

# THE EFFECT OF RESIDENTIAL SOLID WASTE BURNING ON AMBIENT AIR QUALITY IN CENTRAL AND EASTERN EUROPE



**ANDRÁS GELENCSÉR**

**UNIVERSITY OF PANNONIA  
MTA-PE AIR CHEMISTRY RESEARCH GROUP  
VESZPRÉM, HUNGARY**

# **Service Contract for analysing the effect of residential solid waste burning on ambient air quality in Central and Eastern Europe and potential mitigation measures**

*EU DG ENV 07027737/2018/788206/SER/ENV.C3 (WASTE)*

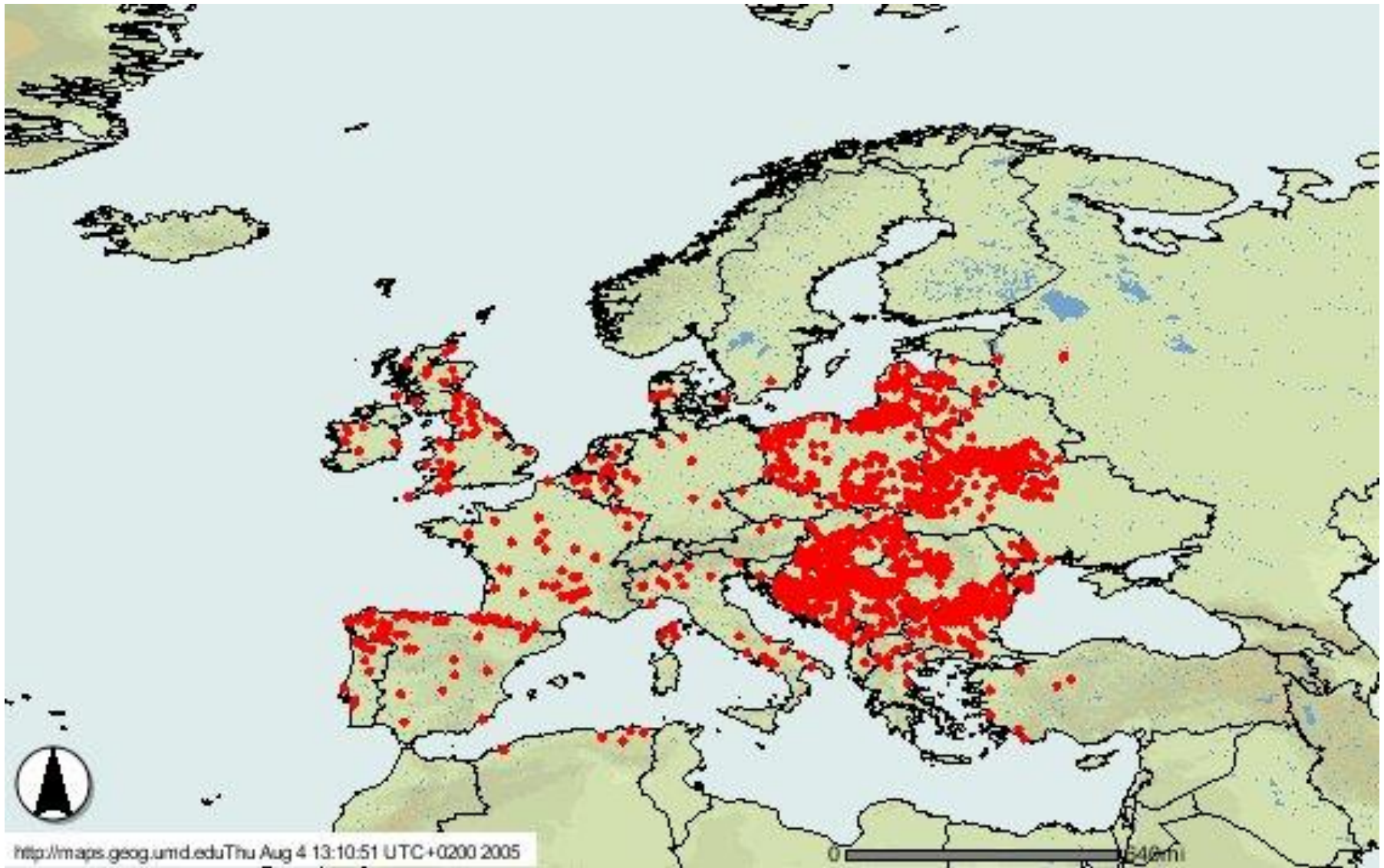
Total: 734.000 €

Duration: December 2018 – November 2020

## Consortium partners:

- University of Pannonia
- Hungarian Meteorological Service
- National Institute of Research and Development for Optoelectronics (INOE 2000) Magurele, Románia
- Vlaamse Instelling Voor Technologisch Onderzoek (VITO) Mol, Belgium
- Institut für Energie- und Umwelttechnik e.V. Duisburg, Németország

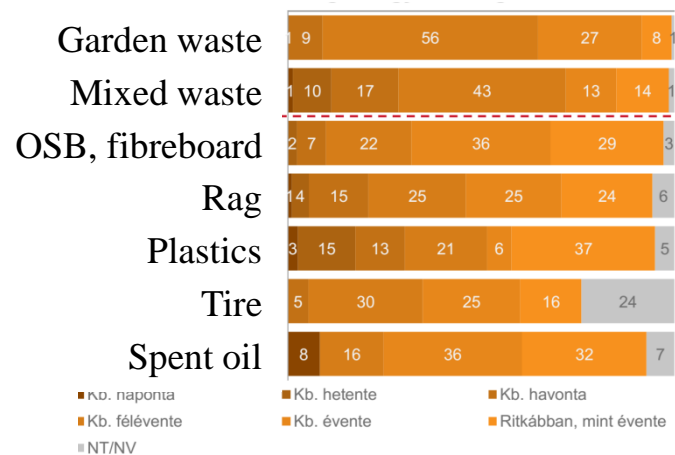
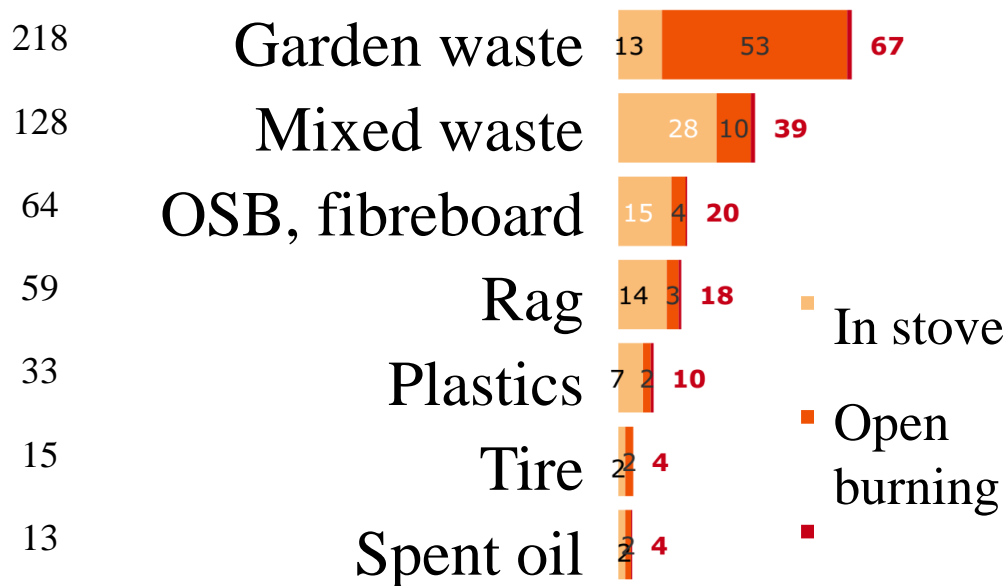
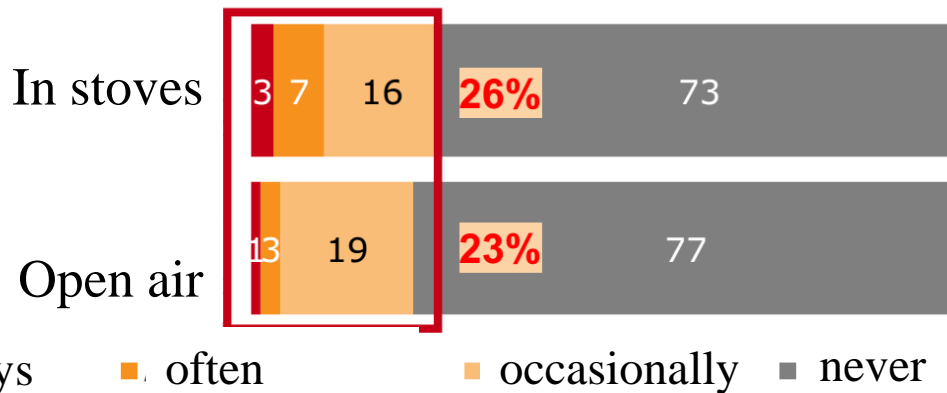
# Open fires in Europe (MODIS)

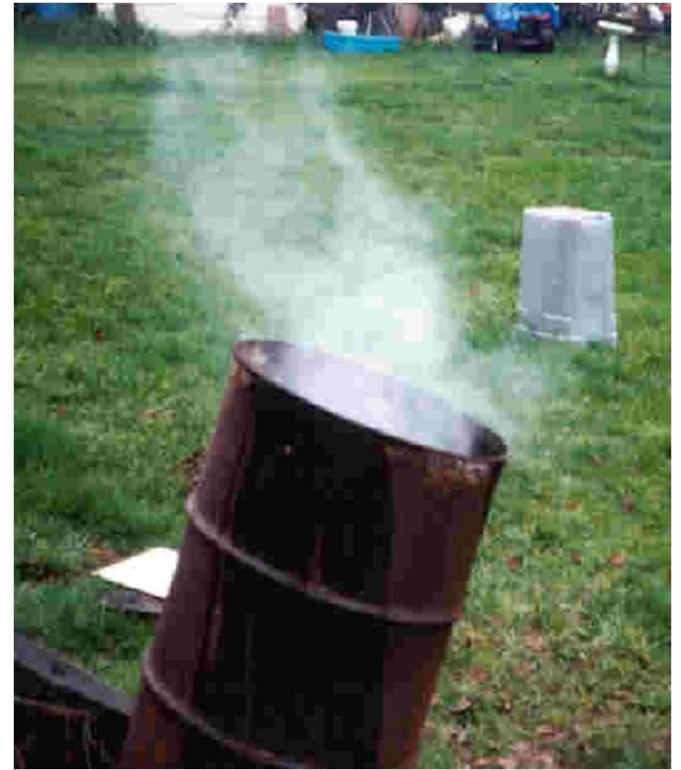


# Waste combustion in Hungary

Kantar Hoffmann  
Marketing Ltd.

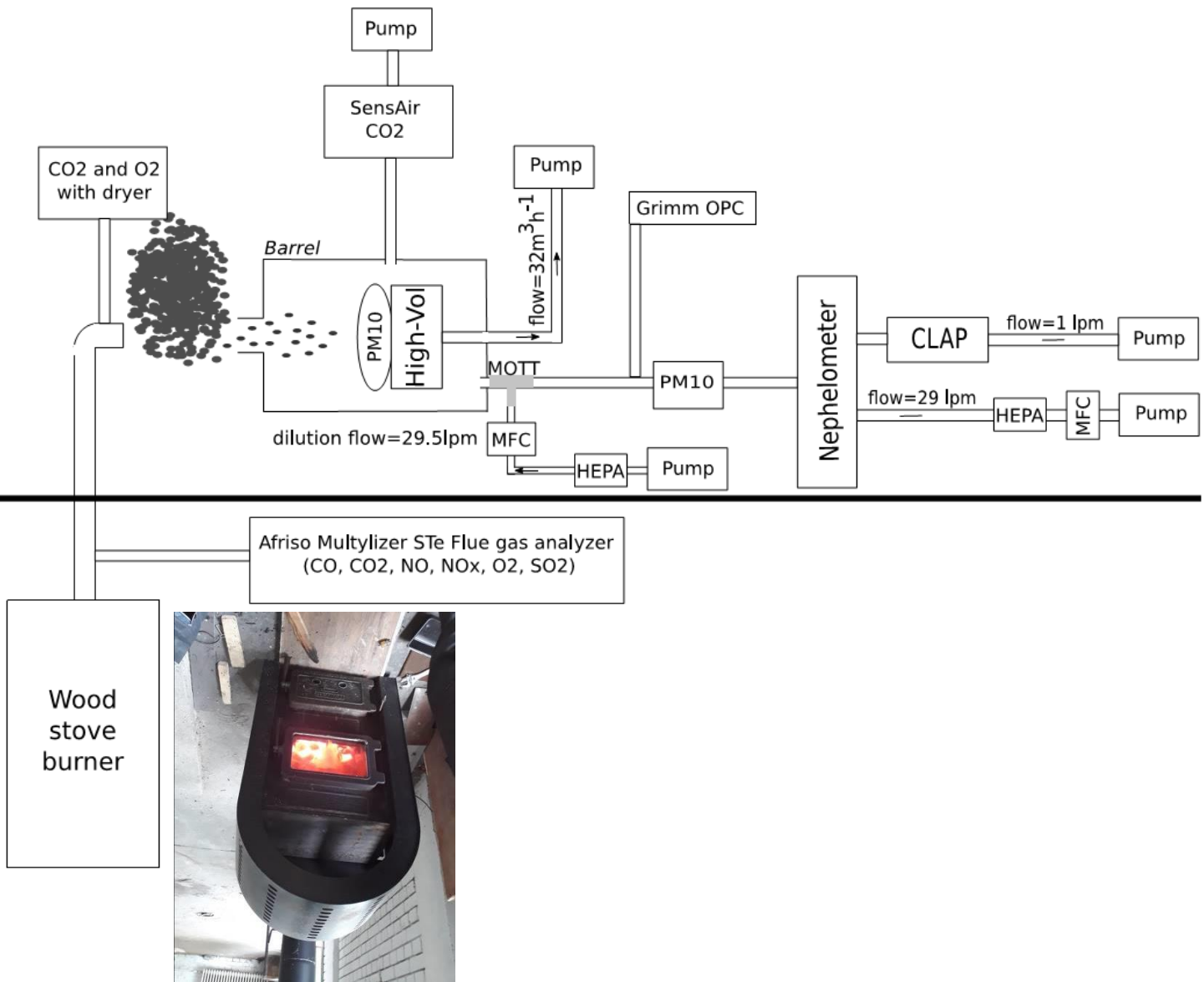
- Population aged 18-65
- Size: 1000 / personal interviews
- August 2017







# Test combustion of waste in lab facility



PET



PS



PU



PE



PVC



PP



Rag



ABS



OSB



Fibreboard



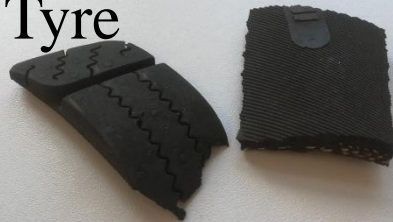
Paper



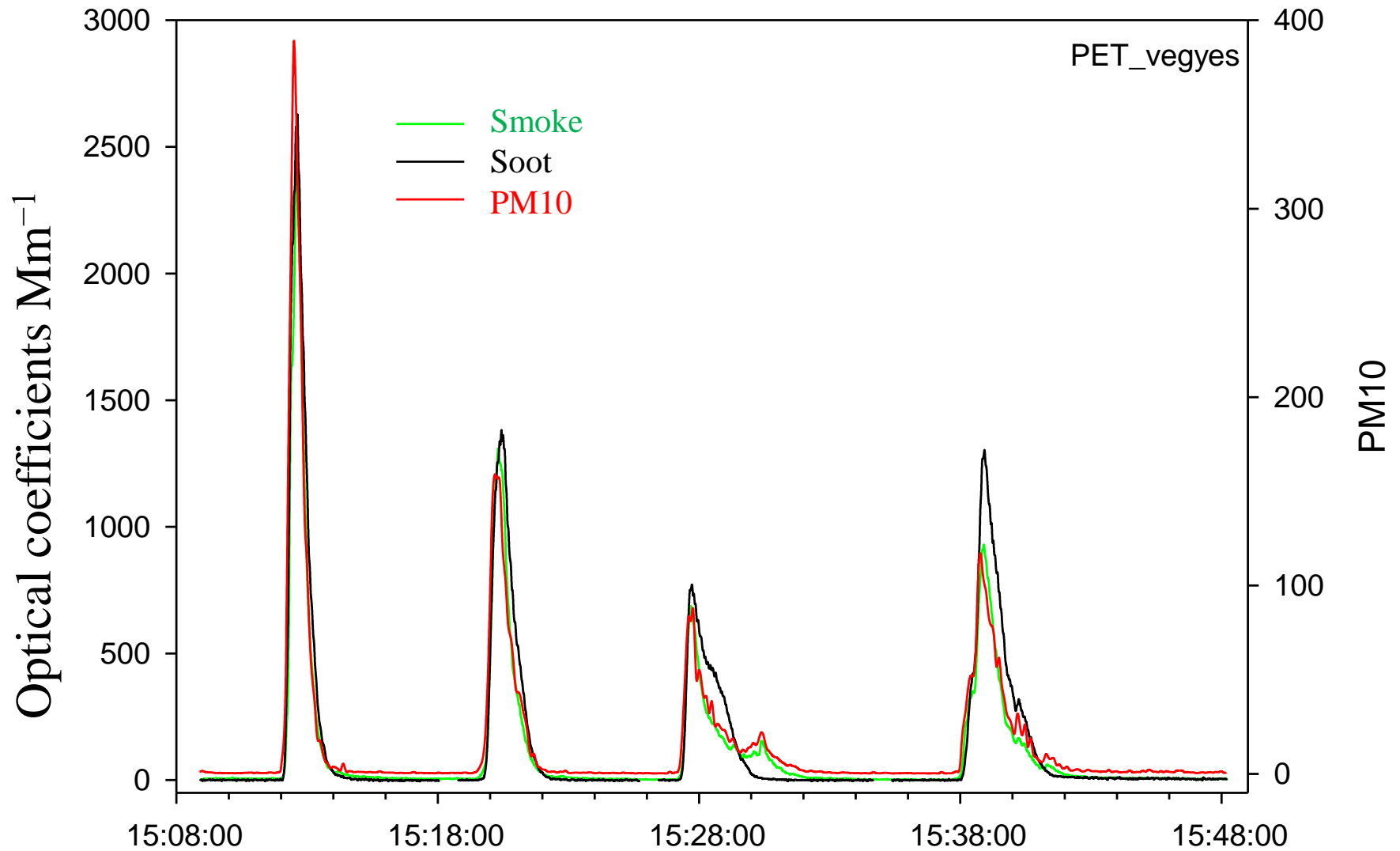
Firewood

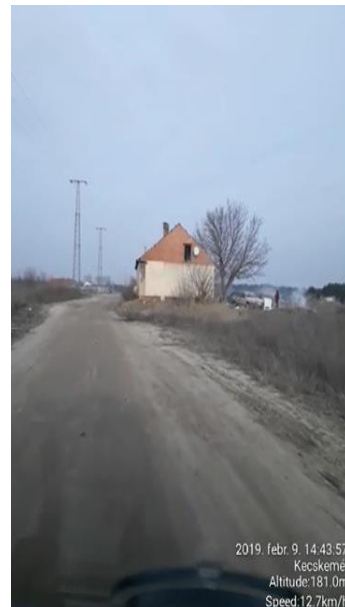


Tyre



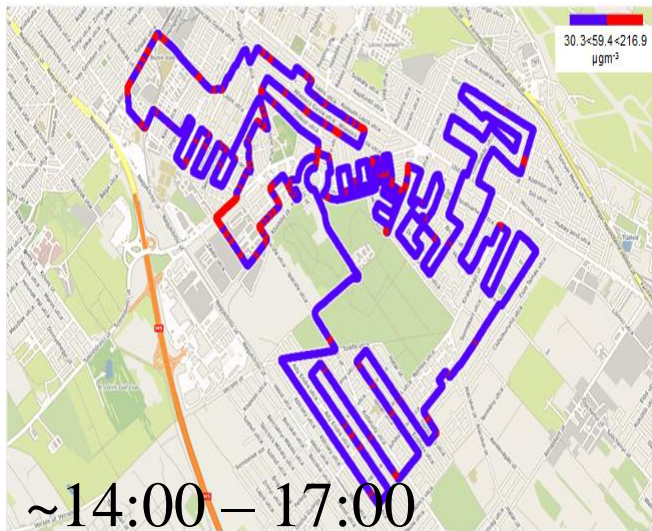
# Laboratory combustion tests



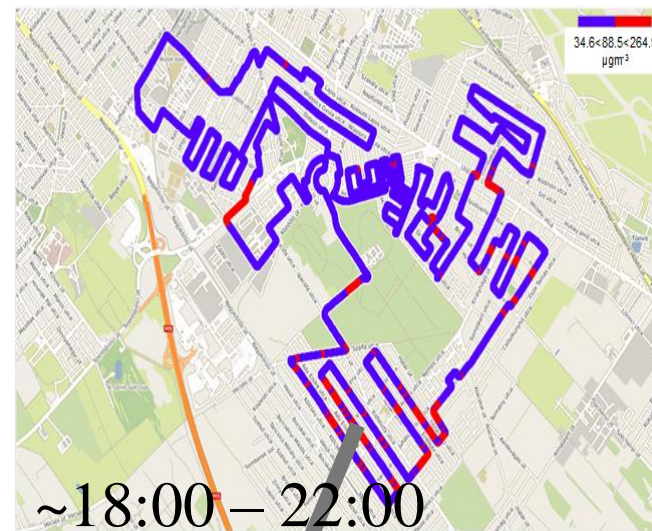


PM10  
Optical instruments  
(scattering, absorption)  
Number concentration and  
LDSA

BUD-9 PM10

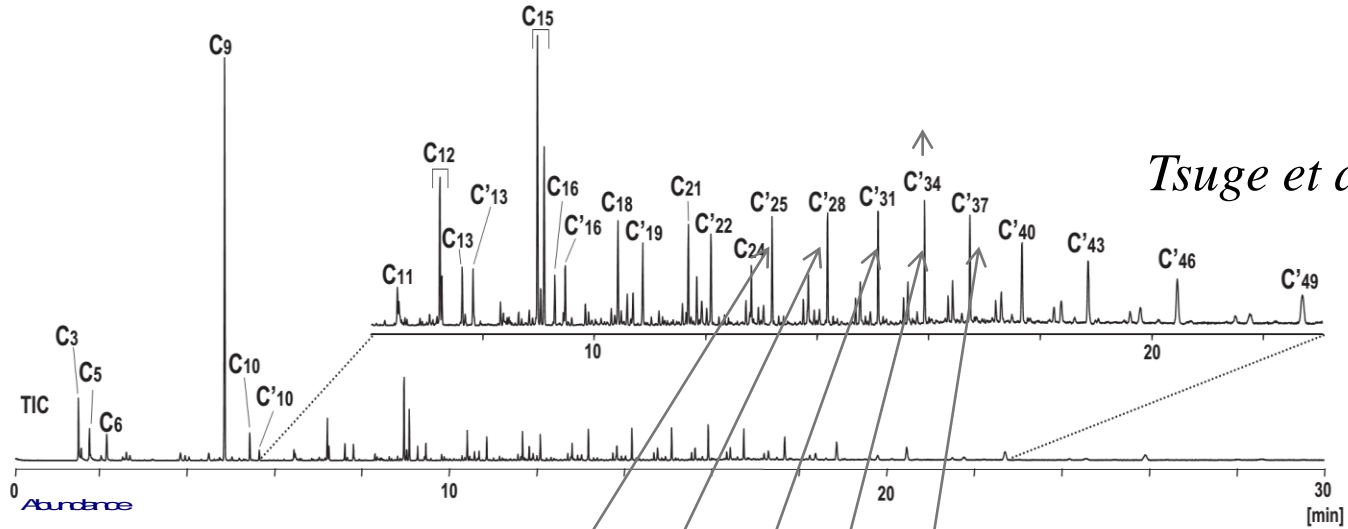


BUD-10 PM10

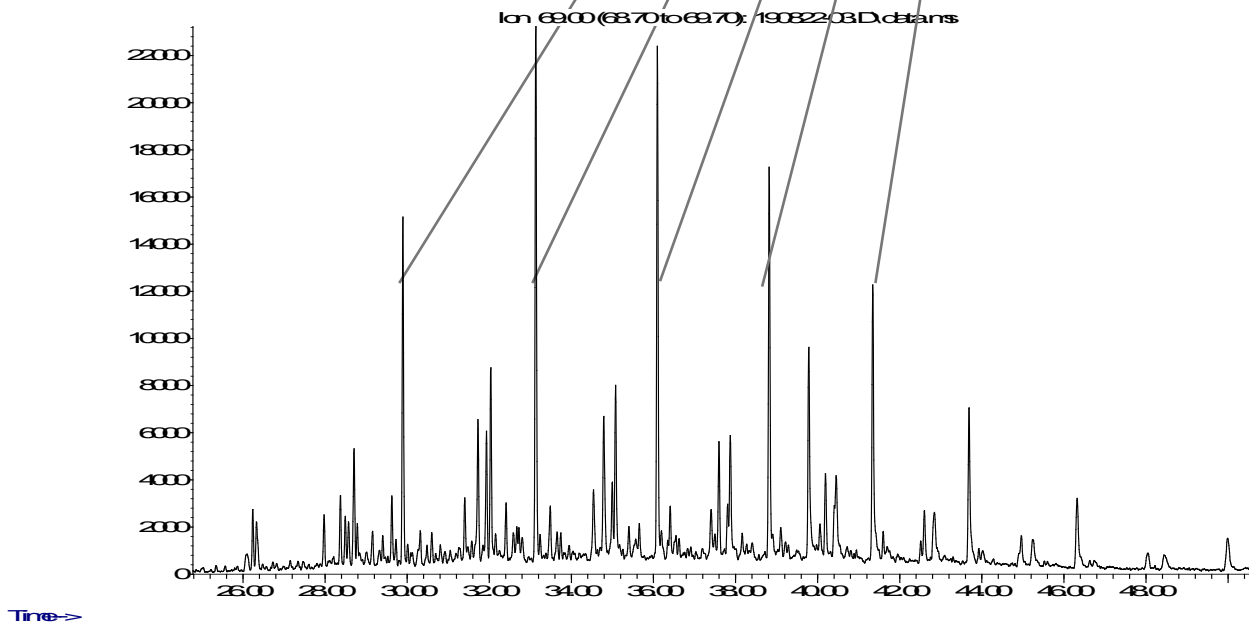


# Special tracers for combustion of different waste types

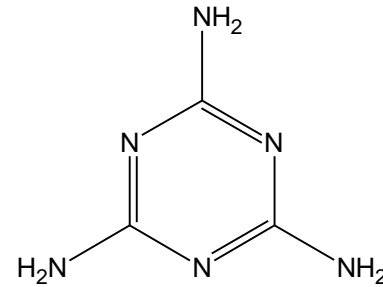
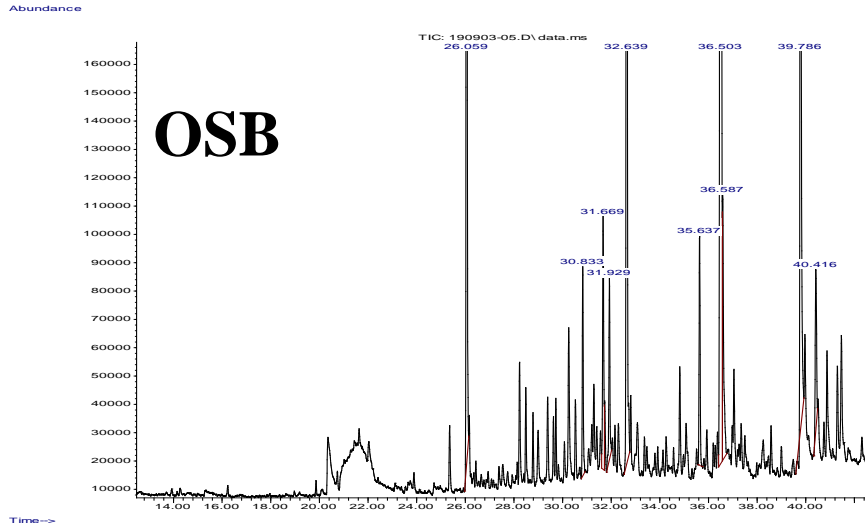
PP



*Tsuge et al., 2011*

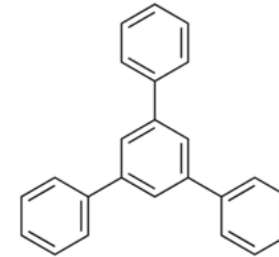


# Special tracers for combustion of different waste types

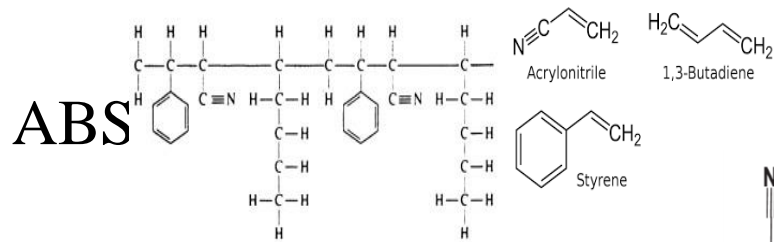


Melamine

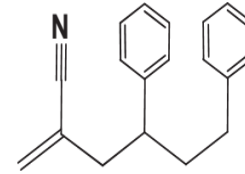
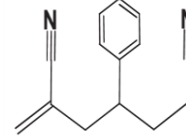
**PET, rag, PS, ABS, cardboard**



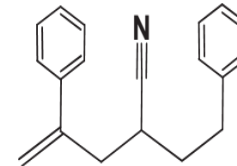
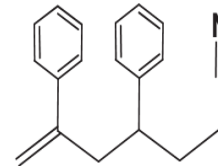
1,3,5-triphenylbenzene



2-methylene-4-phenylheptanedinitrile (ASA)



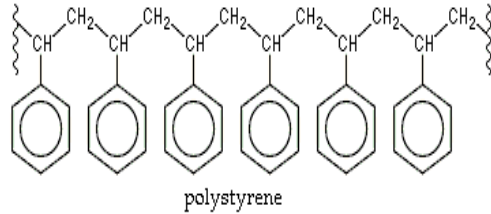
2-methylene-4,6-diphenylhexanenitrile (ASS)



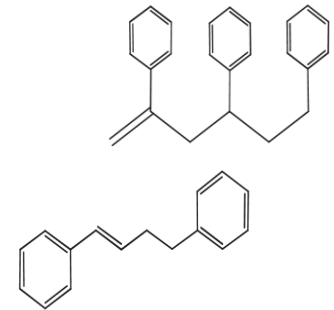
4,6-diphenylhept-6-enenitrile (SSA)

2-phenethyl-4-phenylpent-4-enenitrile (SAS)

PS

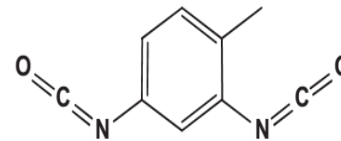


- 5-hexene-1,3,5-triyltribenzene (SSS)
- (*E*)-1-butene-1,4-diyl dibenzene

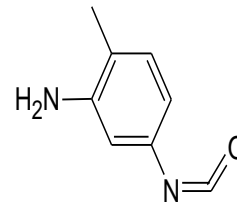


PU

2,4-tolylene  
diisocyanate  
Isomeres

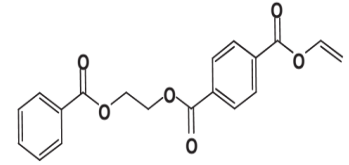


2,4-Diaminotoluene  
Chain extender and  
cross-linker @  
poliurethanes

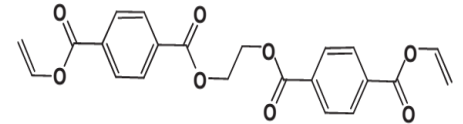


## PE

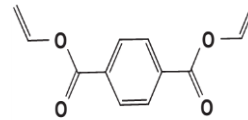
2-(benzoyloxy)ethyl vinyl terephthalate (PET-F)



ethan-1,2-diyl divinyl diterephthalate (PET-G)

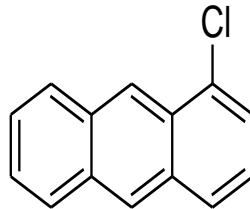


divinyl terephthalate (PET-C)

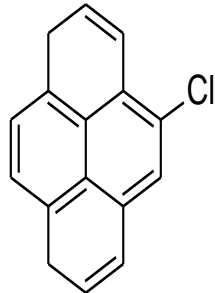


## PVC

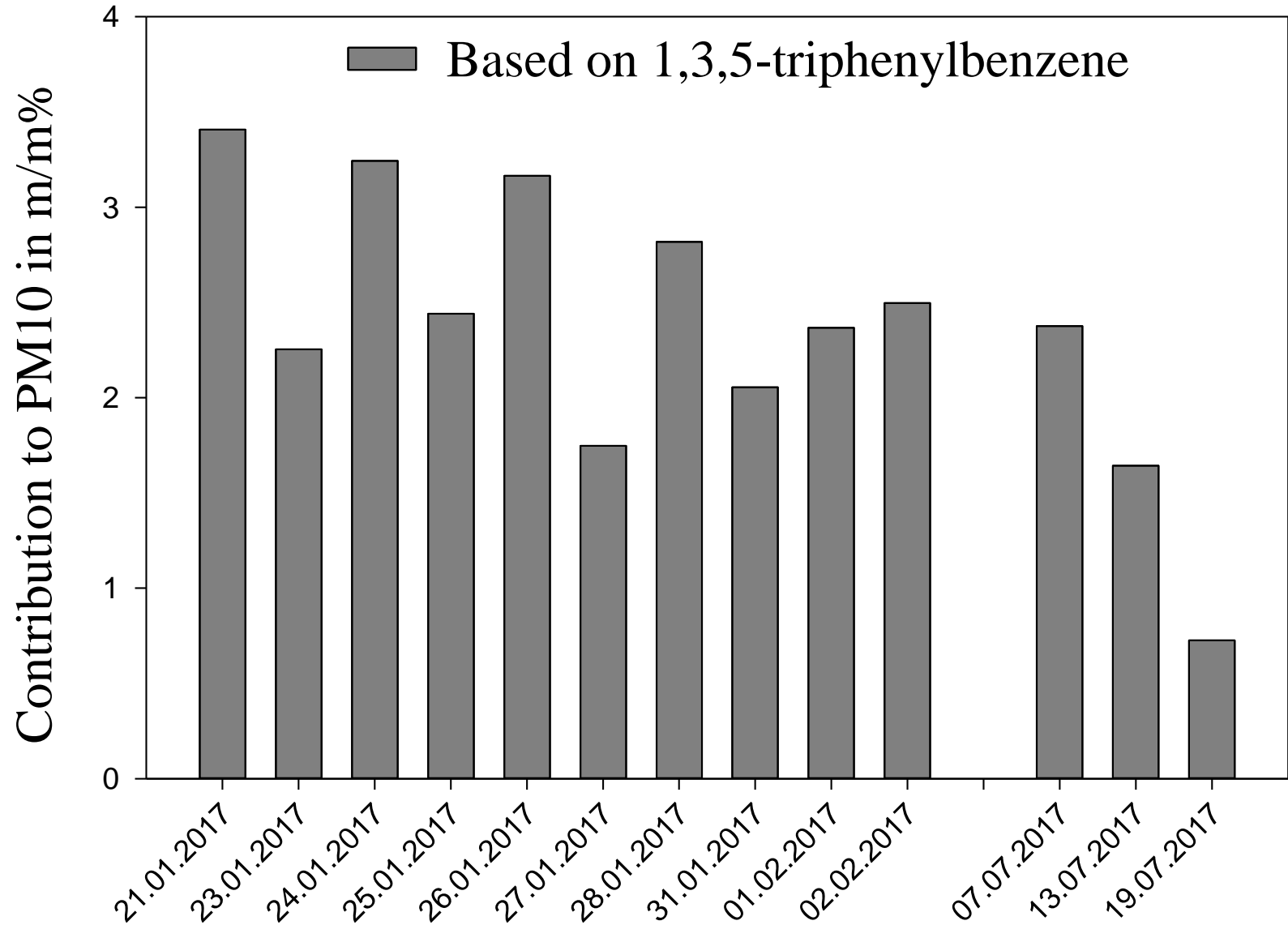
Cl-antracene



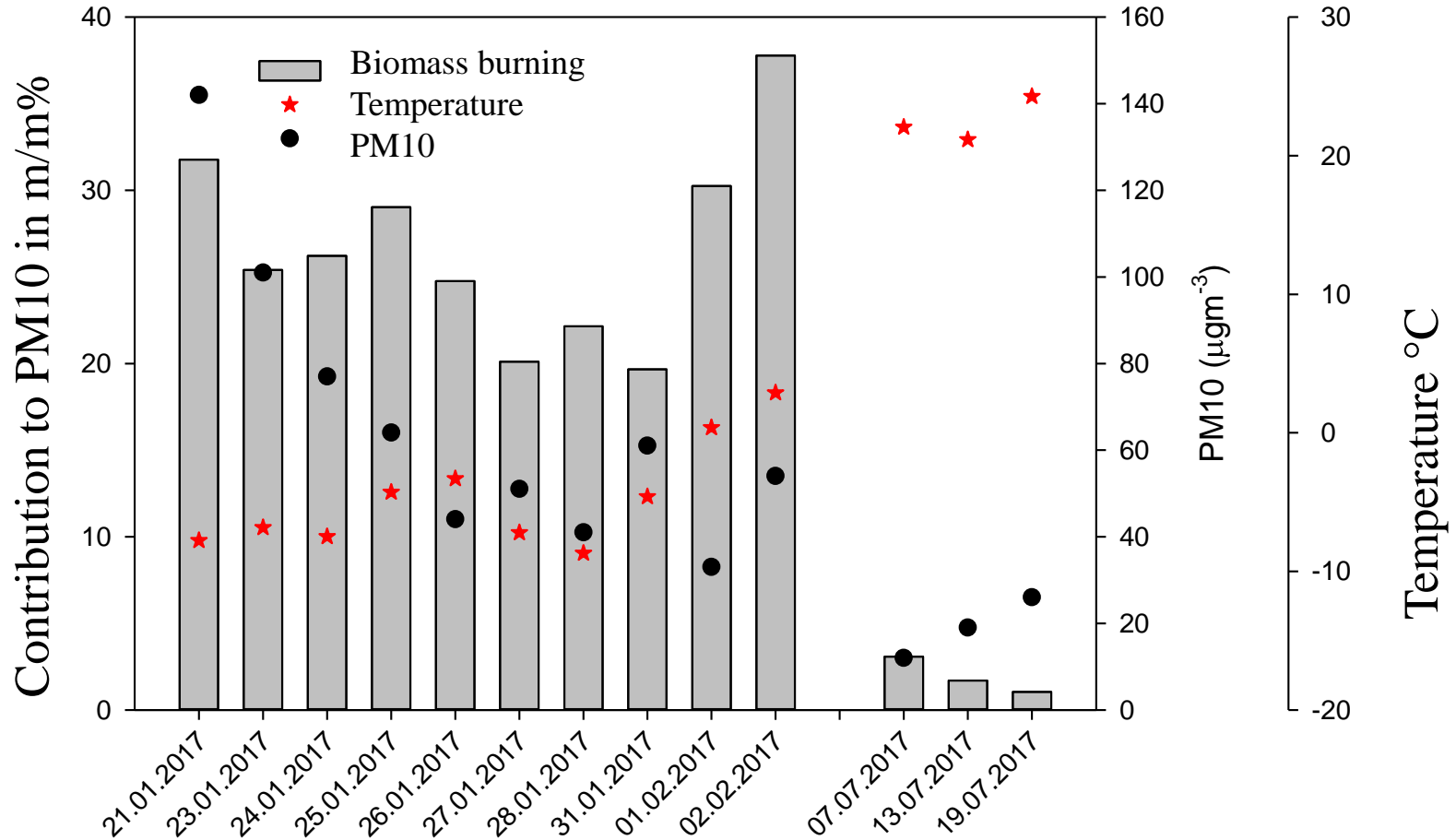
Cl-pyrene



# Estimated contribution to PM10 Budapest

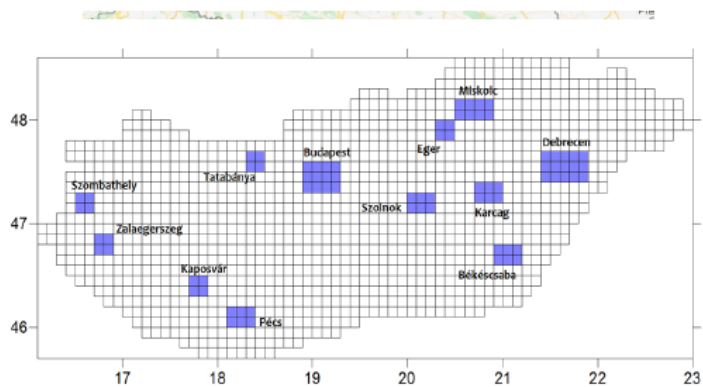


# PM10 Budapest – contribution of biomass burning

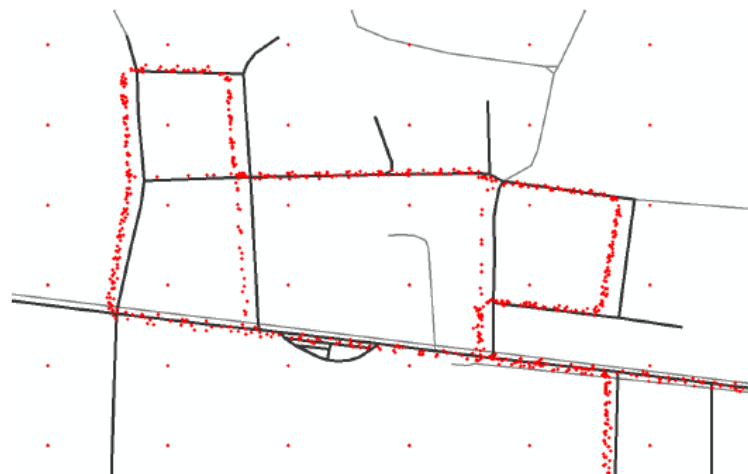


## Modelling

- REGIONAL SCALE
- CHIMERE: Chemical transport model
- $0.1^\circ$  ( $\sim 10$  km) resolution



- LOCAL SCALE
- IFDM: Gaussian plume model
- Irregular grid: points where there is a measurement + a regular grid



## Modelling: emissions

- REGIONAL SCALE emissions
  - All emission categories
  - EMEP 2015 emission inventory
- LOCAL SCALE emissions
  - Only the emissions from non-industrial combustion plants (SNAP2) which includes residential heating
  - CAMS TNO-MACC II inventory

1. CHIMERE
2. CAMS

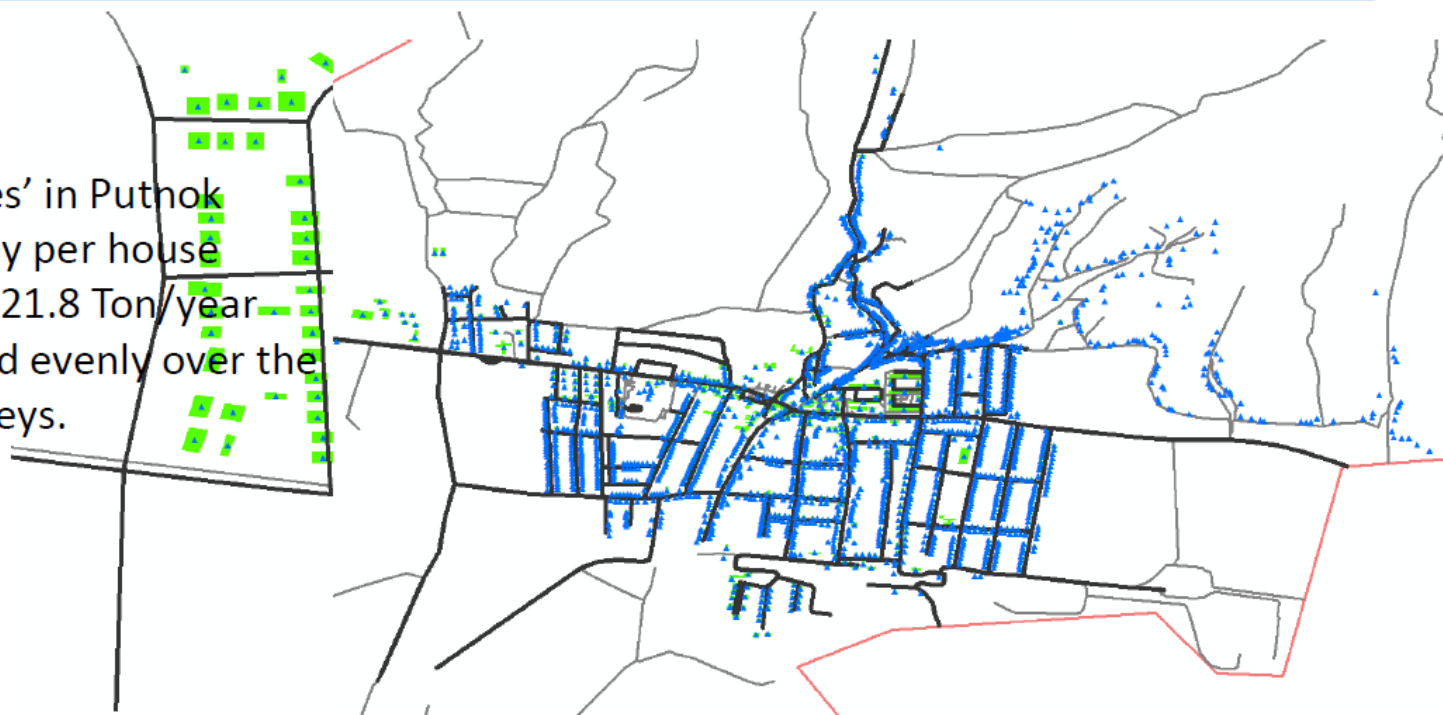


Rest => through background concentration

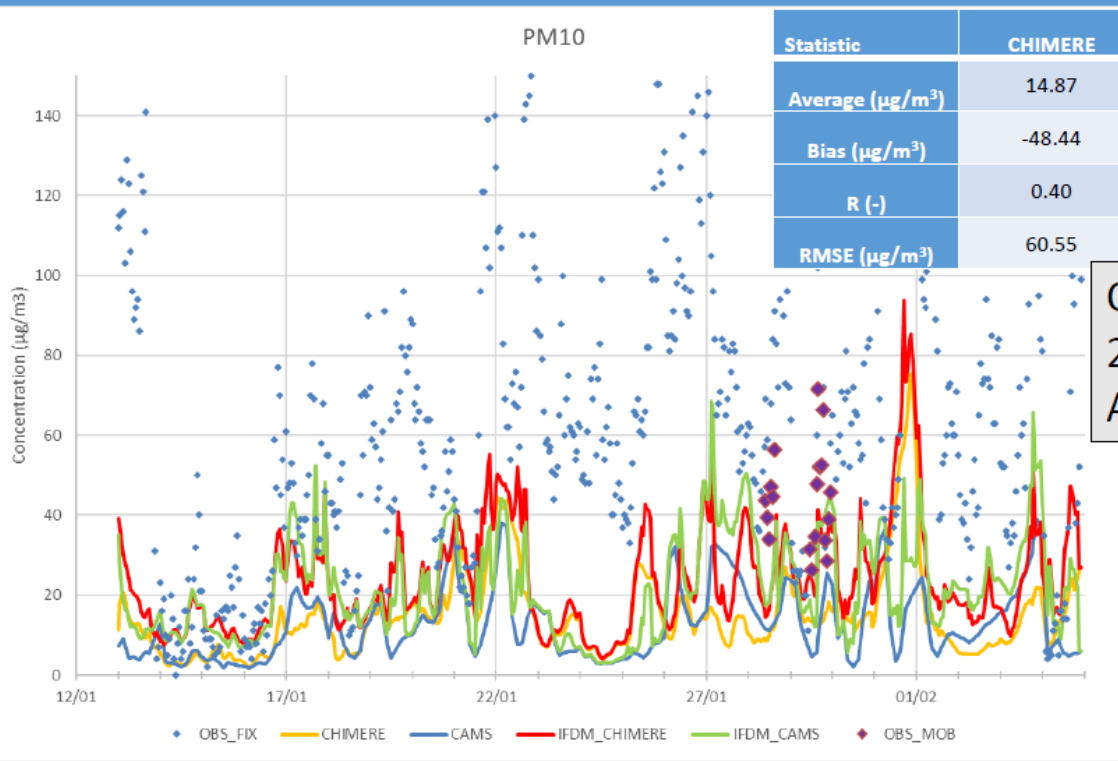
Ton/year	NO <sub>x</sub>		PM <sub>10</sub>		PM <sub>2.5</sub>	
	SNAP2	SNAP7	SNAP2	SNAP7	SNAP2	SNAP7
CAMS	4.9	10.1	21.8	0.7	21.2	0.6
EMEP	1.7	24.2	9.6	1.7	9.4	1.3

## Modelling emissions

- 1990 'houses' in Putnok
- One chimney per house
- Emission of 21.8 Ton/year is distributed evenly over the 1990 chimneys.



## RESULTS: model vs fixed station

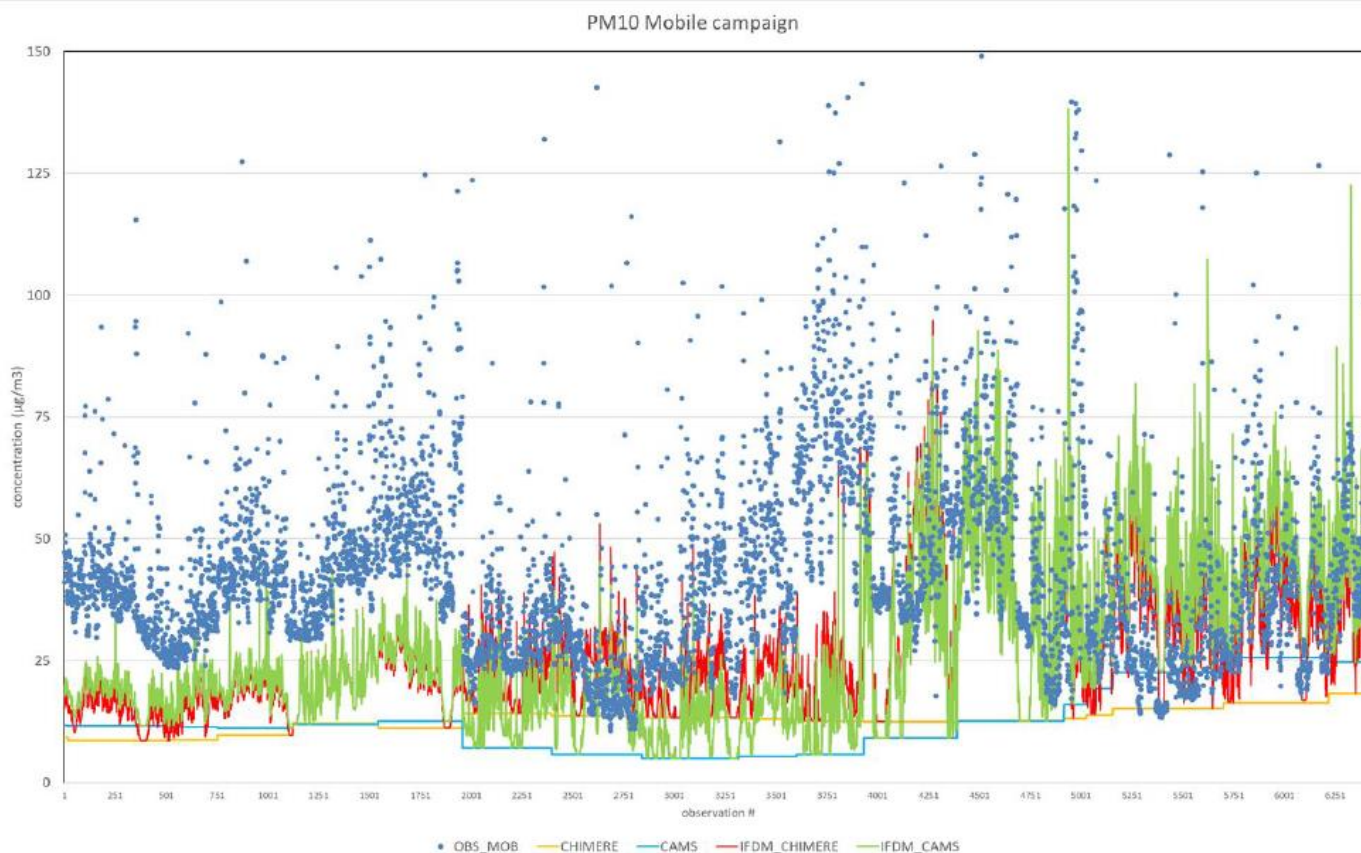


Statistic	CHIMERE	CAMS	IFDM-CHIMERE	IFDM-CAMS
Average ( $\mu\text{g}/\text{m}^3$ )	14.87	12.75	23.80	21.68
Bias ( $\mu\text{g}/\text{m}^3$ )	-48.44	-50.56	-39.51	-41.63
R (-)	0.40	0.30	0.40	0.30
RMSE ( $\mu\text{g}/\text{m}^3$ )	60.55	63.02	53.47	56.02

Observed PM10  
 2  $\mu\text{g}/\text{m}^3$  to 240  $\mu\text{g}/\text{m}^3$   
 Average: 63.31  $\mu\text{g}/\text{m}^3$

## RESULTS: model vs mobile campaign

- 6435 non-equidistant observations: x = rank instead of time
- Regional models: 1 value/hour
- Local models: 1 value/hour BUT for different locations



## Conclusions

- AQ modelling for Putnok using readily available input data and/or existing model setups: result indicative of what can be expected with current modelling practice
- Validation results:
  - In general observed values are underestimated with a negative bias of up to - 80%. This is better when we introduce local scale modelling. A negative bias could indicate that emissions are currently underestimated.
  - Correlation between modelled and observed values is limited especially for the mobile measurement campaign. The model is clearly not able to reproduce the complex spatial and temporal concentration distribution that was observed during the mobile campaign. For the mobile measurements to be useful in the context of (inverse) modelling will require a simpler measurement scheme.

**Thank you for your attention**

