Screening of BTEX in the metropolitan area of Porto

T. Nunes, V. Nogueira, M. J. Matos, C. Pio, C. Borrego

tnunes@ua.pt

CESAM
Centro de Estudos do Ambiente e do Mar
www.cesam.ua.pt

universidade de aveiro

CLICURB - Urban Atmospheric Quality, Climate Change and Resilience

CLICURB

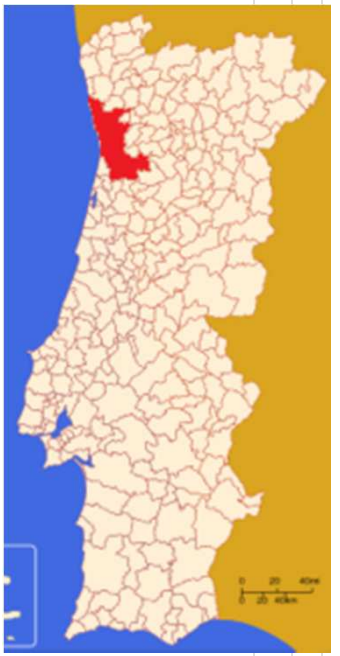
Screening of BTEX in the metropolitan area of Porto

CLICURB project - Urban Atmospheric Quality, Climate Change and Resilience

Objectives

To bridge the gap between global CC trends and urban development considering the inclusion of adaptation strategies on planning and decision making process. In detail it intends to assess the impact of future climate on urban areas, using as case study the Porto urban area.

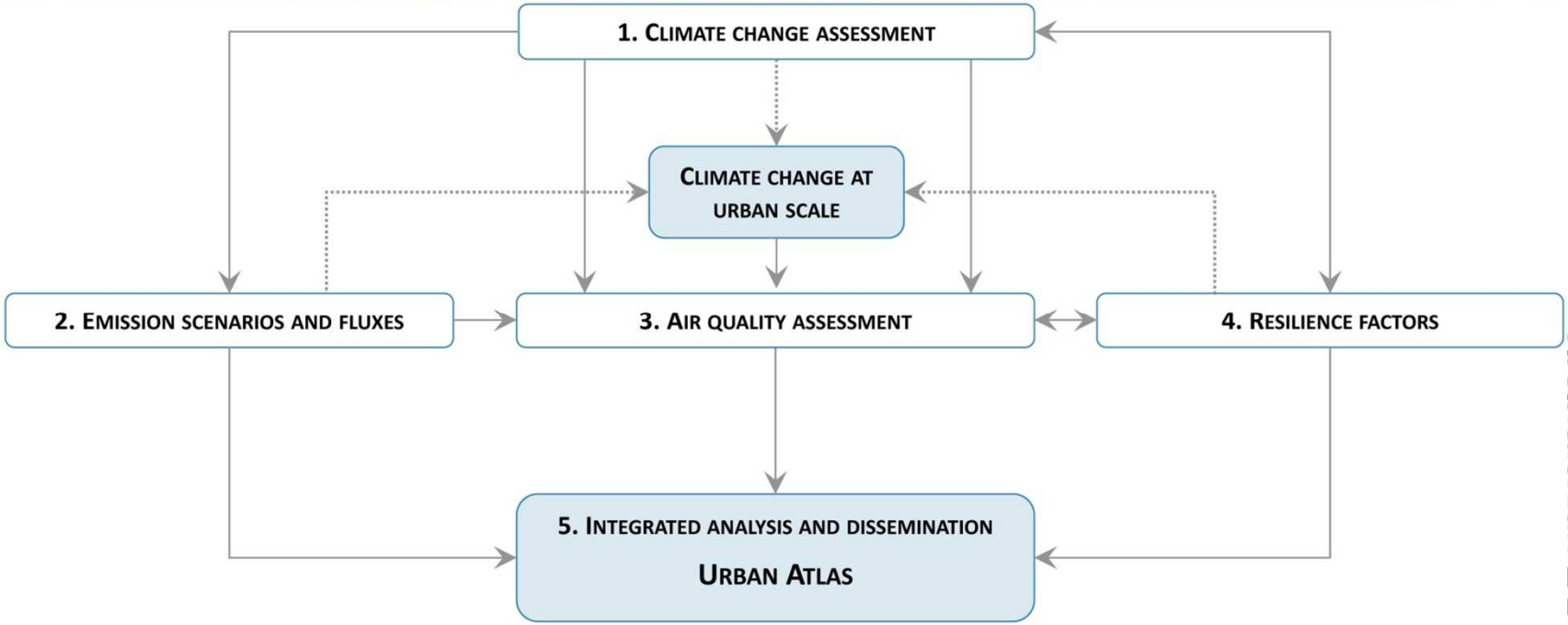
The **most relevant outcome** production of an urban atlas, the present and the mid-21st century (series of layers (maps) for: urban climate, thermal comfort and human wellbeing, air pollutant emissions, air quality and resilient factors) in order to develop guidelines for adapting urban areas to CC.



CLICURB

Screening of BTEX in the metropolitan area of Porto

CLICURB - Urban Atmospheric Quality, Climate Change and Resilience



CLICURB

Screening of BTEX in the metropolitan area of Porto

Why BTEX compounds?

Human health

All of the BTEX chemicals can produce neurological impairment, and exposure to benzene can additionally cause hematological effects including acute myelogenous leukemia.

- The carcinogenic potential of benzene is well established as indicated by its consensus classification as a human carcinogen by the National Toxicology Program, U.S. Environmental Protection Agency (USEPA 2001), and International Agency for Research on Cancer (IARC 1987)
- Ethylbenzene is possibly carcinogenic to humans based on a recent assessment by IARC (IARC 2000).
- Toluene and xylenes have been categorized as not classifiable as to human 11 carcinogenicity by both EPA (2001) and IARC (1999; 1999), reflecting the lack of evidence for the carcinogenicity of these two chemicals.

EU Limit Value for C_6H_6 – 5 µg m^{-3} (annual average)

WHO C_6H_6 guideline – 1,7 µg m^{-3}

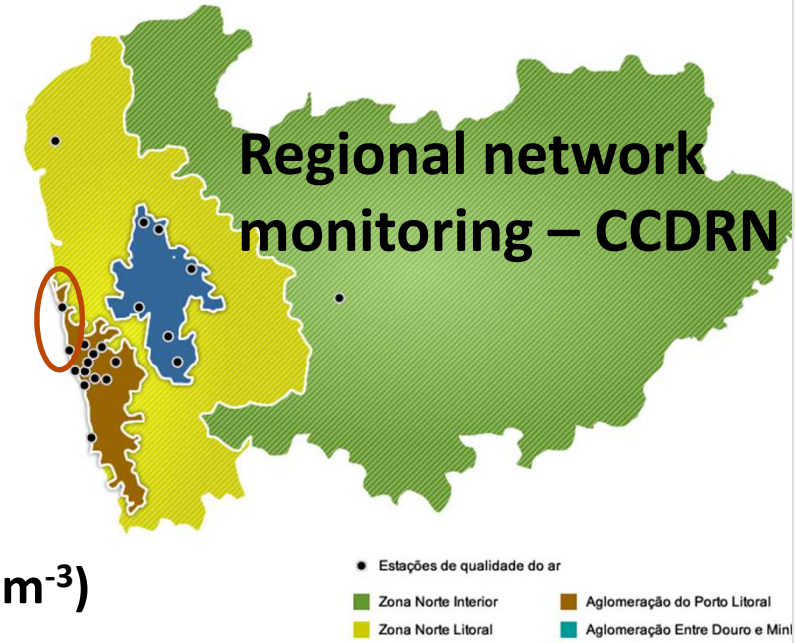
CLICURB

Screening of BTEX in the metropolitan area of Porto

Why BTEX compounds?

- **Scarse data available for BTEX at urban Porto region**

Benzene measurement started in 2004 (irregular). Since 2010 regular monitoring of BTEX at one **AQ station** and after 2013, 2 AQS (industrial influence).



Average and max (h) concentration (μg m^{-3})

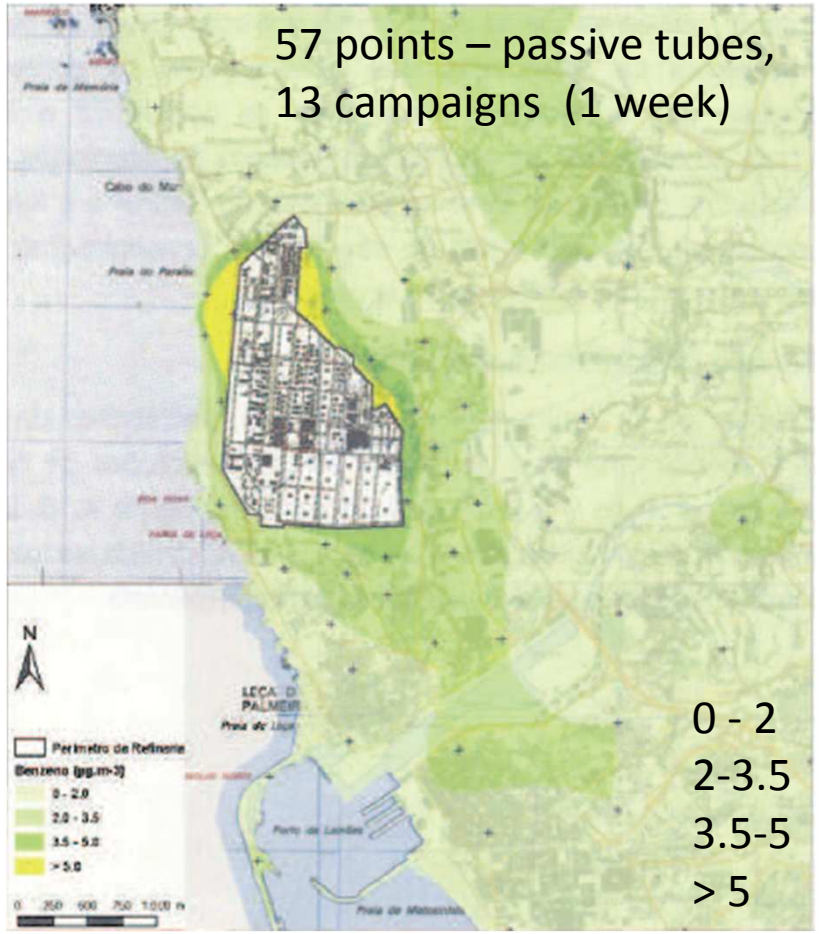
	Compound	2010	2011	2012	2013
Perafita (> 94 %)	benzene	1.9 (75)	1.9 (25)	2.1 (14)	2.1 (10)
	toluene	5.1 (51)	5.1 (51)	6.4 (84)	5.8 (55)
Custóias (< 63 %)	benzene	--	--	--	1.4 (13)
	toluene	--	--	--	4.4 (85)

higher in Winter
C_6H_6 - **3,3** μg m^{-3}

CLICURB

Screening of BTEX in the metropolitan area of Porto

Assessment of benzene concentrations in the vicinity of the Petrochemical Complex – (CCDR-N 2011)



Max. week average conc. observed 50 µg m^{-3}

Sources of BTEX

- Incomplete combustion of fuels is the largest source of C_6H_6 and aromatic congeners.
- Benzene is an additive to petrol - 80% to 85% of C_6H_6 emissions are attributable to vehicle traffic in Europe. Other sources of C_6H_6 include domestic heating and oil refining, as well as the handling, distribution and storage of petrol.
- In general, contributions to C_6H_6 emissions made by domestic heating are small (~5 % of total emissions), but there are sharp differences across regions. In areas where wood burning accounts for more than half of domestic energy needs, wood combustion can be a substantial local source of C_6H_6 (Hellén et al., 2008).
- Benzene emissions are not included as an individual pollutant in European emissions inventories covering VOC - C_6H_6 emissions are not recorded.
- BTEX emissions from combustion, fossil fuel or biomass combustion, are strongly dependent on fuel/combustion process .

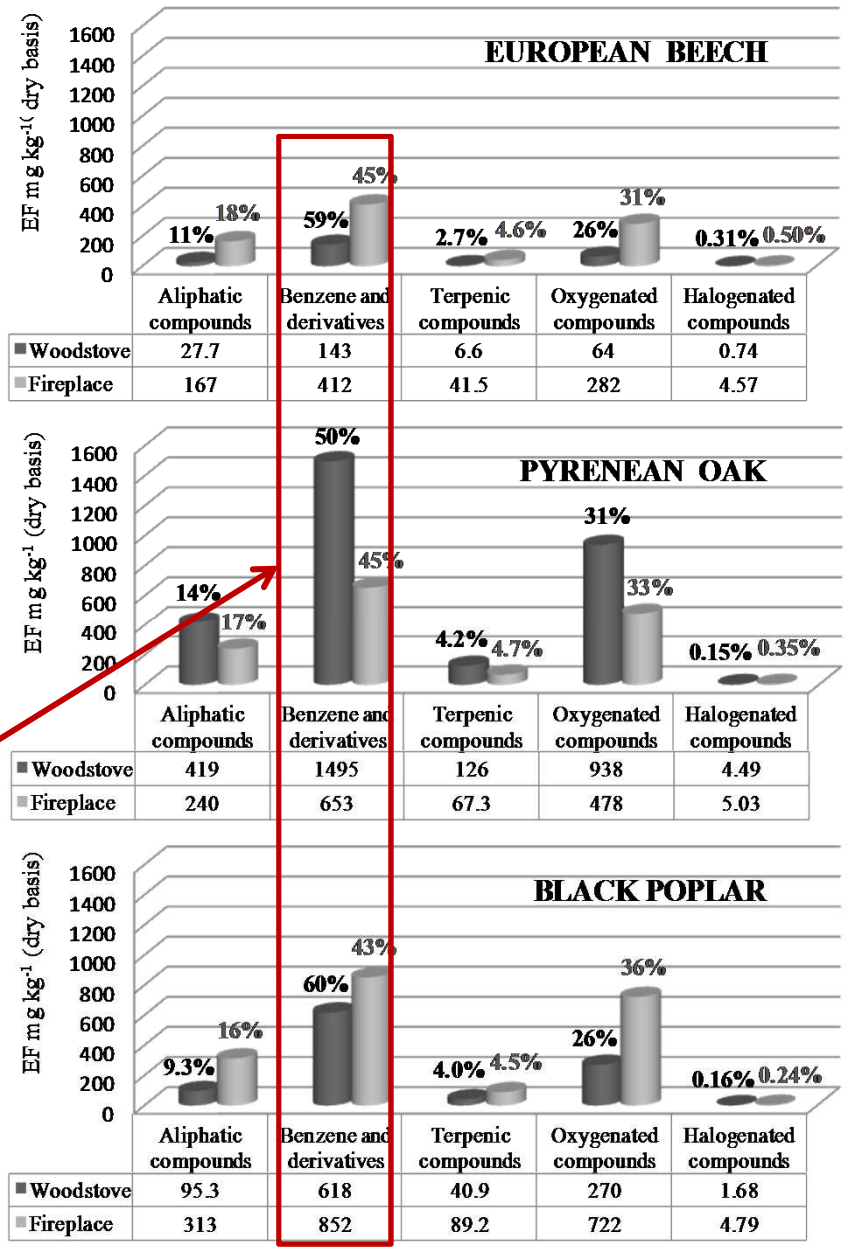
CLICURB

Residential combustion

Emissions of VOCs expressed in g kg $^{-1}$ (dry biomass burned) and as a percentage (Evtyugina et al. 2014)

BTEX emissions

C_6H_6 the most abundant VOC

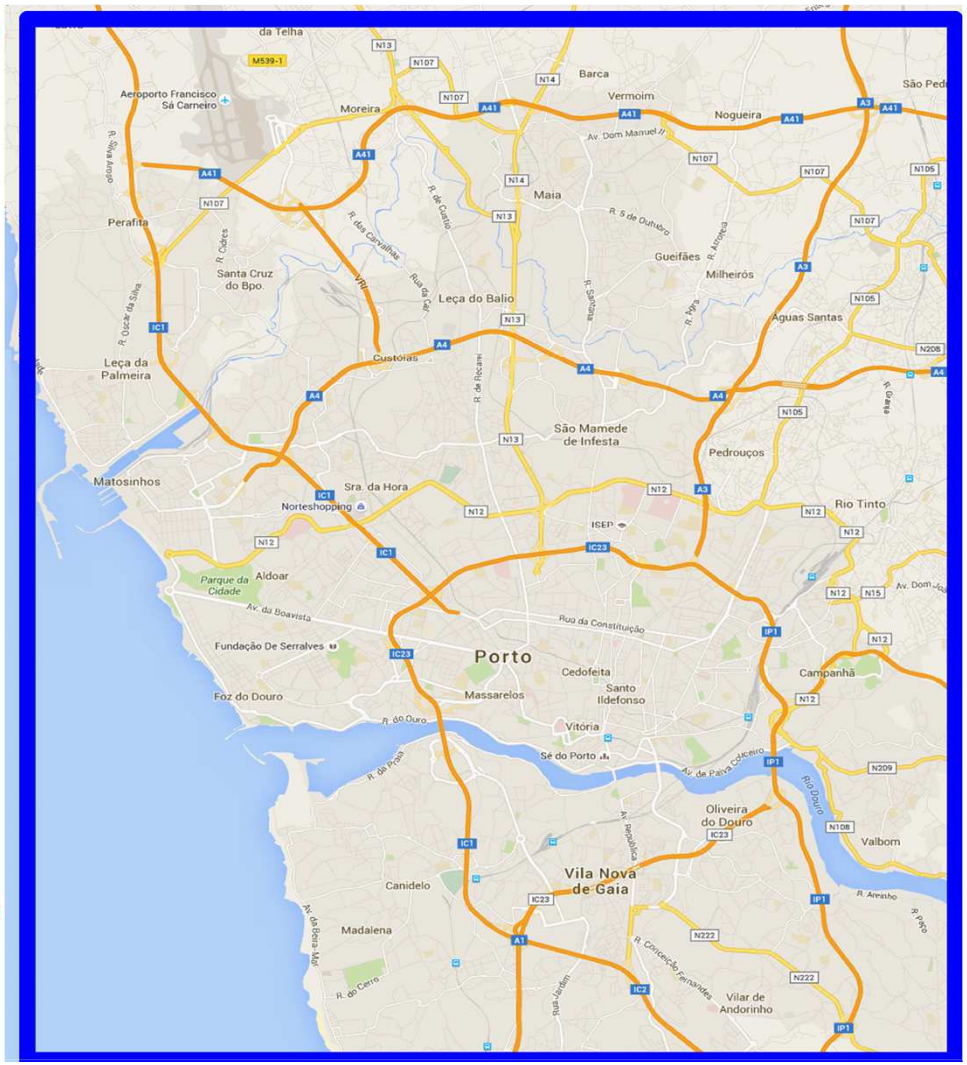


CLICURB

Screening of BTEX in the metropolitan area of Porto

Methodology

Case study – Oporto



passive sampling

active sampling

CESAM Centre of Environmental and Marine Studies

universidade de aveiro

CLICURB

Screening of BTEX in the metropolitan area of Porto

Methodology

- Two **passive** campaigns - **space variability**

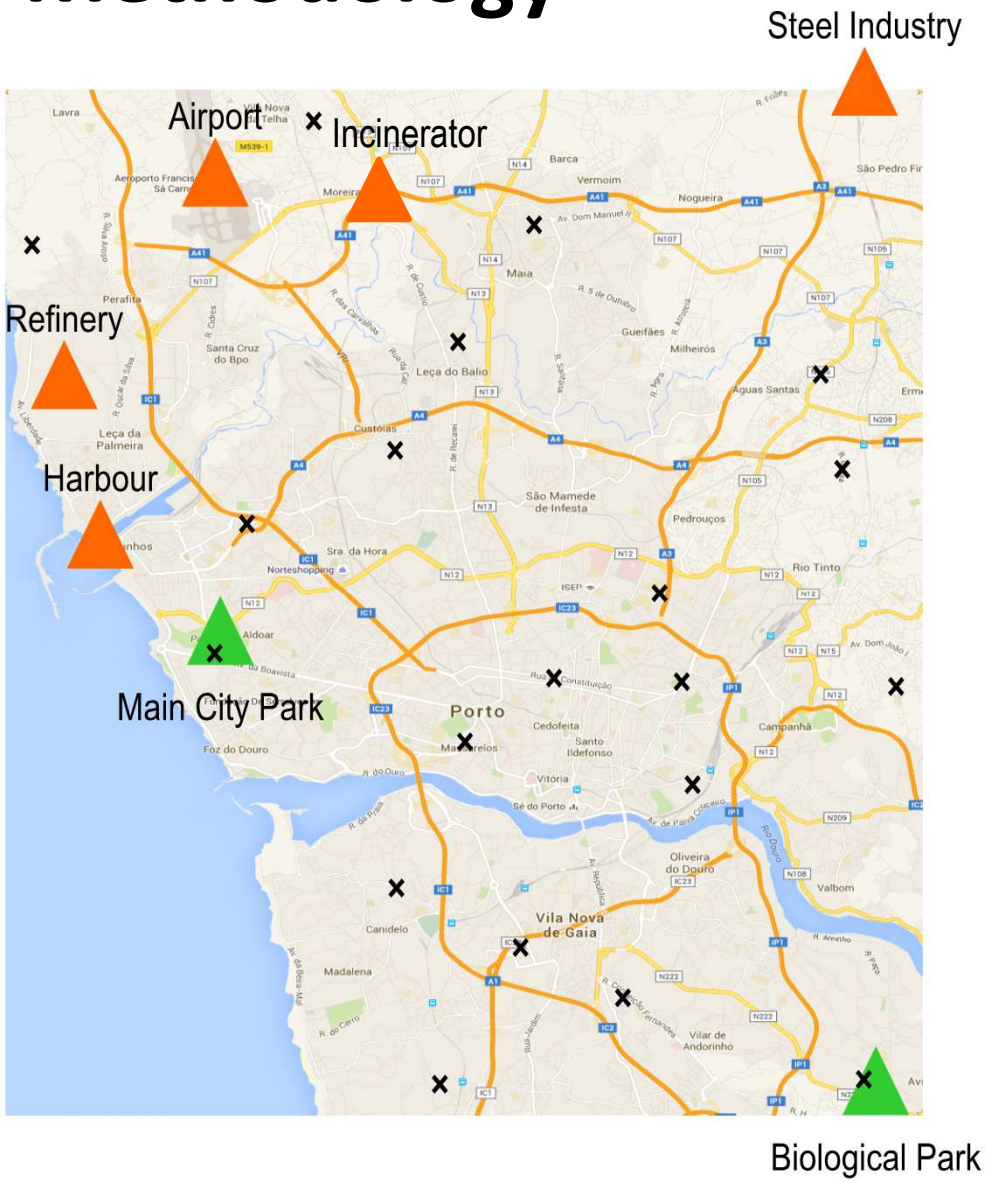
1st campaign	2nd campaign
• 1 Week	• 2 Week
• Beginning of Spring	• 3rd and 4th week of Summer
• 20 singular points	• 15 singular points and 5 double points

Identification and estimation on Tenax diffusion tubes through GC/Ms by Gradko International Ltd (method GLM 13)

CLICURB

Screening of BTEX in the metropolitan area of Porto

Methodology



Passive campaign

20 sampling points distributed in ~400km^2

Sampling sites (both campaigns), 10 of them at AQS

and potential emission sources of BTEX

green parks

CESAM Centre of Environmental and Marine Studies

universidade de aveiro

CLICURB

Screening of BTEX in the metropolitan area of Porto

Methodology

- Two **active** campaigns – **time variability**

Traffic Urban site

- **24 samples**
- **2-3 july 2015**
- **Flow rate: 30 ml/min**
- **Volume = 1800 to 2700 ml**

Identification and estimation on Gradko Tenax-TA tubes through GC/Ms by Gradko International Ltd (method GLM 13)

Urban background site

- **67 samples**
- **23 Jun – 3 Sep 2015**
- **Flow rate: 50 ml/min**
- **V = 1500 to 2000 ml**

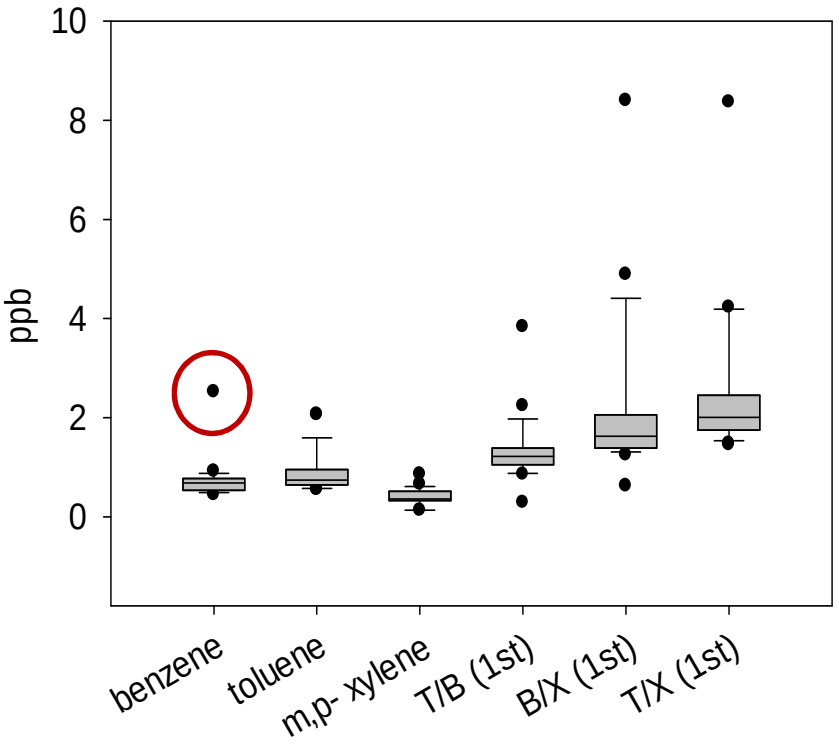
Direct sampling on Tenax-TA trap 5^{0}C (thermal desorption injector -Master TD DANI)
Analysis by TD-GC-FID (Thermo Scientific – Trace GC ULTRA)
Colunm - TRB-1MS capillary column (50 m × 0.20 mm i.d., 0.50 µm); split ratio - 12

Screening of BTEX in the metropolitan area of Porto

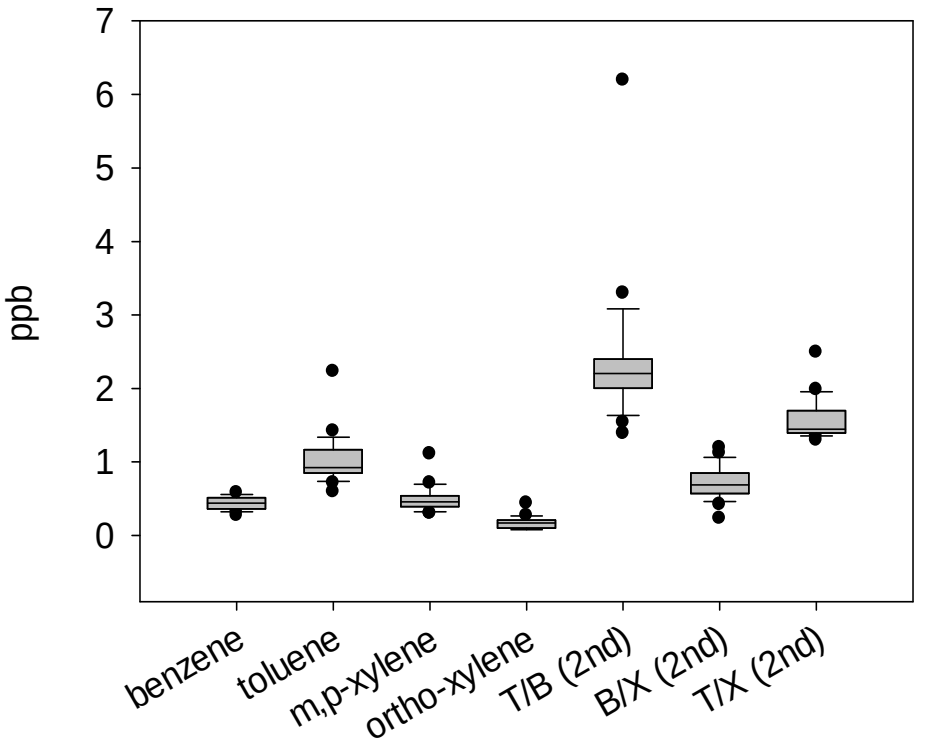
Results

Passive tube campaigns

1st passive campaign



2nd passive campaign



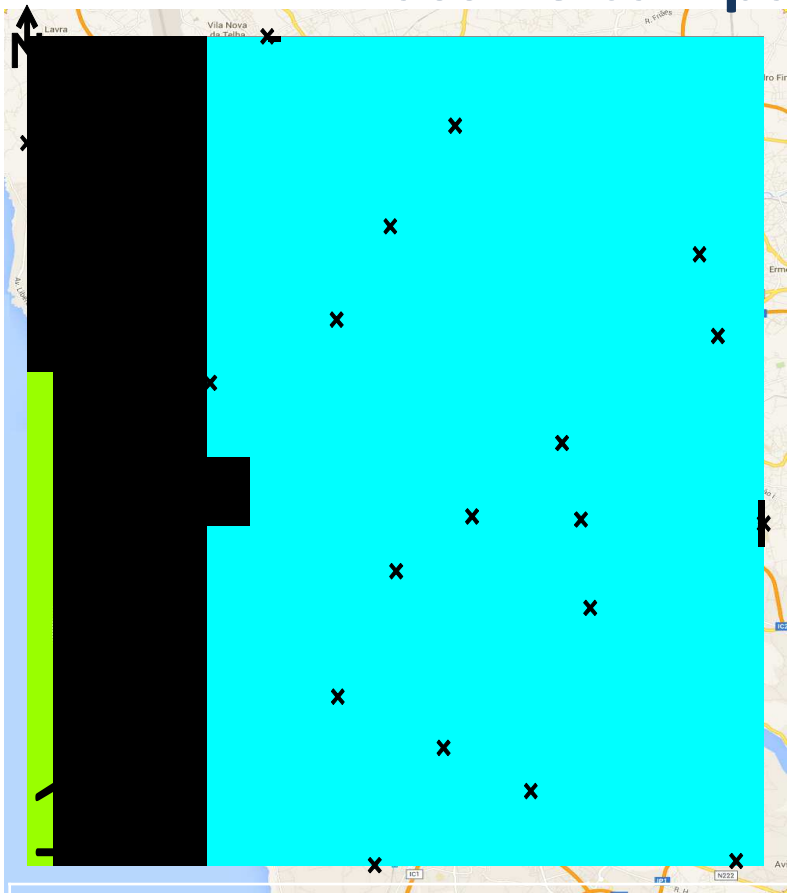
1 ppb benzene = 3,3 µg m^{-3}

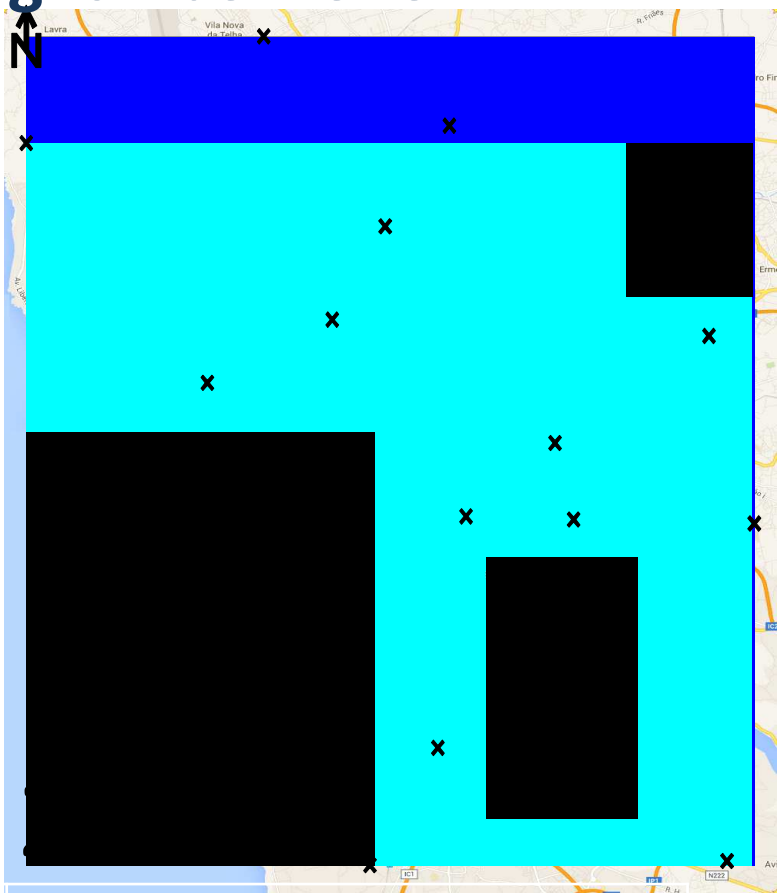
CLICURB

Screening of BTEX in the metropolitan area of Porto

Results

Passive campaigns - benzene





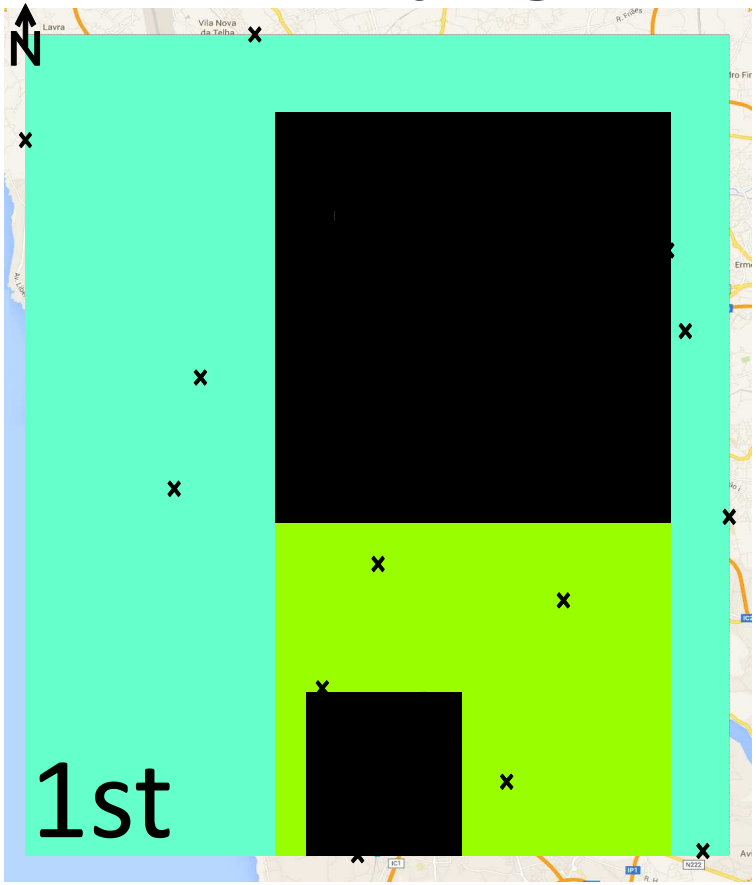
22^{0}C (Max)
6^{0}C (Min)
Wind dir.: East and Southeast

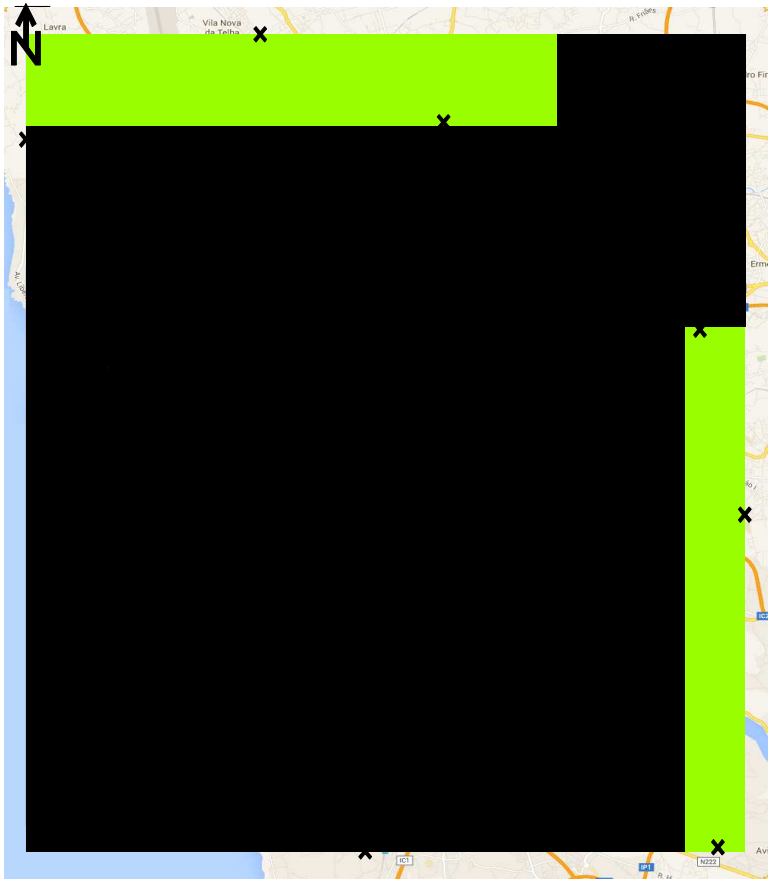
35^{0}C (Max)
15^{0}C (Min)
Wind dir.: Northwest

CLICURB

Screening of BTEX in the metropolitan area of Porto

Passive campaigns results (toluene)





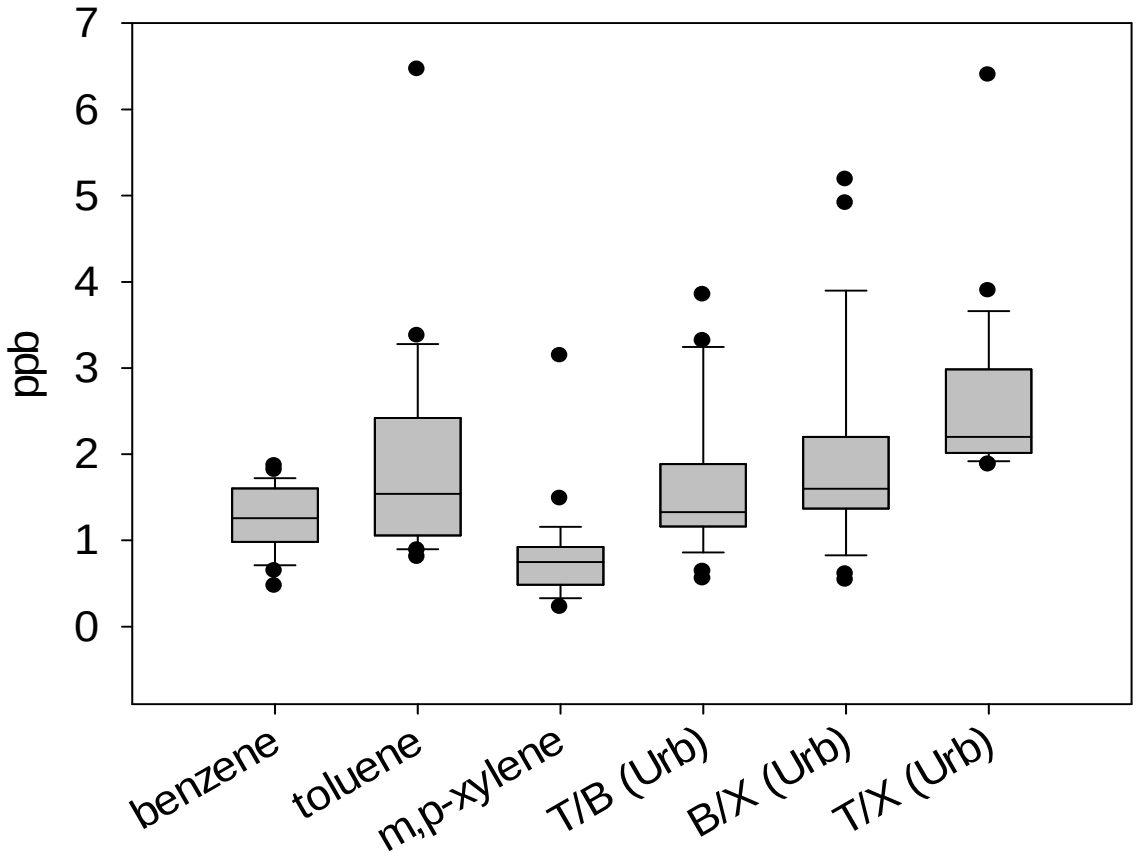
22^{0}C (Max)
6^{0}C (Min)
Wind dir.: East and Southeast

35^{0}C (Max)
15^{0}C (Min)
Wind dir.: Northwest

Screening of BTEX in the metropolitan area of Porto

Results

Active campaign – traffic urban site

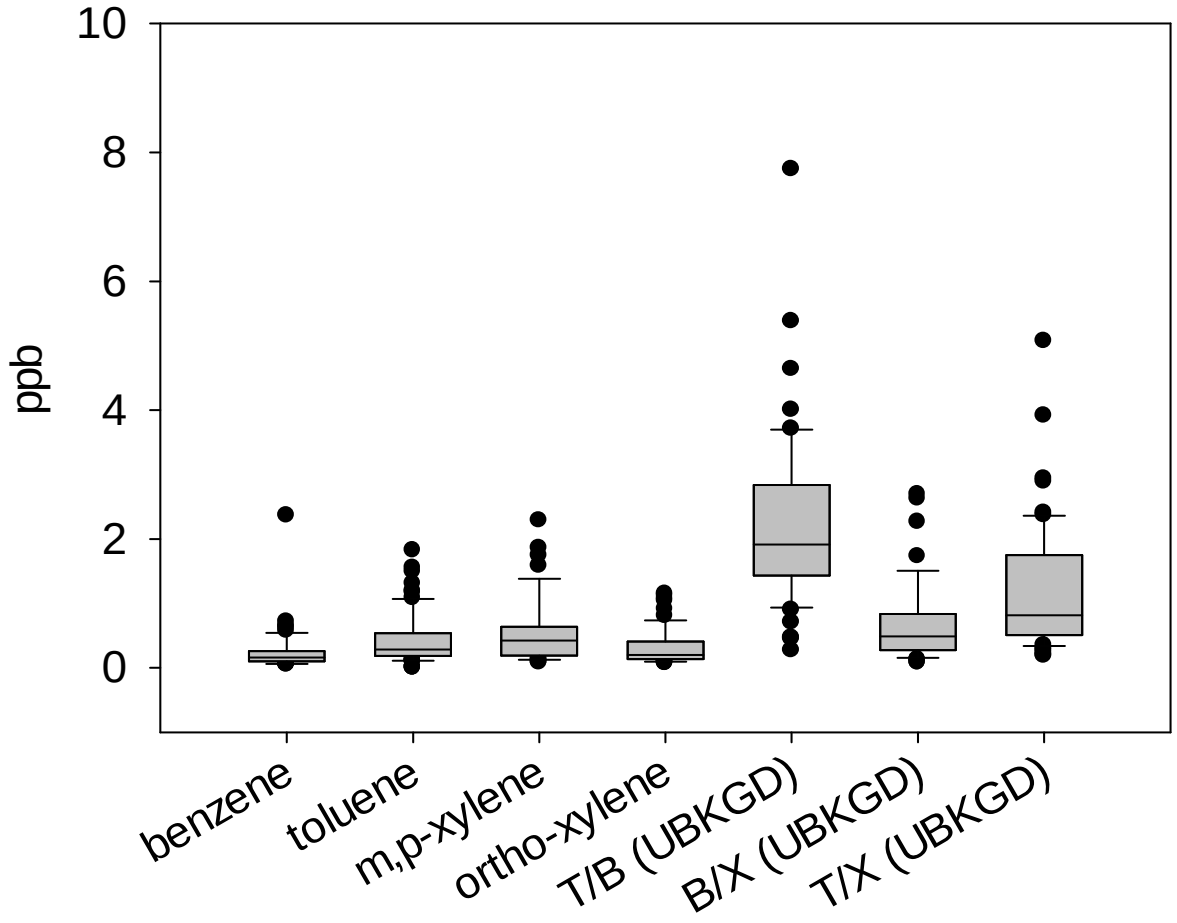


Maximum BTEX concentrations followed the traffic peaks (~1400 vehicles/h), with minimum at night

Screening of BTEX in the metropolitan area of Porto

Results

Active campaign – urban background site



Conclusions

- The concentrations of benzene (passive and active sampling) were systematically < 5 μg m^{-3}, with few exceptions, but at some sites close to the WHO guideline;
- The space distribution of the different BTEX compounds didn´t show the same variability – contribution of different sources, wind directions, different lifetime (OH reactivity);
- Urban background showed BTEX concentrations 2 times or more lower than traffic site during the day, with the highest concentration observed at the morning peak traffic at both sites.
- The resident population in the vicinity of Petrochemical Complex could experience a significant exposure to BTEX
- Domestic biomass combustion and lower photochemical activity in winter could represent a significant increase of BTEX concentrations at Oporto region;

ACKNOWLEDGENTS

National Funds through the Portuguese Science Foundation (FCT) within the project CLICURB (EXCL/AAG-MAA/0383/2012)

Thank you for your attention

Questions?