Mapping Black Carbon and aerosol absorption in a major European city

G. Veratti[1], I. Stavroulas[2], A. Bigi[1], G. Grivas[2], P. Kalkavouras[2], D. Paraskevopoulou[2], E. Liakakou[2], A. Bougiatioti[2], O. Speyer[2], C. Chatzidiakos[2], G. Ghermandi[1], E. Gerasopoulos[2], and N. Mihalopoulos[2]

[1] UNIMORE, Department of Engineering "Enzo Ferrari", Modena, 41125 (Italy)
[2] Institute for Environmental Research and Sustainable Development- NOA, Athens, 15236 (Greece)

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Goals of the study:

- Investigate the spatial variability of Black Carbon concentrations in the Greater Area of Athens during two intensive pedestrian mapping campaigns:
  - Summer (7 - 27 June 2021)
  - Winter (7 - 27 February 2022)

  along 4 different circular routes, conducted twice *per* day (morning and evening), representative of as many areas.

- Provide spatially resolved information for pedestrian exposure estimate to Black Carbon concentrations.

- Preliminary attempt to estimate the contribution of non-BC absorbers to the absorption coefficient from MicroAethalometer measurements.

Materials & Methods

Six MicroAethalometer MA200 Aethlab (USA) have been used for the mapping campaign

Portable instruments which measure the mass concentration of light absorbing carbonaceous particles in a sampled aerosol. They operate at five wavelengths between IR and UV (880 nm, 625 nm, 528 nm, 470 nm, 375 nm).

↳ eBC *(equivalent Black Carbon)*

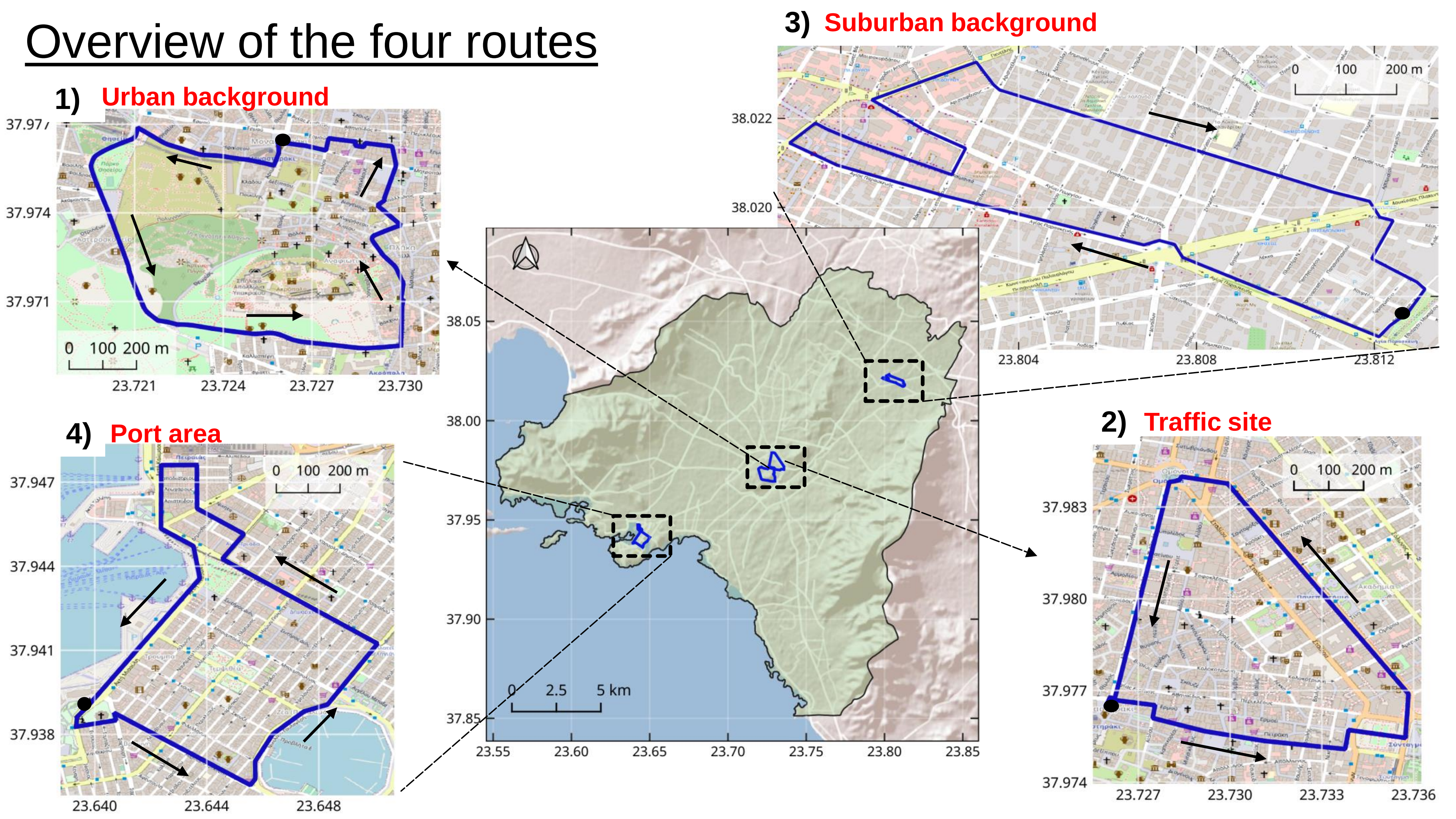
Featured by the DualSpot® loading compensation method* and a GPS tracker.

Set-up:

- Sampling timebase =10sec
- Air flow rate = 150 mL/min
- The MA200 were placed inside a backpack and the aerosol entered the instrument through a conductive tubing.

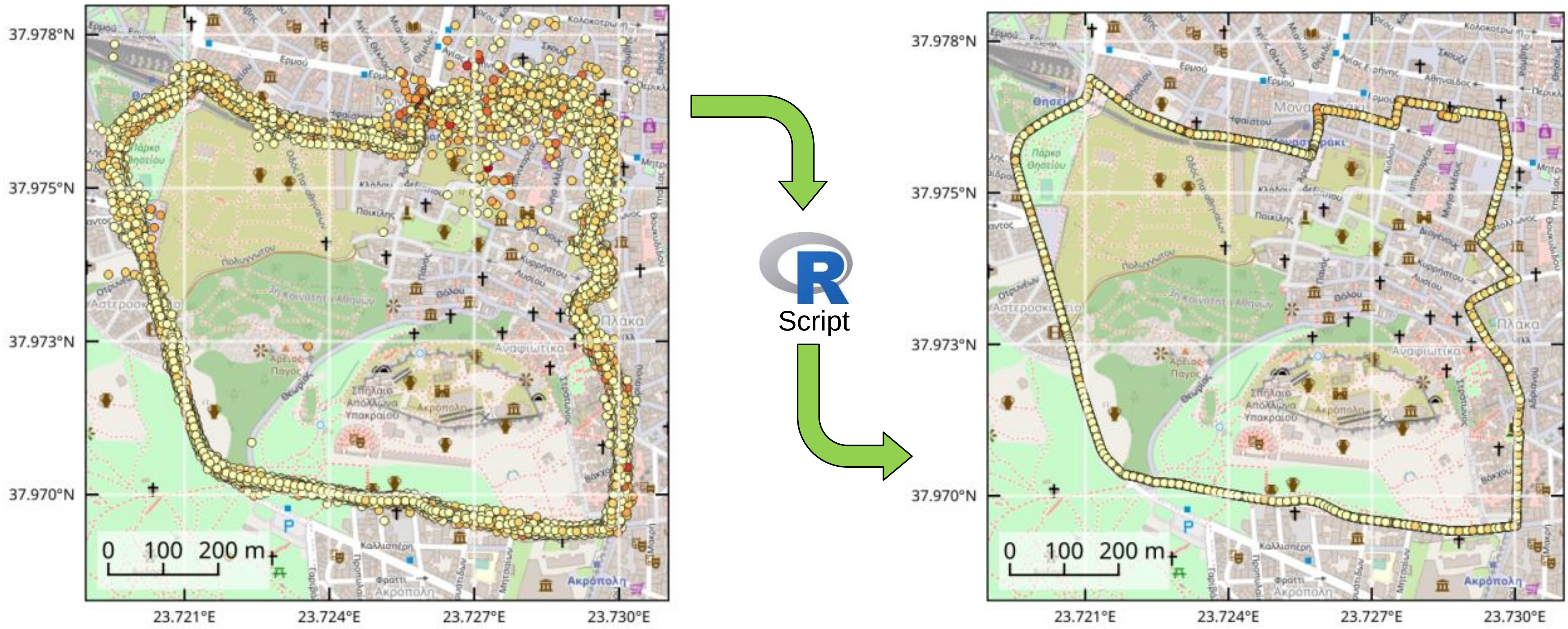
* Drinovec et al. (2015) The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation, Atmos. Meas. Tech.

Overview of the four routes



Post-processing methods

A GIS analysis of measurement point locations was carried out and an automatic procedure devoted to data assortment along four reference routes was implemented with the R language.



Post-processing methods

- ✓ Four different noise reduction techniques were applied to the measured concentrations:*

  - Kolmogorov–Zurbenko low-pass filter (KZ)
  - Centered moving average (CMA)
  - Optimized Noise reduction Averaging (ONA)
  - Local polynomial regression (POL)

Scores related to the urban background area during the summer period

	Raw data	**KZ**	**CMA**	**ONA**	**POL**
Averge Noise (ng m^{-3})	1175	142	238	113	608
N. negative values	730	11	39	1	604
N. peak samples	447	415	452	357	419
Avg. peak sample conc (ng m^{-3})	3592	3542	3829	3529	3972

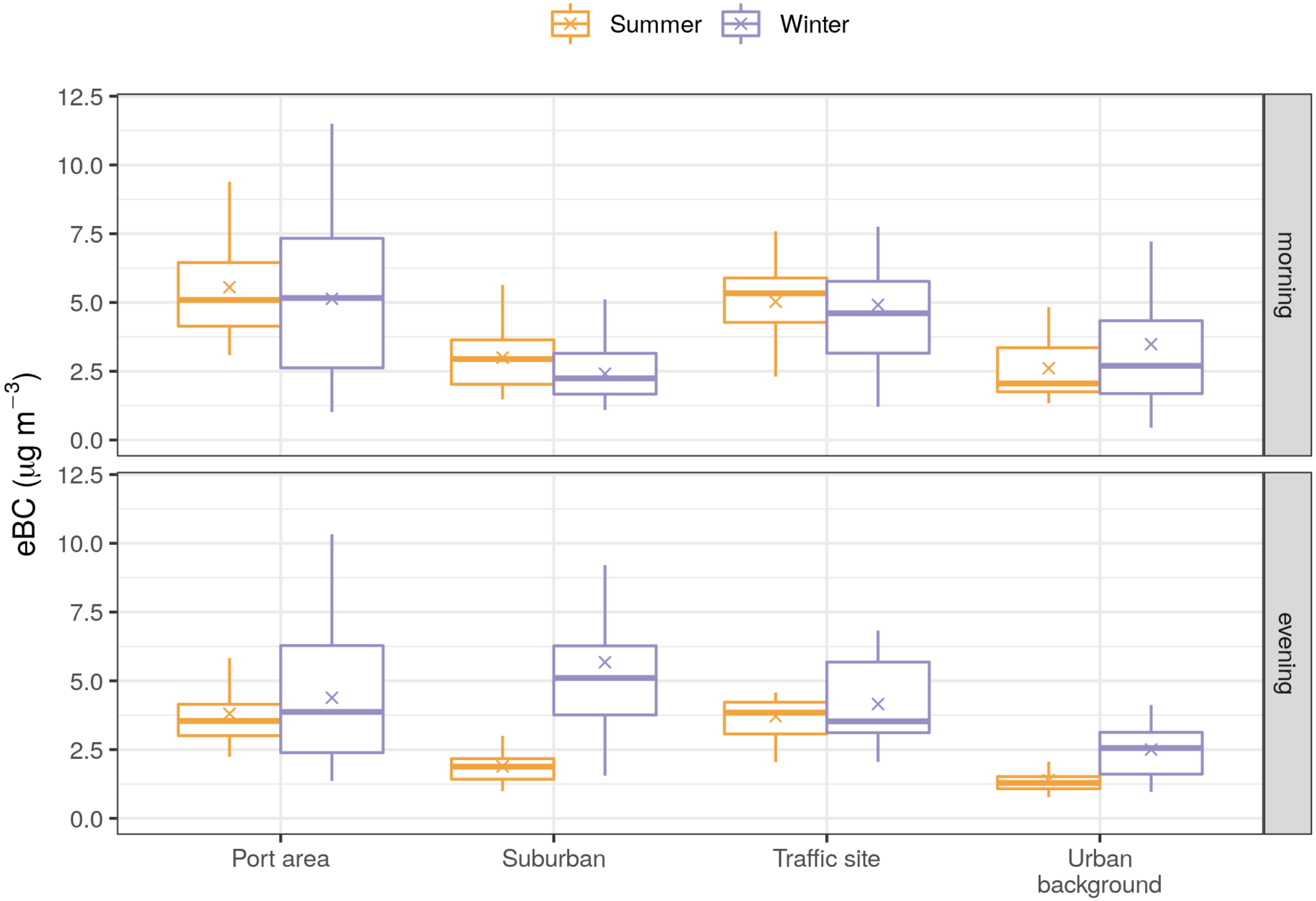
$$\text{Noise (ng/m}^3) = \frac{1}{n}\sum_{i=0}^{n}\left|BC_{i+1} - BC_i\right|$$

*Liu, X. et al. (2021) Analysis of mobile monitoring data from the microAeth® MA200 for measuring changes in black carbon on the roadside in Augsburg, Atmos. Meas. Tech

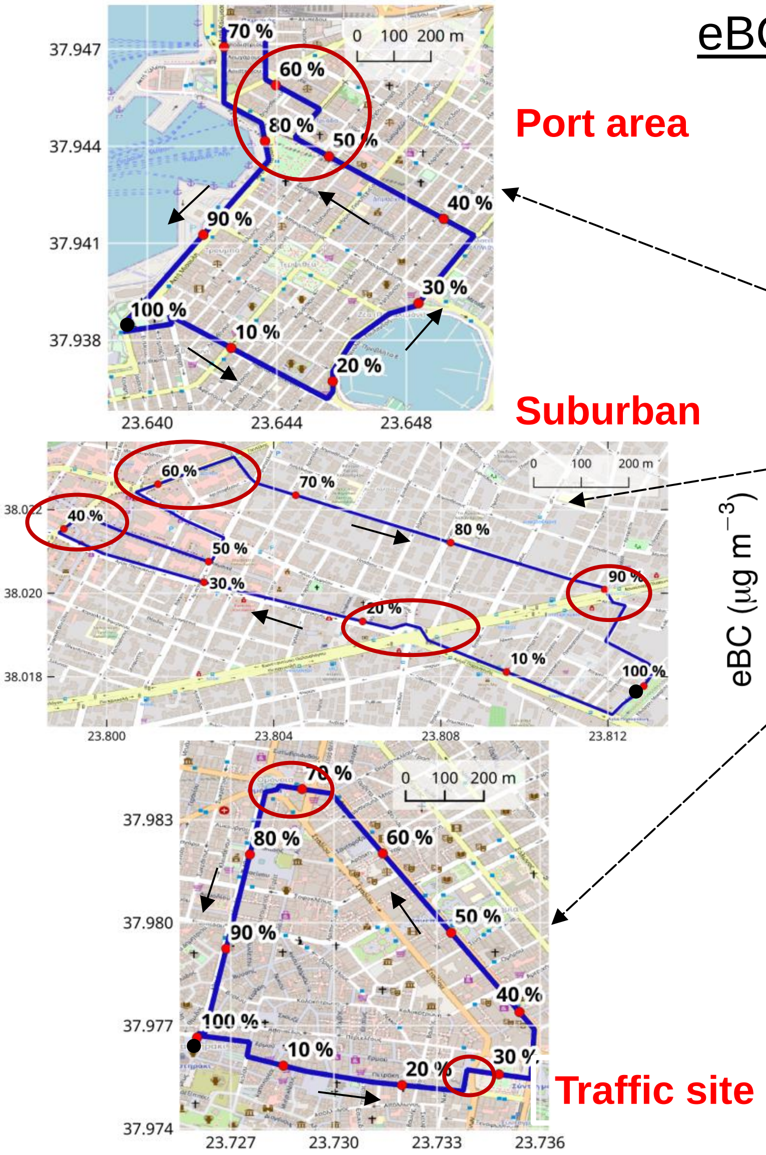
Hagler, G.S., et al. (2011). Post-processing Method to Reduce Noise while Preserving High Time Resolution in Aethalometer Real-time Black Carbon Data. Aerosol Air Qual. Res

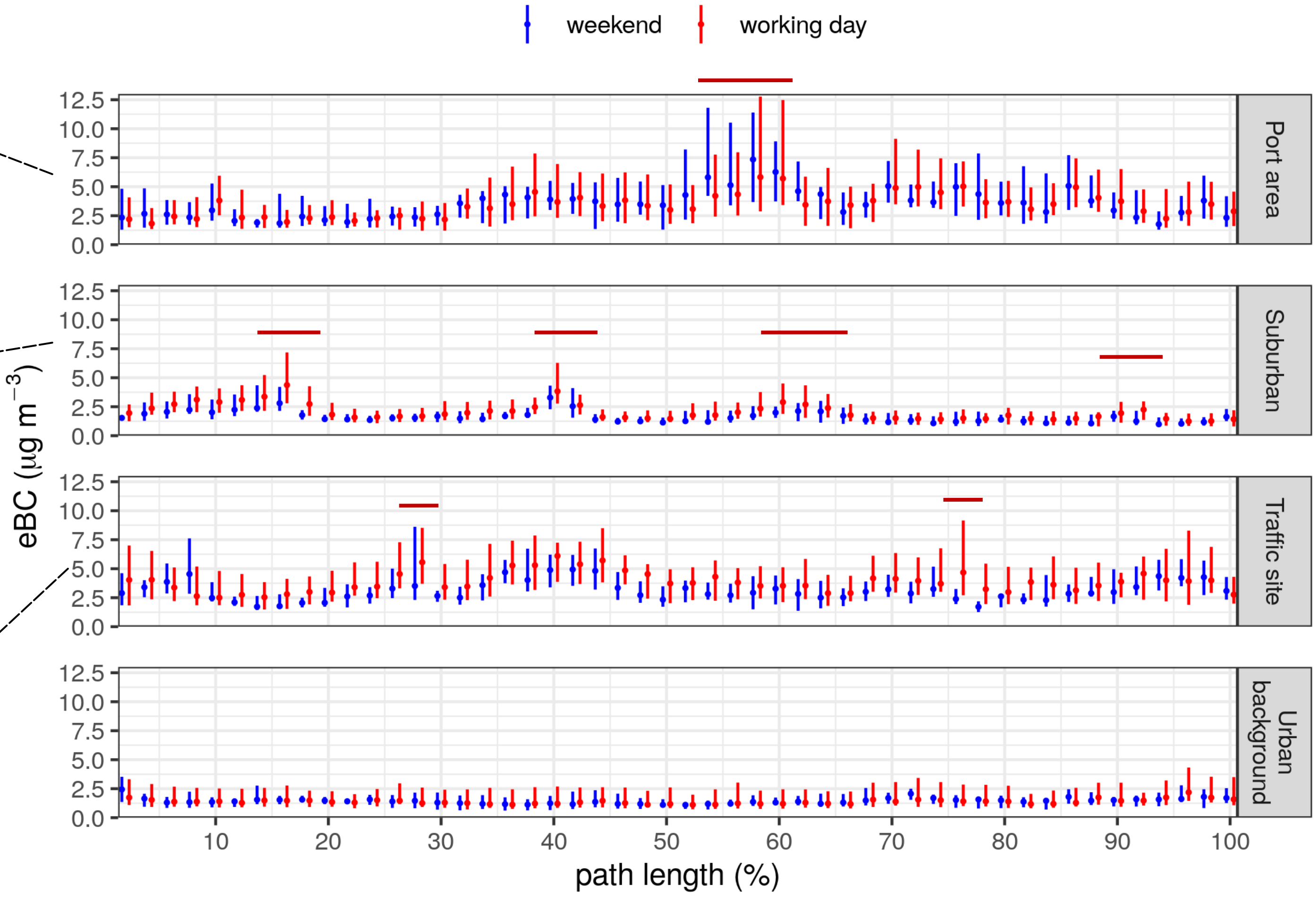
Results from the mapping campaigns: eBC concentrations

Constant Multiple-scattering correction factor: C_{ref} = 1.3



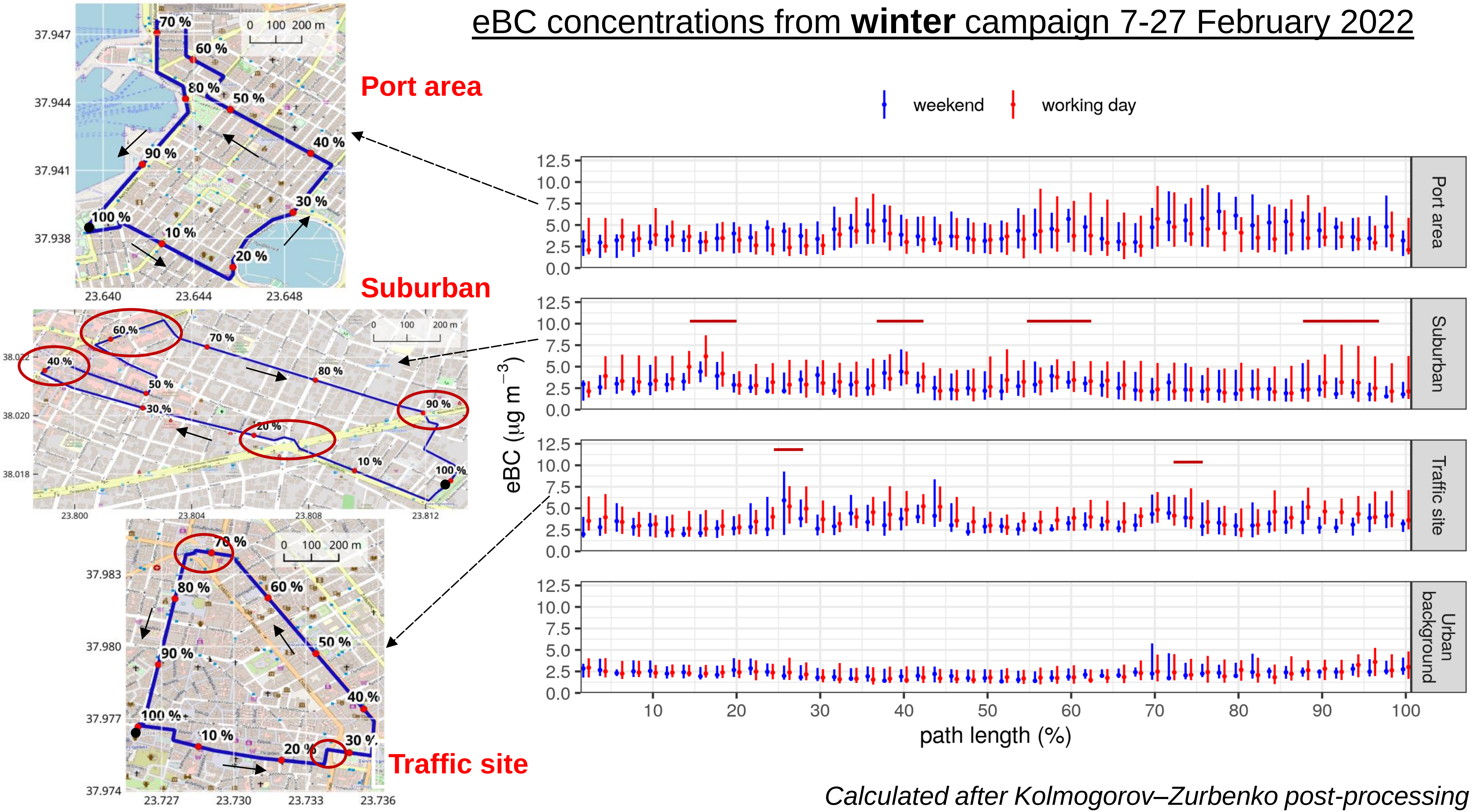
eBC concentrations from **summer** campaign 7-27 June 2021





Calculated after Kolmogorov–Zurbenko post-processing

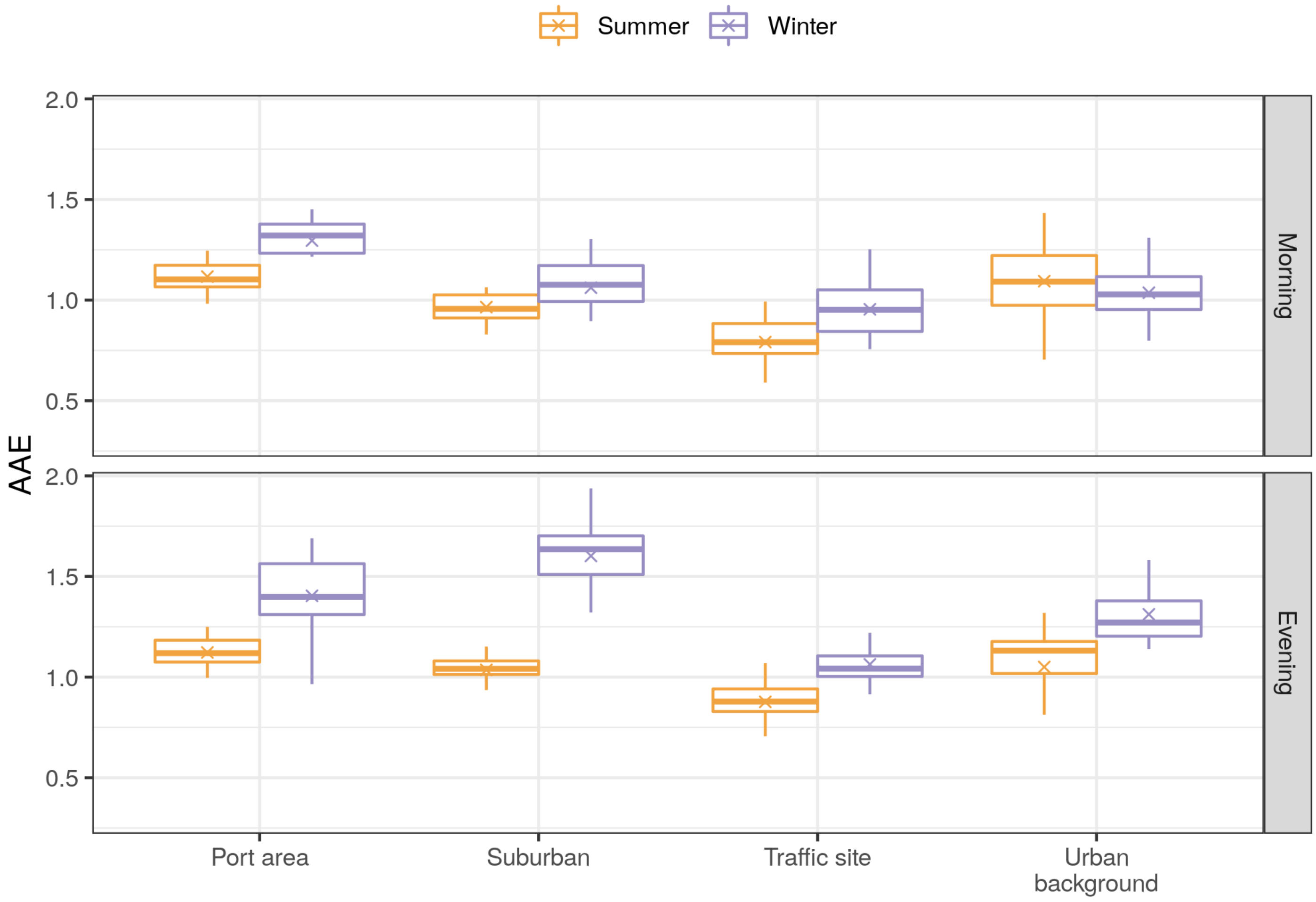
eBC concentrations from **winter** campaign 7-27 February 2022



Calculated after Kolmogorov–Zurbenko post-processing

Analysis of the Absorption Ångström Exponent (AAE)

AAE computed between 375 and 880 nm; MAE_{375nm} = 24.069 m^2 g^{-1}; MAE_{880nm} = 10.12 m^2 g^{-1}



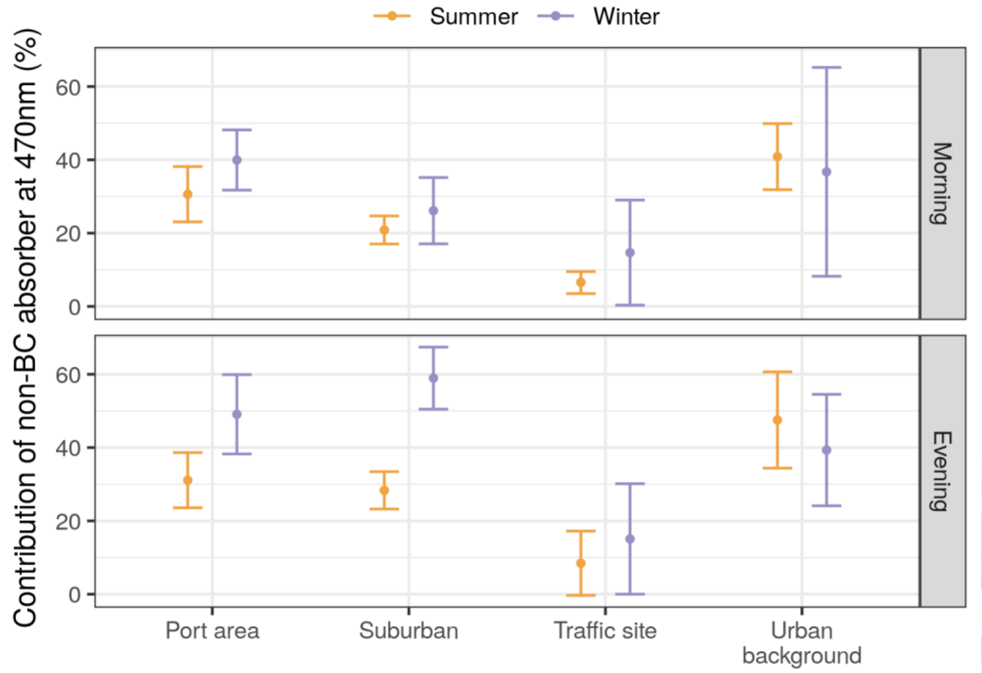
Preliminary estimation of the contribution of non-BC absorbers to the absorption coef. at 470nm

Assumptions:
- Abs. coefficient @880 nm can be attributed to BC
- AAE-BC estimated close to traffic source from MA200 measurements

AAE-BC-summer = 0.9 ± 0.3

AAE-BC-winter = 1.04 ± 0.3

$$^{*}\, b_{BrC,470nm} = b_{abs,470nm} - b_{abs,880nm} \cdot \left(\frac{470}{880}\right)^{-AAE}$$



* Li et al. (2021): Correcting micro-aethalometer absorption measurements for brown carbon aerosol. Sci. Total Environ.

Conclusions

- BC concentrations showed considerable spatial and temporal variability:

  - The port area displayed on average the highest BC concentrations and the highest variability along the route, especially during winter.

  - The traffic route presented on average similar BC concentrations between seasons and small variability within the same season.

  - The suburban route highlighted on average low BC levels with high contrast in winter between morning/evening driven by biomass burning, as suggested by the preliminary analysis of the contribution of non-BC absorber at 470nm.

  - The urban background path that winds around the Acropolis showed the lowest level of BC-Concentrations.

Further steps and details

- ✓ Apportionment between BC and BrC through spectral analysis of absorption coefficient and source apportionment between FF and BB.

- ✓ Assessment of the applied filtering methods by inter-comparison with reference absorption photometer (MAAP and AE33), located at the NOA Actris station (Thissio) in the urban background of Athens.

- ✓ Characterization of the performance of the MA200 through field unit-to-unit inter-comparison at the NOA Actris station (Thissio) will be discussed in the following session:

AMT-9: Novel Measurement Techniques III Thursday, September 8, 15:30 – 17:00

<u>Stavroulas I. et al</u>.: Field evaluation of miniature absorption photometers in an Eastern Mediterranean urban environment

Post-processing methods

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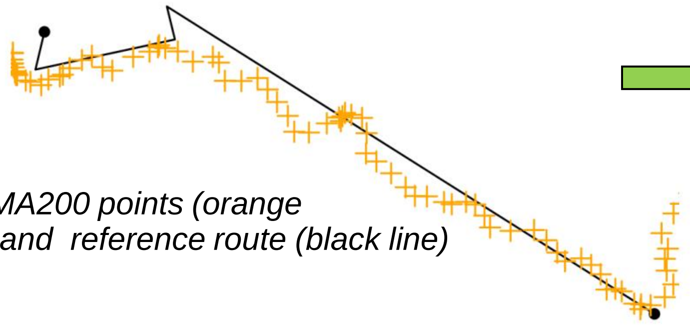
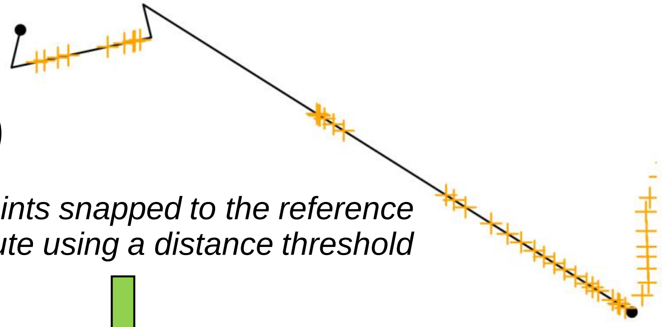


1)

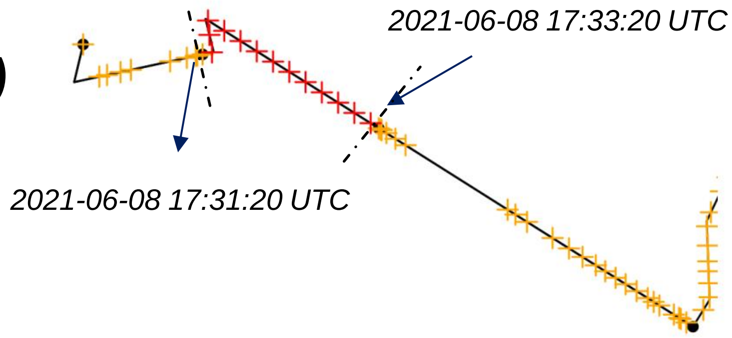
Original MA200 points (orange crosses) and reference route (black line)



2)

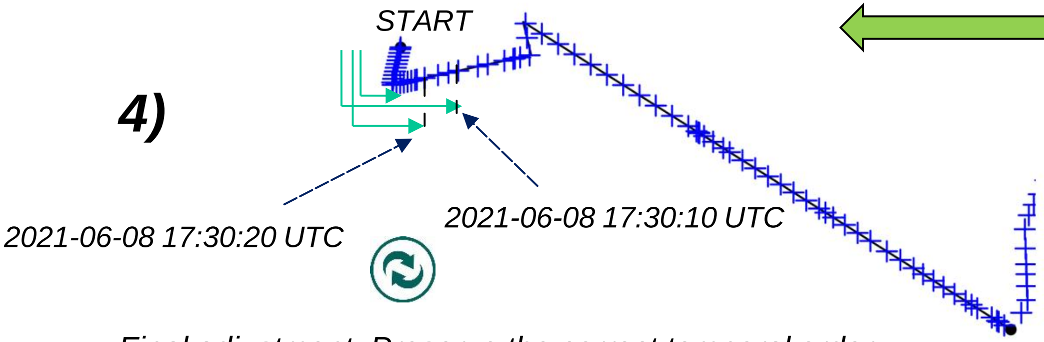
Points snapped to the reference route using a distance threshold

3)



Based on the sampling time -> n. of missing points
Missing points were introduced at a regular distance.

4)



Final adjustment: Preserve the correct temporal order