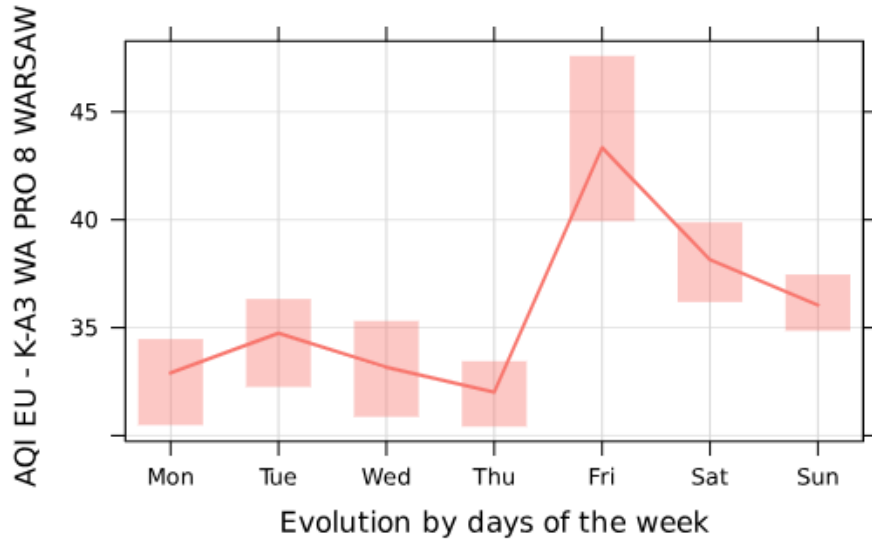
GOOD

0-25

The AQI calendar plot indicates the AQI for each day during the monitoring period. Helping us to have a first glimpse of the conditions for each day. The AQI measured in June shows a relatively low levels attesting fair to moderate air quality. The worst and best AQI values reported over the period are (76) and (28) respectively.

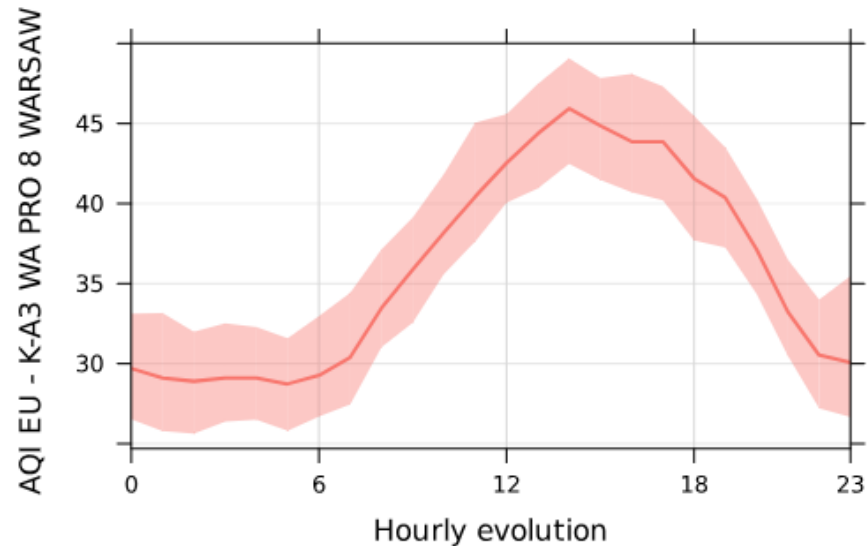


# AQI - Time variation - June 1st to June 30th



Aggregated data of the AQI evolution throughout the monitoring period helps us understand how the AQI changed based on day of the week and time of the day.

Aggregated data of the evolution by days of the week indicates the lowest AQI values were recorded on Thursday.

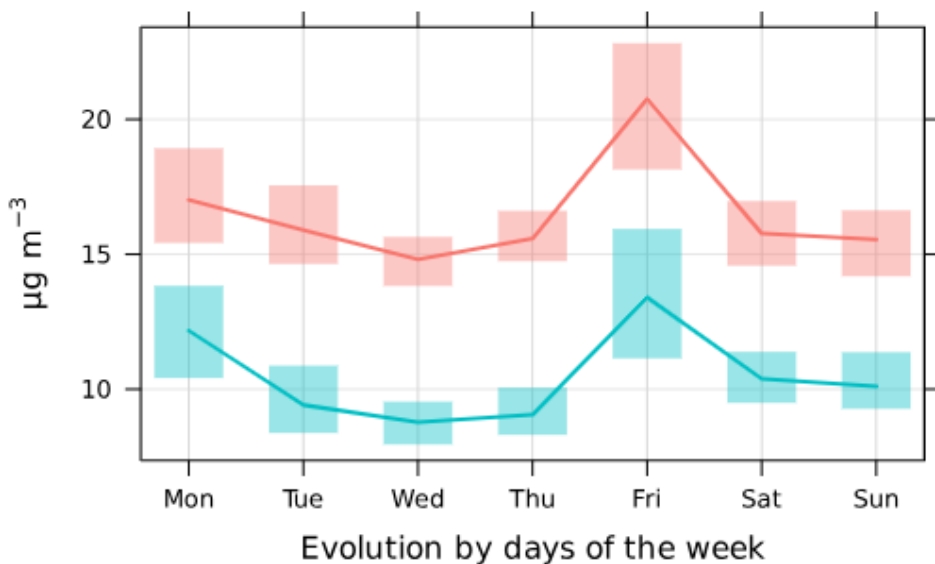


Aggregated data of the AQI hourly evolution indicates the lowest AQI values during nights and mornings, and highest AQI values during early afternoon between 13:00 and 17:00

# PARTICULATE MATTERS - Time variation - June 1st to June 30th

PM<sub>10</sub> - K-A3 WA PRO 8 WARSAW

PM<sub>2.5</sub> - K-A3 WA PRO 8 WARSAW



Aggregated data of the particulates pollutants evolution by days of the week indicates that absolute concentrations were higher on Friday.

#### Guideline values

Coarse particulate matter (PM10): 45 µg/ m<sup>3</sup> 24-hour mean

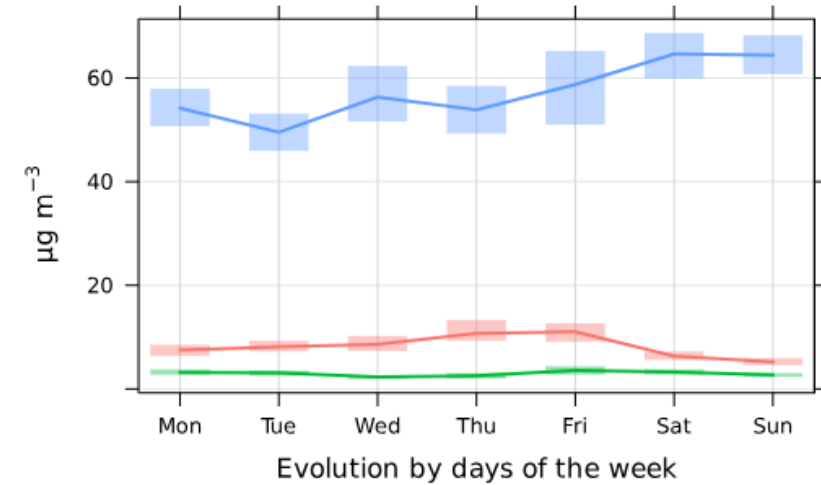
Fine particulate matter (PM2.5): 15 µg/ m<sup>3</sup> 24-hour mean

# GASEOUS POLLUTANTS - Time variation - June 1st to June 30th

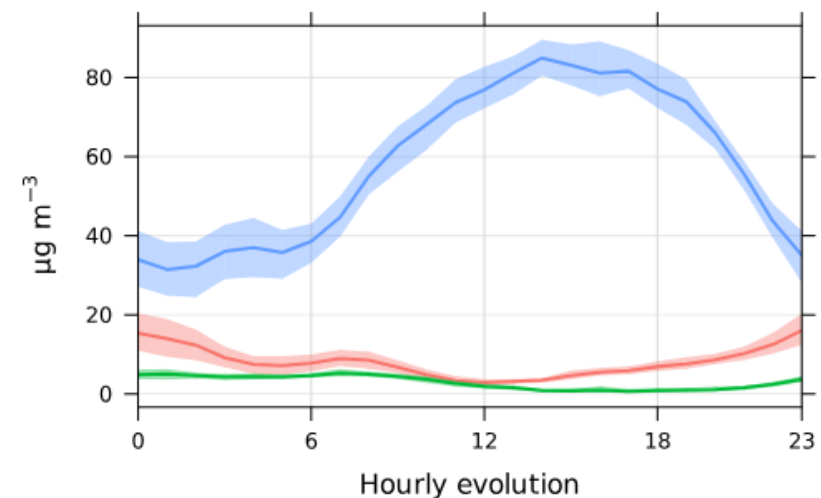
NO<sub>2</sub> GCc - K-A3 WA PRO 8 WARSAW

NO GCc - K-A3 WA PRO 8 WARSAW

O<sub>3</sub> GCc - K-A3 WA PRO 8 WARSAW



Aggregated data of the gaseous pollutants evolution by days of the week indicates that absolute concentrations were relatively low for NO<sub>2</sub>, NO. O<sub>3</sub> shows constant values at a relatively higher levels.



Aggregated data of the gaseous pollutants hourly evolution do not show any typical trends for NO<sub>2</sub> and NO suggesting a very low influence of vehicle traffic emissions (morning and evening rush hours) in this location. O<sub>3</sub> peaked in the early afternoon between 14:00 and 16:00. Typically, ozone levels reach their peak in mid-afternoon, after exhaust fumes from morning rush hour have had time to react in sunlight.

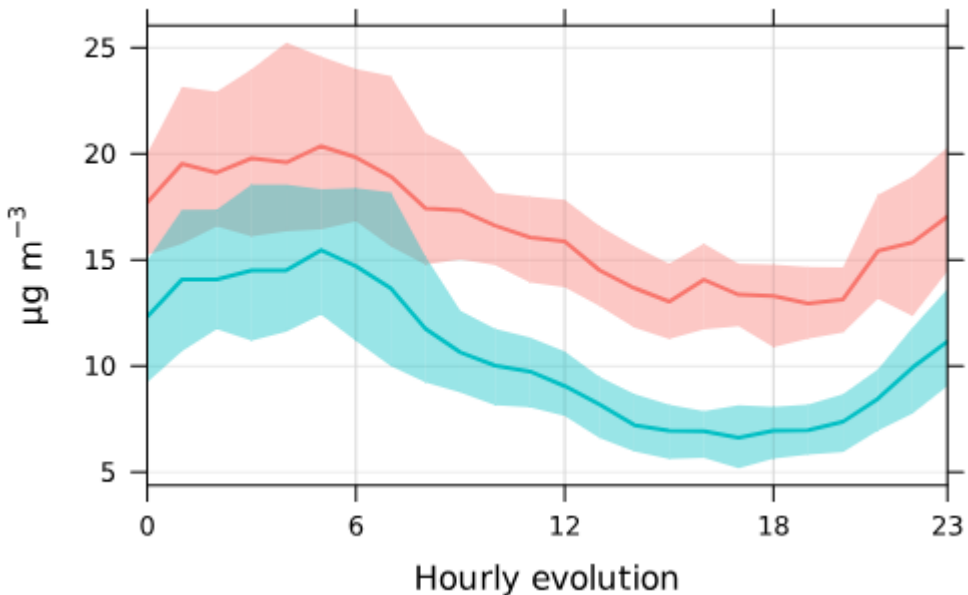
Guideline values NO<sub>2</sub>  
25 µg/m<sup>3</sup> (24h)  
200 µg/m<sup>3</sup> 1-hour mean

Guideline values O<sub>3</sub>  
100 µg/m<sup>3</sup> 8-hour mean

# PARTICULATE MATTERS - Time variation - June 1st to June 30th

PM<sub>10</sub> - K-A3 WA PRO 8 WARSAW

PM<sub>2.5</sub> - K-A3 WA PRO 8 WARSAW



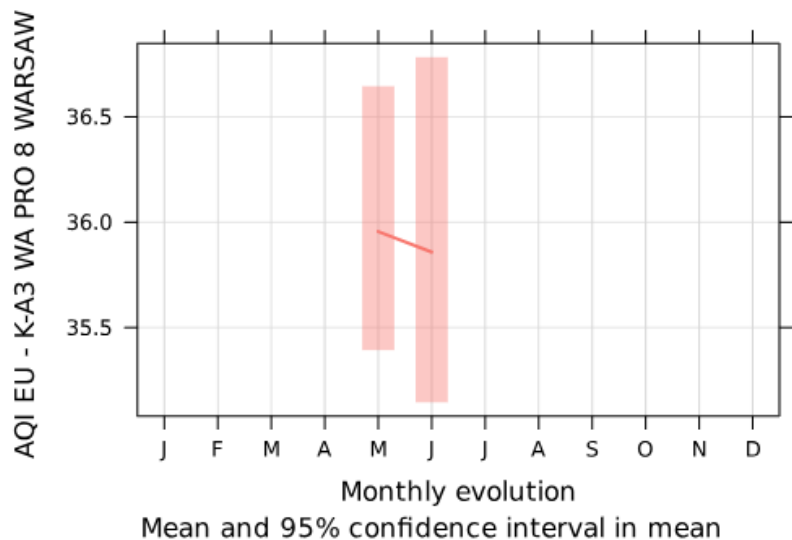
Aggregated data of the particulates pollutants hourly evolution show a moderate to poor levels. PM<sub>2.5</sub> and PM<sub>10</sub> showed higher concentrations at early morning from 04:00 to 6:00. These organic compounds can be emitted by both natural sources, such as trees and vegetation, as well as from man-made (anthropogenic) sources, such as industrial processes and motor vehicle exhaust. In this situation, both hypotheses are likely.

#### Guideline values

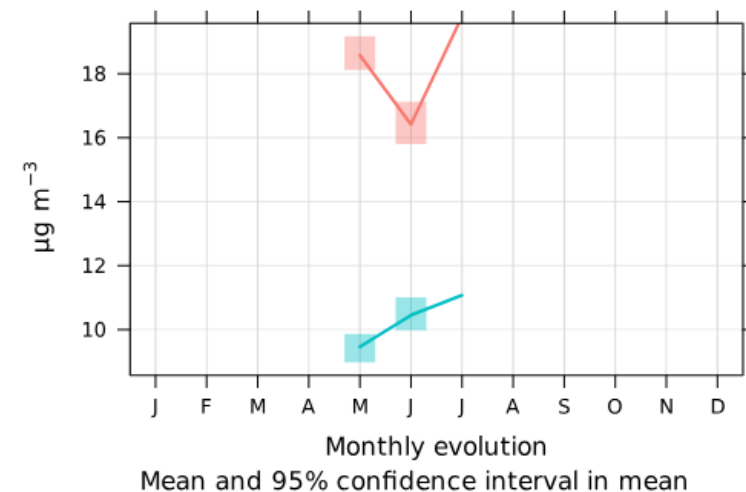
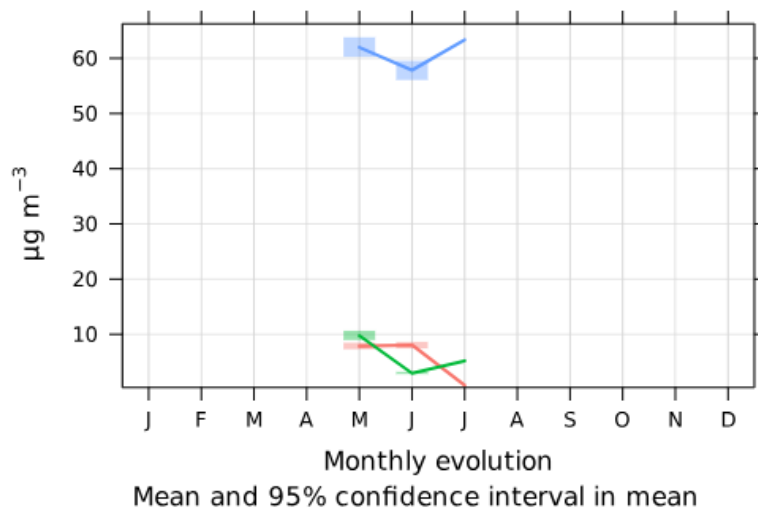
Coarse particulate matter (PM<sub>10</sub>): 45  $\mu\text{g/ m}^3$  24-hour mean

Fine particulate matter (PM<sub>2.5</sub>): 15  $\mu\text{g/ m}^3$  24-hour mean

# May/June comparison



AQI EU



NO<sub>2</sub> GCc

NO GCc

O<sub>3</sub> GCc

PM<sub>10</sub>

PM<sub>2.5</sub>



# CONCLUSIONS

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Air Quality Index values recorded during the month of June shows a fair to moderate levels of air pollution. AQI index was largely influenced by Ozone levels.

WBGT index increases during this period and starts to become a significant level of heat stress for training athletes.

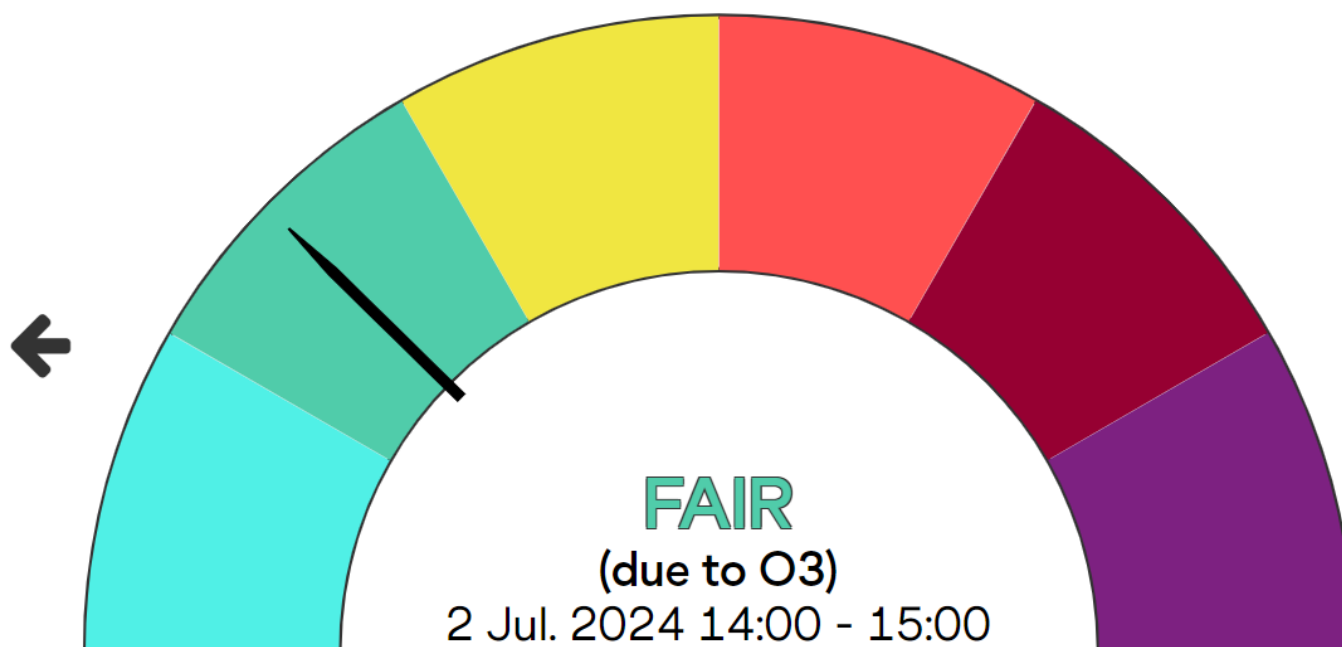
Aggregated data of the gaseous pollutants hourly evolution indicates typical trends for NO<sub>2</sub> and NO do not show any typical trends suggesting a very low influence of vehicle traffic emissions (morning and evening rush hours) in this location. Ozone levels reached their peak in the early/mid-afternoon, after exhaust fumes from morning rush hours have had time to react to the sunlight.

Aggregated data of the particulates pollutants hourly evolution show a moderate to poor levels. PM<sub>2.5</sub> and PM<sub>10</sub> showed higher concentrations at early morning, These organic compounds can be emitted by both natural sources, such as trees and vegetation, as well as from man-made (anthropogenic) sources, such as industrial processes and motor vehicle exhaust. In this situation, both hypotheses are likely.

Pollution levels recorded in June were very similar to those of the previous month.

# Appendix

## AIR QUALITY INDEX (EUROPE)



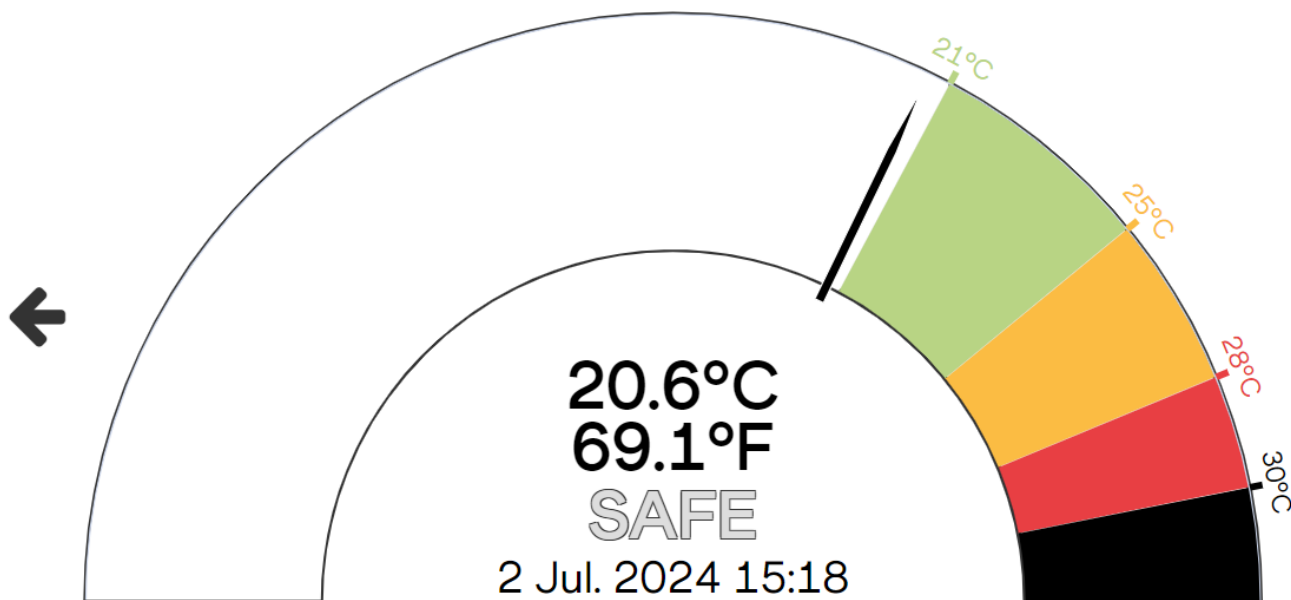
Good Fair Moderate Poor Very Poor Extremely Poor

WARSAW

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# Appendix

## HEAT STRESS INDEX WET BULB GLOBE TEMPERATURE



🌡️ Air Temperature **23.5 °C / 74.4 °F**  
💧 Relative Humidity **50.1 %**

Safe Caution Warning Severe Warning Danger

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An abstract graphic on a teal background. In the center is a black silhouette of a hand, palm facing left. From the hand, numerous black lines radiate outwards in various directions, creating a sunburst or starburst effect. The lines vary in length and thickness, some extending towards the edges of the frame. The overall composition is dynamic and modern.

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