

PMinter

MARIBOR, 18. - 19. SEPTEMBER 2013

www.pminter.eu



Source apportionment of PM air pollution in Slovenia and Austria using Aethalometers

Griša Močnik¹, L. Drinovec¹, I. Ježek¹, T. Dobovičnik¹, J. Sciare², J. Turšič³, G. Muri³, T. Bolte³, M. Kiestler⁴, E. Cetintas⁴, H. Bauer⁴⁺, A. Kasper Giebl⁴



Naložba v vašo prihodnost

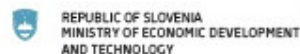
Operacijo delno financira Evropska unija
Evropski sklad za regionalni razvoj



Investition in Ihre Zukunft

Operation teilweise finanziert von der Europäischen Union
Europäischer Fonds für regionale Entwicklung

PMinter



Source apportionment of PM air pollution in Slovenia and Austria using Aethalometers

PMinter, Maribor, September 2013

Griša Močnik¹, L. Drinovec ¹, I. Ježek¹, T. Dobovičnik¹, J. Sciare², J. Turšič³, G. Muri³, T. Bolte³, M. Kiestler⁴, E. Cetintas⁴, H. Bauer^{4†}, A. Kasper Giebl⁴

¹ Aerosol d.o.o., Slovenia

² LSCE CNRS-CEA-IPSL, France

³ Environmental Agency of Republic of Slovenia

⁴ TU Wien, Austria



grisa.mocnik@aerosol.si

Aerosol Black Carbon

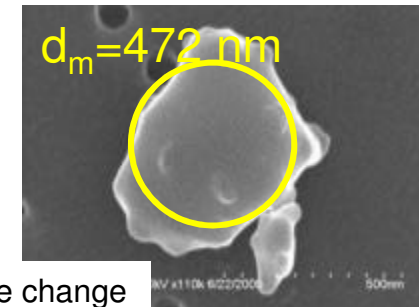
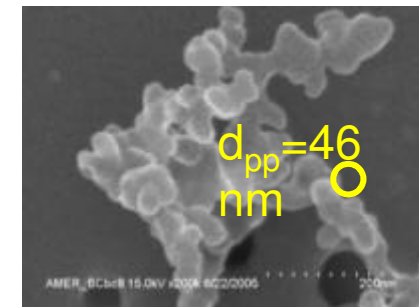
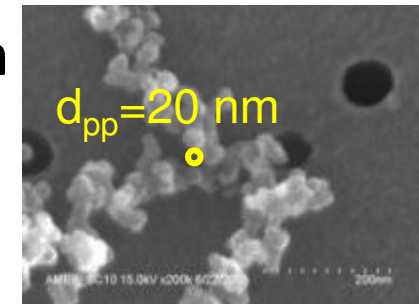
- BC is a **primary** product of incomplete **combustion**
- BC not automatically related to CO₂ emission
- BC emissions can not be predicted:

must be measured

- BC particles from different sources can have different characteristics that produce different effects in the atmosphere:

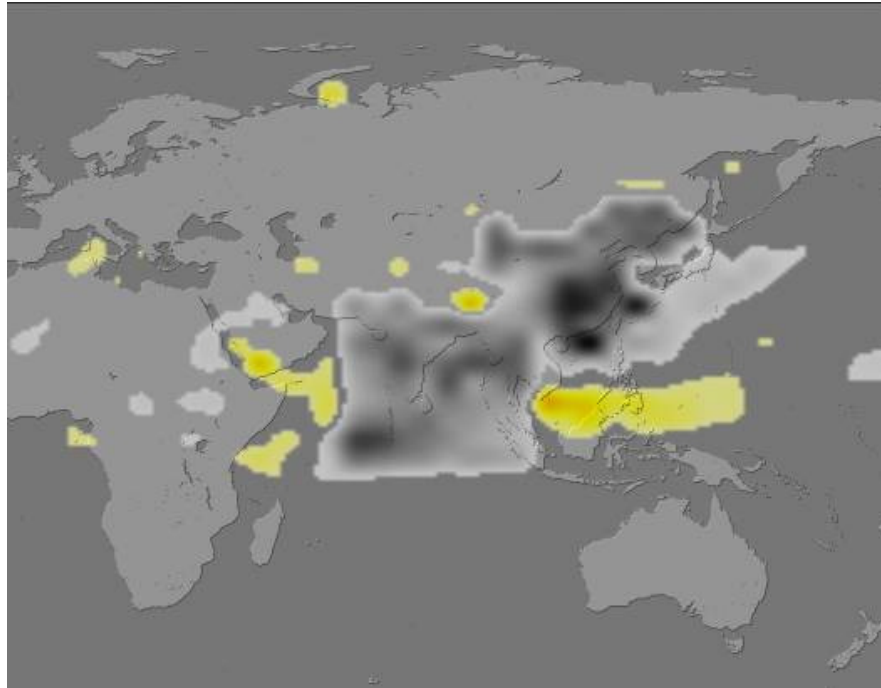
(Coal/Diesel/Biomass, USA/Asia/Europe)

- **relevance:** climate change, health



Note change
in scale

Climate Change Effects of Aerosols



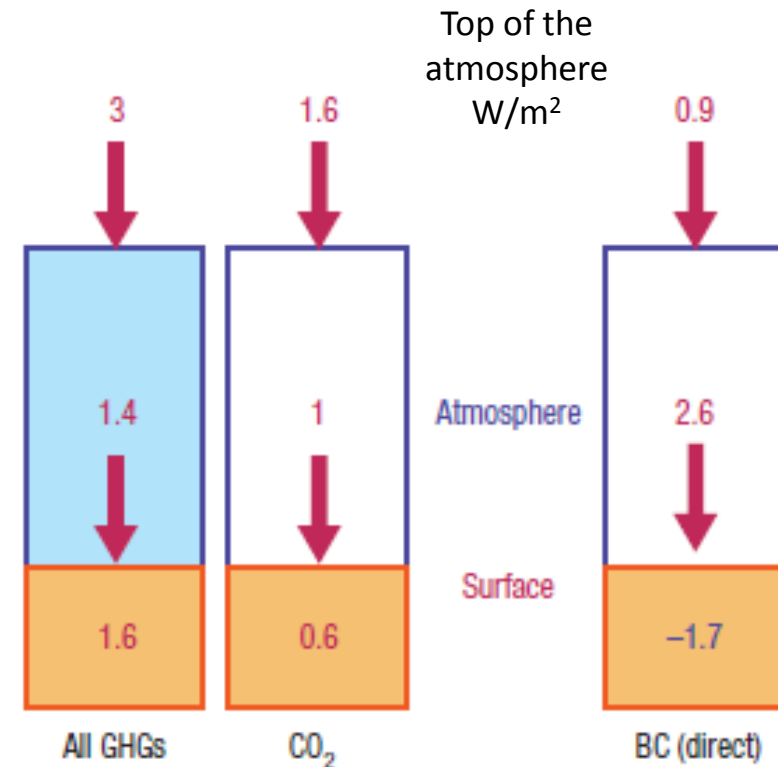
S. Menon, J. Hansen et al. *Science* (2002) 2250

Haze over Asia: up to 40% of sunlight absorbed. Crop yields reduced ; local rainfall changed.

Total BC forcing:
direct + indirect

1,1 W/m²

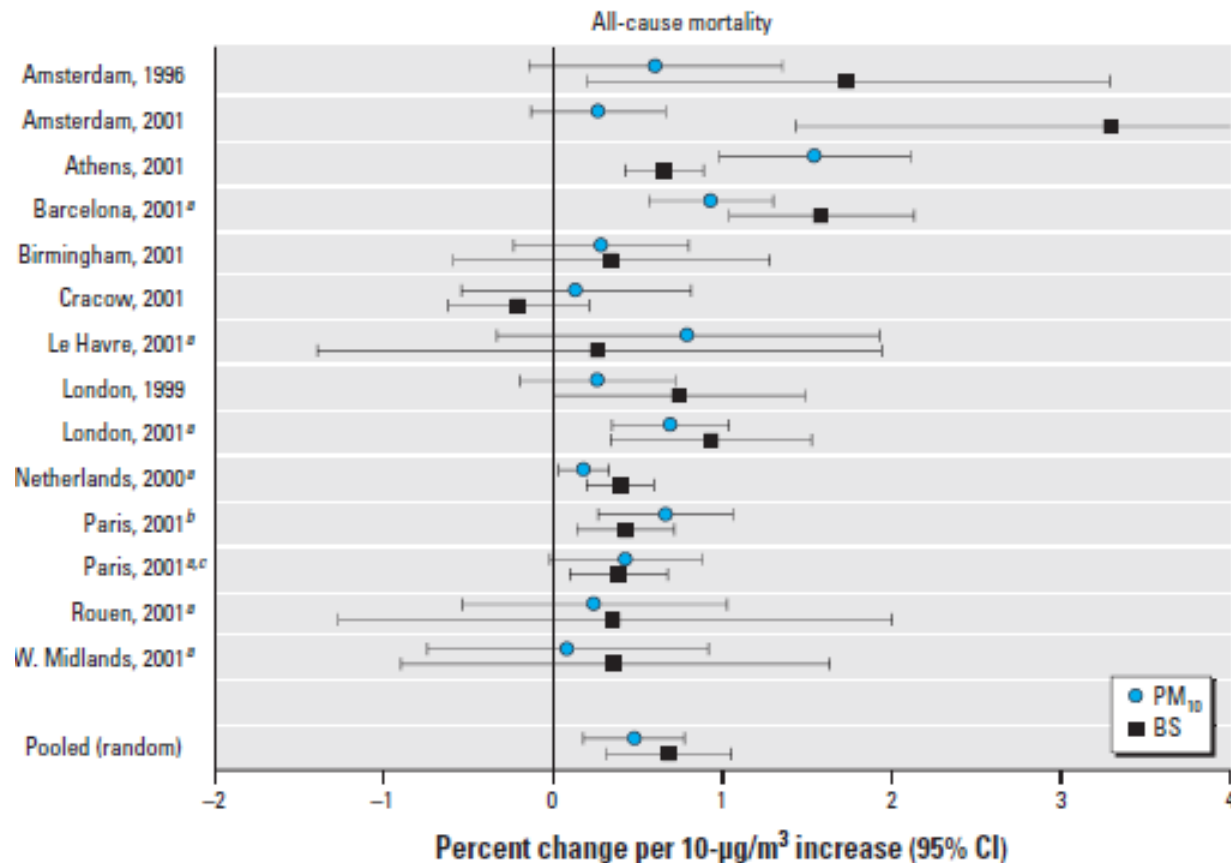
(Bond et al 2013)



V. Ramanathan, G. Charmichael, *Nature Geosci* (2008) 221

BC forcing is almost 1/3 of the total TOA GHG forcing!
Heat redistribution → weather

Health Effects



Dockery et al., *N. Engl. J. Med.* 329: 1753 (1993)

Mortality Ratio

Mortality

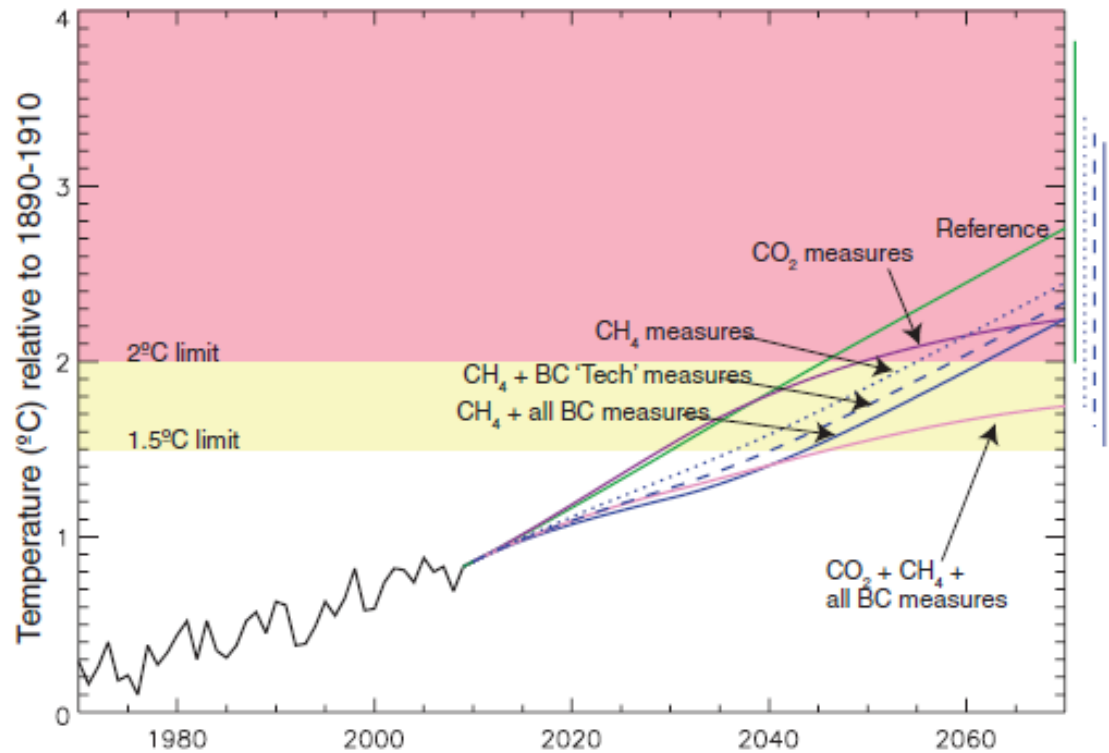
Highest vs. Lowest PM

All causes	1.26
Lung cancer	1.37
Other cardiopulmonary	1.37
Non-cardiopulmonary	1.01

Two-pollutant models in time-series studies suggested that the effect of BCP was more robust than the effect of PM mass. The estimated increase in life expectancy associated with a hypothetical traffic abatement measure was four to nine times higher when expressed in BCP compared with an equivalent change in PM_{2.5} mass.

Jansen et al, 2011 EHP

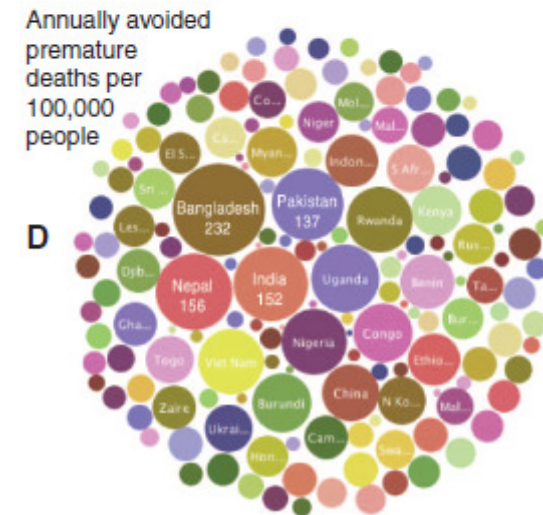
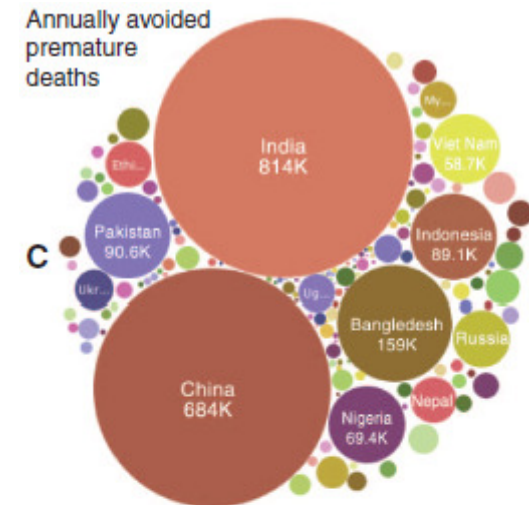
Climate & health!

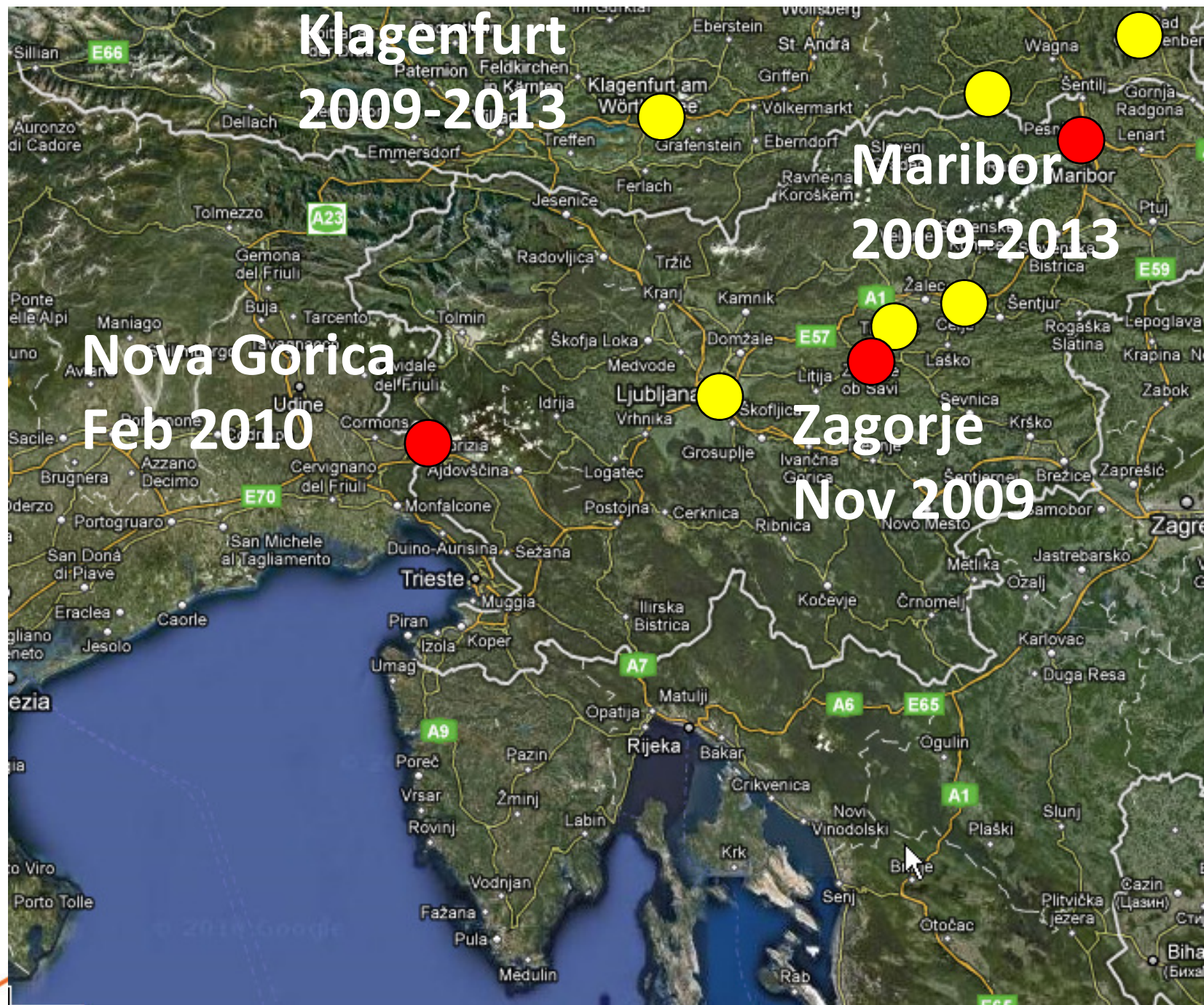


Drew Shindell, *et al.*

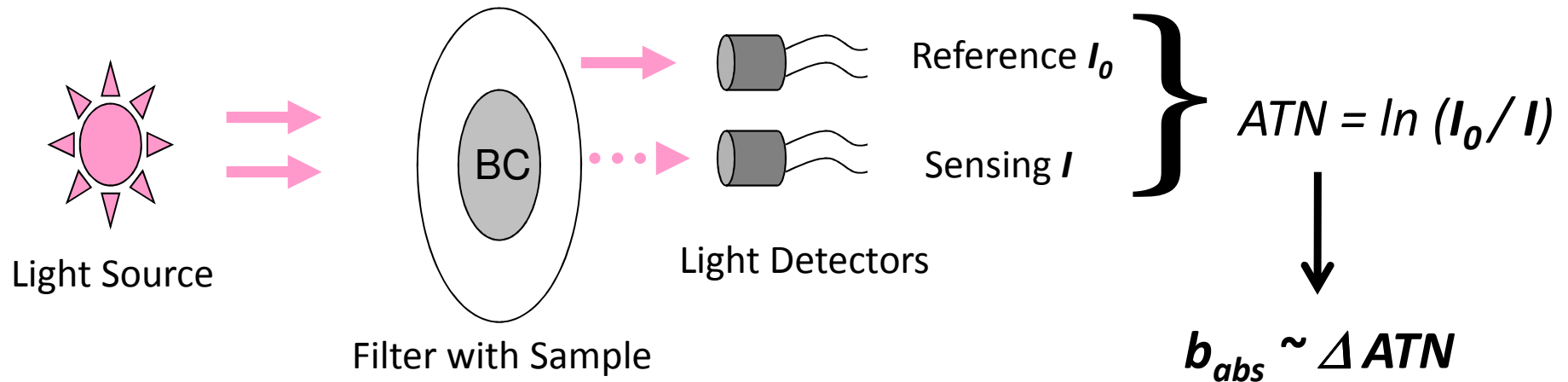
Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security

Science **335**, 183 (2012);





Optical detection of BC: Aethalometer™

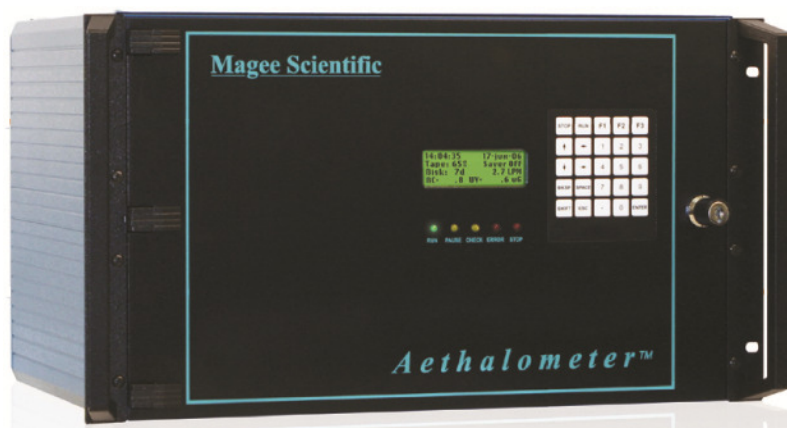


- Collect sample **continuously**.
- ***Optical absorption*** $\sim$ change in ATN.
- Measure optical absorption **continuously** : $\lambda = 370$ to 950 nm.
- Convert ***optical absorption*** to ***concentration of BC***:

$$BC(t) = b(t) / \sigma$$

- Real-time data: **minutes**
 - Dynamical, real-time measurement, updated each period

Aethalometer – Continuous rack mount instruments

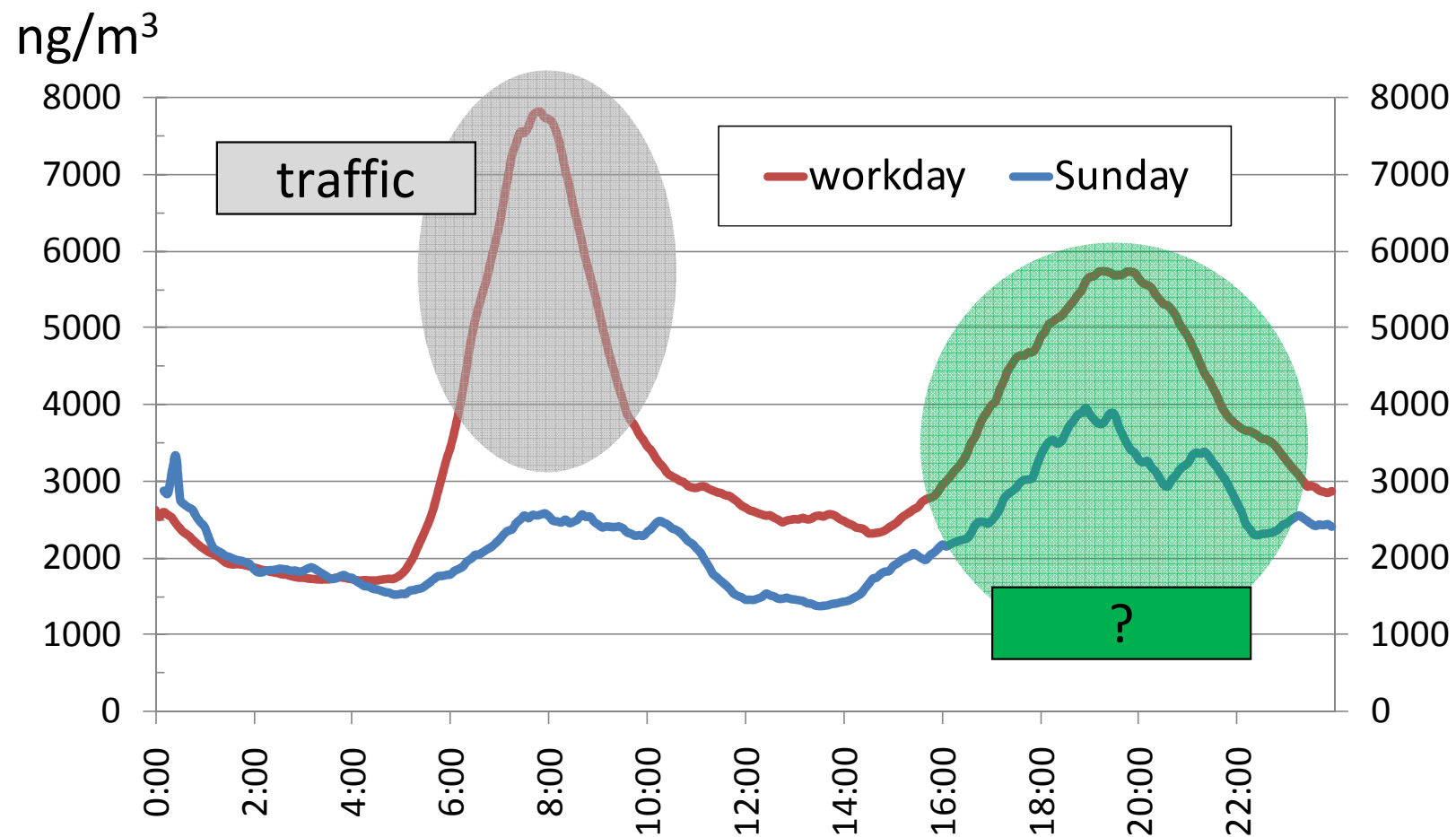


AE31 & AE33 – Ambient Air Quality Monitoring

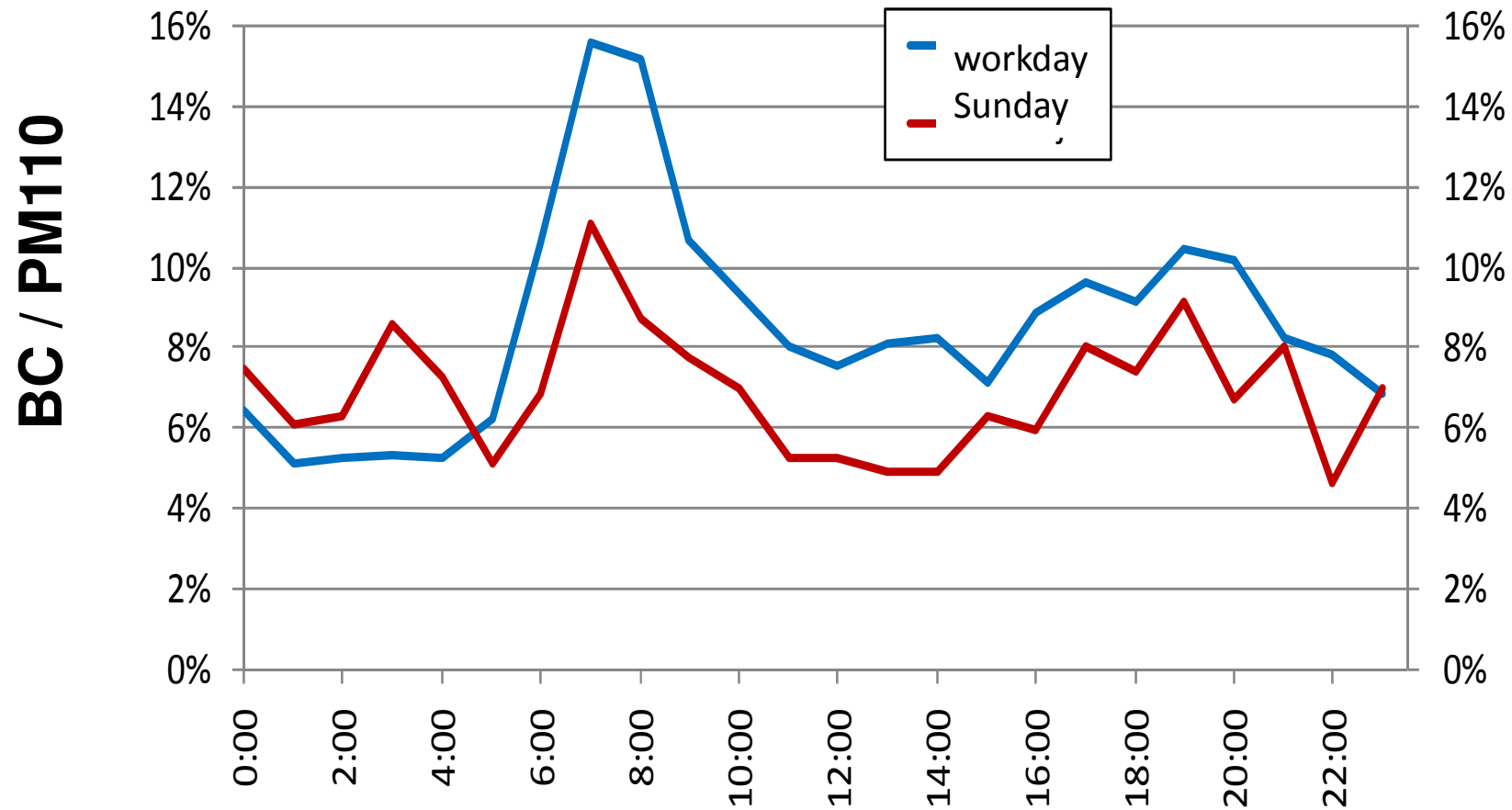
- ✓ *Seven wavelength (370, 470, 520, 590, 660, 880, and 950 nm)*
- ✓ *Local source identification*
- ✓ *Regional, Continental, Global Atmospheric studies*
- ✓ *Particle size distribution, radiative transfer*
- ✓ *Climate change, albedo, cloud modification*



BC in Nova Gorica – diurnal variation



Composition of PM10 changes during the day!



Biomass is globally a major energy source

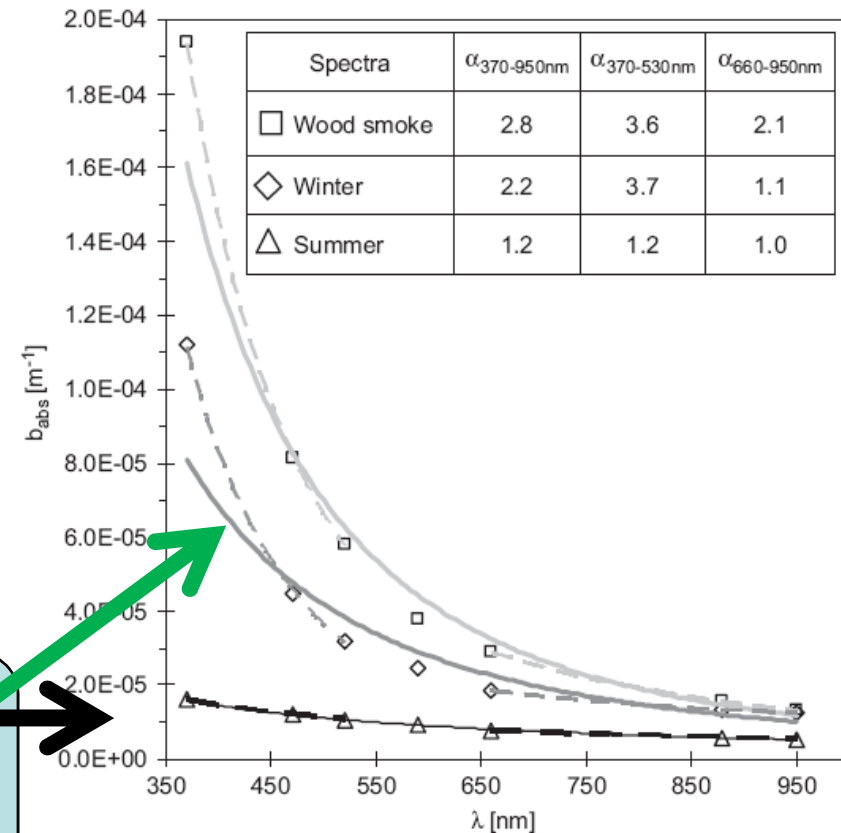


Biomass-smoke vs. diesel - 7λ

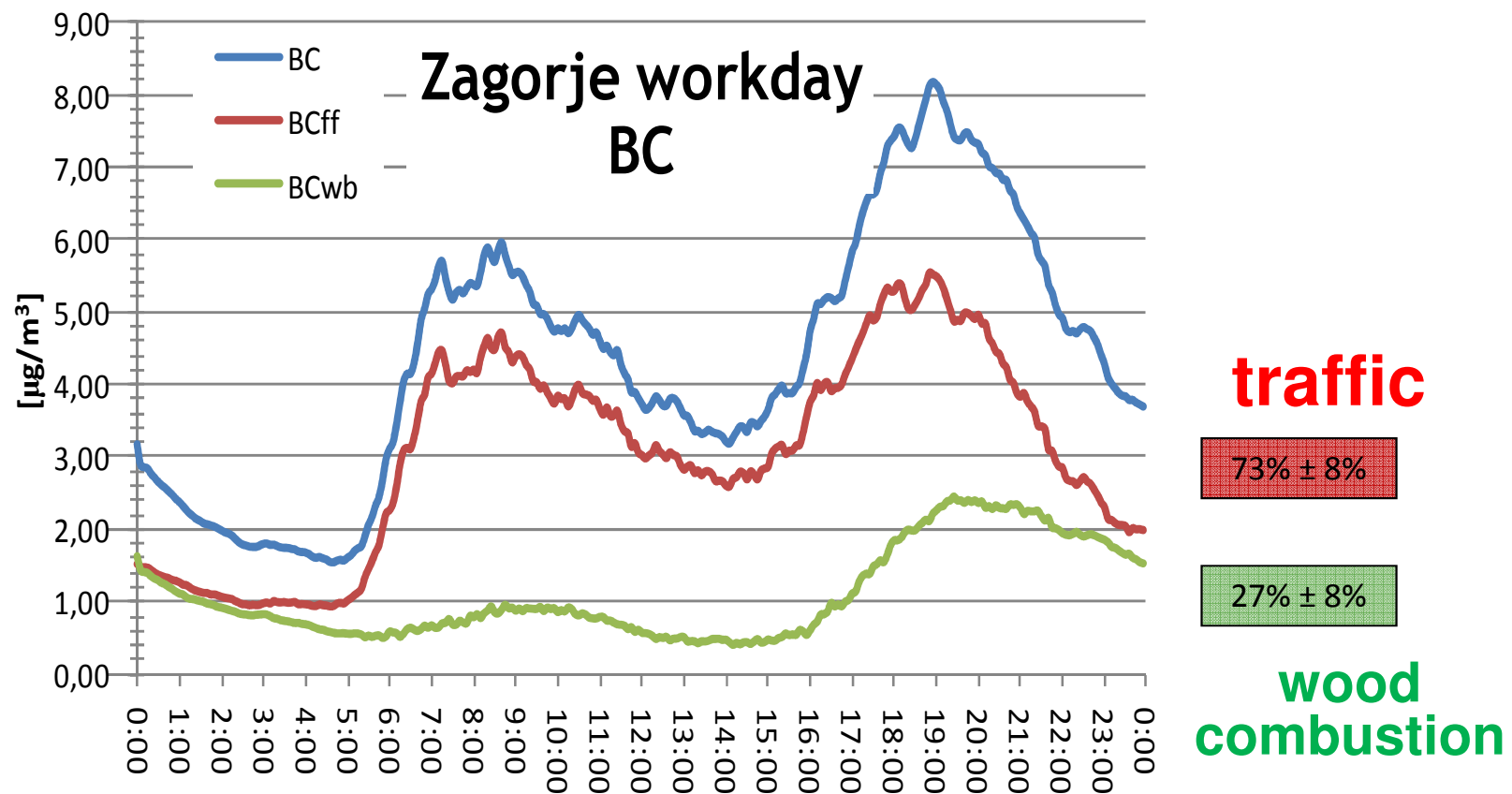
- measure attenuation with the Aethalometer
- absorption coefficient - b_{abs}
- for pure black carbon: $b_{abs} \sim 1/\lambda$
- generalize **Angstrom exponent**:
$$b_{abs} \sim 1/\lambda^\alpha$$

diesel: $\alpha \approx 1$

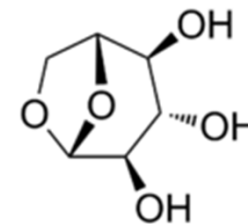
biomass-smoke: $\alpha \approx 2$ and higher



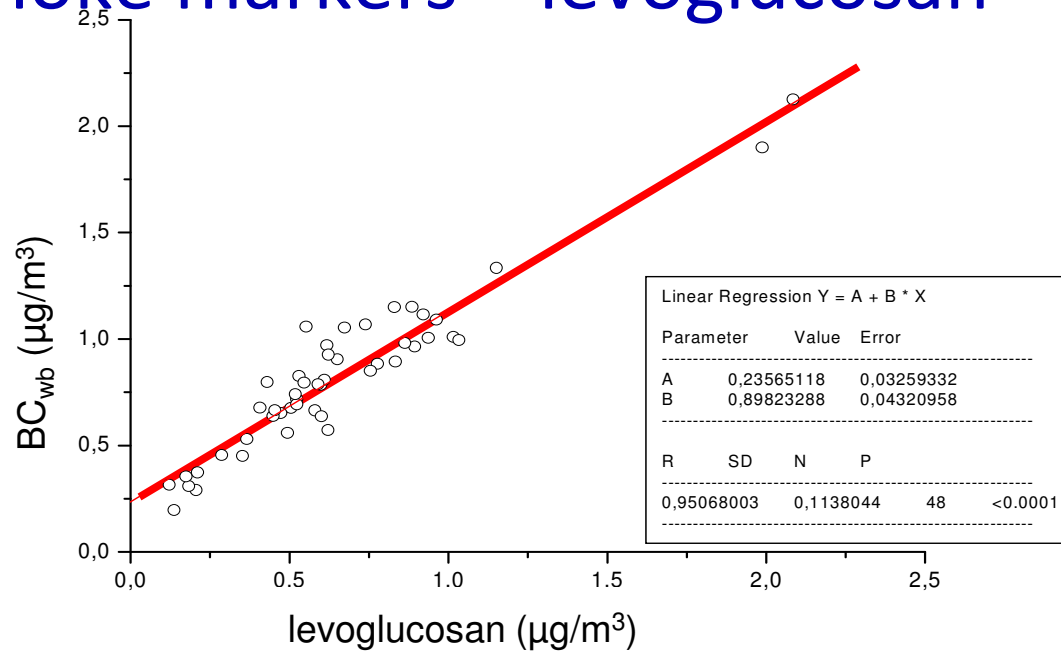
Source apportionment: which sources to regulate?



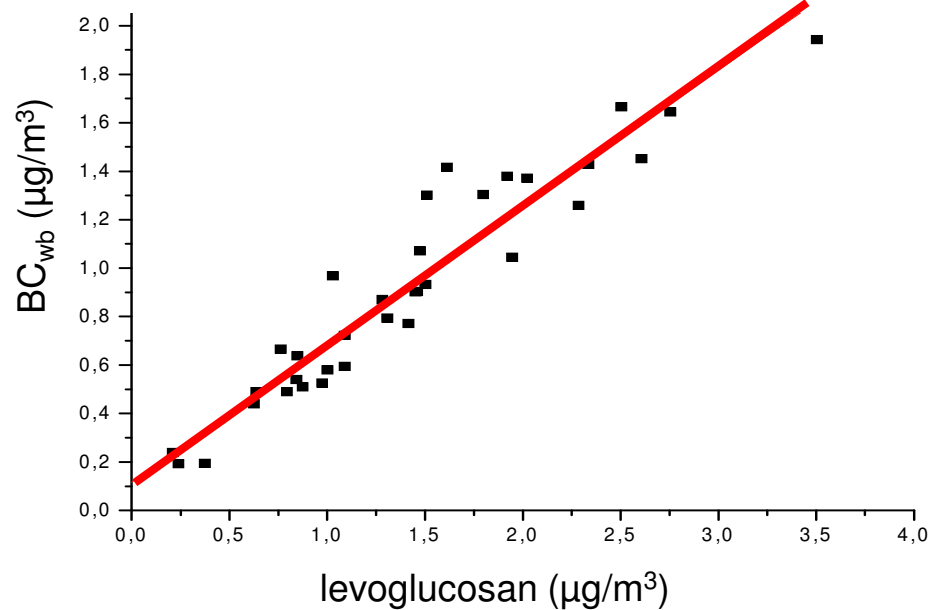
Wood-smoke markers – levoglucosan



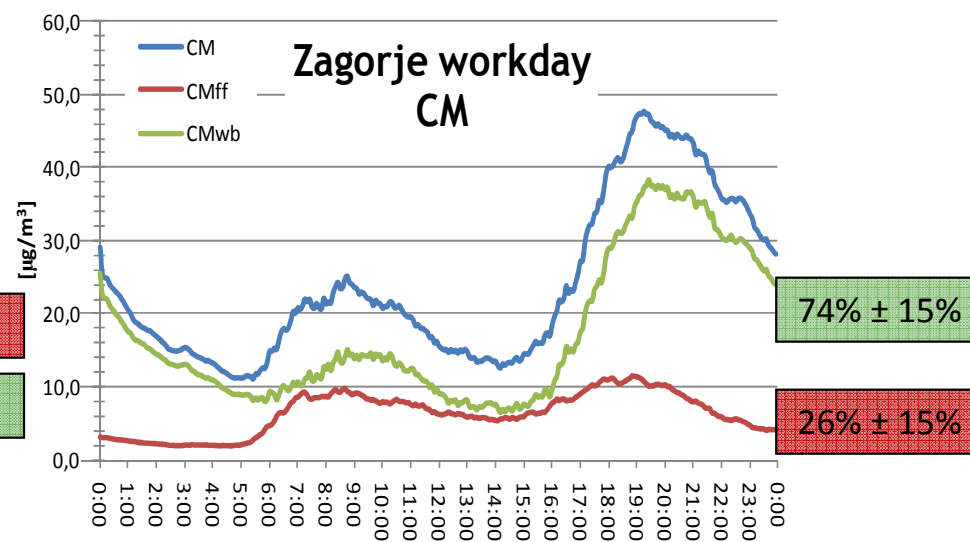
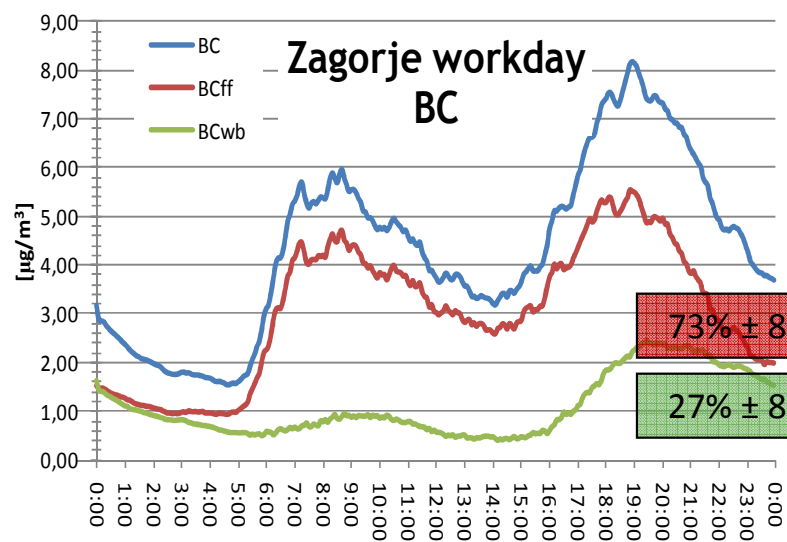
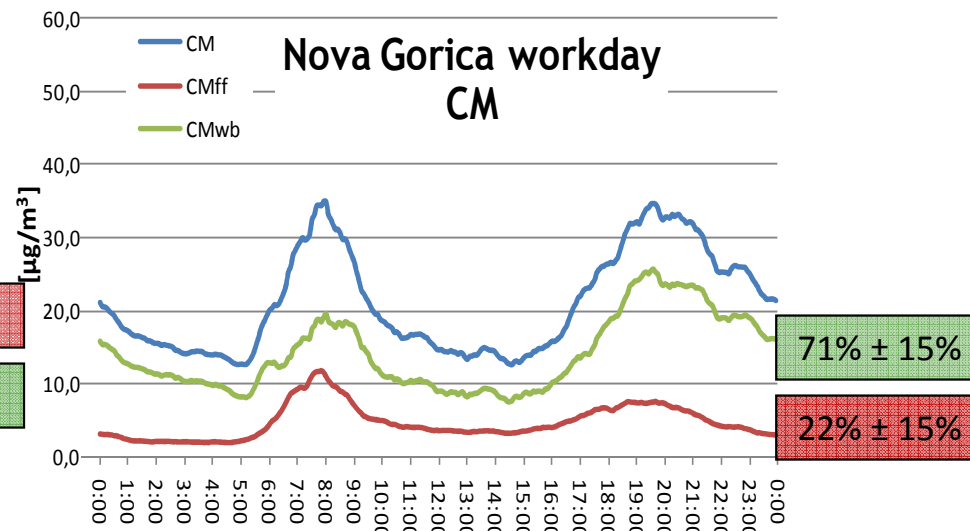
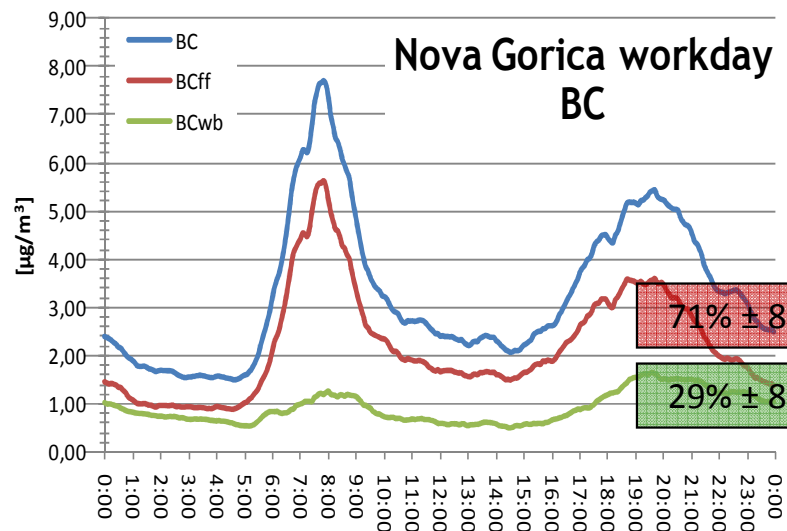
Nova Gorica



Zagorje

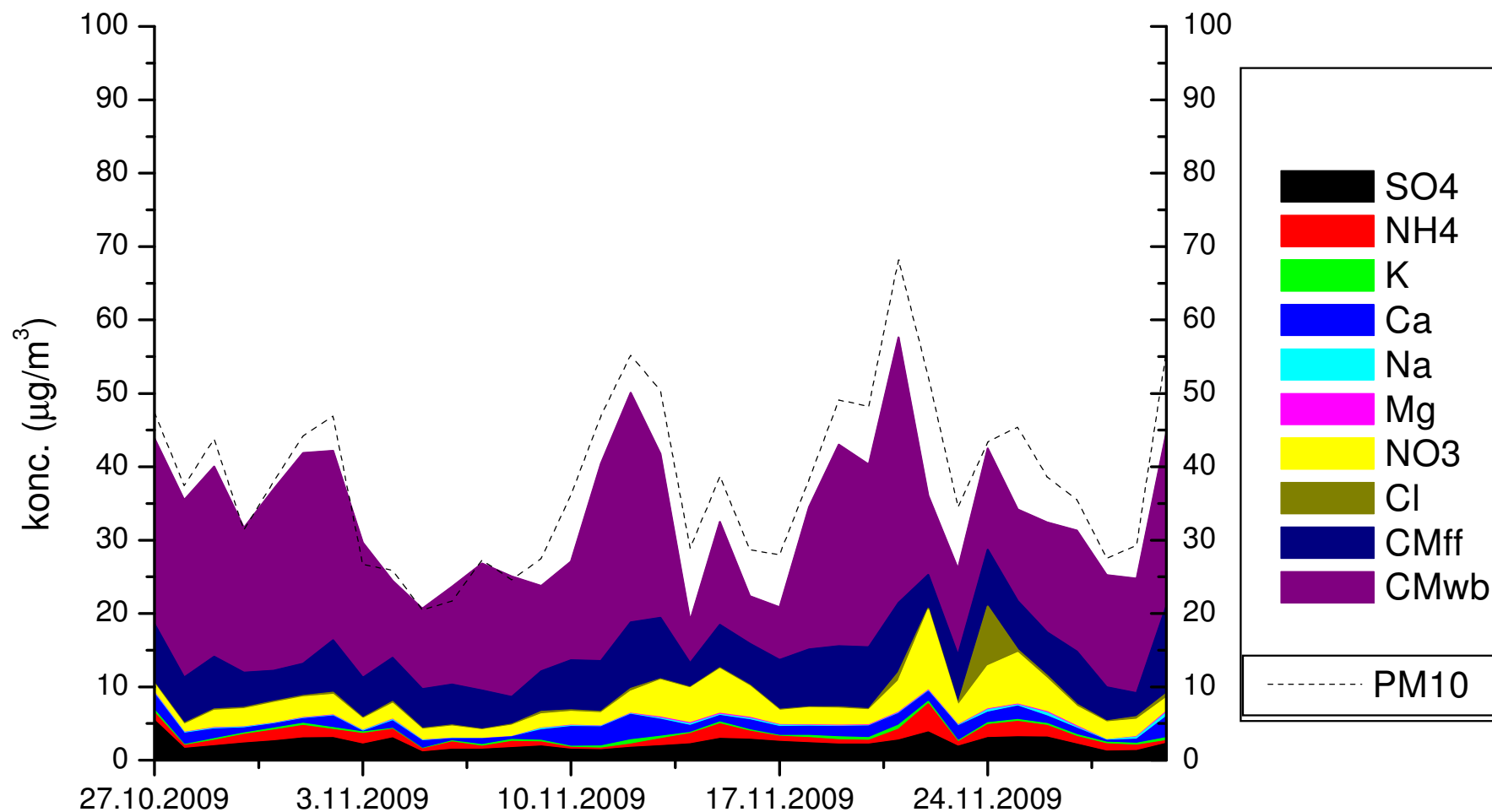


Levoglucosan - ion
chromat. EARS

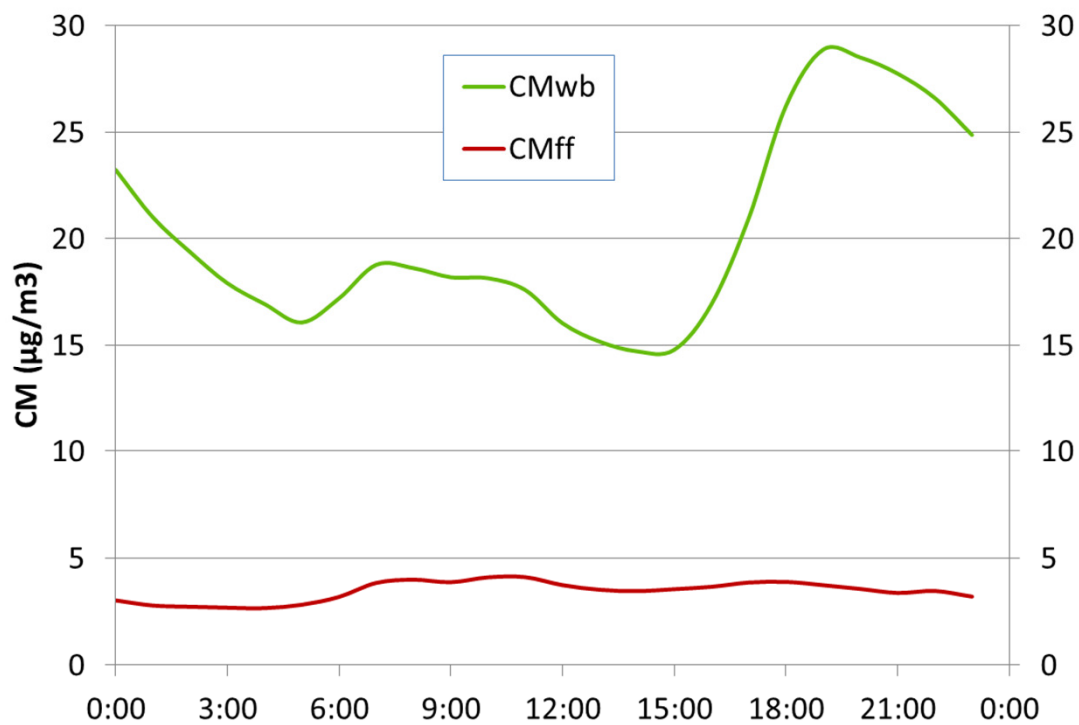


Mass closure - Zagorje

Filter chemical analysis- EARS





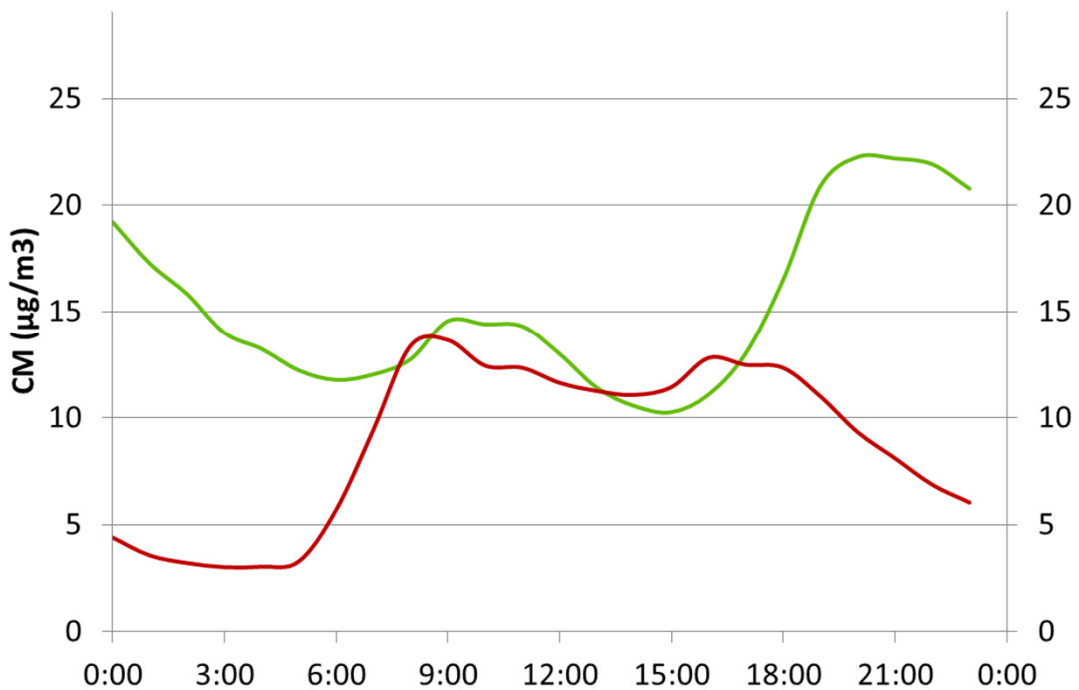


85% ± 16%

Vrbanski plato

15% ± 16%

2010-2011



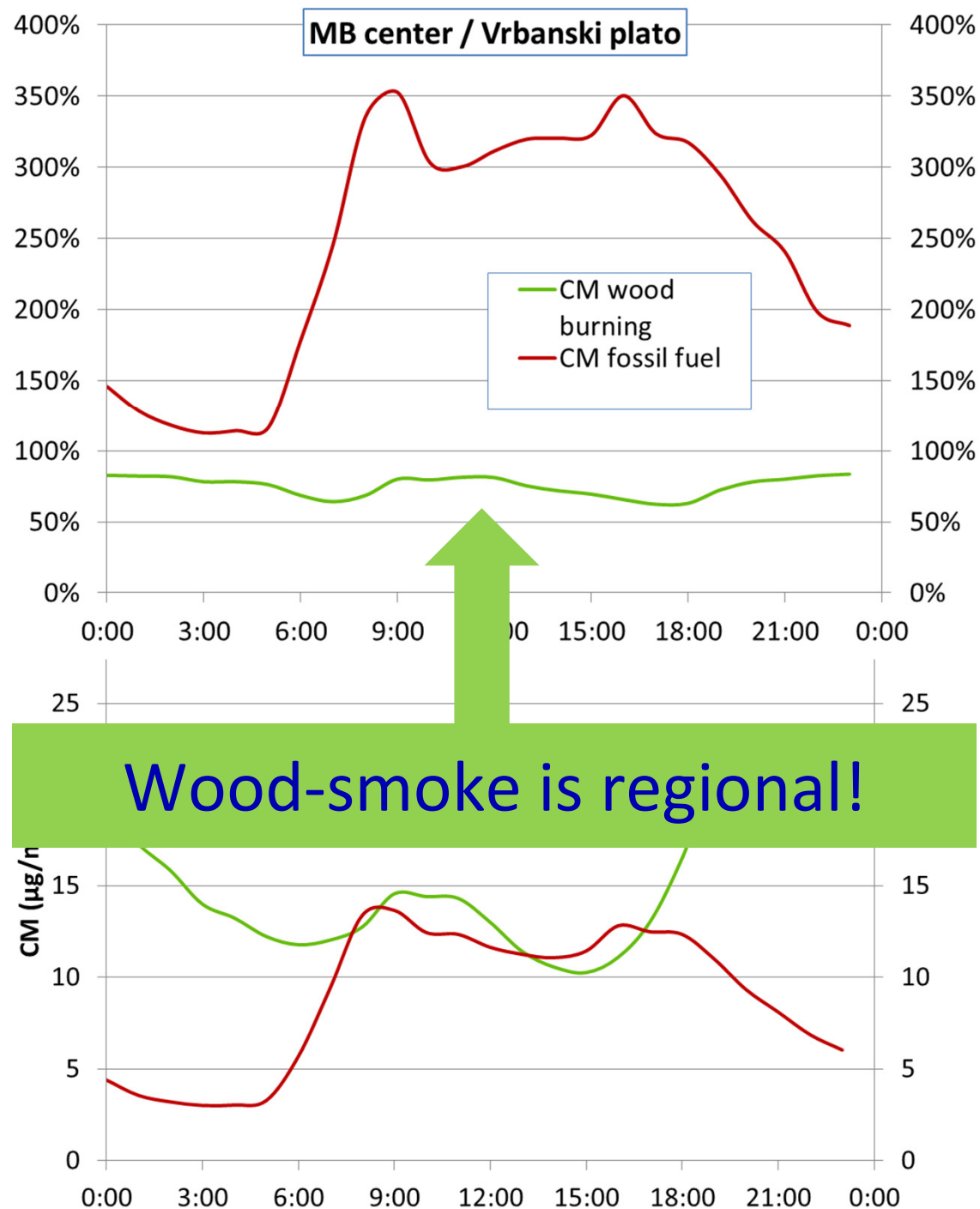
63% ± 16%

Maribor

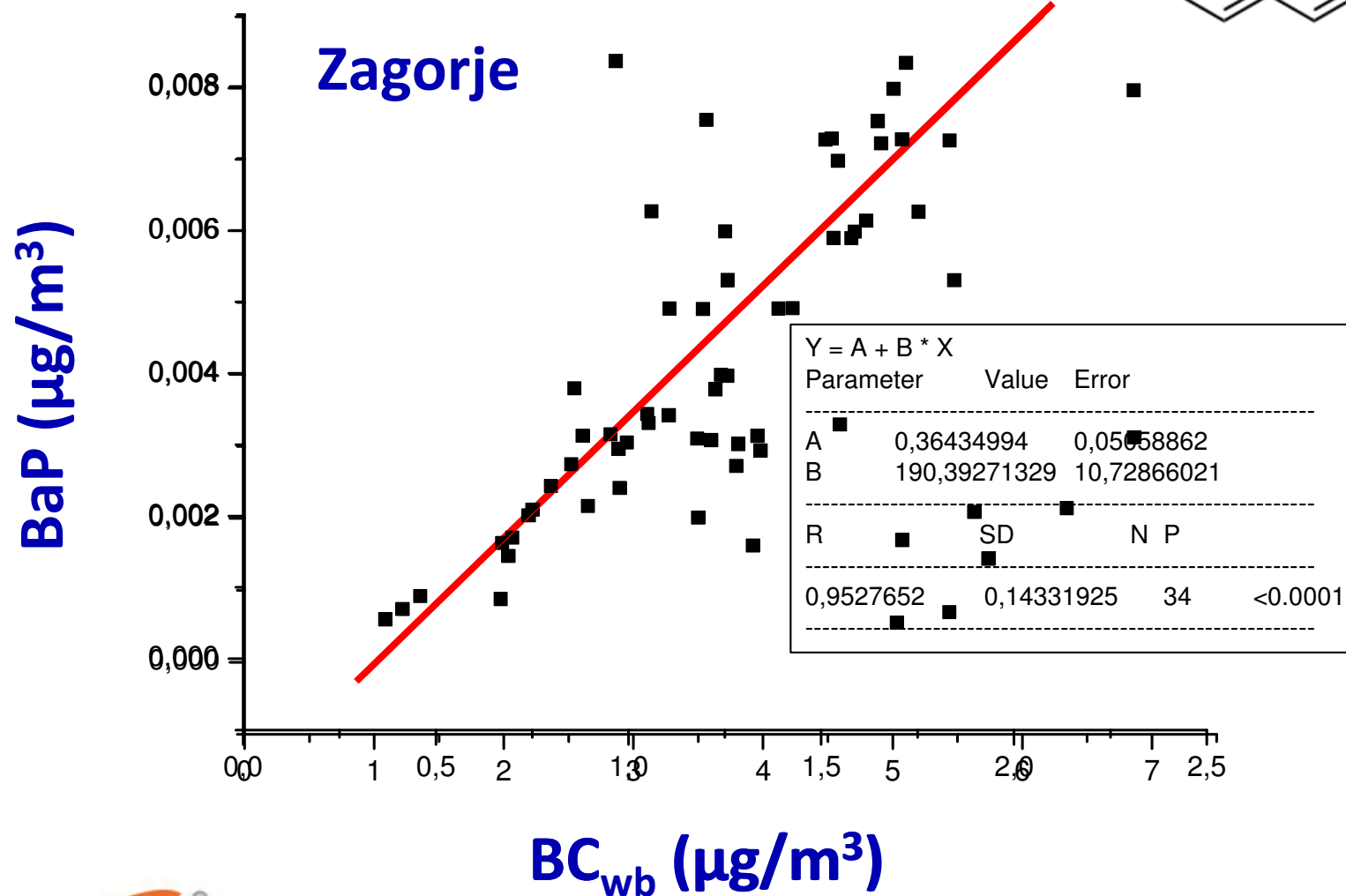
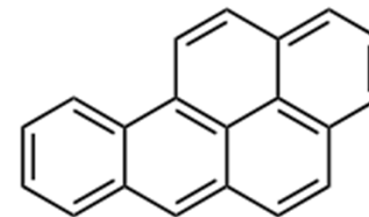
37% ± 16%

Ratio:
city / background

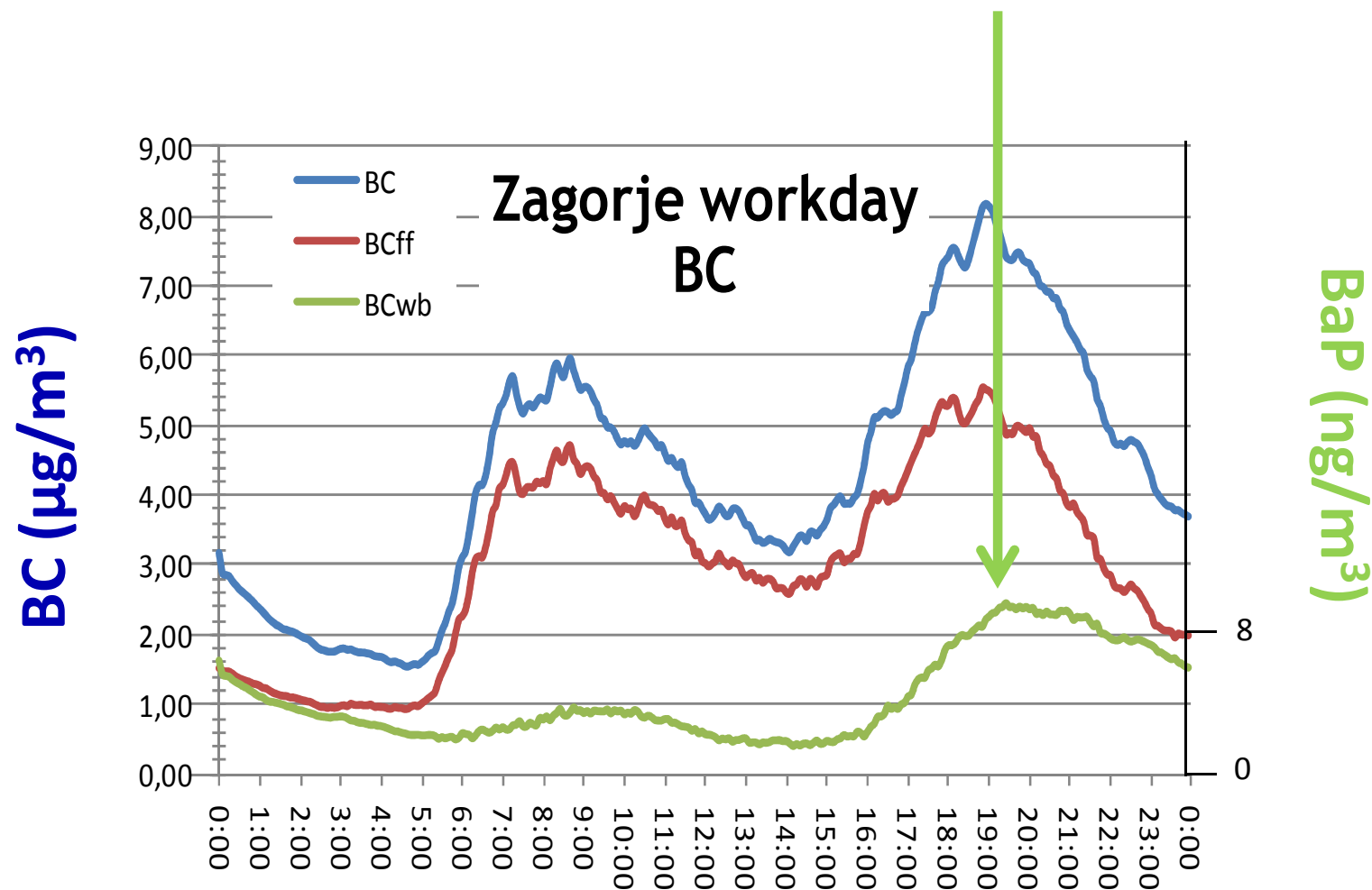
Maribor, SI
2010-2011



PAH – what is the source?



Diurnal variation of $BC_{wb} = BaP$



Conclusions

- source apportionment, “Aethalometer model”: **biomass vs. diesel**, excellent correlation with markers
- time resolution is **1 min**
- we can investigate **time evolution, spatial distribution**: BC, CM
- **correlation** between different pollutants: **PAH source**
- **quantitative Wood-Smoke determination** – “Aethalometer model” CM time resolution: 15 min
- the new dual-spot Aethalometer AE33 with **real-time loading compensation** was developed, online source app.
- technical improvements facilitate **monitoring**



Thank you for your attention!

Questions?

Aerosol d.o.o.
Kamniška 41
SI-1000 Ljubljana
Slovenia

tel: +386 59 191 220

fax: +386 59 191 221

grisa.mocnik@aerosol.si



Heating oil price in Slovenia: 2007-2013

Gibanje cene

Gibanje cen kurilnega olja

☒ Kurilno olje



☒ Kurilno olje