THE 5- YEAR TREND OF PM_1 AND $PM_{2.5}$ MASS CONCENTRATIONS AND THEIR CARBON CONTENT AT AN URBAN BACKGROUND SITE IN ZAGREB. CROATIA

Ranka Godec, Martina Šilović Hujić, Valentina Gluščić, Gordana Pehnec

Institute for Medical Research and Occupational Health,
Division of Environmental Hygiene,
Ksaverska c. 2. Zagreb. Croatia

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

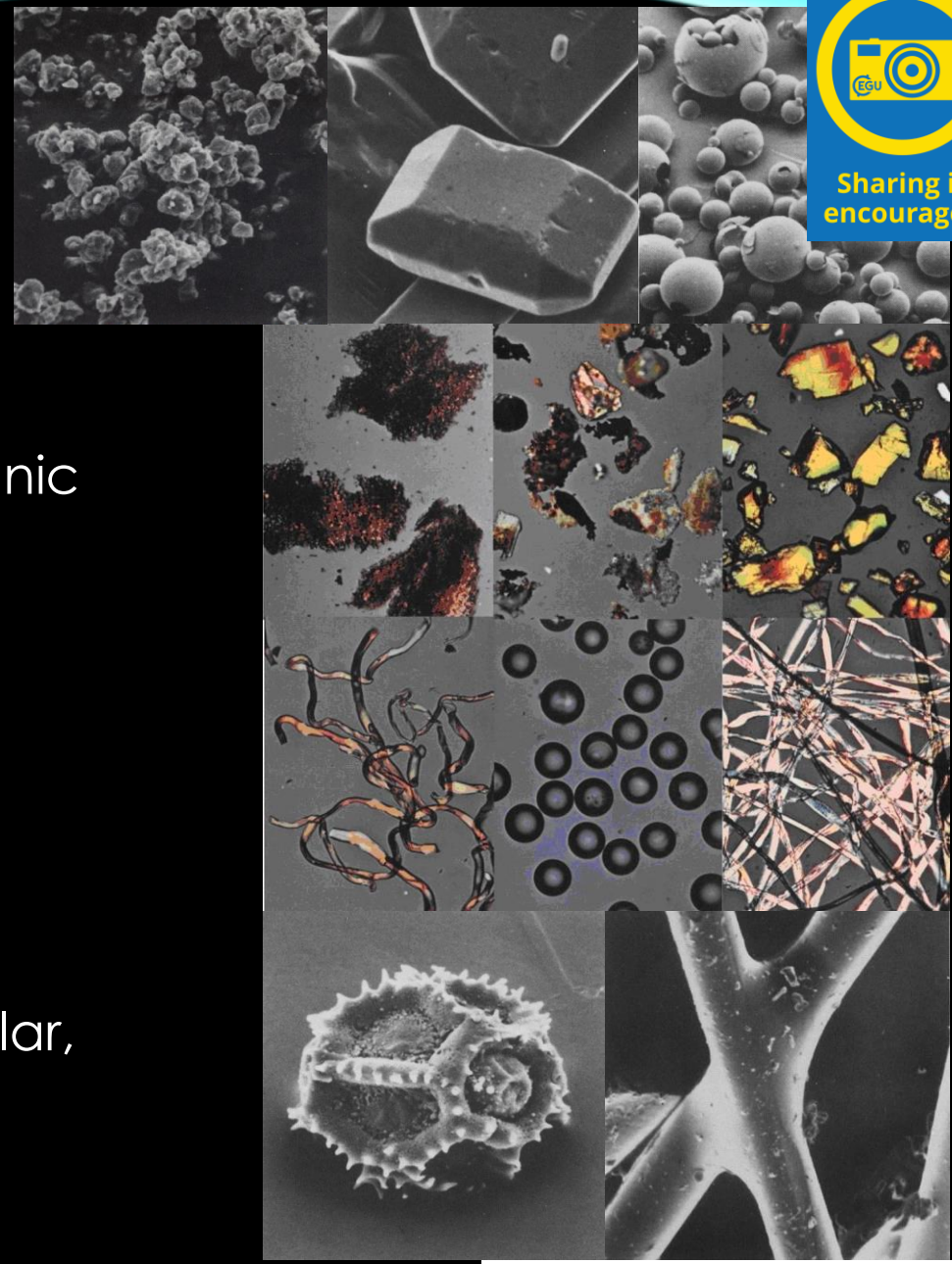
CONTENT

- Introduction and purpose of this work
- Experimental part
- Results
- Conclusions

EnvironPollutHealth
Funded by the European Union NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

INTRODUCTION



- **Particulate matter:**
  - one of the major air pollutants;
  - contains a large number of organic and inorganic compounds.

- **Sources of particulate matter**:
  - natural
  - anthropogenic

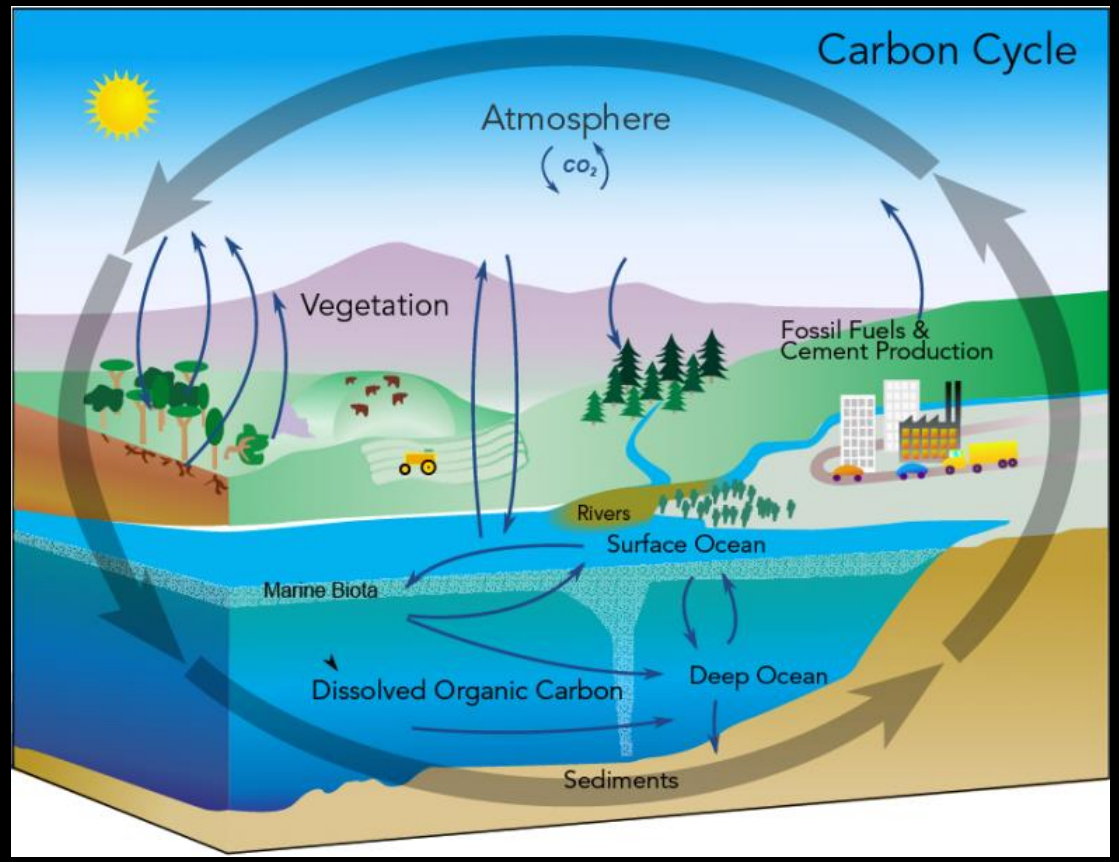
- **Harmful effects of particulate matter**:
  - on the environment
  - on human health (the respiratory, cardiovascular, nervous system)

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

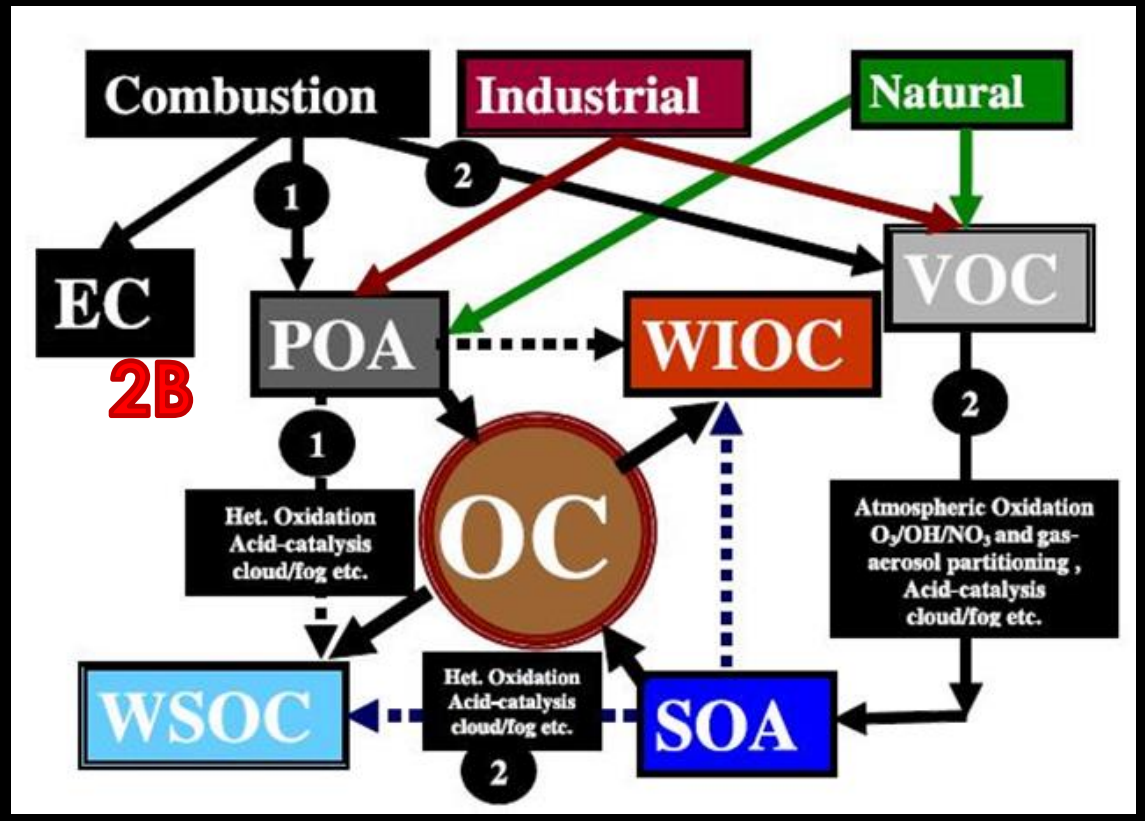
R. Godec et al.. IMROH

ReC-IMI
European Union
European Structural and Investment Funds

INTRODUCTION



The carbon cycle (Source: Let's Talk Science, Derivative work: FischX [Public domain] via Wikimedia Commons)



R.K. Pathak, T. Wang, K.F. Ho i S.C. Lee. Characteristics of summertime $PM_{2.5}$ organic and elemental carbon in four major Chinese cities: Implications of high acidity for water-soluble organic carbon (WSOC). Atmos. Environ. 45 (2011) 318-325

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

INTRODUCTION

Primary sources

natural

- volcanic eruptions
- forest fires
- located in the loess, sand, fossil and ice cores
- photochemical oxidation of gaseous organic precursors
- emissions plant spores and pollen

anthropogenic

- incomplete combustion of fossil and biomass fuels
- traffic exhaust fumes from motor vehicles
- tobacco smoke, households
- biomass burning, burning farmland
- industrial processes (factories. power plants, waste incinerators, constructions)

Secondary sources

- conversion of gaseous pollutants in the air
- photochemical oxidation of gaseous organic precursors

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

THE PURPOSE OF THIS STUDY

- to determine levels of:
  - particle matter (PM)
  - elemental carbon (EC)
  - organic carbon (OC)
  - total carbon (TC)
  - as well as the black smoke index (IBS) in PM_1 and $PM_{2.5}$ particle fraction
- compare levels of all measured pollutants between days, seasons and years
- establish the existence of a trend for individual pollutants in the PM
- at one urban background location in Zagreb during the 5-years period

EnvironPollutHealth
Funded by the European Union NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

EXPERIMENTAL PART

- sampling station was located in the northern. residential part of Zagreb, with sampling inlets 2 m above the ground
- moderate traffic and household appliances
- defined as an urban background monitoring station
- $PM_{2.5}$ and PM_1

maps.google.com

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

EXPERIMENTAL PART

- **SAMPLE COLLECTION:**
- PM_1
- sequential reference device Sven Leckel sequential sampler SEQ47/50
- January 1st 2018 till December 31st 2022
- 55 m^3 of air per day

- **PREPARATION OF FILTERS:**
- filter diameter: 47 mm (PALLFLEX TISSUEQUARTZ 2500QAT-UP)
- pre-fired during 3h at 850 °C in a furnace
- to reduce carbon content in filters before collecting PM
- plastic petri dishes – easy transport
- aluminium foil – freezer (until analysis)
- blank samples - the same procedure – one per 10-15 samples + same batch prefiring

- **DETERMINATION OF MASS CONCENTRATION OF PM IN THE AIR:**
- mass concentration of PM_1 fraction of particles were determined according to HRN EN 12341 (which is for PM_{10} and $PM_{2.5}$)
- filter conditioning and weighing was carried out under conditions of constant temperature (20 ± 1) °C and relative humidity (47.5 ± 2.5) %
- Mettler Toledo MX 5 AND XP6/M microbalances with resolution of 10^{-6} g and electrostatic charge outflows systems

EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

EXPERIMENTAL PART

- **Determination of EC. OC. TC. WSOC**
- Carbon Aerosol Analyzer (CAA. Sunset Laboratory. USA) for laboratories - He-Ne laser and FID - EUSAAR_2 protocol

- **Determination of IBS**
- Smokestain reflectometer EEL43M

EnvironPollutHealth
Funded by the European Union NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

RESULTS AND DISCUSSION

Statistical parameters for PM_1. $PM_{2.5}$ and carbon species concentrations during five years period

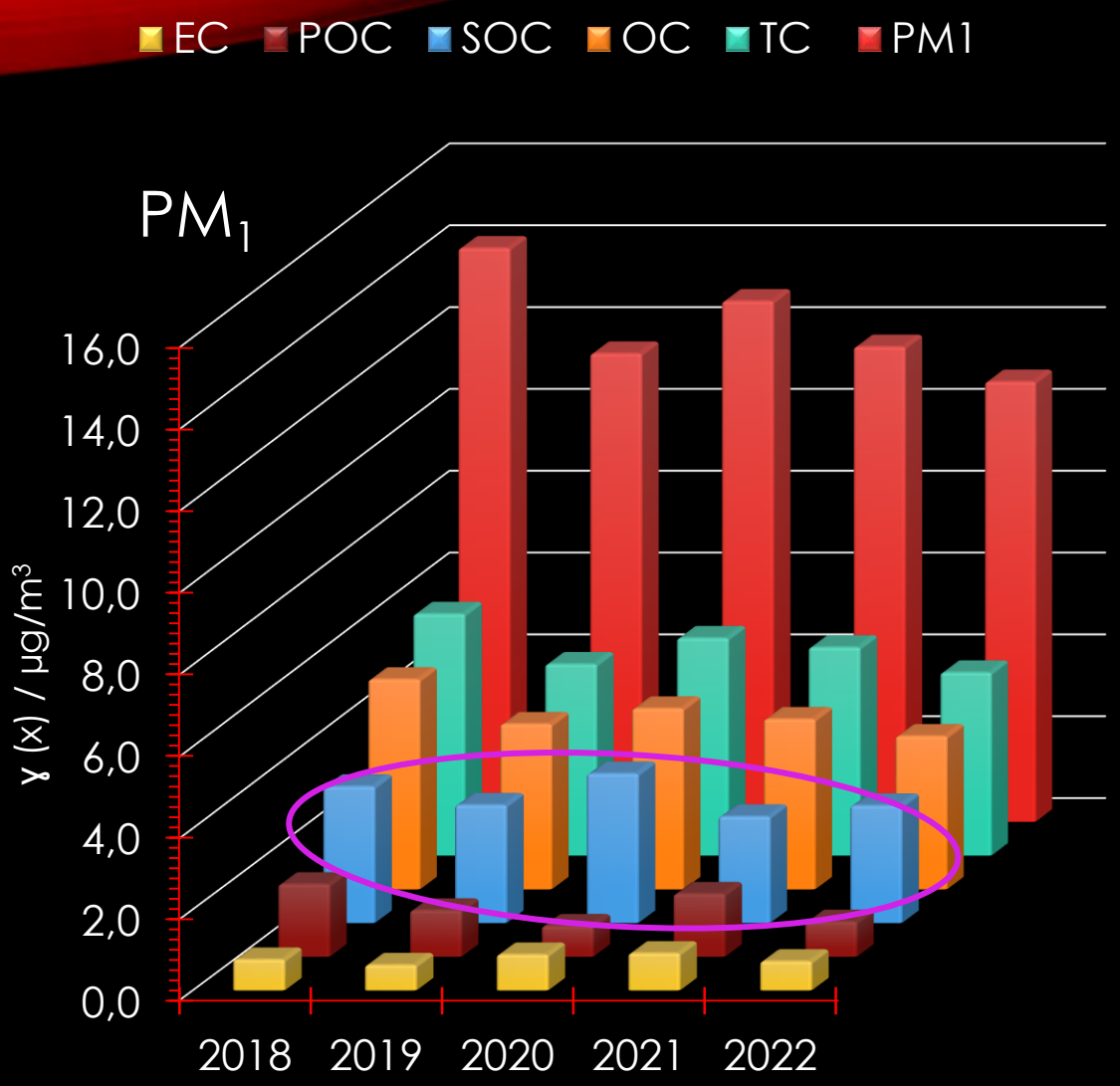
	PM_1	IBS	EC	POC	SOC	OC	TC	WSOC	LVG	$PM_{2.5}$	IBS	EC	POC	SOC	OC	TC
N	1814	1449	1814	1809	1809	1814	1814	1451	1451	1818	1821	1818	1813	1813	1818	1818
$\bar{x}$	12.12	2.09	0.79	1.29	3.04	4.32	5.10	2.04	0.53	16.14	2.25	0.94	1.67	3.85	5.51	6.45
σ_x	8.86	1.21	0.68	1.22	2.50	3.18	3.71	1.62	0.79	11.78	1.34	0.77	1.49	3.41	4.34	4.92
x_{max}	69.28	7.63	6.93	10.35	22.04	24.78	27.94	13.53	5.99	85.88	1.23	0.41	0.71	1.79	2.78	3.26

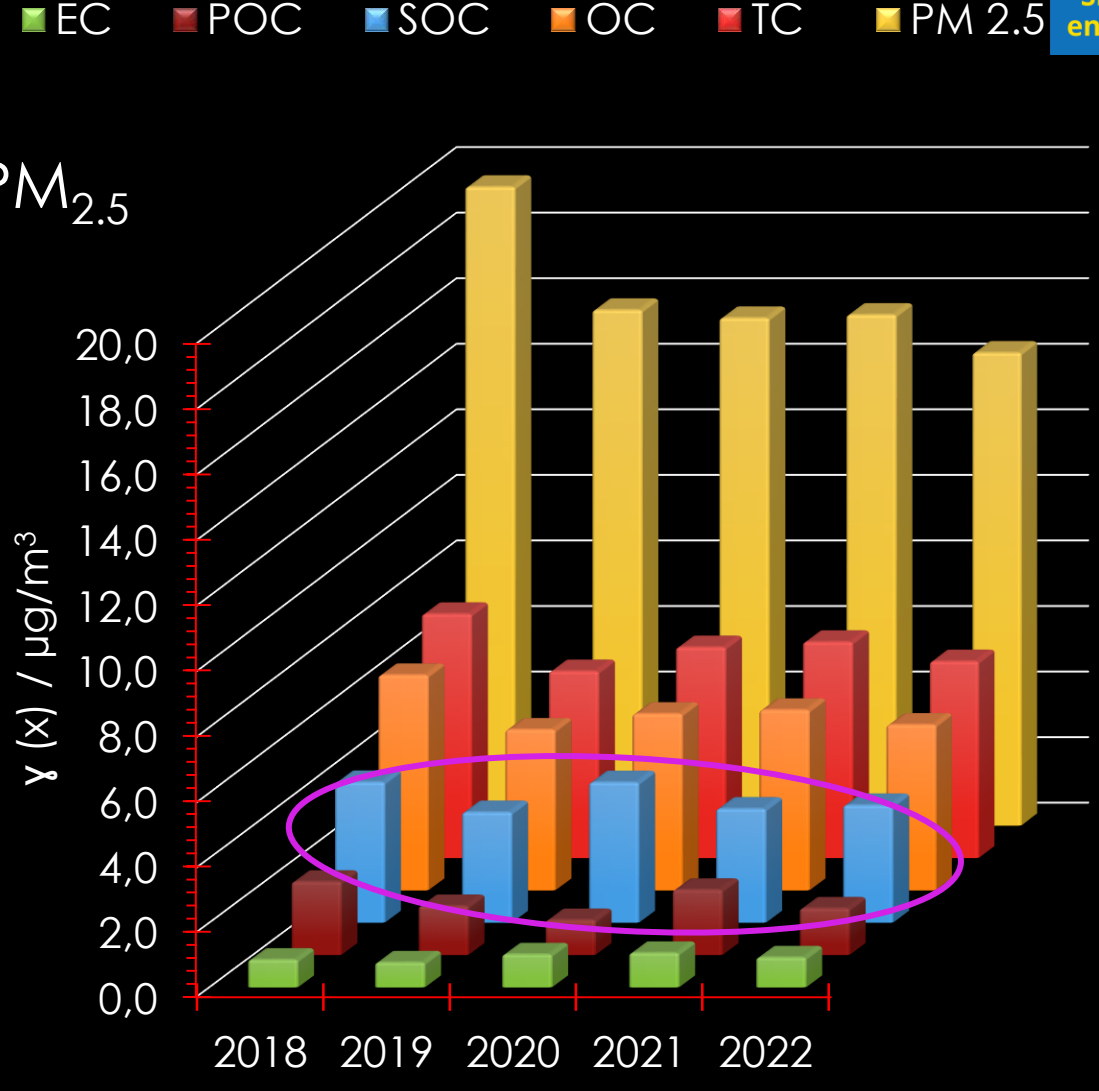
N - number of samples. - average. σ_x – standard deviation. x_{min} – minimum measured value. x_{max} – maximum measured value

only 12 days missing data

only 8 days missing data

YEARLY TRENDS





Sharing is encouraged

EnvironPollutHealth

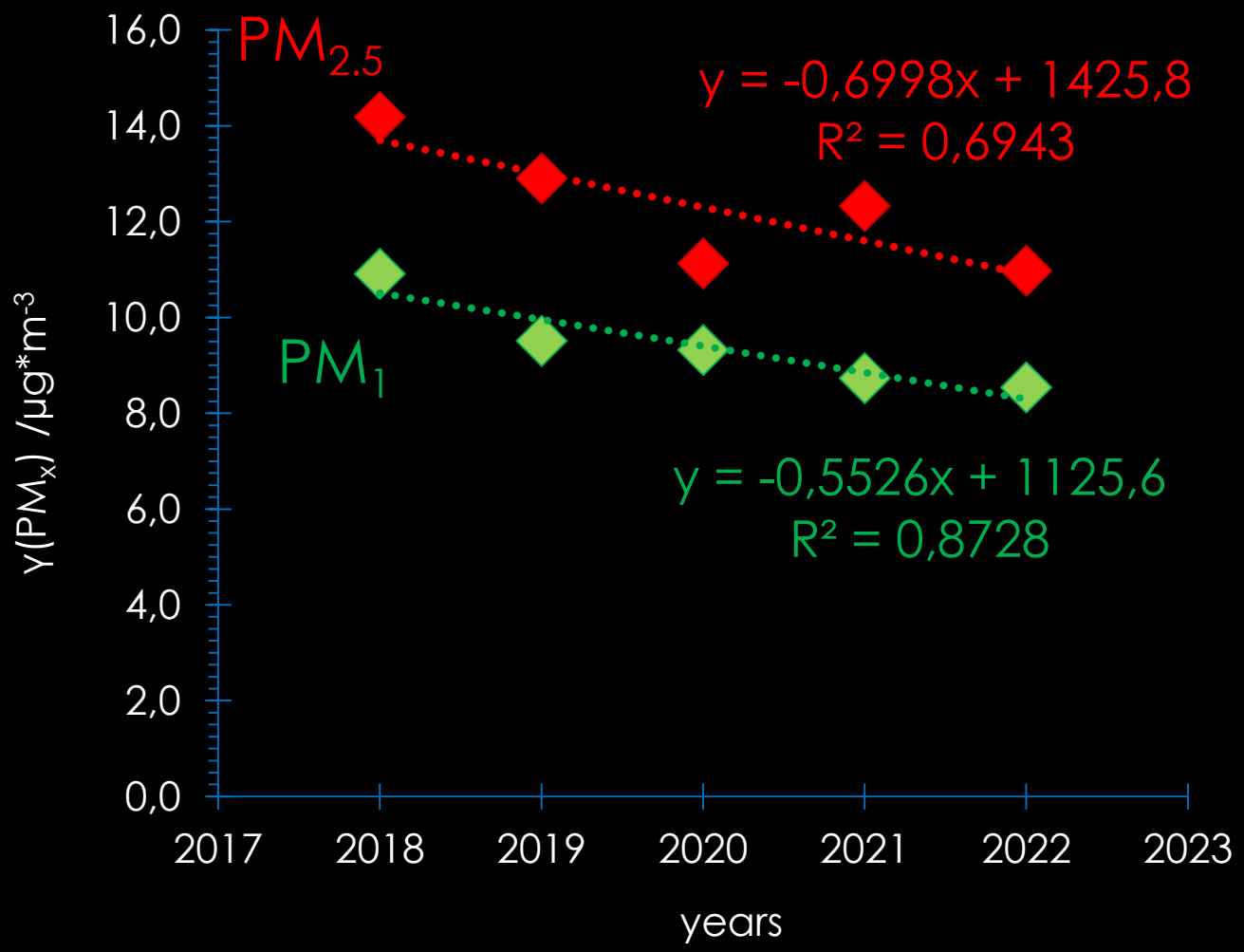
Funded by the European Union NextGenerationEU

R. Godec et al.. IMROH

ReC-IMI

European Union
European Structural and Investment Funds

YEARLY TREND



5-years trend of the PM medians

EnvironPollutHealth
Funded by the European Union NextGenerationEU
R. Godec et al.. IMROH
ReC-IMI
European Union European Structural and Investment Funds

STATISTICAL SIGNIFICANT DIFFERENCE BETWEEN YEARS

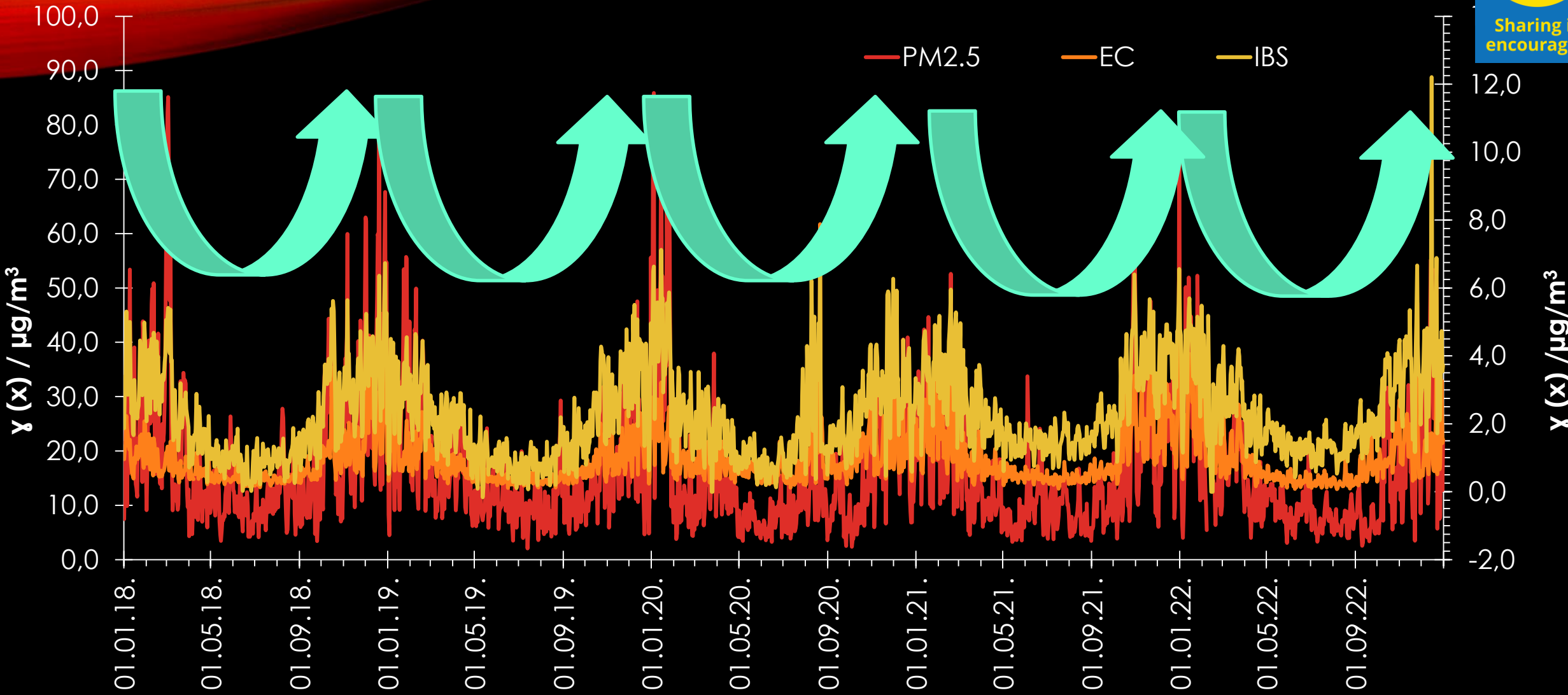
Sharing is encouraged

GODINA	2018/2019	2018/2020	2018/2021	2018/2022	2019/2020	2019/2021	2019/2022	2020/2021	2020/2022	2021/2022
$PM_{2.5}$	+	+	+	+						
OC	+	+	+	+		+				
EC		+	+		+	+	+			+
SOC	+		+	+	+			+	+	
POC	+	+		+	+	+		+	+	+
TC	+	+	+	+	+	+				
PM_1	+	+	+	+					+	
OC	+	+	+	+					+	+
EC	+	+	+		+	+	+		+	+
SOC	+		+	+	+			+	+	+
POC	+	+	+	+	+	+	+	+	+	
TC	+		+	+	+				+	+

EnvironPollutHealth
Funded by the European Union NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

DAILY DISTRIBUTION

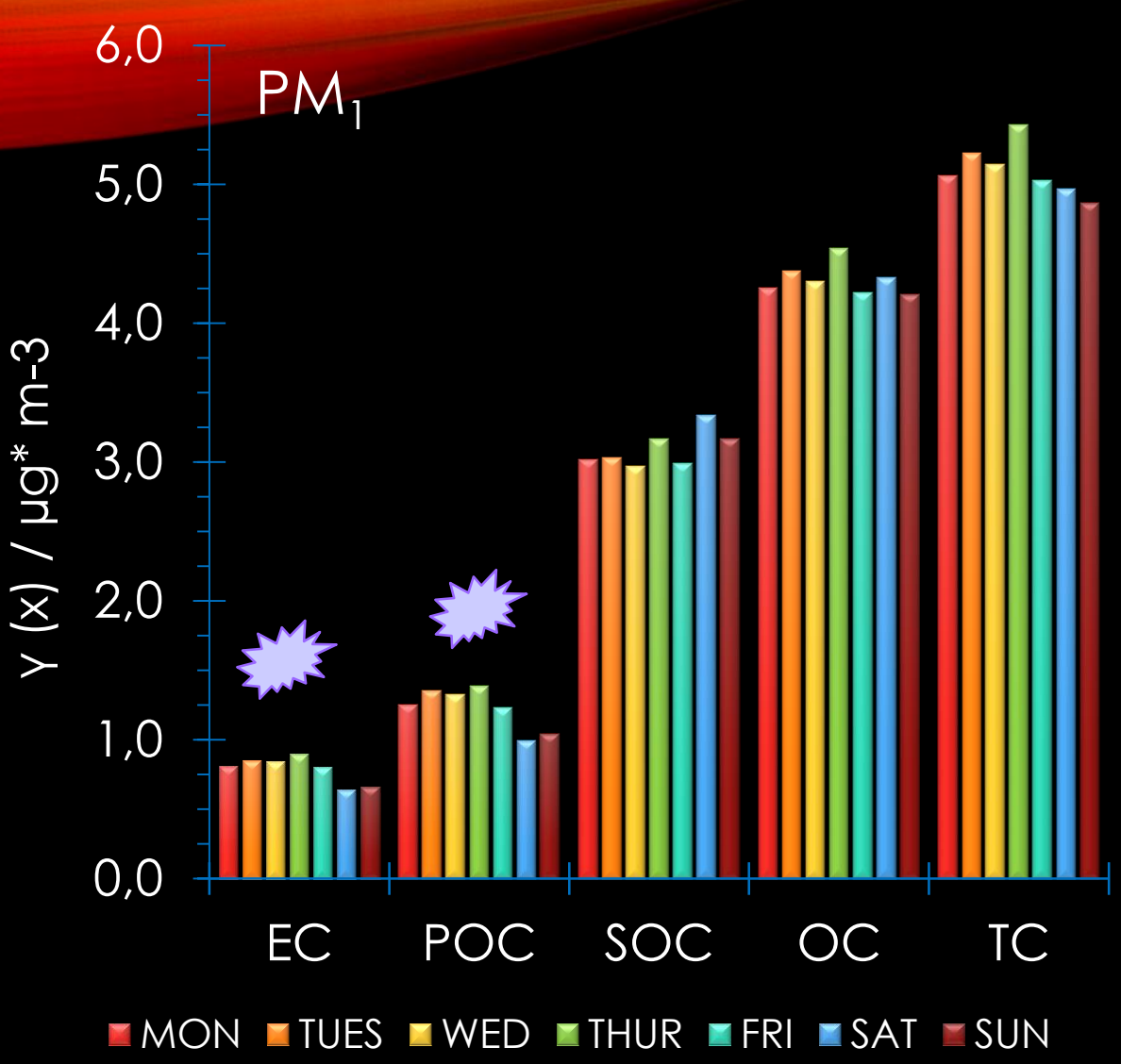


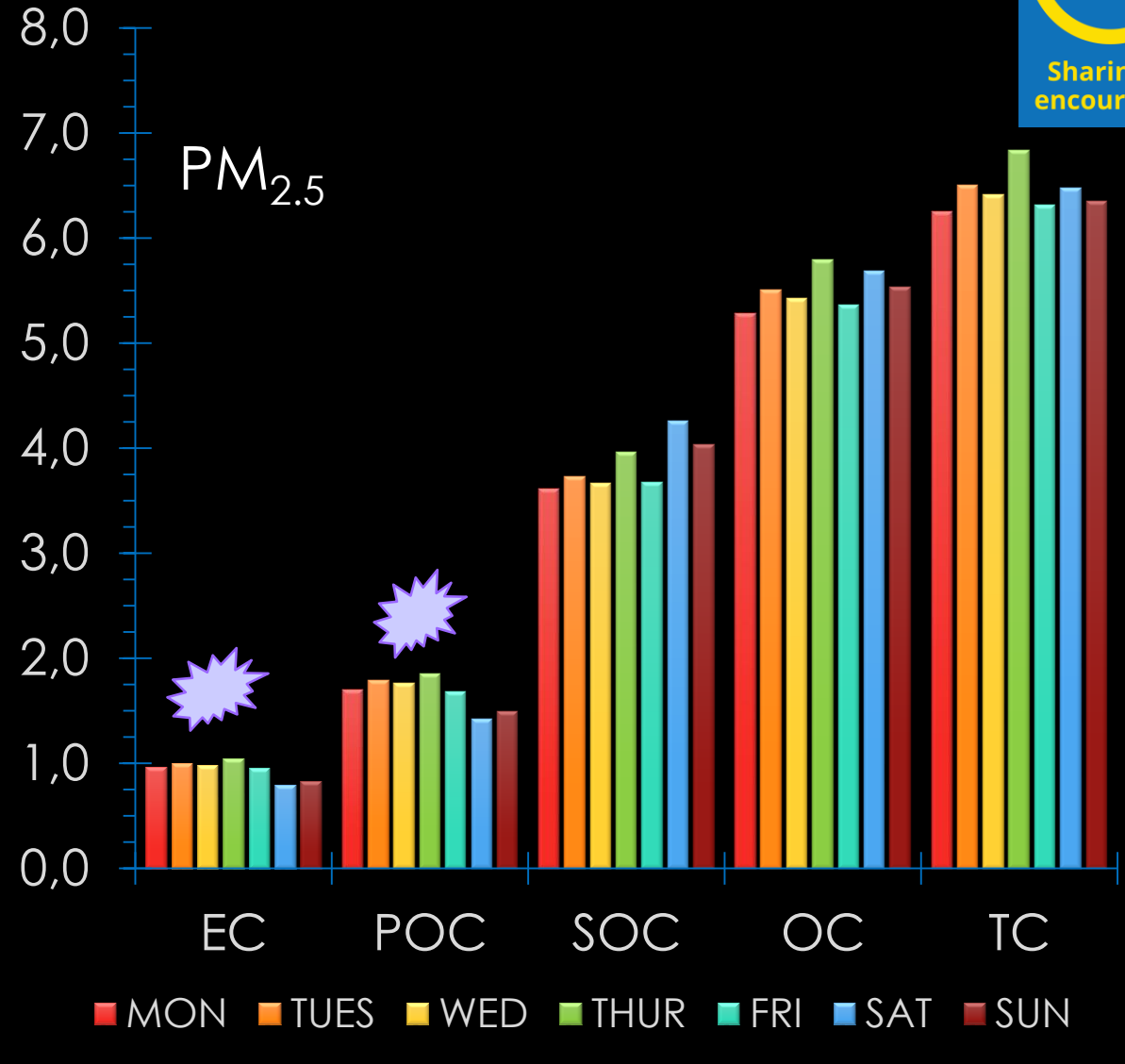
EnvironPollutHealth
Funded by the European Union
NextGenerationEU

R. Godec et al.. IMROH

ReC-IMI
European Union
European Structural and Investment Funds

DAILY DISTRIBUTION



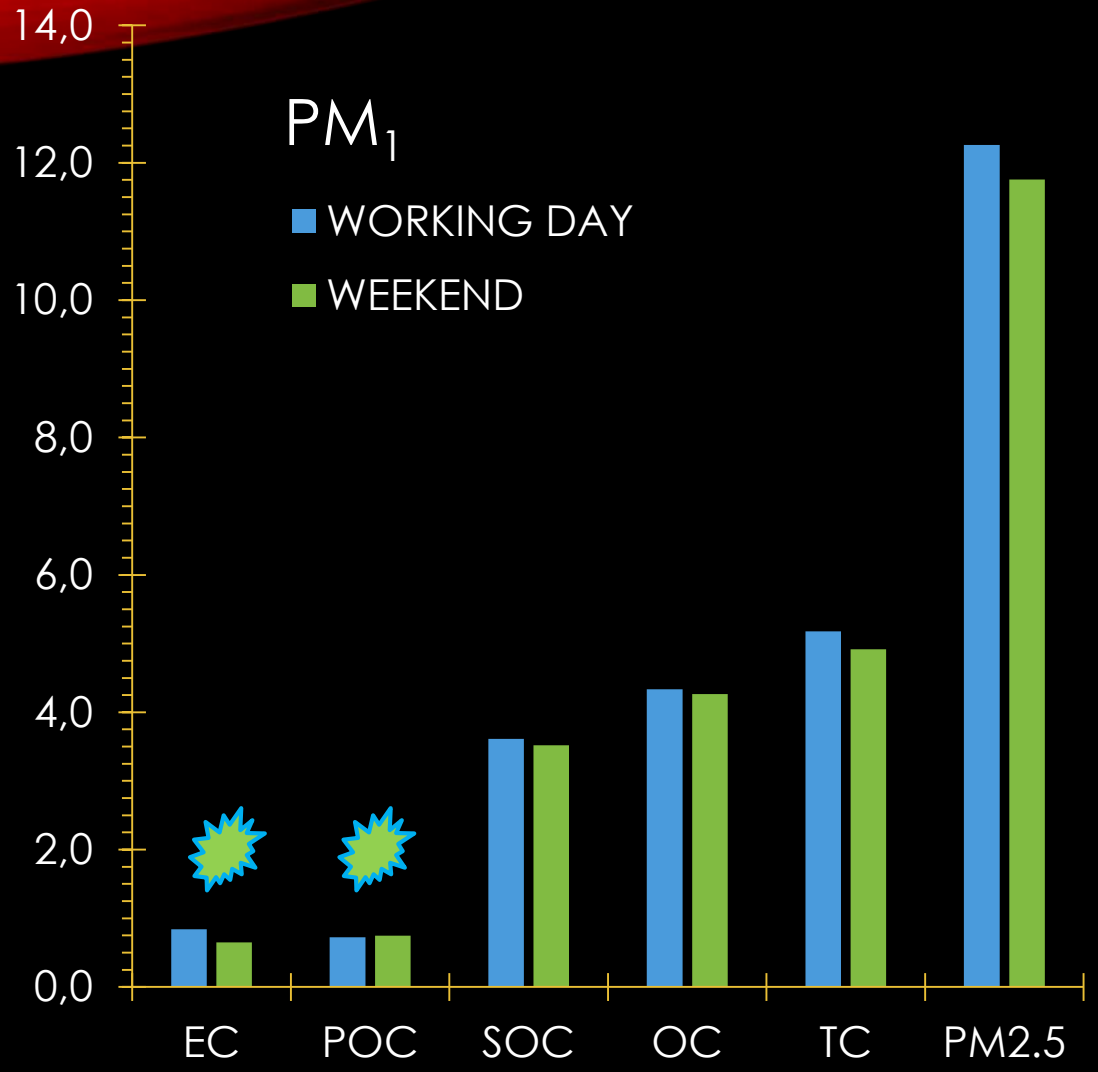


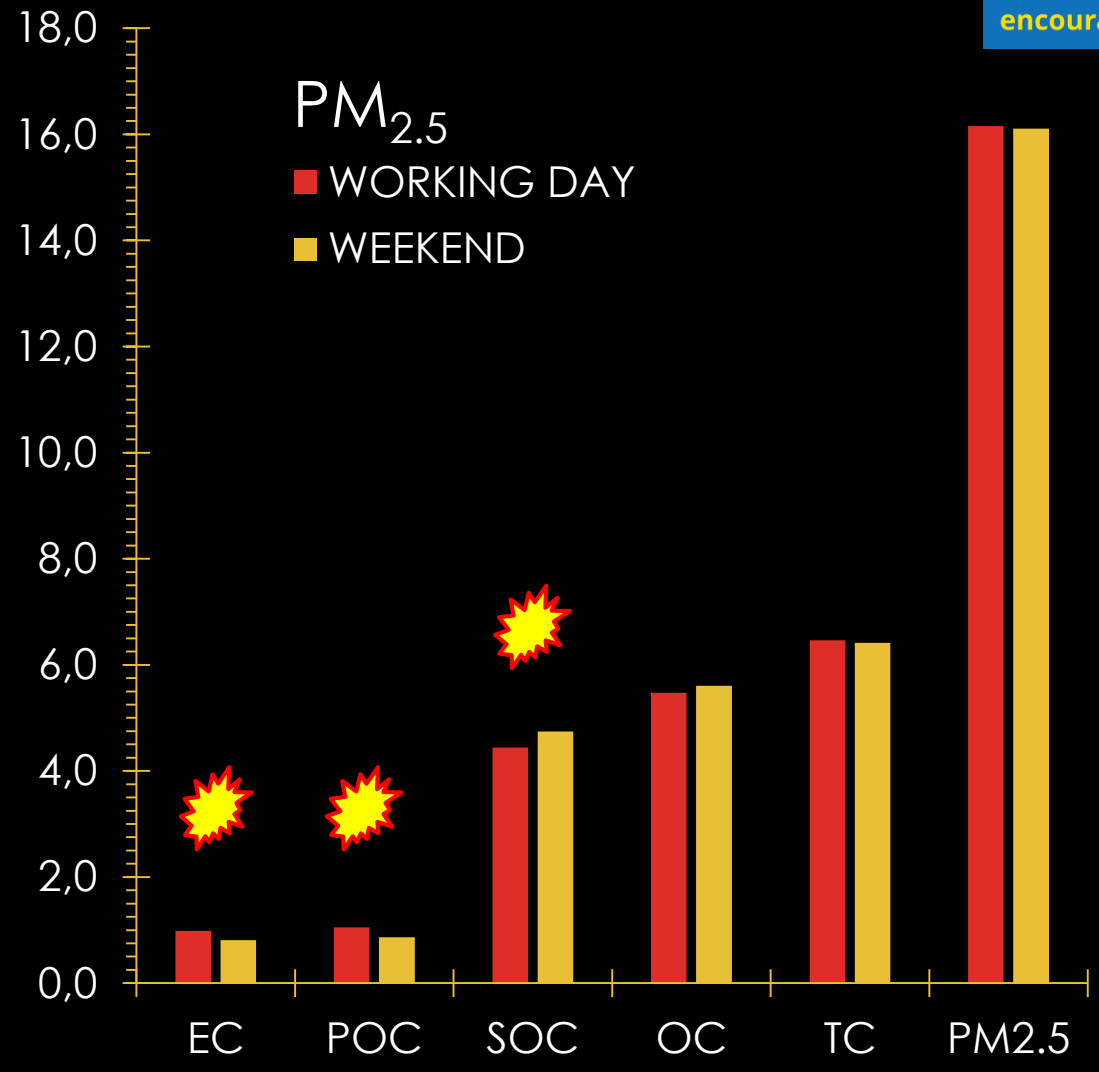
EnvironPollutHealth
Funded by the European Union
NextGenerationEU

R. Godec et al.. IMROH

ReC-IMI
European Union
European Structural and Investment Funds

WORKING DAY/WEEKEND



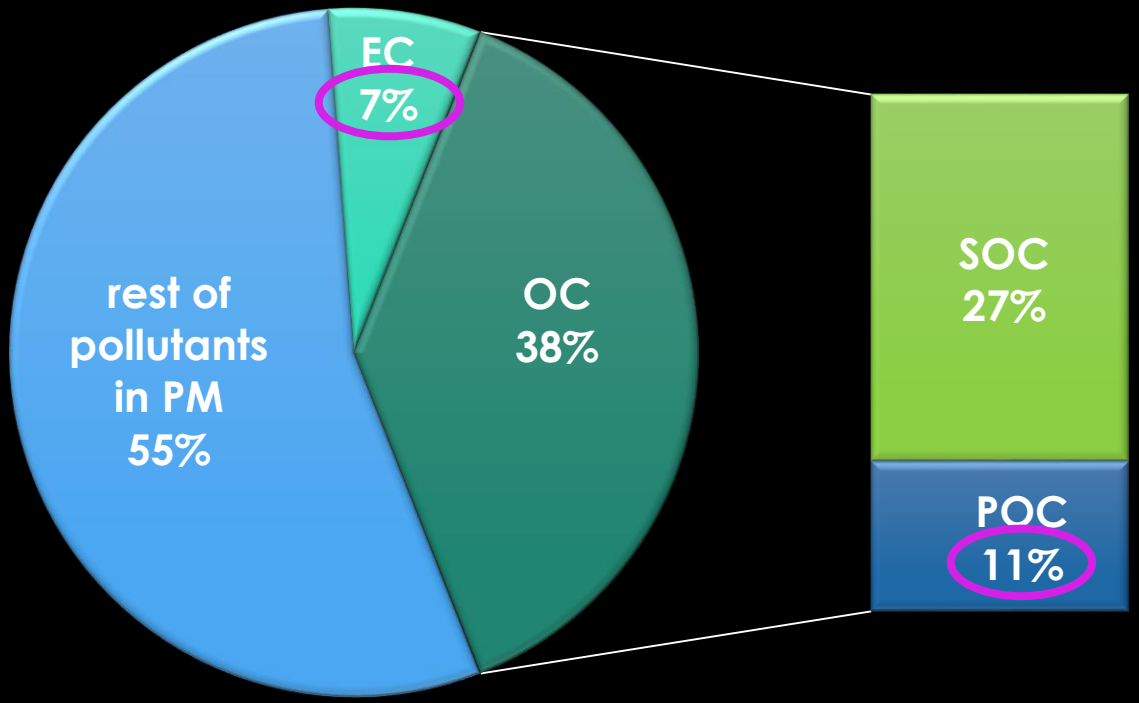


EnvironPollutHealth
Funded by the European Union
NextGenerationEU

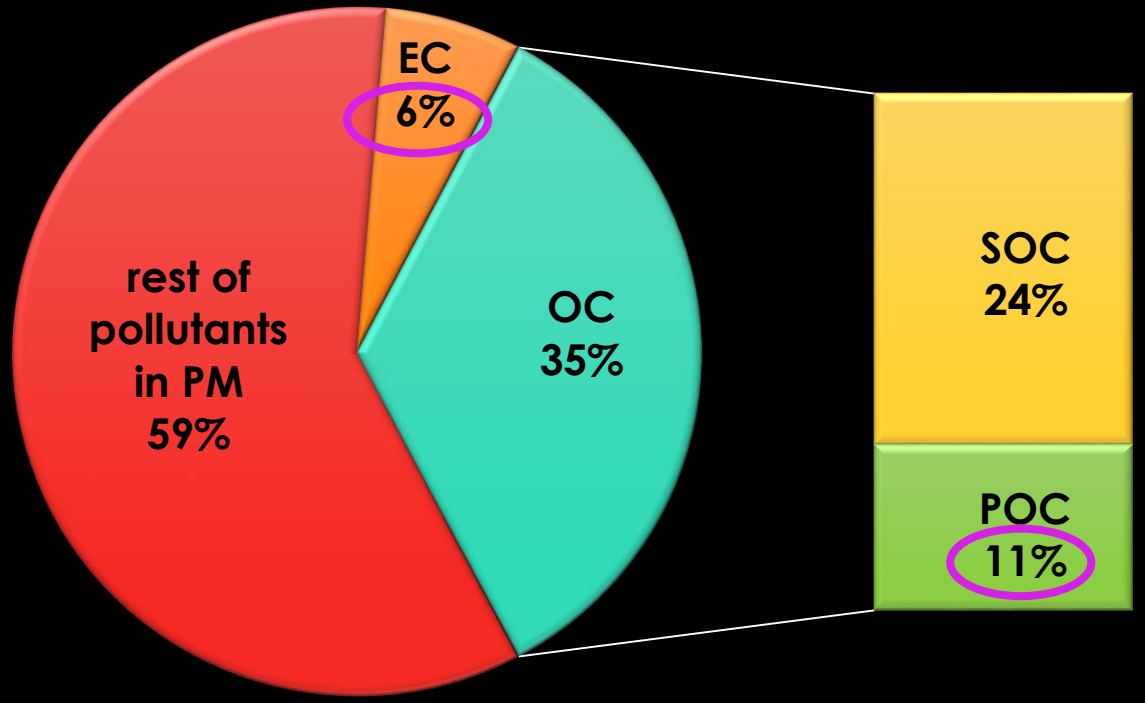
ReC-IMI
European Union
European Structural and Investment Funds

CONTENT OF PM

PM_1



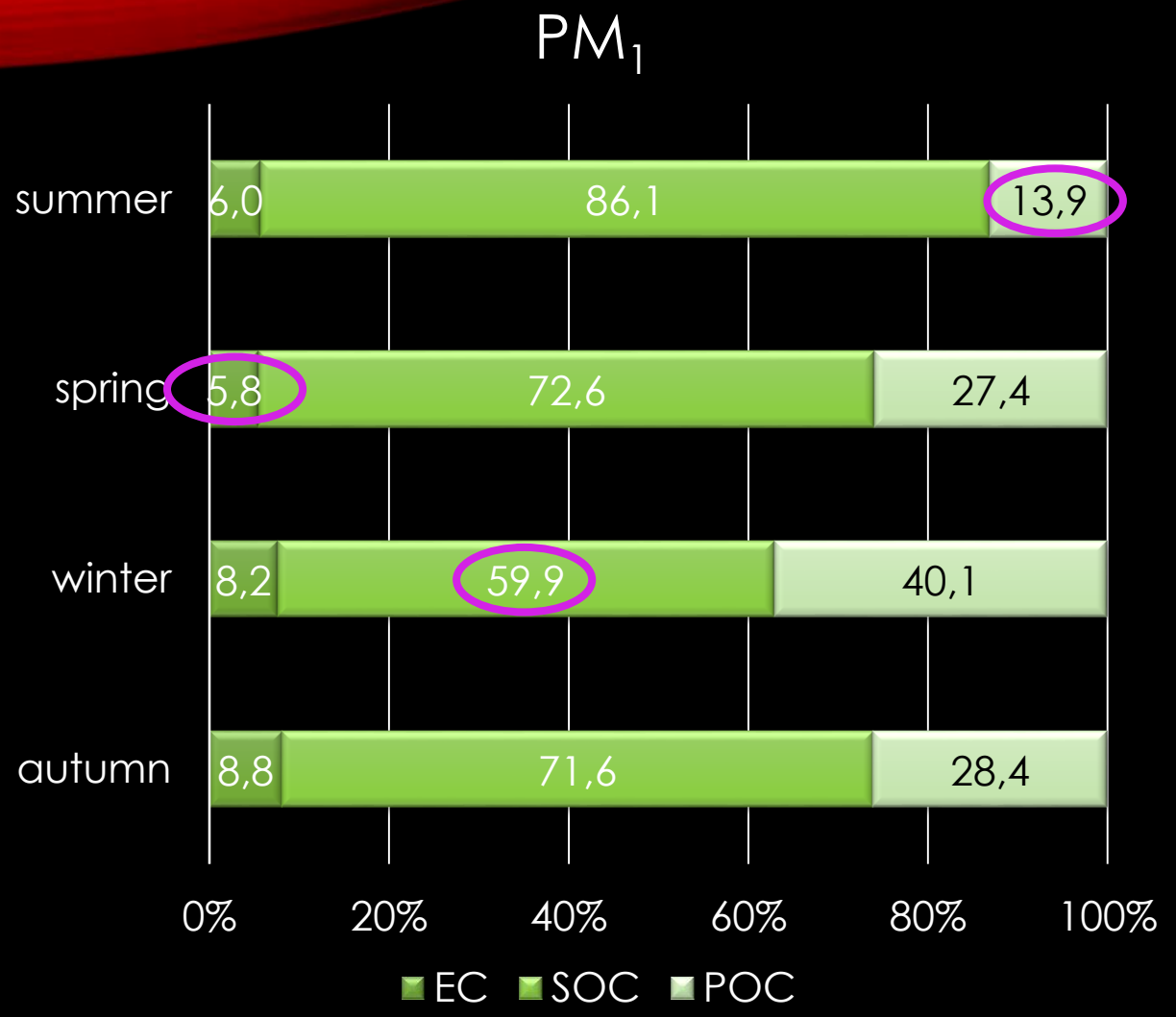
$PM_{2.5}$

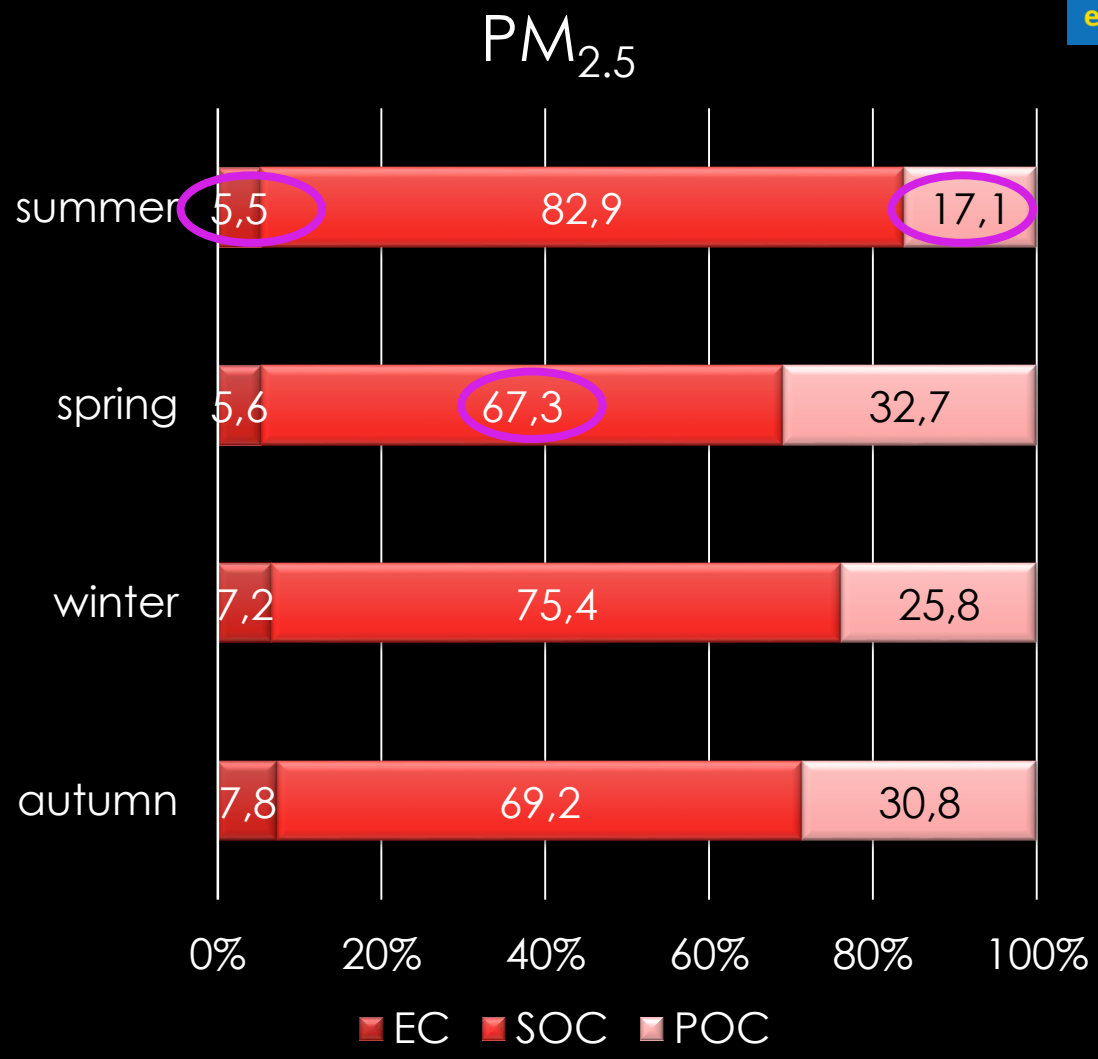


EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

CONTENT OF TC

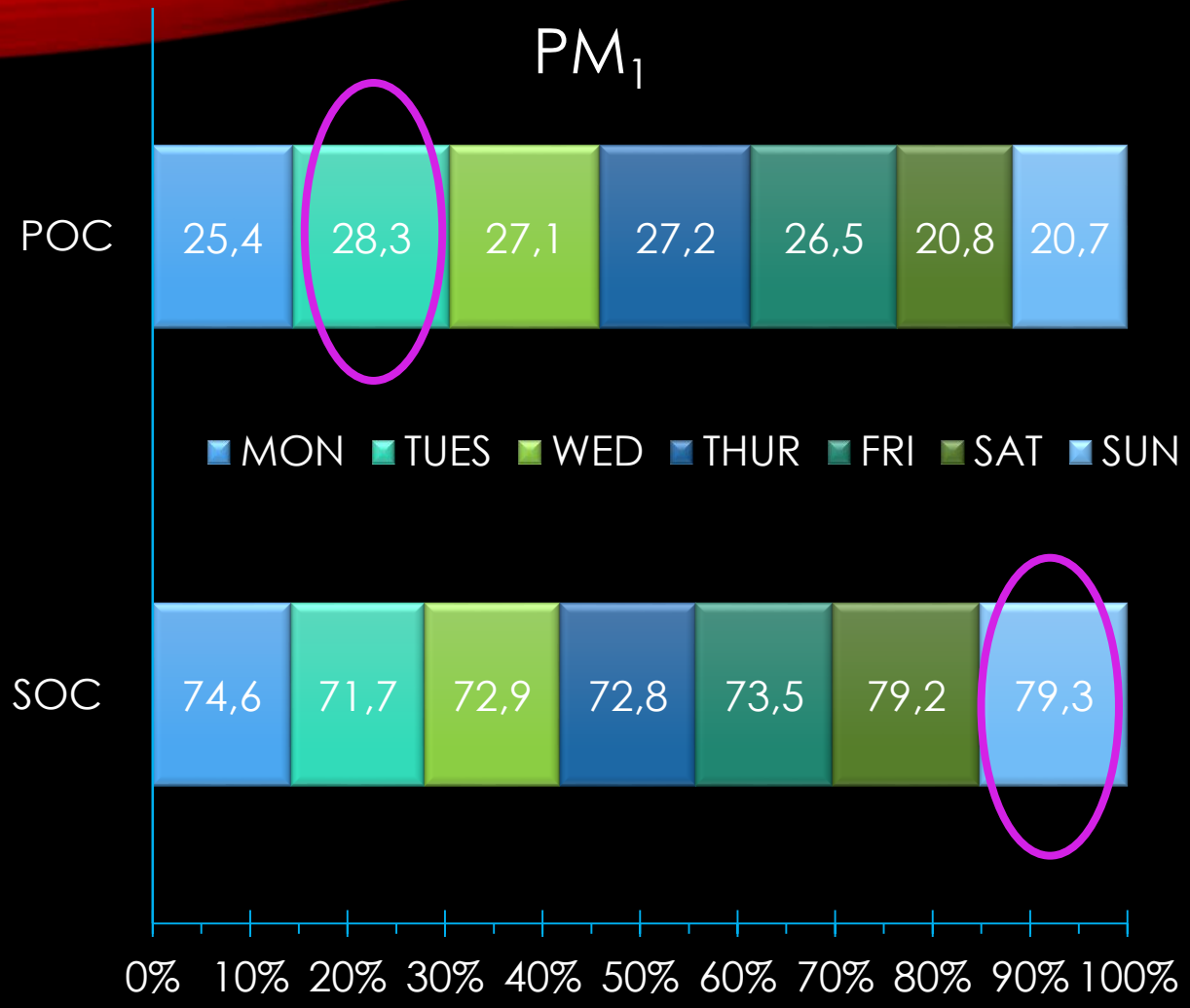


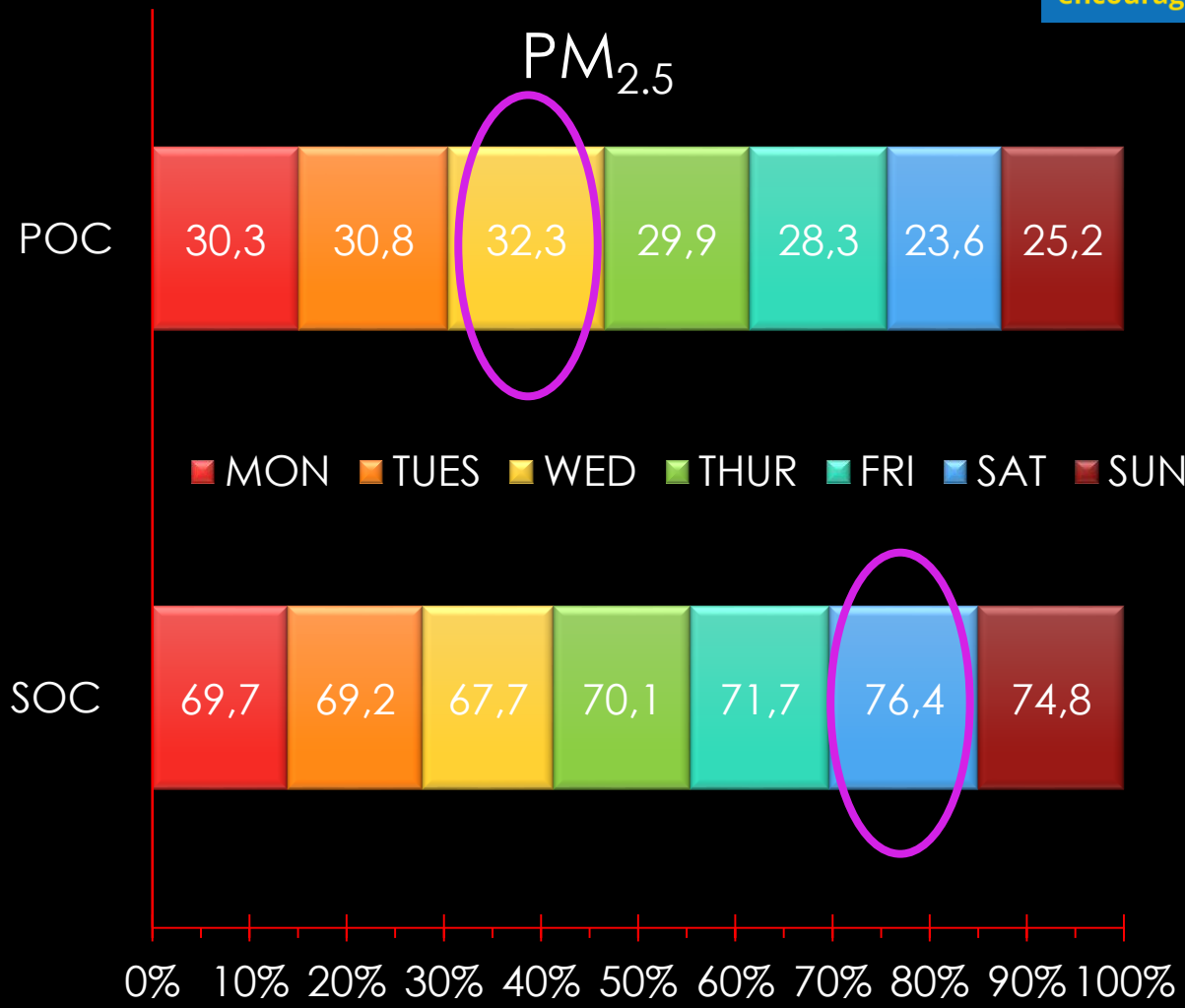


EnvironPollutHealth
Funded by the European Union
NextGenerationEU

ReC-IMI
European Union
European Structural and Investment Funds

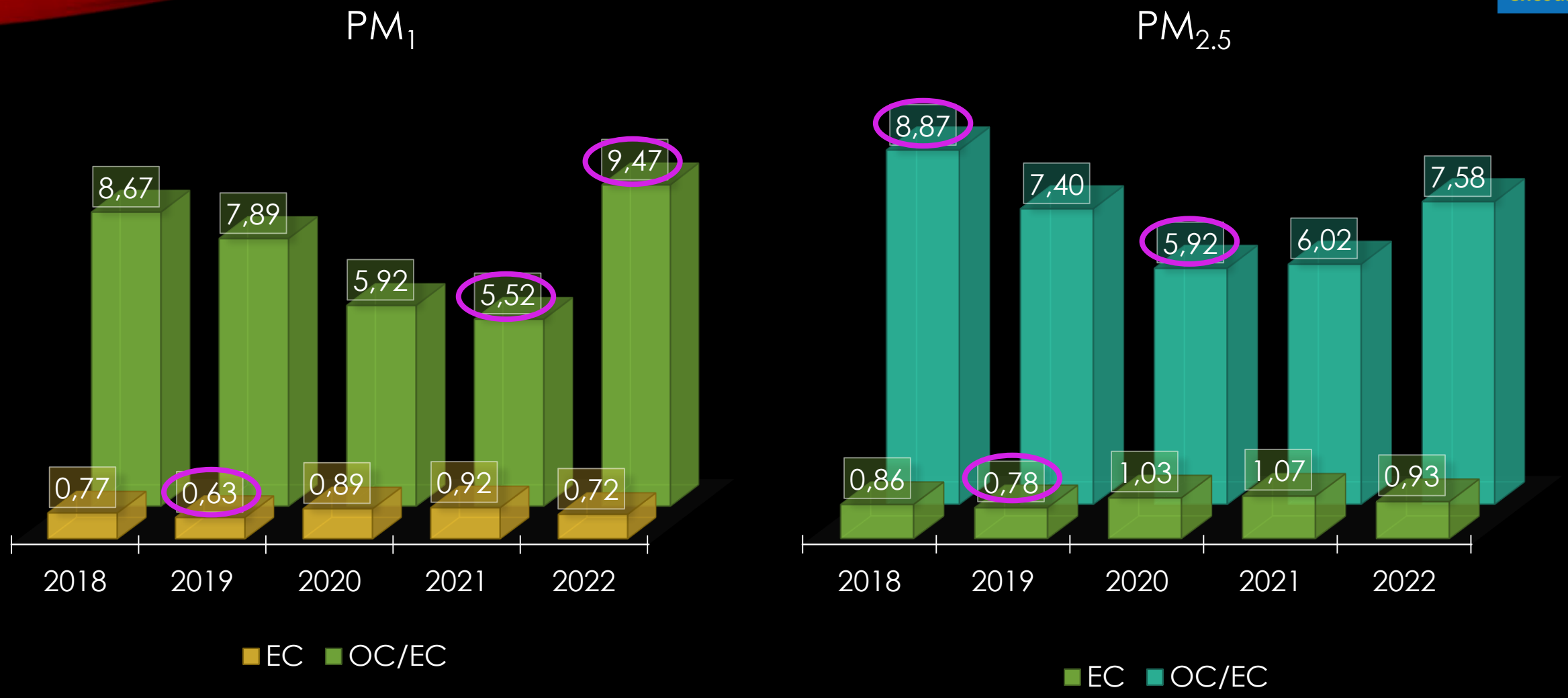
CONTENT OF OC





EnvironPollutHealth
Funded by the European Union NextGenerationEU
R. Godec et al.. IMROH
ReC-IMI
European Union European Structural and Investment Funds

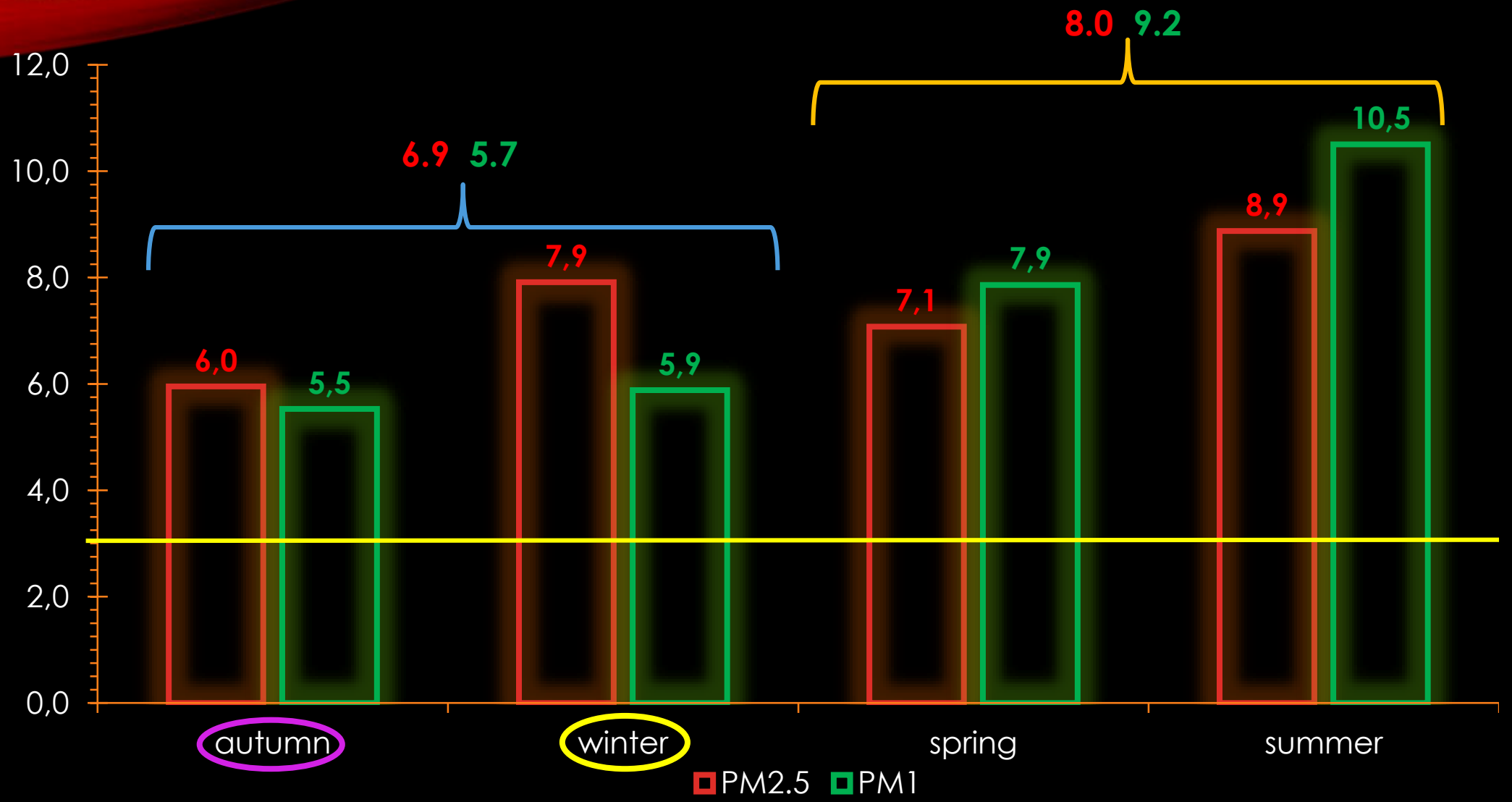
OC/EC RATIO



EnvironPollutHealth
Funded by the European Union NextGenerationEU

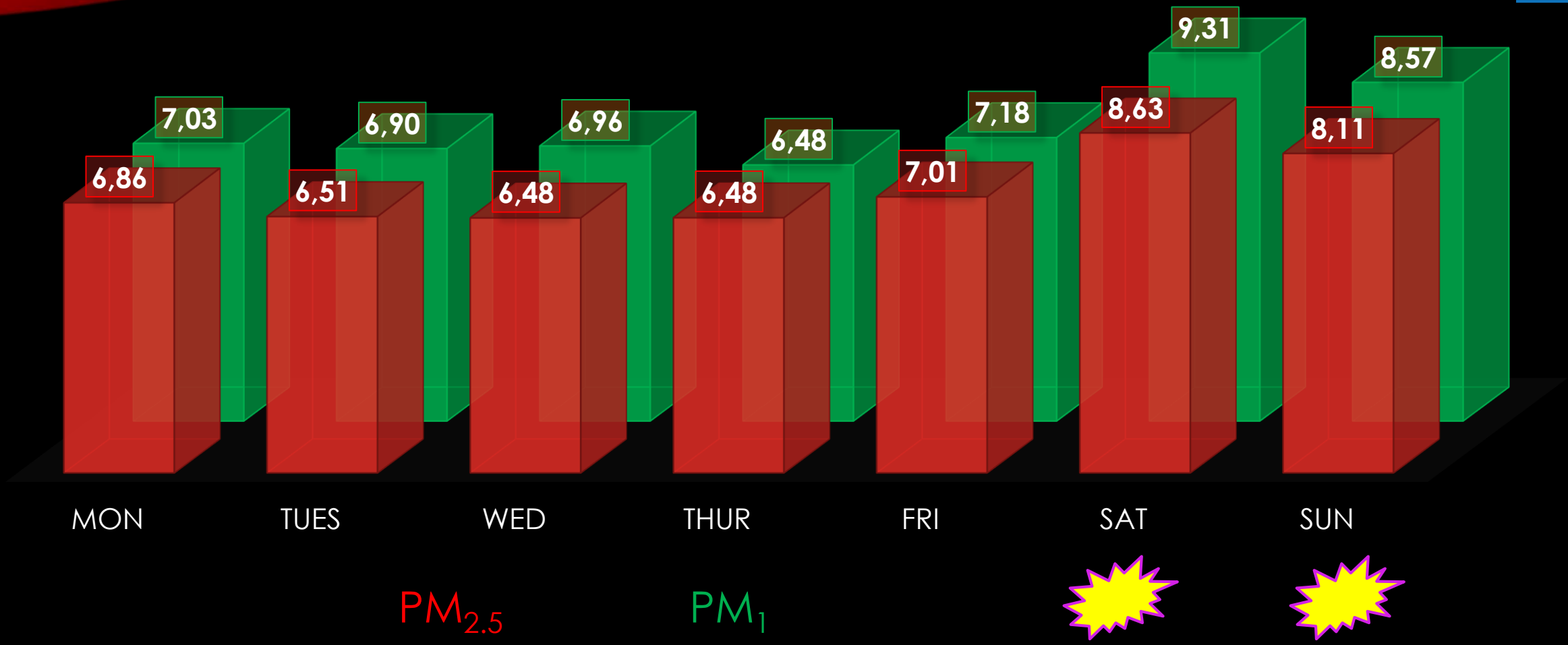
ReC-IMI
European Union
European Structural and Investment Funds

OC/EC RATIO



EnvironPollutHealth
Funded by the European Union NextGenerationEU
R. Godec et al.. IMROH
ReC-IMI
European Union European Structural and Investment Funds

OC/EC RATIO



Sharing is encouraged

EnvironPollutHealth
Funded by the European Union NextGenerationEU
R. Godec et al.. IMROH
ReC-IMI
European Union European Structural and Investment Funds

CONCLUSIONS

Measurements showed:

- ✓ slightly downward trend for all pollutants, except SOC in both PM
- ✓ seasonal variations of mass concentrations for carbon species in PM - the higher conc. were observed during the cold periods of the year, while lower conc. were recorded during the warmer period
- ✓ no significant statistical difference between days in week or working/weekend days except EC and POC
- ✓ similar PM content during long period of measurement for both PM fractions
- ✓ different content of TC during the seasons for different PM fractions
- ✓ different POC and SOC content of OC during each day of the week
- ✓ POC content: ↑TUE and ↓SUN in PM_1, while in $PM_{2.5}$ ↑WED and ↓SAT
- ✓ different sequence for OC/EC ratio - PM_1: 2021 < 2020 < 2019 < 2018 < 2022 while $PM_{2.5}$: 2020 < 2021 < 2019 < 2022 < 2018
- ✓ OC/EC ratio higher the 3 ➔ presence of SOC
- ✓ statistically significant difference between working and weekend days for OC/EC ratio in both PM

EnvironPollutHealth
Funded by the European Union NextGenerationEU

ReC-IMI
European Union European Structural and Investment Funds

✓These measurements were conducted within the internal scientific project of the Institute for Medical Research and Occupational Health "**Organic content of PM_1 particle fraction**" (PI: R. Godec).

✓The results of this research were obtained using the facilities and equipment funded within the European Regional Development Fund project KK.01.1.1.02.0007 "**Research and Education Centre of Environmental Health and Radiation Protection – Reconstruction and Expansion of the Institute for Medical Research and Occupational Health**", and funded by the European Union – Next Generation EU (Program Contract of 8 December 2023, Class: 643-02/23-01/00016, Reg. no. 533-03-23-0006)-**EnvironPollutHealth**.

THANK YOU FOR YOUR ATTENTION

Sharing is encouraged

EnvironPollutHealth
Funded by the European Union NextGenerationEU

R. Godec et al.. IMROH

ReC-IMI
European Union
European Structural and Investment Funds