

# Harmonization and source apportionment of eBC particles in European cities in the frame of the RI-URBANS project



M.Savadkoohi, A.Alastuey, M.Pandolfi, X.Querol and the RI-URBANS Team





# Map of Europe Available eBC data



## Country

13 European Countries



## Site/Station

50 sites/station  
(UB/SUB/T/R)



## City

31 European Cities



## Instrument

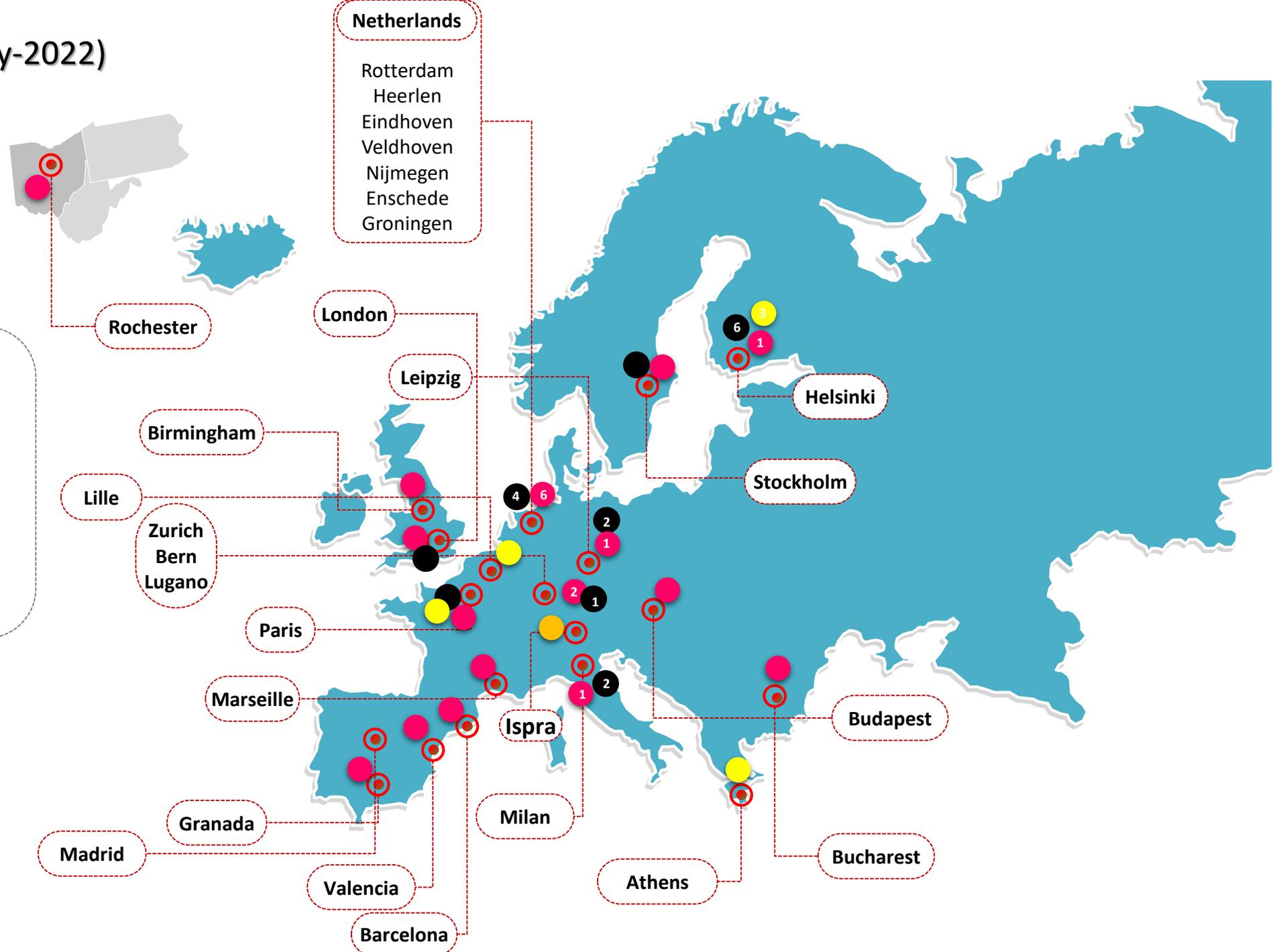
AE33-AE31-AE21-MAAP



# eBC Data Availability (July-2022)

**Sites/Stations**

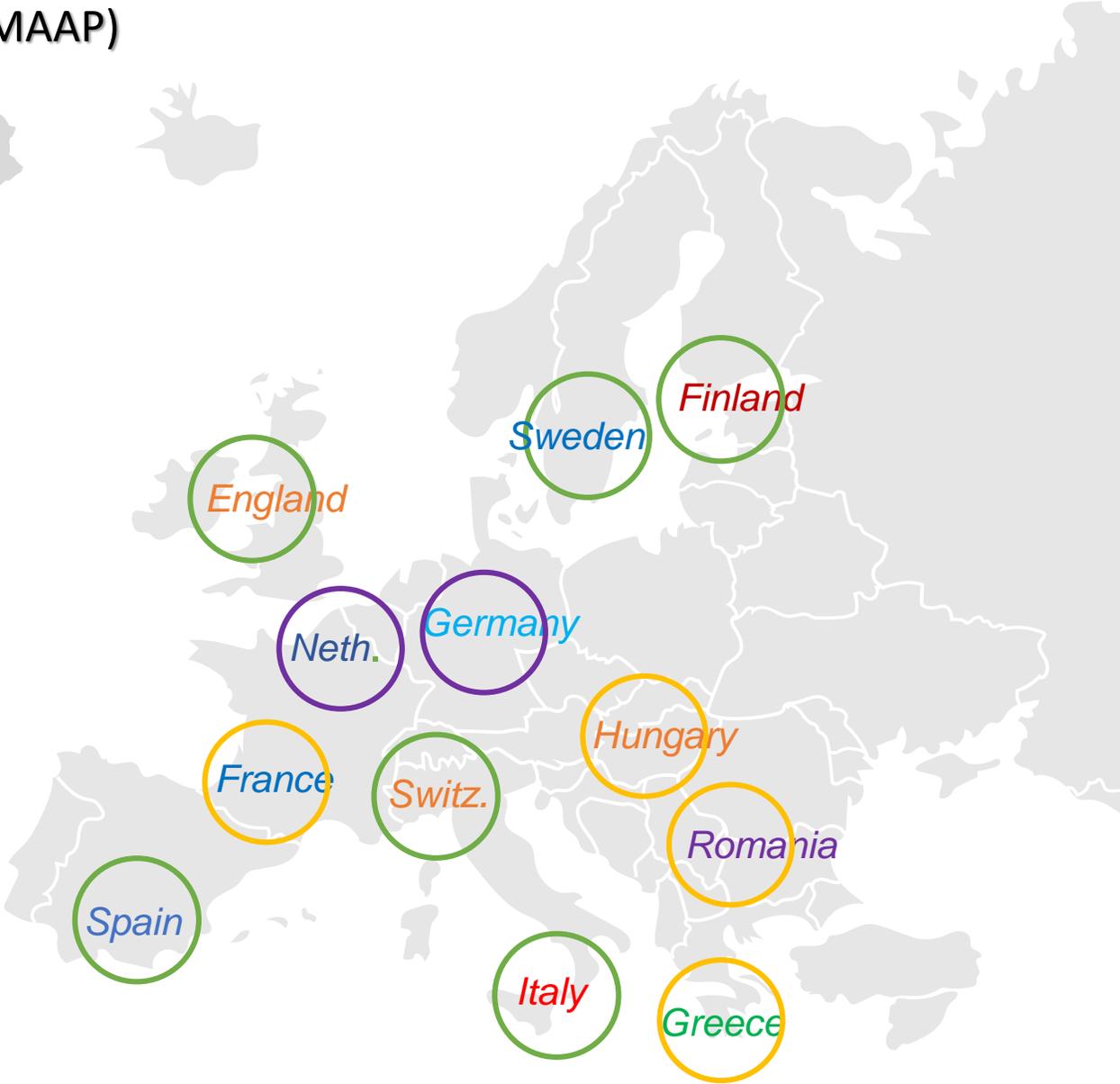
- Traffic (T=18)
- Urban (UB=23)
- Suburban (SUB=8)
- Rural (R=1)



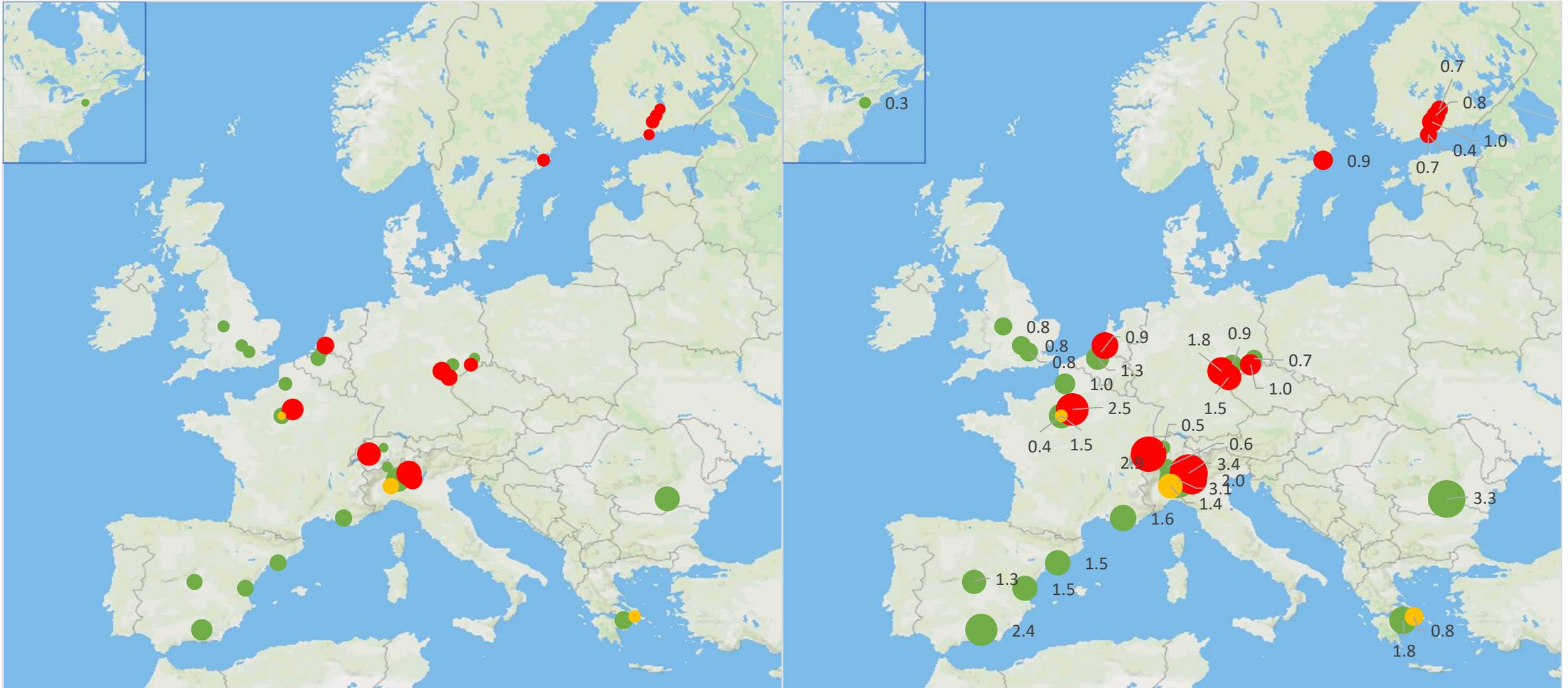
eBC Data Availability based on Instruments derived from optical methods (Filter-based aethalometer, MAAP) (July-2022), RI-URBANS

**Instrument**

- MAAP-AETH
- AETH33-31-21
- MAAP

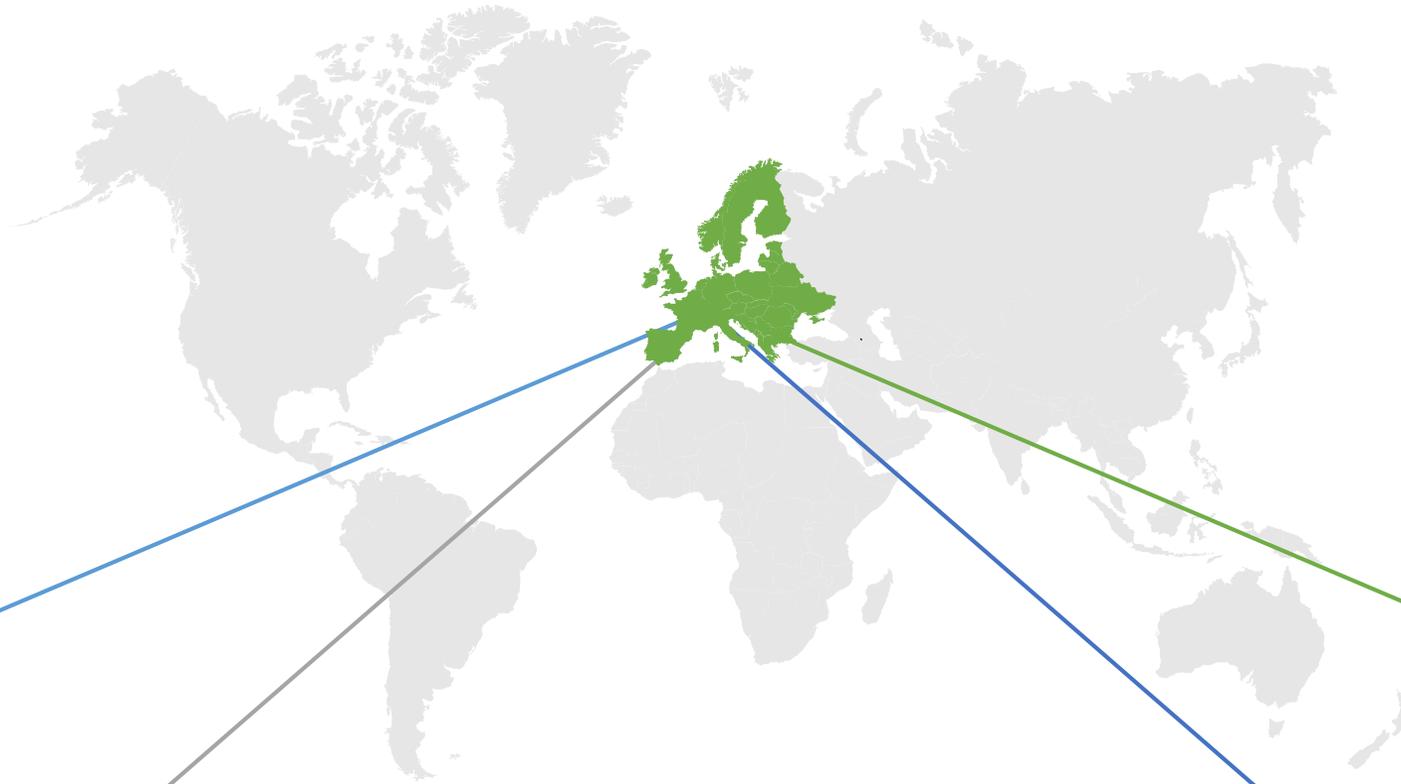


# Map with eBC concentrations (Nominal MAC)





# Overview



eBC Concentrations  $\mu\text{g}/\text{m}^3$

Site dependent MAC  
(RI-URBANS cities)

Providing an average  
"urban" MAC

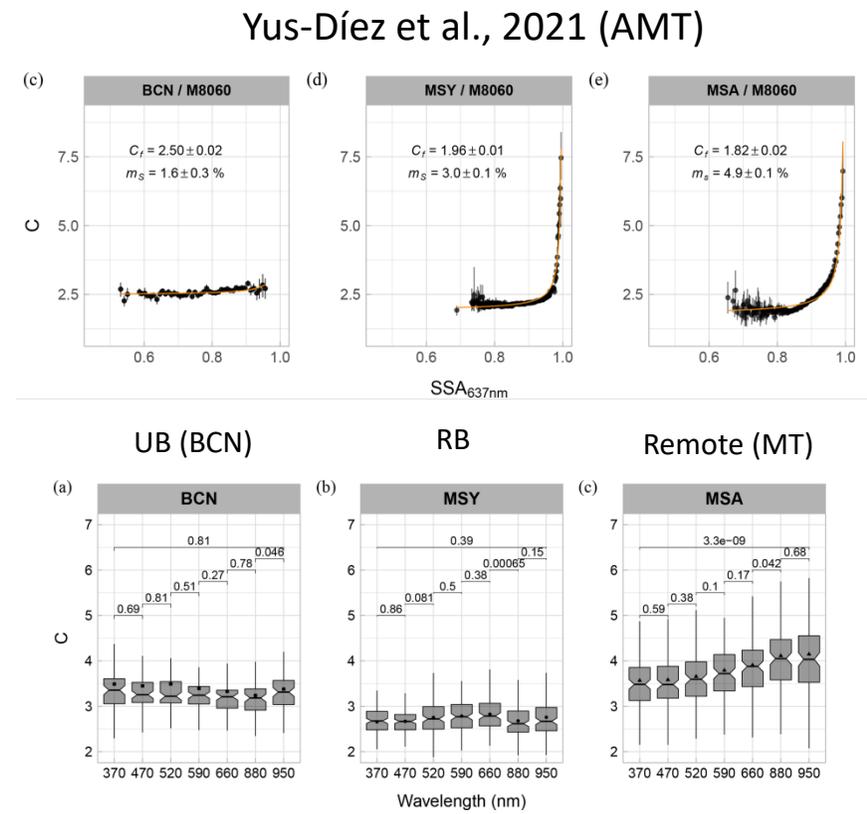
Calculate Rolling MAC  
Recalculate eBC with  
rolling MAC

# Motivation

- 1 eBC provided by filter-based photometers (AE33 and MAAP)
- 2 eBC calculated from **absorption** using specific **MAC** values
- 3 We need a good estimation of the absorption
- 4 We need a good estimation of the MAC
- 5 eBC source apportionment techniques (Sandradewi, PMF)

➤ Which AAEff and AAEwb ?  
 ➤ Here we used 1 and 2.  
 ➤ Possibility to define site-specific AAEff and AAEwb from AAE frequency distribution data.

➤ Both AE33 and MAAP use specific MAC values.  
 ➤ But MAC can change from site to site: Zanatta et al. (2016) proposed a mean value of 10 m2/g using data from RB sites.  
 ➤ We can provide MAC values for RI-URBAN sites (urban sites) where EC concentration data are available.



- MAAP directly provide absorption.
- AE33 calculate absorption from ATN measurements (HARMONIZATION FACTOR H = 0.57 – ACTRIS)
- But C (or H) changes depending on the physical properties of particles collected on the filter tape and could be I-dependent.



## Deriving Absorption and MAC from “RI-URBANS” cities

### MAC calculated from EC and Absorption data

#### □ Absorption:

$$\text{Abs (MAAP) [637 nm]} = [\text{BC}] * 6.6 * 1.05$$

$$\text{Abs(AE33; M8060) [880 nm]} = [\text{BC}] * \text{MAC} / \text{H1} \text{ (H harmonization factor = 0.57 )}$$

$$\text{Abs(AE33; M8020) [880 nm]} = [\text{BC}] * \text{MAC} / \text{H2} \text{ (H harmonization factor = 2.21 )}$$

$$\text{Abs(AE21) [880 nm]} = [\text{BC}] * \text{MAC} / \text{H3} \text{ (H harmonization factor = 3.5 )}$$

#### □ MAC:

$$\text{MAC} (\lambda) = \text{Abs} (\lambda) / \text{EC} \text{ } (\lambda = 637 \text{ nm and } 880 \text{ nm})$$

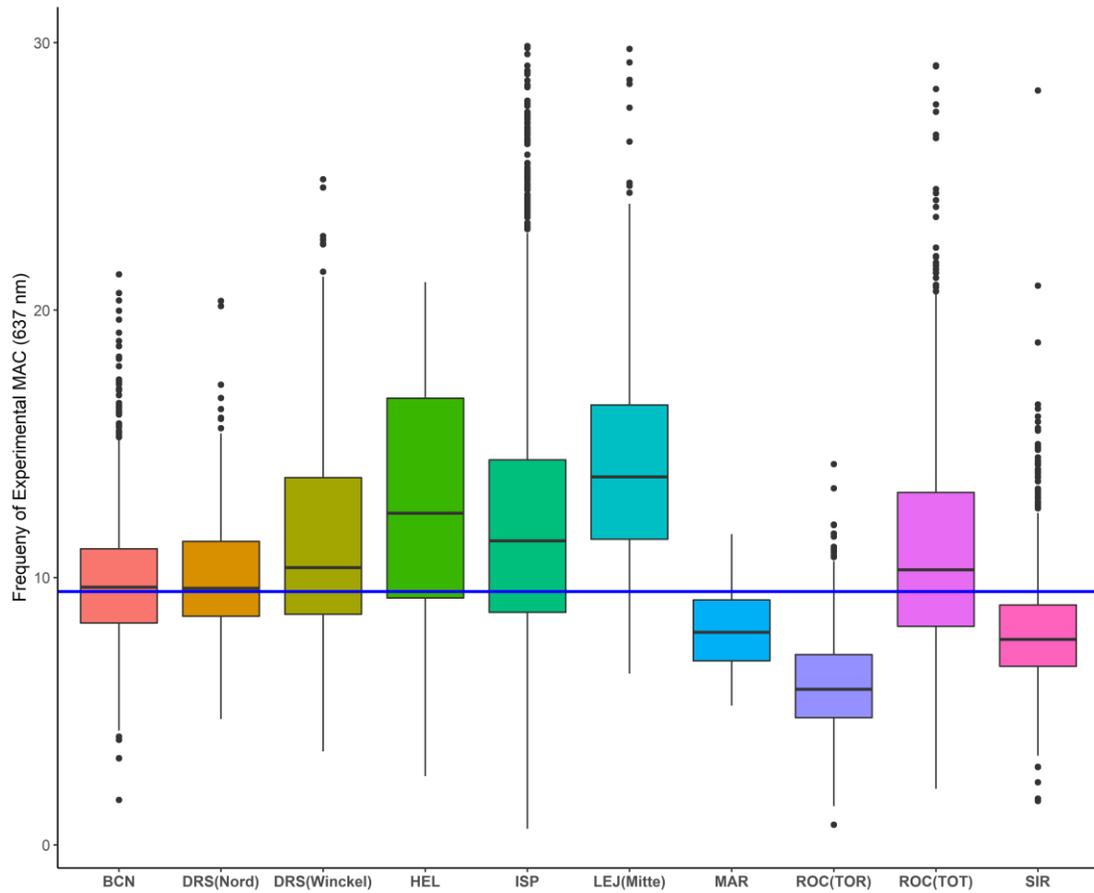
$$\text{MAC}[637 \text{ nm}] = \text{MAC}[880] * 880 / 637 \text{ (AAE = 1)}$$

# ➤ Average MAC from “RI-URBANS” cities

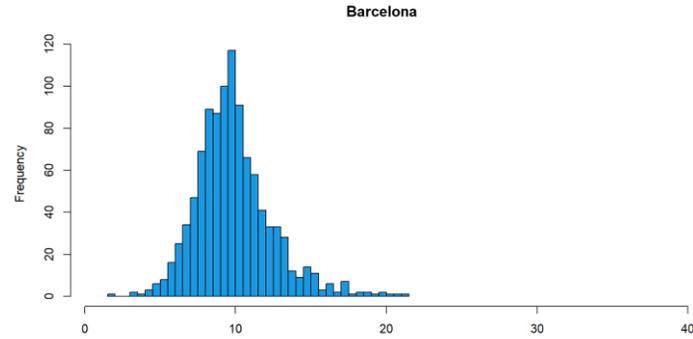
Note

637 nm

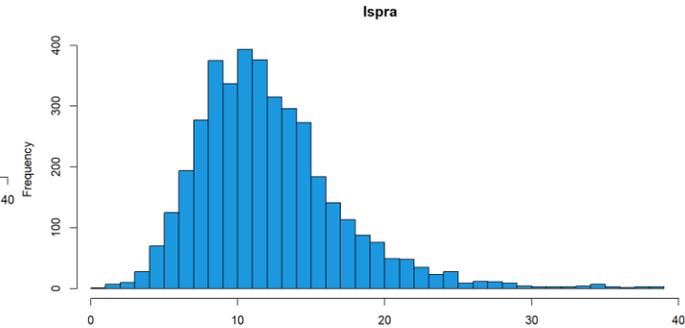
Median: 9.17+/-4.49



Barcelona (PM<sub>10</sub>, 637 nm, MAAP)

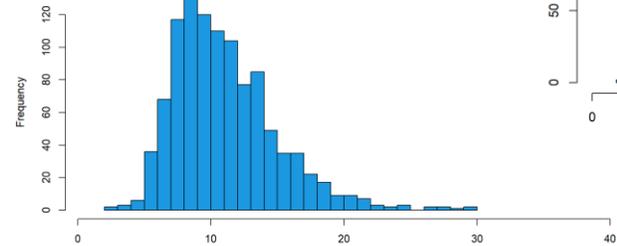


Ispra (PM<sub>10</sub>, 637 nm, MAAP)

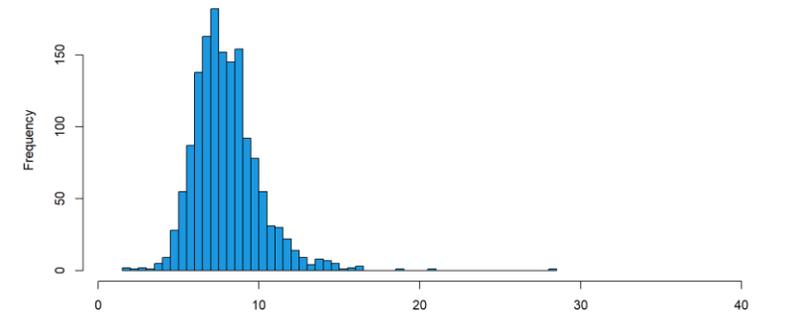


- MAAP(1030 Obs)
- MAAP(181 Obs)
- MAAP(178 Obs)
- MAAP(38 Obs)
- MAAP(3907 Obs)
- MAAP(164 Obs)
- AE33(67 Obs)
- AE33(1069 Obs)
- AE21(1059 Obs)
- AE21(1488 Obs)

Rochester(TOT)



Ispra



Sirta (PM<sub>2.5</sub>, 637 nm, AE33)

Rochester (PM<sub>2.5</sub>, 637 nm, AE21)

Frequency distribution of Mass absorption cross-section (MAC) coefficient



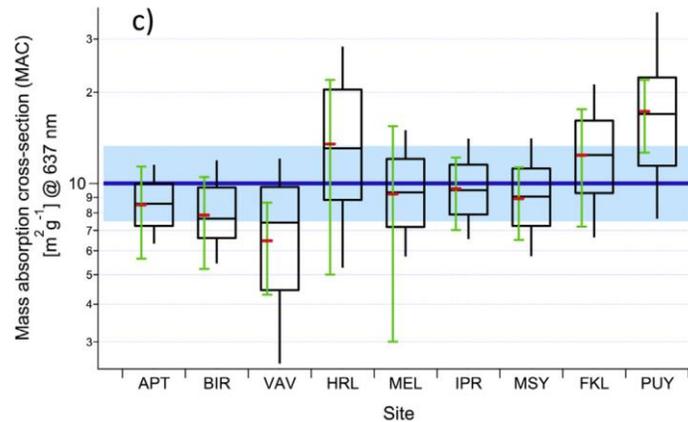
# Methodology

**Table 9**

Trimmed geometric mean and geometric standard deviation (in brackets) of mass absorption cross-section ( $MAC^{637}$ ) for all nine stations. Data are averaged over 24 h at all sites, except for the Scandinavian sites where single filter samples were collected over 3–7 days. Data points below/above the 5th/95th percentile were filtered before statistical analysis.

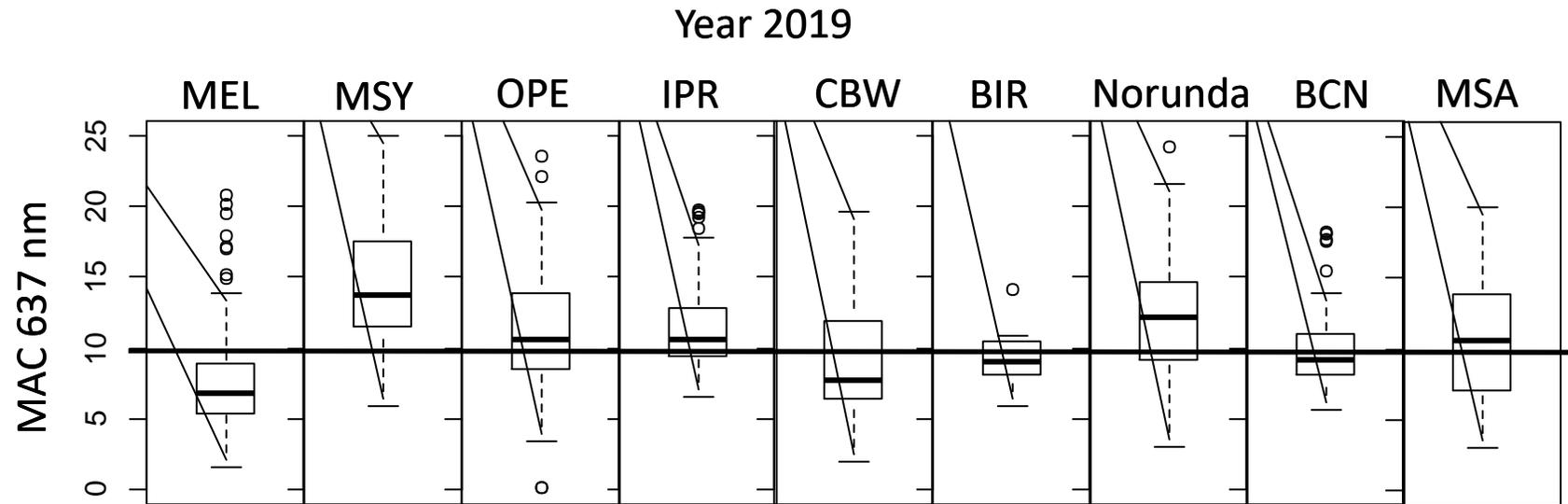
| Mass absorption cross-section ( $MAC^{637}$ ) [ $m^2 g^{-1}$ ] @ 637 nm |             |             |             |             |             |
|---|-------------|-------------|-------------|-------------|-------------|
| Site  | Annual      | Winter      | Spring      | Summer      | Autumn      |
| APT   | 8.51 (1.26) | 8.38 (1.22) | 9.10 (1.27) | 8.41 (1.24) | 8.17 (1.30) |
| BIR   | 7.86 (1.34) | 8.09 (1.33) | 7.59 (1.30) | 8.12 (1.27) | 7.71 (1.43) |
| FKL   | 12.4 (1.56) | 15.1 (1.75) | 11.1 (1.47) | 10.9 (1.55) | 15.1 (1.45) |
| HRL   | 13.5 (1.82) | 8.87 (1.84) | 14.9 (1.75) | 15.9 (1.71) | 15.1 (1.56) |
| IPR   | 9.61 (1.34) | 9.31 (1.35) | 9.03 (1.30) | 10.9 (1.35) | 9.34 (1.30) |
| MEL   | 9.23 (1.45) | 8.22 (1.47) | 8.74 (1.47) | 9.5 (1.38)  | 11.3 (1.36) |
| MSY   | 8.92 (1.65) | 8.29 (1.82) | 8.97 (1.64) | 9.73 (1.55) | 8.73 (1.57) |
| PUY   | 17.3 (1.71) | 13.4 (1.62) | 16.5 (1.70) | 19.9 (1.68) | 19.8 (1.73) |
| VAV   | 6.47 (1.81) | 7.04 (1.87) | 7.23 (1.61) | 4.85 (1.71) | 4.20 (2.39) |

Zanatta et., al, 2016



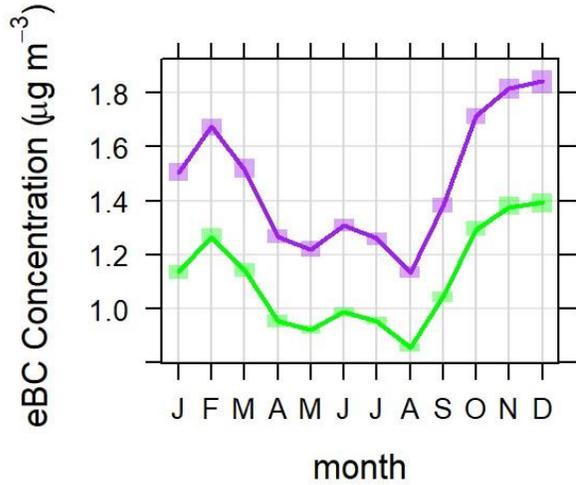
Using an average MAC based on data from regional background stations (Zanatta et al., 2016, ACTRIS WG on Lev.3 eBC)

Courtesy of ACTRIS WG on eBC Lev3.

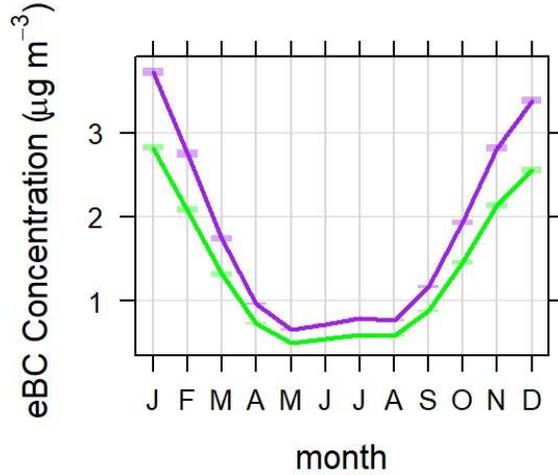




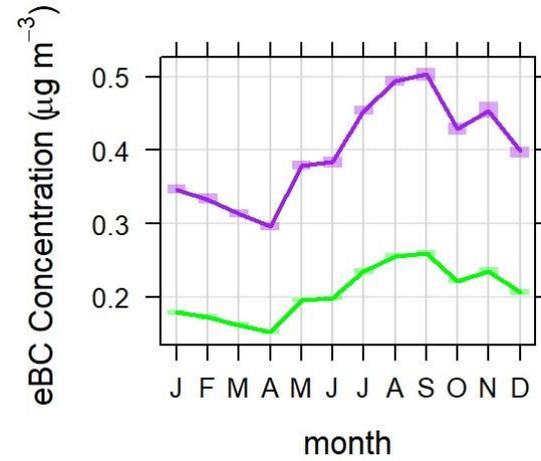
Case studies from Ispra and Barcelona to show how much the choice of the MAC affects the eBC concentrations



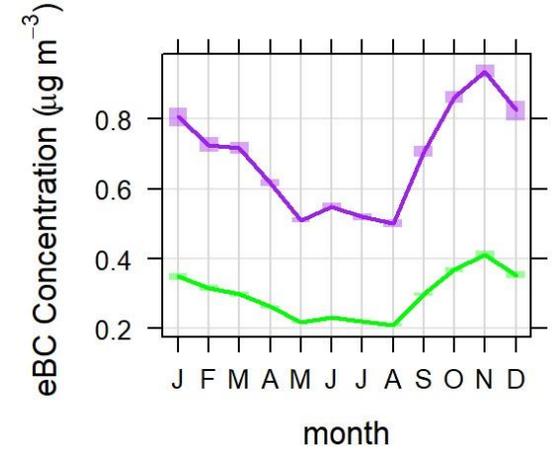
 Barcelona



 Ispra



 Rochester



 Sirta

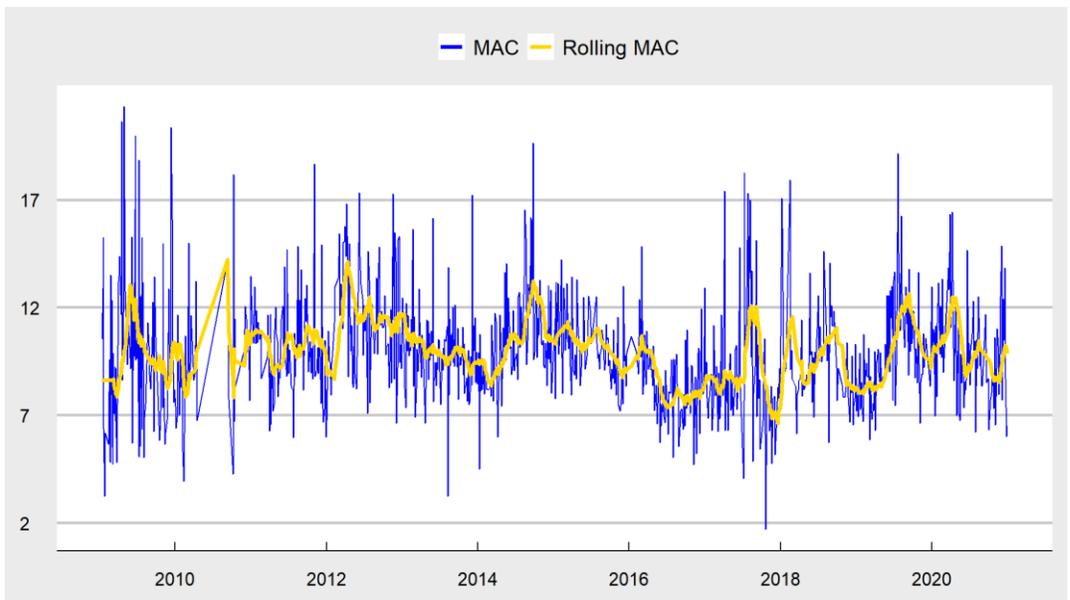
The difference between eBC instrument (nominal) and eBC RI-URBANS

Objective: providing an average “urban” MAC: to show the difference between raw eBC and EC-normalized eBC at all available urban sites in RI-URBANS.

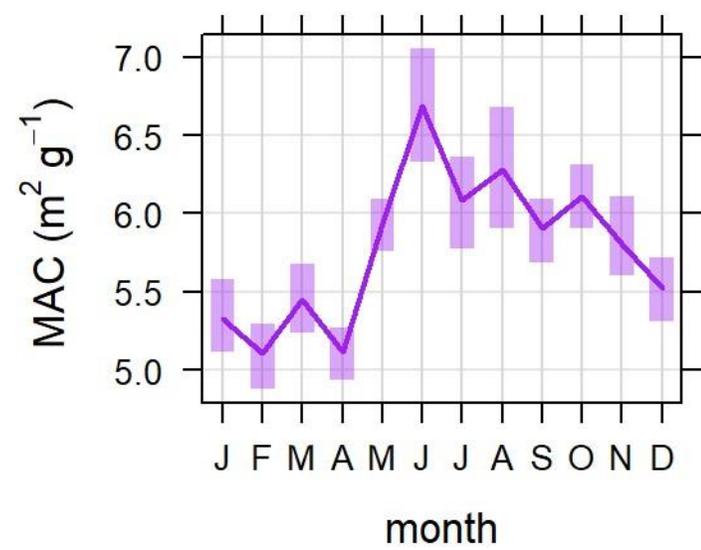
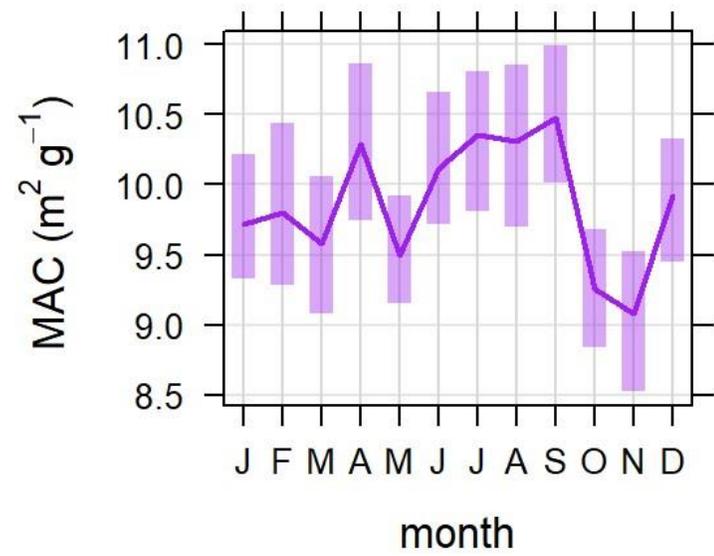
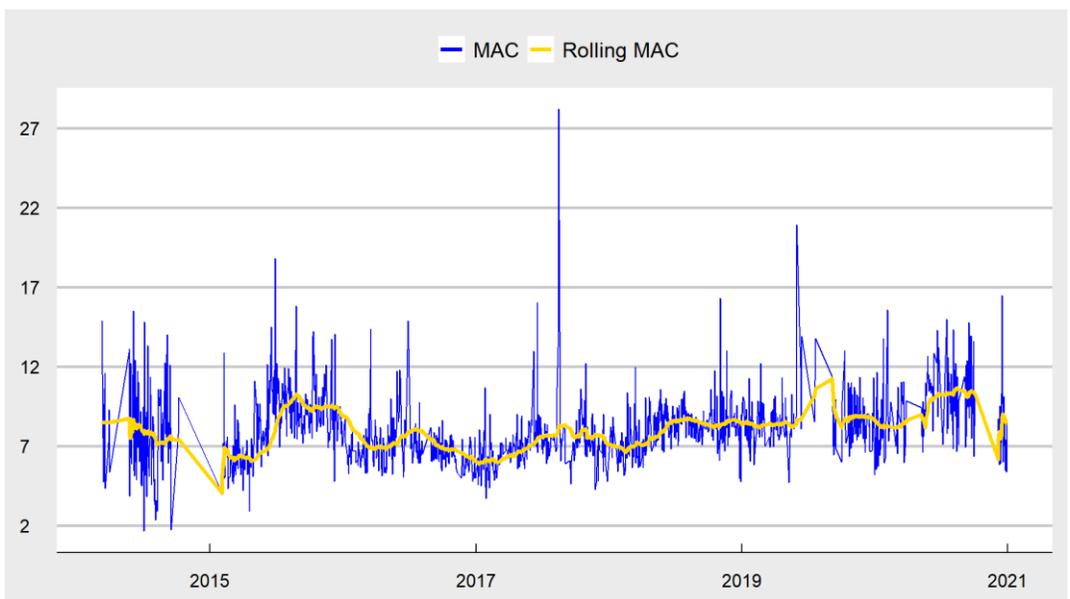
# ➤ Site-dependent MAC, long-term trends and temporal variations



Barcelona



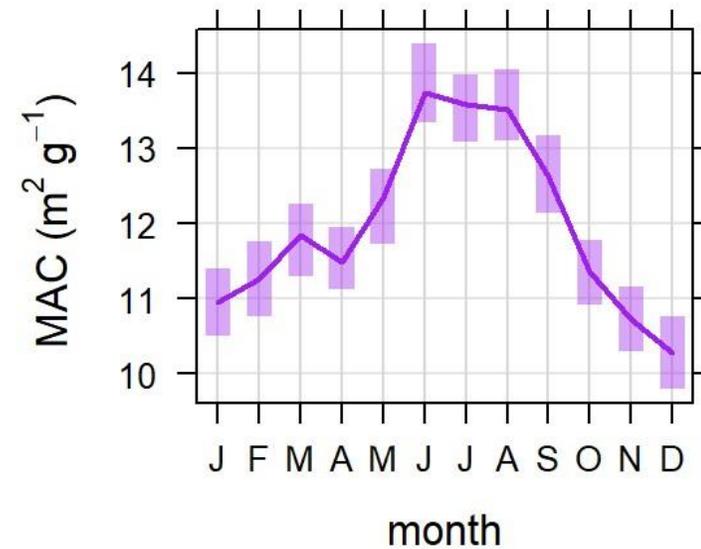
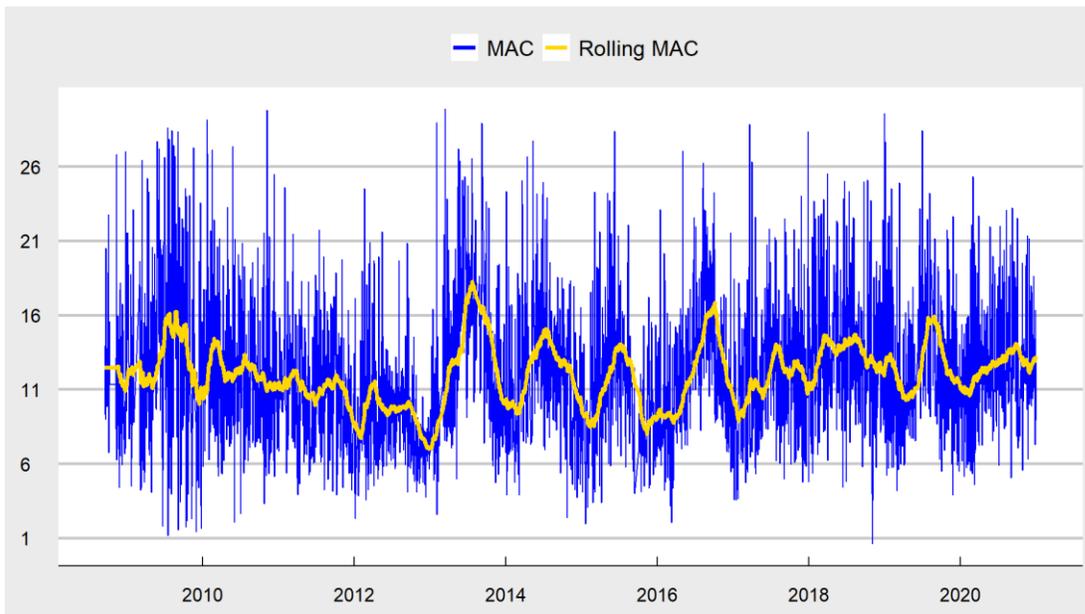
Sirta



A site-dependent MAC should be calculated and used to properly estimate eBC concentrations.



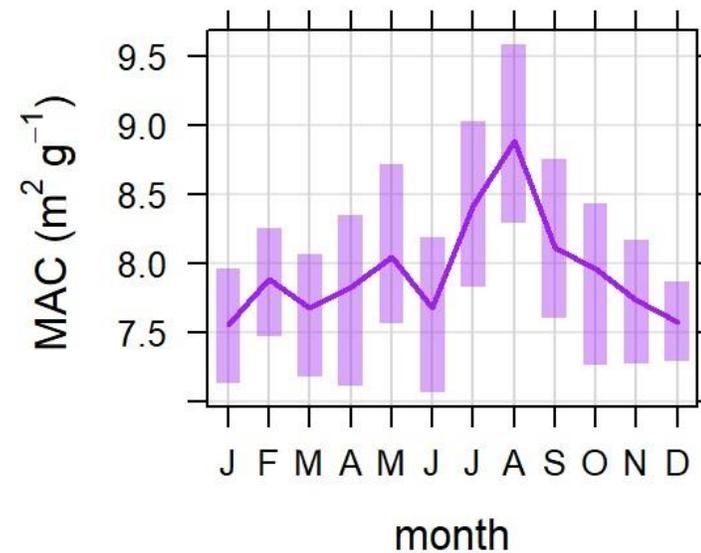
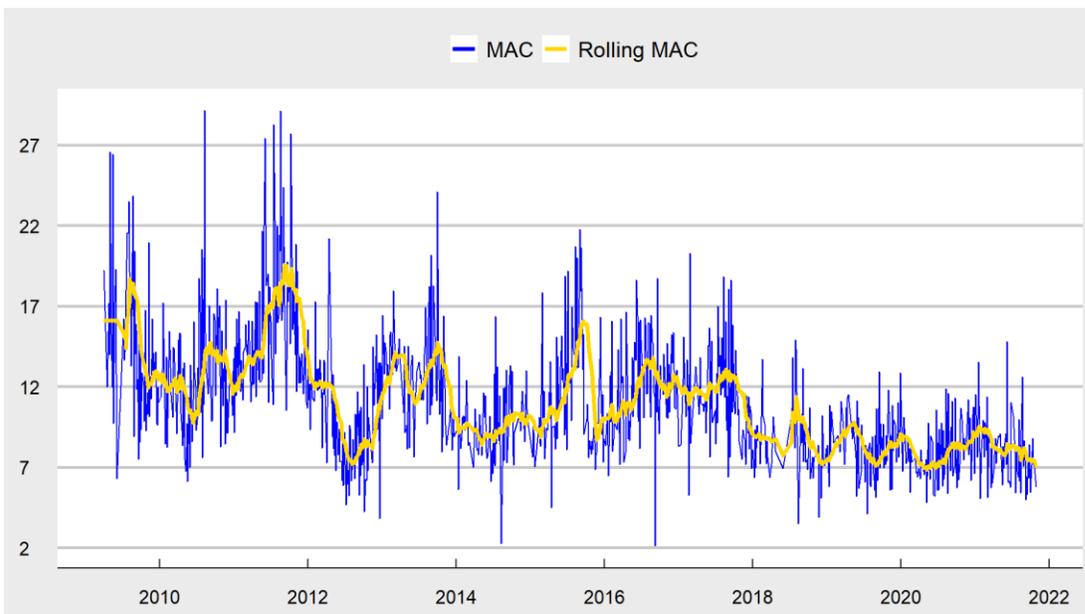
Ispra



A site-dependent MAC should be calculated and used to properly estimate eBC concentrations.

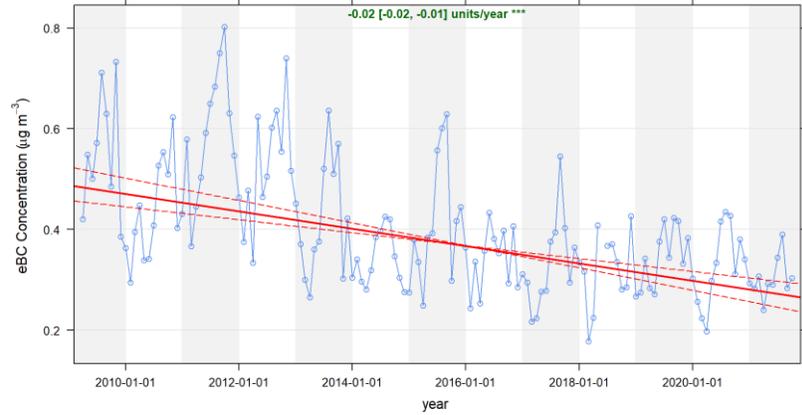


Rochester

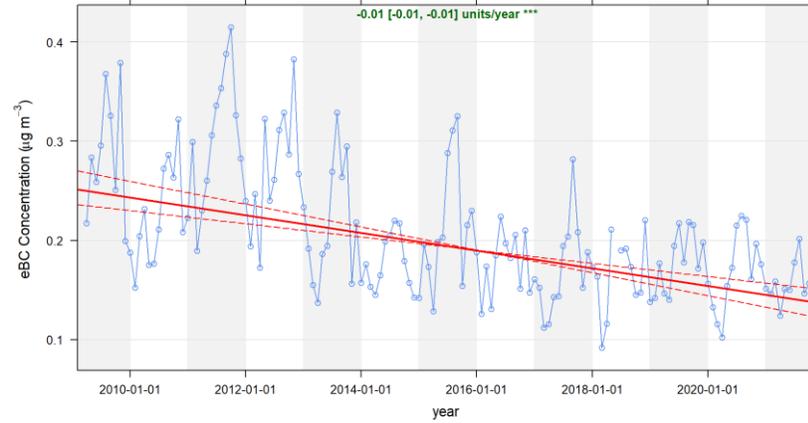




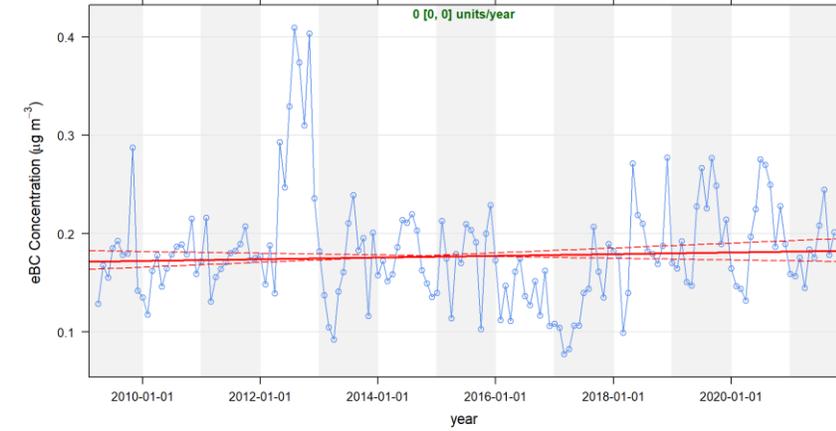
# Result and Discussion



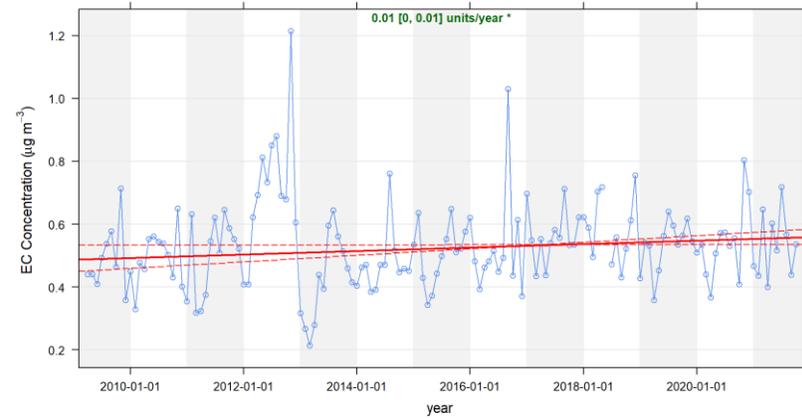
eBC Instrument (nominal)



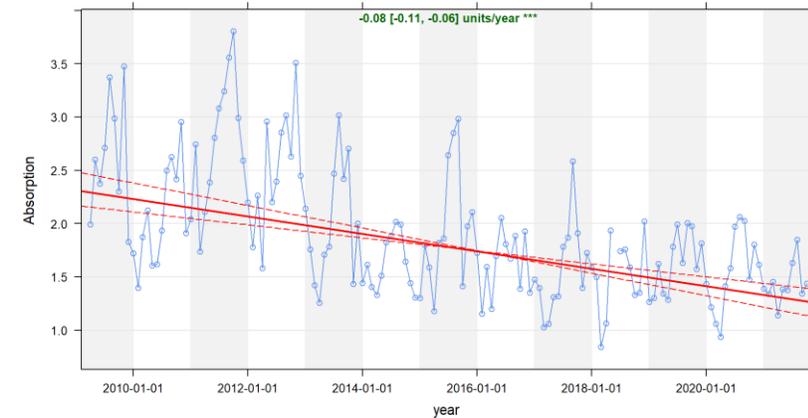
eBC RI-URBANS



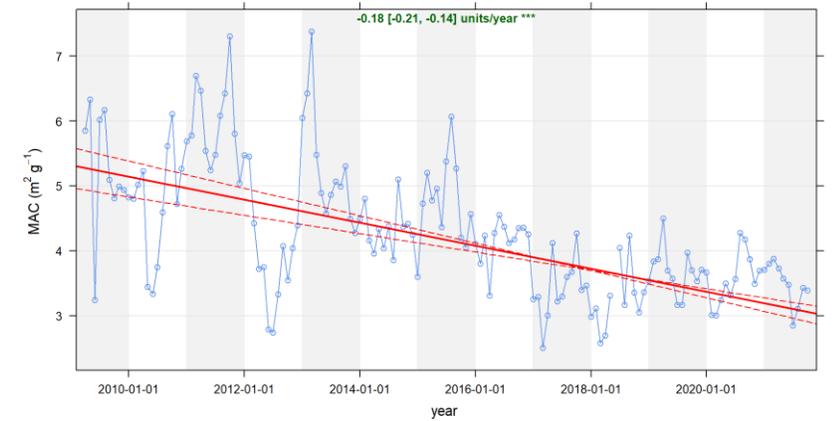
eBC Rolling MAC



EC Concentration



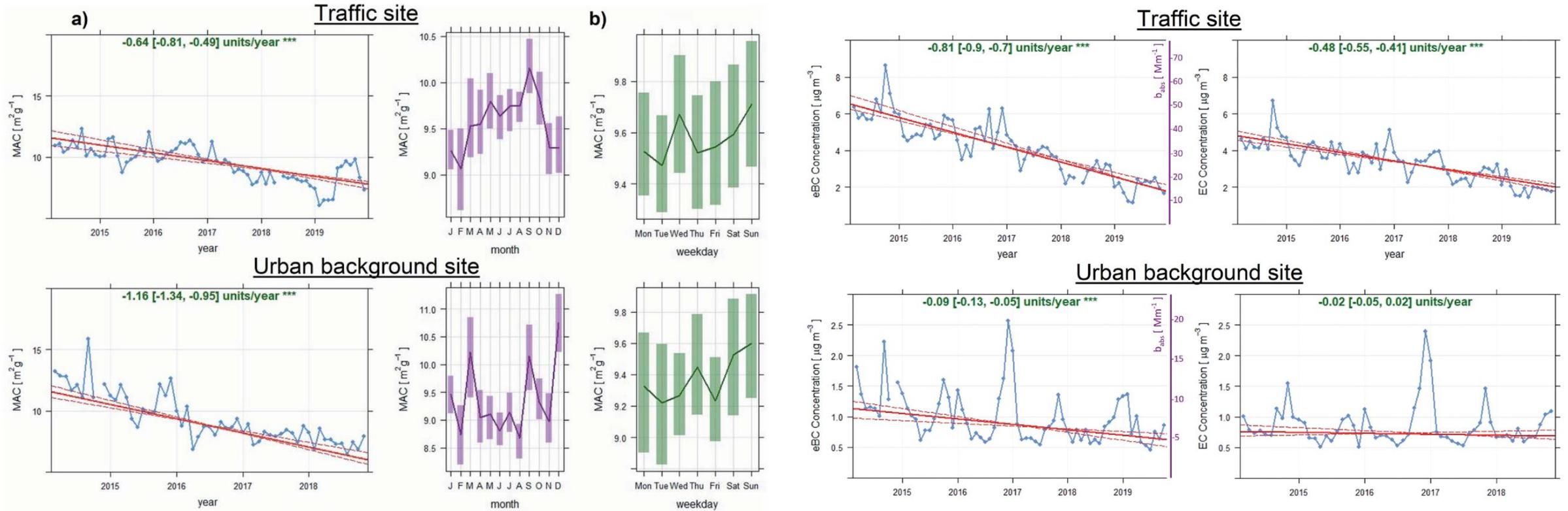
Absorption @ 880 nm



Experimental MAC @637 nm

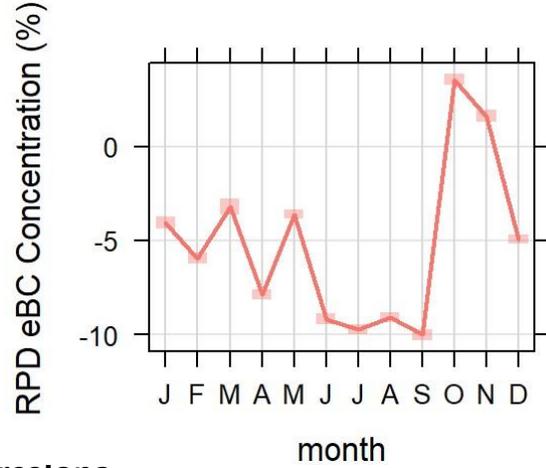
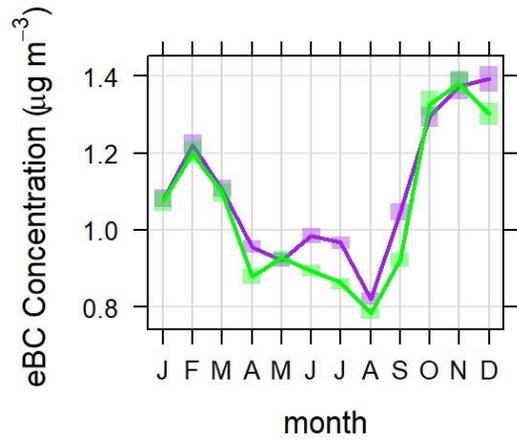


- Mass absorption cross-section derived from equivalent black carbon and elemental carbon
- Mass absorption cross-section (MAC) coefficients by using rolling mean regression

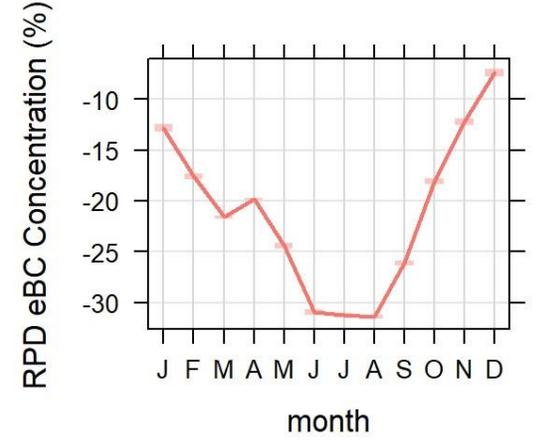
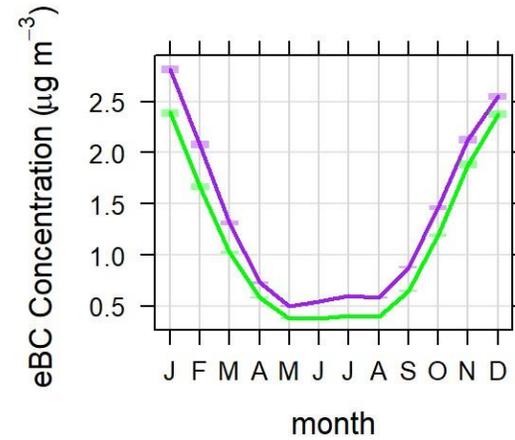


Credit: Ciupek et al., 2021

# Impact of MAC on eBC estimates

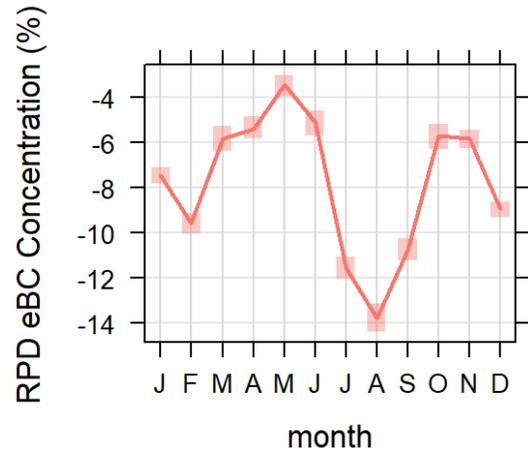
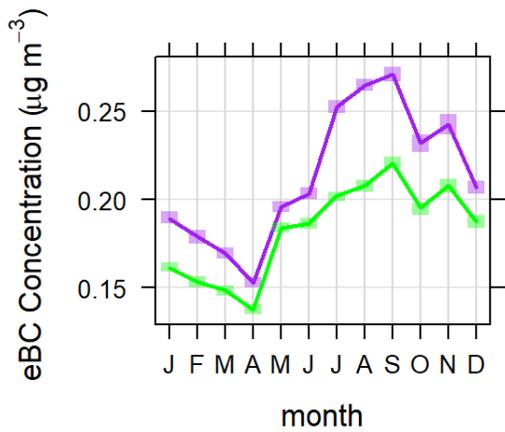


**Barcelona**

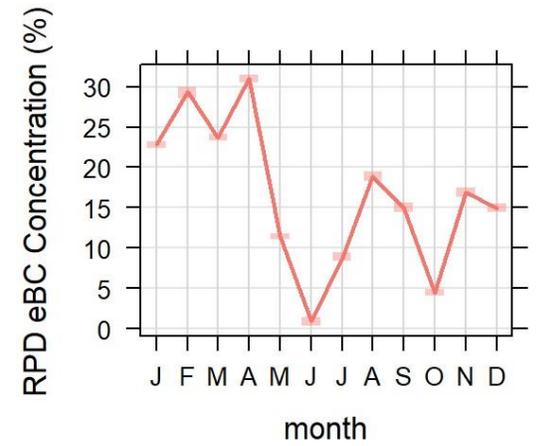
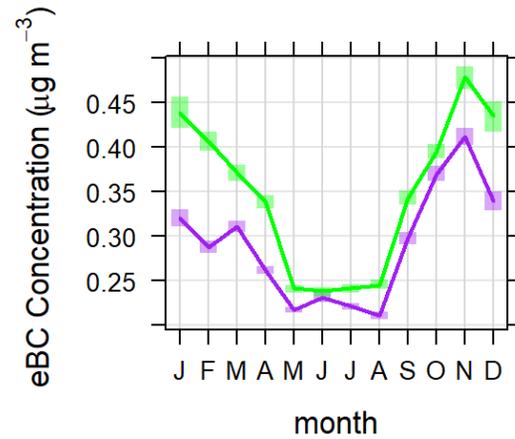


**Ispra**

■ eBC-RI-URBANS     
 ■ eBC-Rolling-based-on-Monthly-Average



**Rochester**



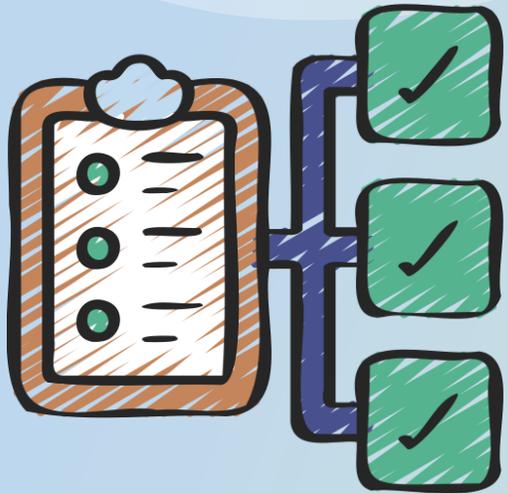
**Sirta**



Variation in monthly average eBC concentration: eBC RI-URBANS vs. eBC monthly average with relative percent difference



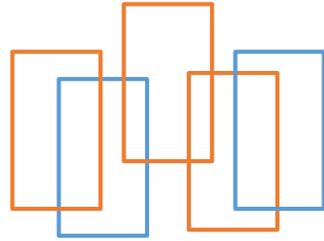
## Conclusion



- ❖ eBC harmonization in RI-URBANS: 50 Stations; 13 Countries; MAAP and AE33
- ❖ For 12 stations EC data were available, allowing calculation of the MAC
- ❖ A median MAC of  $9.17 \pm 4.9$  provided for urban sites in RI-URBAN
- ❖ Consistent (slightly lower) compared to RB ACTRIS value of  $10 \pm 1.33$
- ❖ MAC shows a significant seasonal and monthly variation at all sites
- ❖ Using a constant MAC can cause misleading results
- ❖ Having EC data together with eBC can improve considerably the estimation of eBC

### Further steps:

- Sandradewi (Delta C)
- Brown Carbon
- Exploring the AAE frequency distribution to determine site-dependent AAEff and AAEwb.
- Study the reasons for changing MAC with chemistry data where available.
- Study if the MAC changes are related to changes in BC sources (e.g. Rochester).



*Thank you for your attention!*

Do you have any questions?

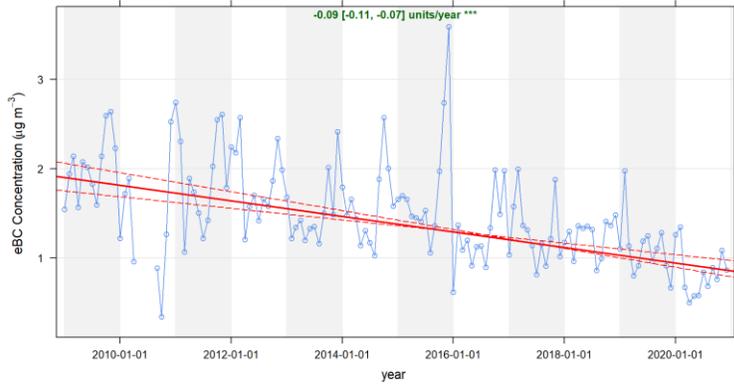
+34 664801902

Marjan Savadkoochi

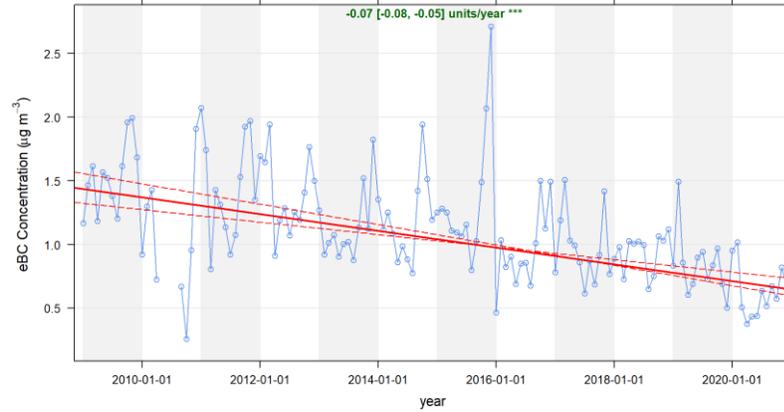
[marjan.savadkoochi@idaea.csic.es](mailto:marjan.savadkoochi@idaea.csic.es)



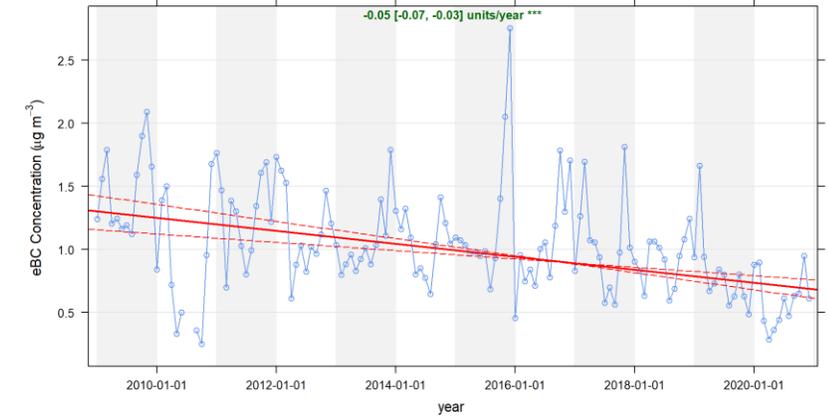
# Result and Discussion



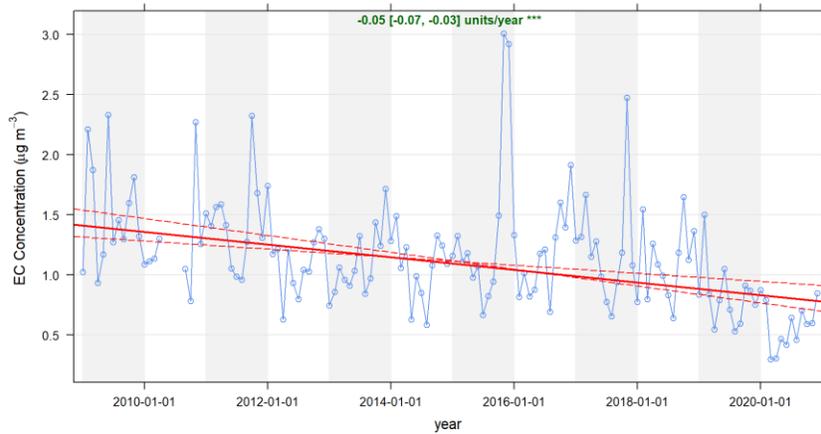
eBC Instrument



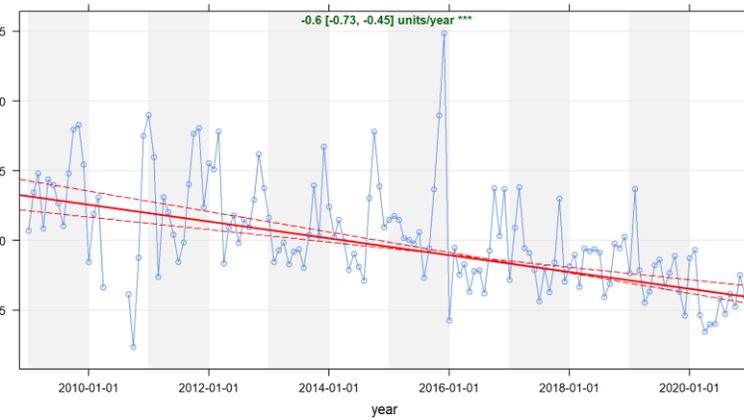
eBC RI-URBANS



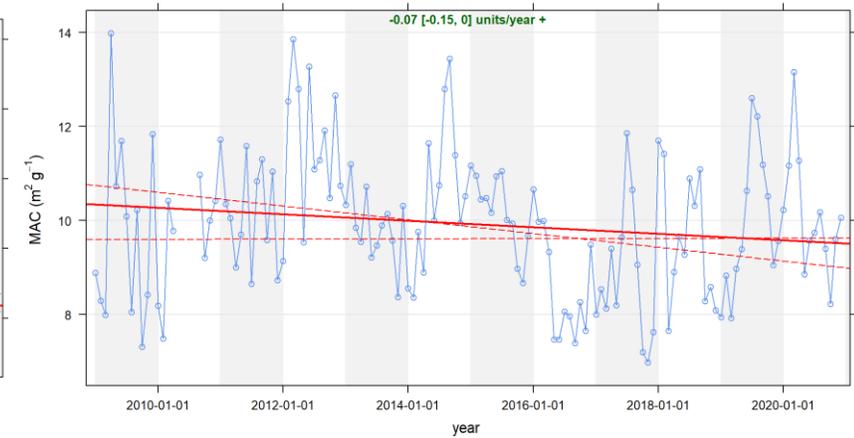
eBC Rolling MAC



EC Concentration



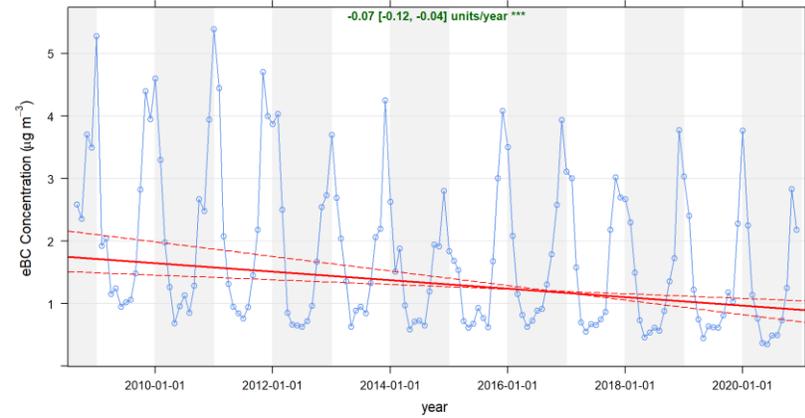
Absorption @ 637 nm



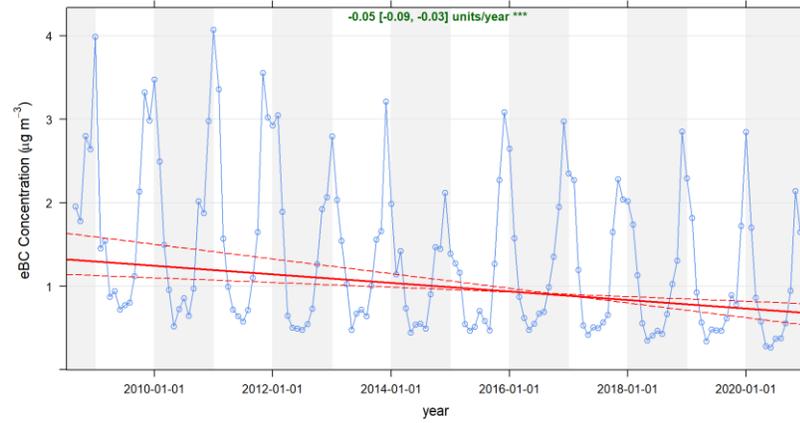
Experimental MAC @ 637 nm



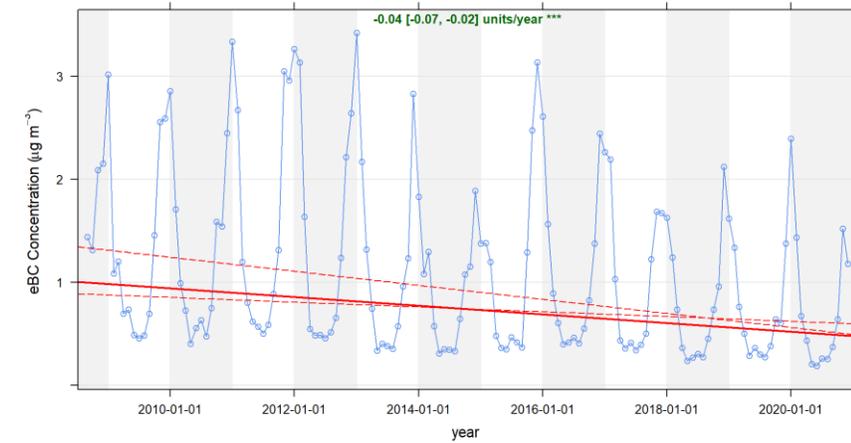
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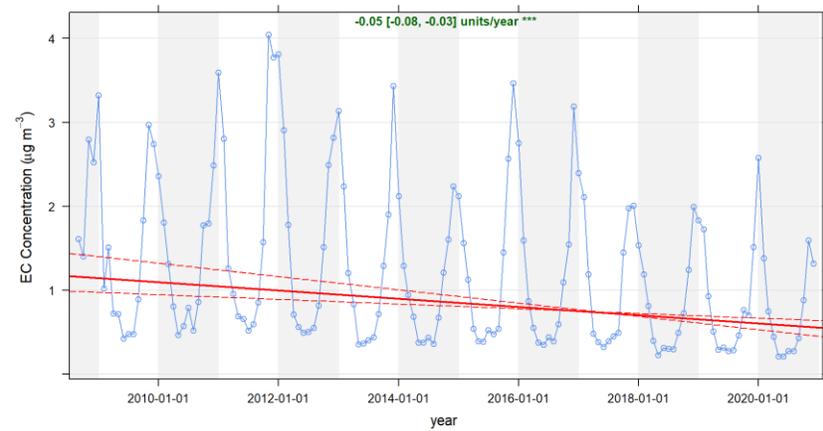
eBC Instrument



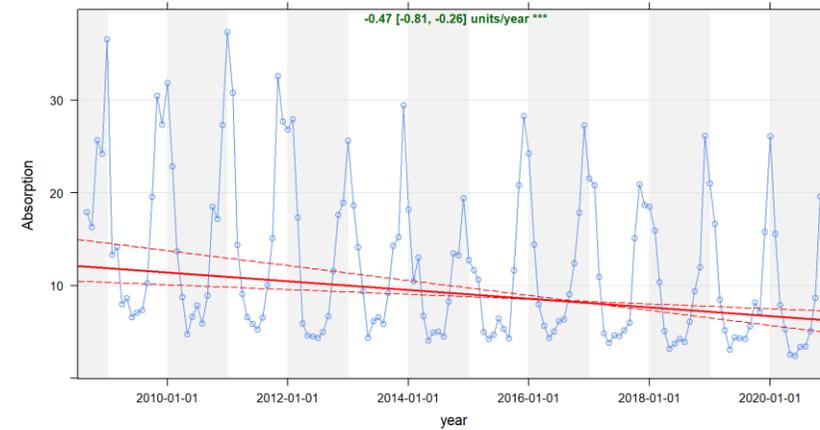
eBC RI-URBANS



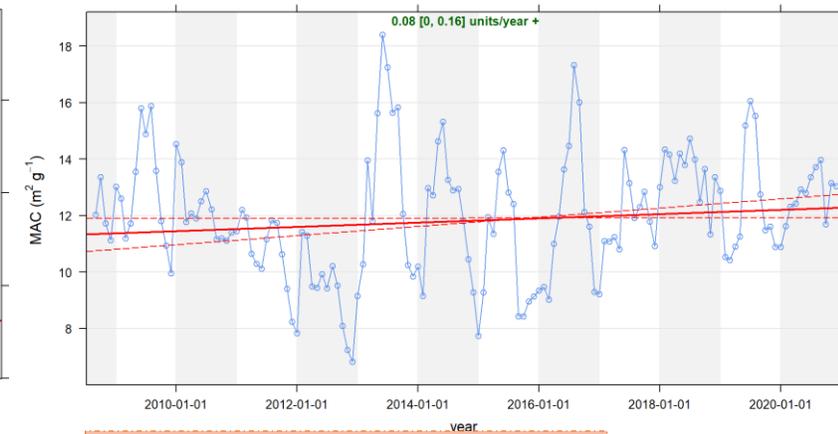
eBC Rolling MAC



EC Concentration



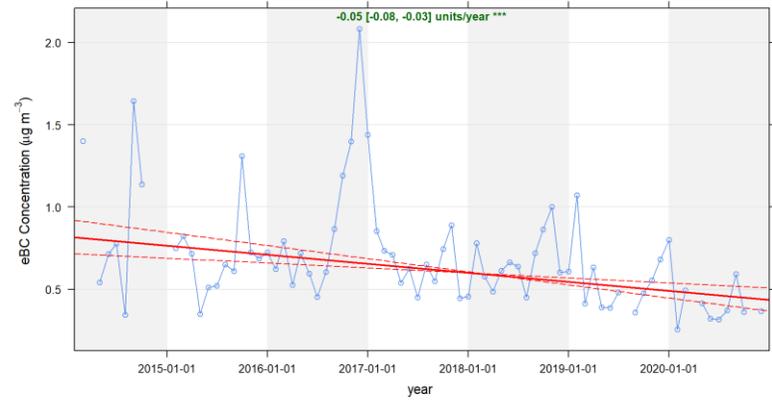
Absorption @ 637 nm



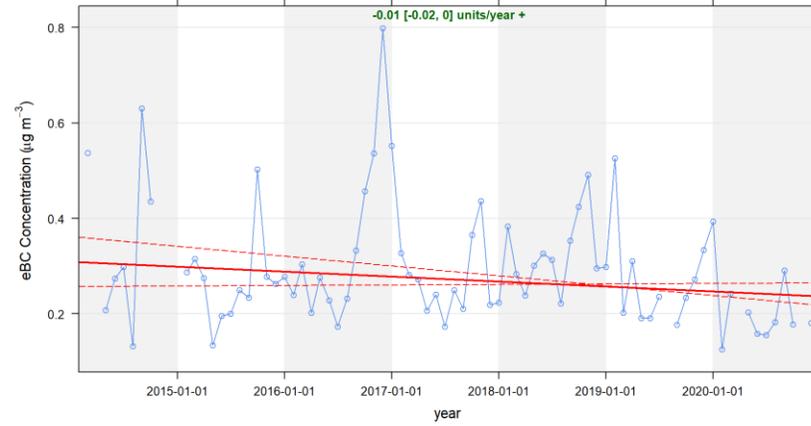
Experimental MAC @ 637 nm



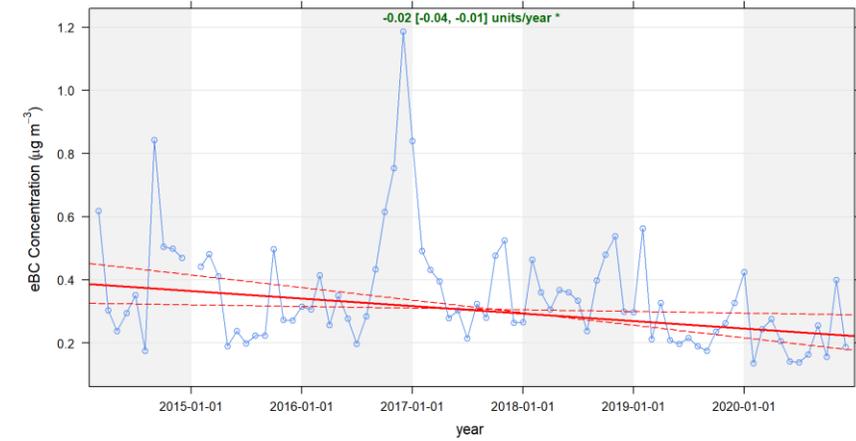
# Result and Discussion



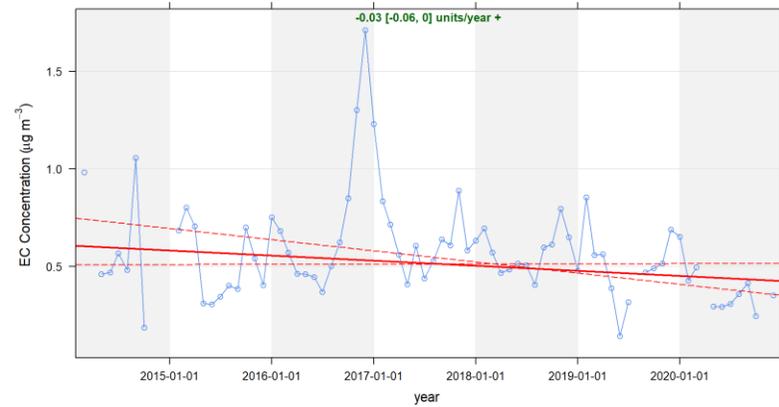
eBC Instrument



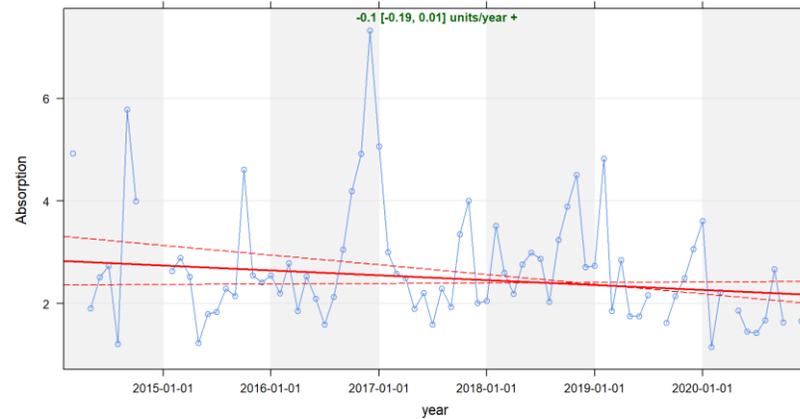
eBC RI-URBANS



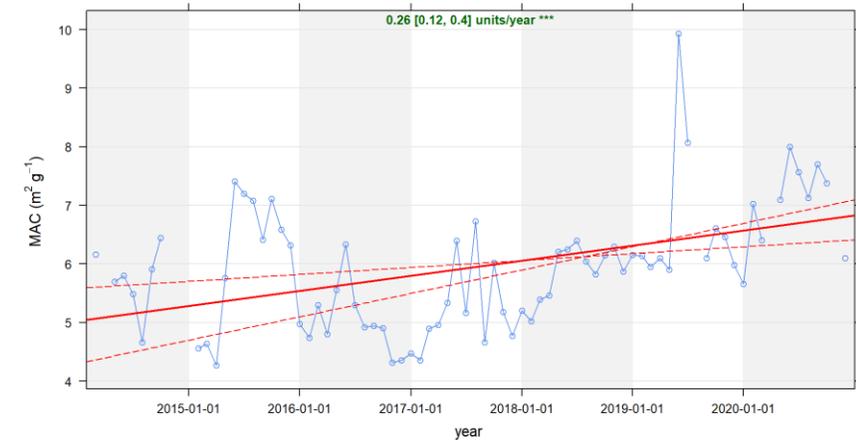
eBC Rolling MAC



EC Concentration



Absorption @ 880 nm



Experimental MAC @637 nm