Variabilità di Black Carbon equivalente a Barcellona da mappatura pedonale

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[4]IDAEA-CSIC

Motivation

Scientific motivations

- Black Carbon is the aerosol fraction with the largest direct radiative forcing, along with a large uncertainty[1]
- Black Carbon is a carcinogenic and toxic aerosol fraction[2]
- Black Carbon is included in the latest WHO guidelines and in the latest AAQD

Technical motivations

- Assessment of the performance of portable BC samplers
- Assessment of the intra-urban BC variability
- Assessment of the harbour impact on AQ and
  of the suitability of portable BC samplers to detect it

Social justice motivations

- Air pollution and urban heat have a greater impact on vulnerable groups (the children, the elderly, people with disabilities and the poor)

[1] IPCC WG1, 2021
[2] Janssen et al, WHO, 2012

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Overview of the campaign

MA200 microaethalometer
dual spot, 5 λ (375 – 870 nm)
PTFE filter tape (C_{ref} = 1.3)

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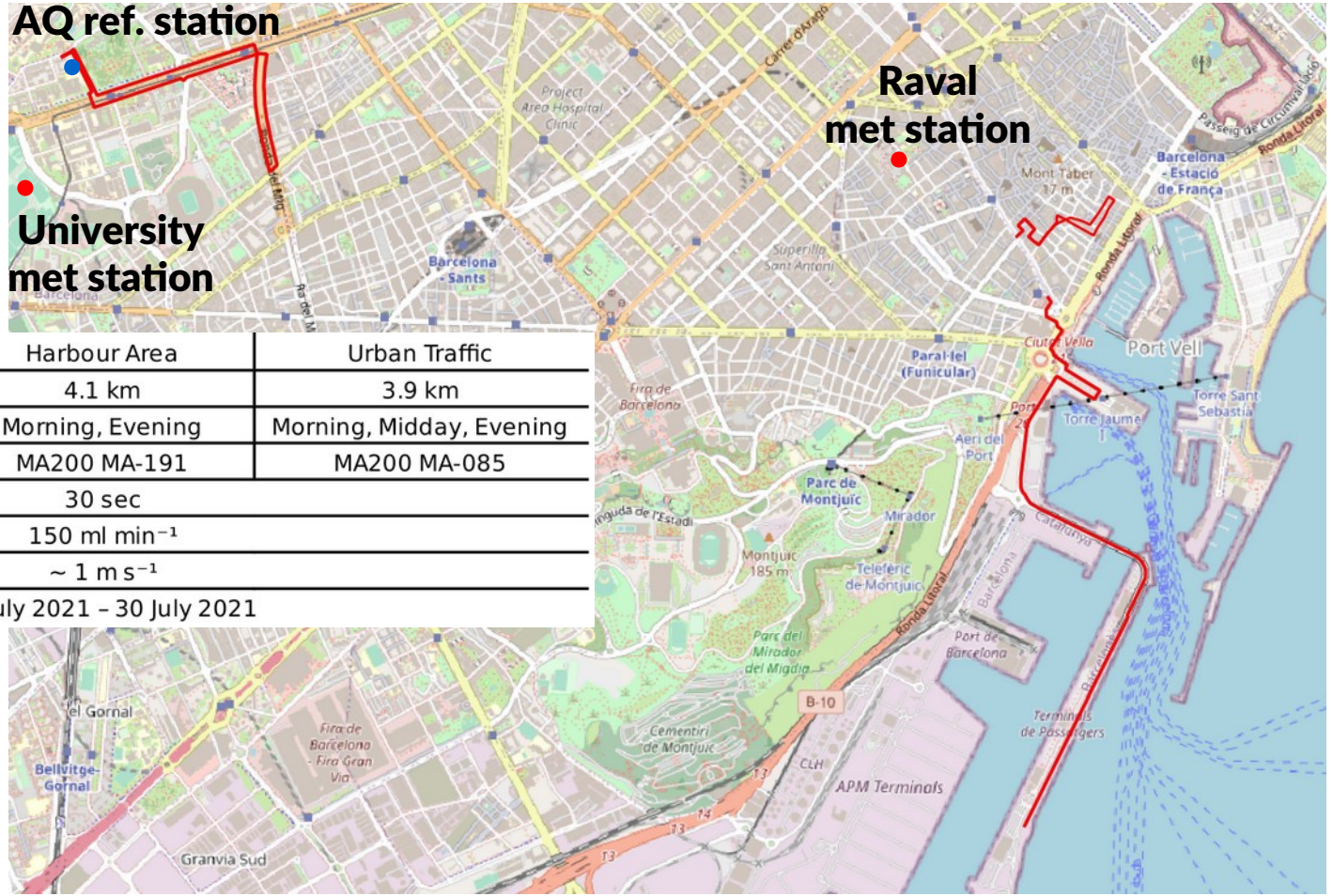

Route	Low Emission Zone	Harbour Area	Urban Traffic
Length	1.8 km	4.1 km	3.9 km
Repetition	Morning, Midday, Evening	Morning, Evening	Morning, Midday, Evening
Instrument	MA200 MA-201	MA200 MA-191	MA200 MA-085
Sampling interval	30 sec		
Sampling flowrate	150 ml min^{-1}		
Walking speed	~ 1 m s^{-1}		
Mapping period	19 July 2021 – 30 July 2021		

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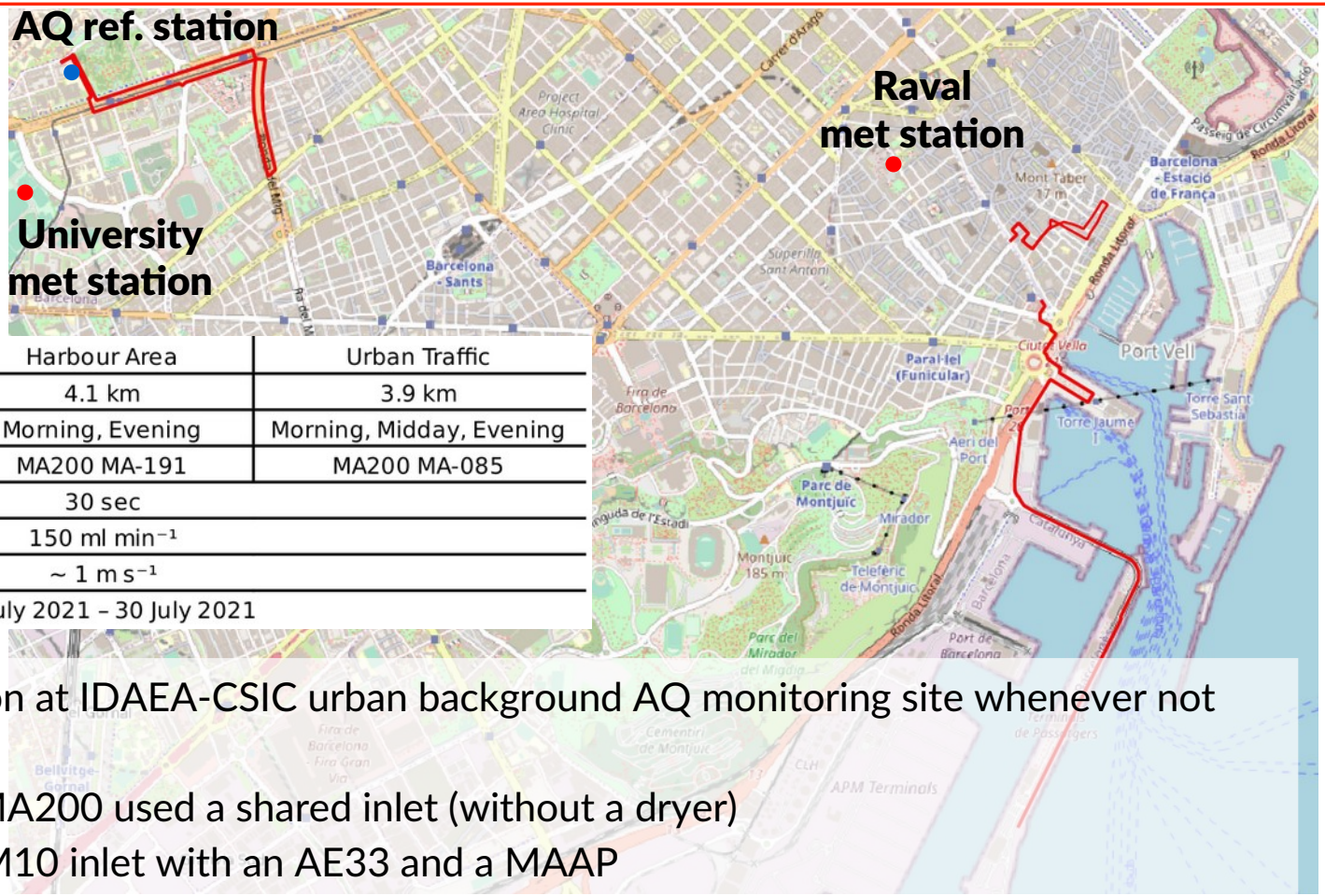

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- All MA200 were in intercomparison at IDAEA-CSIC urban background AQ monitoring site whenever not involved in mapping
- During the intercomparison, the MA200 used a shared inlet (without a dryer)
- AQ reference station had a dry PM10 inlet with an AE33 and a MAAP
  (also an online EC/OC and a SP2 were active during the campaign, but they are not part of this talk

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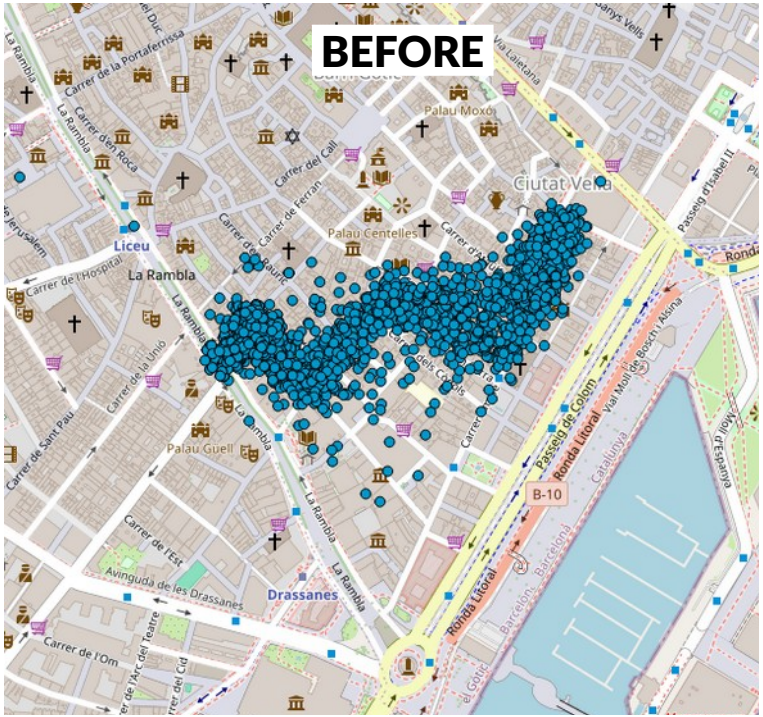
Pre-processing mapping data



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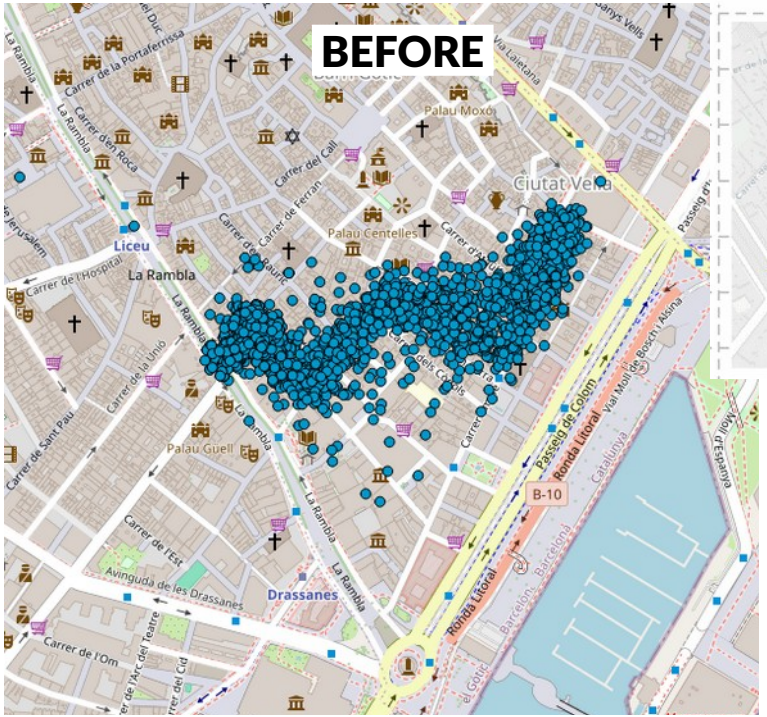

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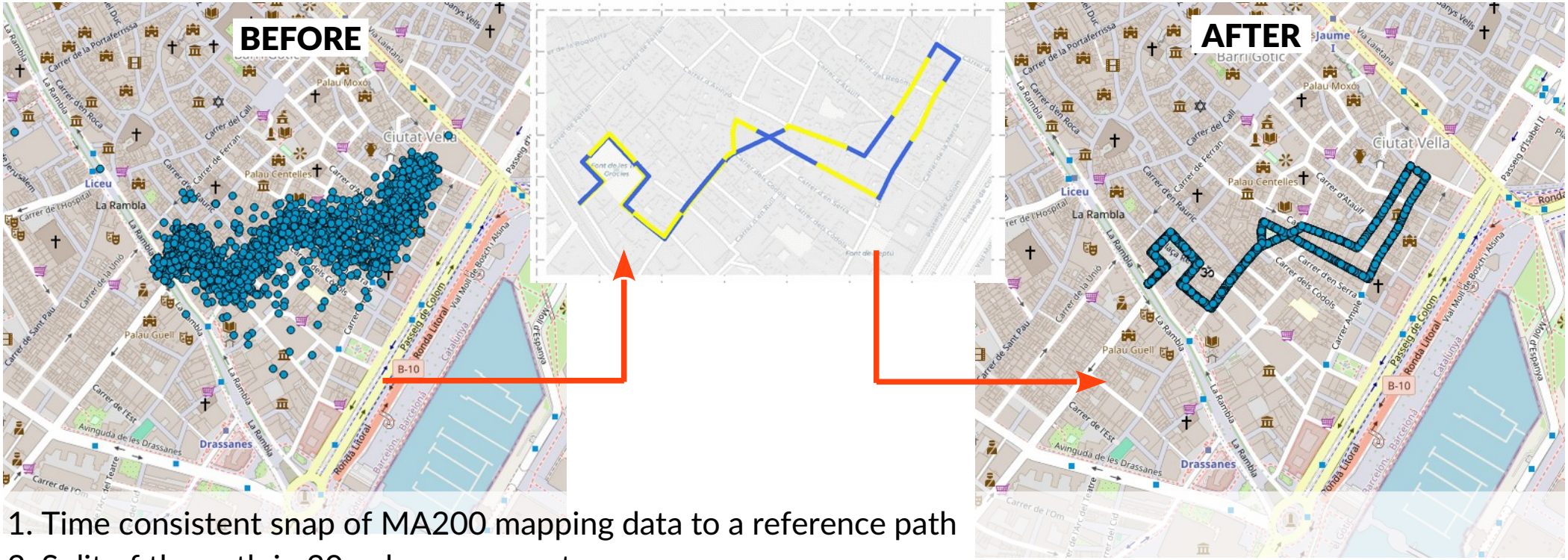

1. Time consistent snap of MA200 mapping data to a reference path
2. Split of the path in 30 m long segments
3. Allocation of the MA200 data to each segment and computation of statistics for each segment
4. From 9 to 12 total repetitions of each path for each time of the day (i.e. morning, midday, evening)
   - the mapping speed is 1 m s^{-1}, the measurement integration interval is 30 s^{-1}
   - ~ 1 sample per segment per rep.: the statistics on each segment is based on ~ 10 rep., i.e. **~ 5 minutes**

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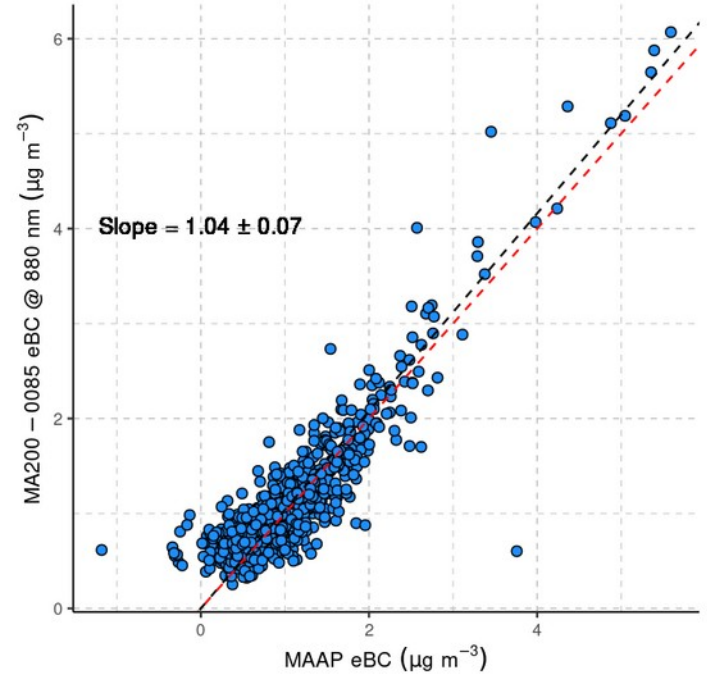
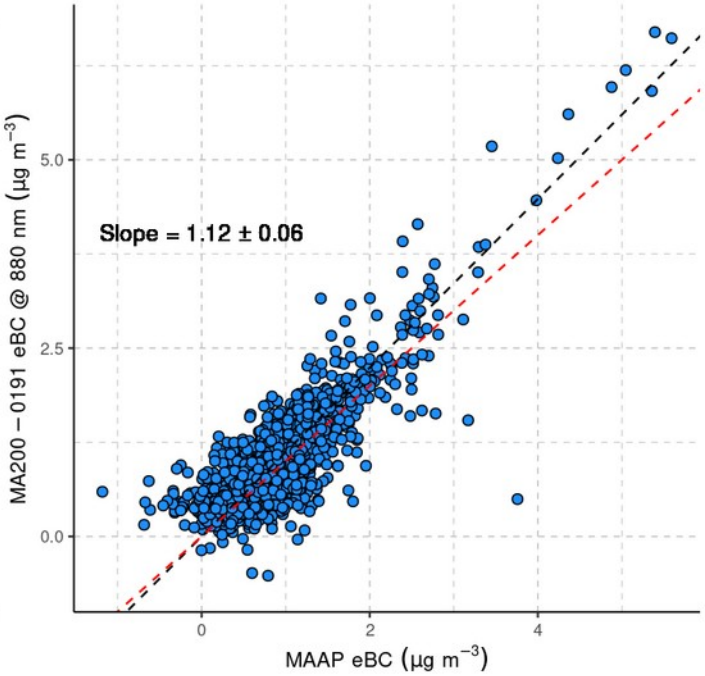
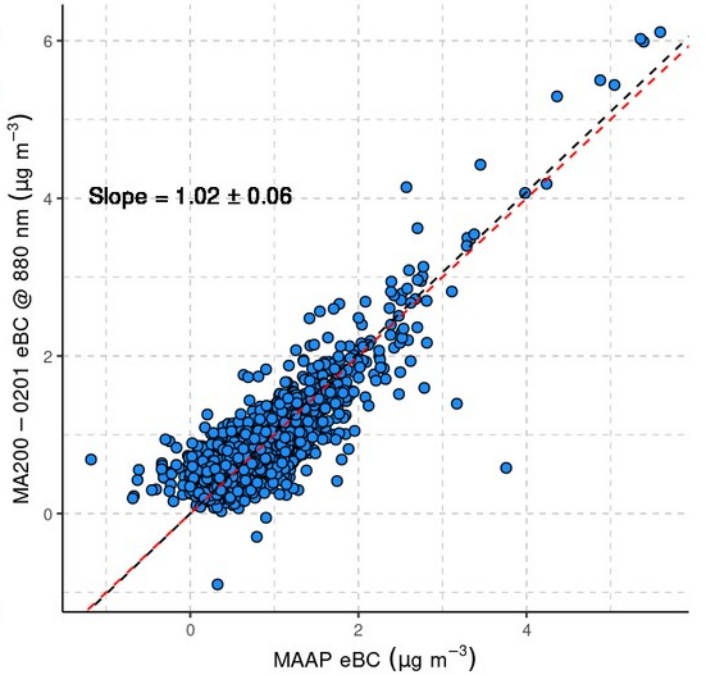
INTERCOMPARISON

MA200 vs MAAP: eBC







- 5 minute averages – Total Least Squares (TLS) linear regression
- eBC from MA200 (internal firmware, C_{ref} = 1.3) and MAAP are quite scattered
- Unit 0191 has some bias (slope 1.12±0.06)

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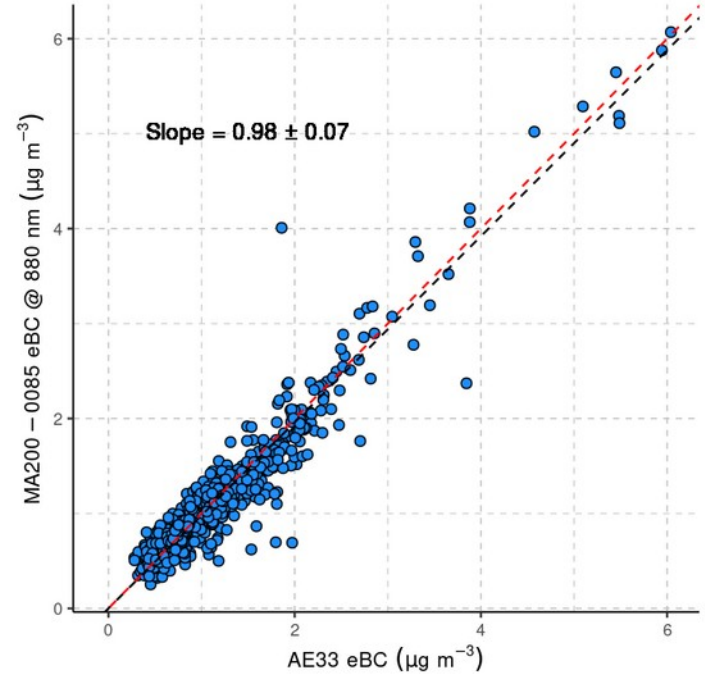
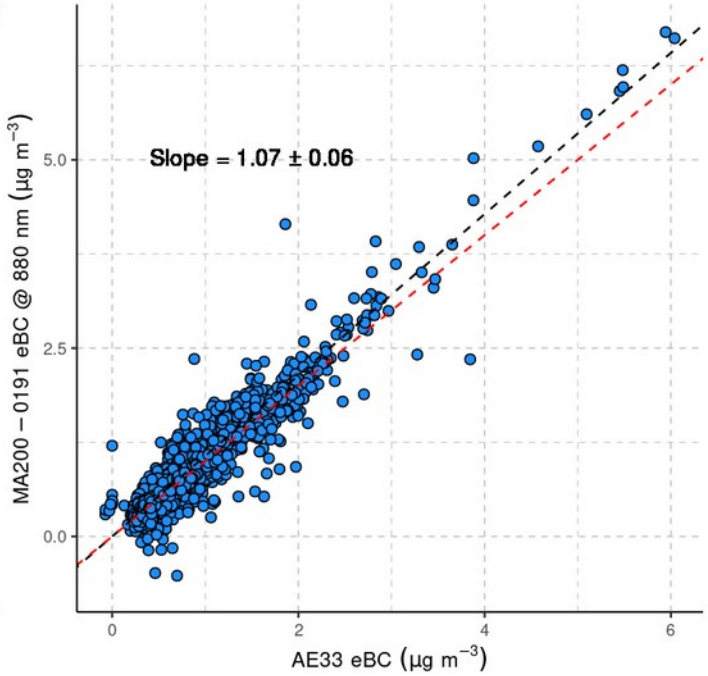
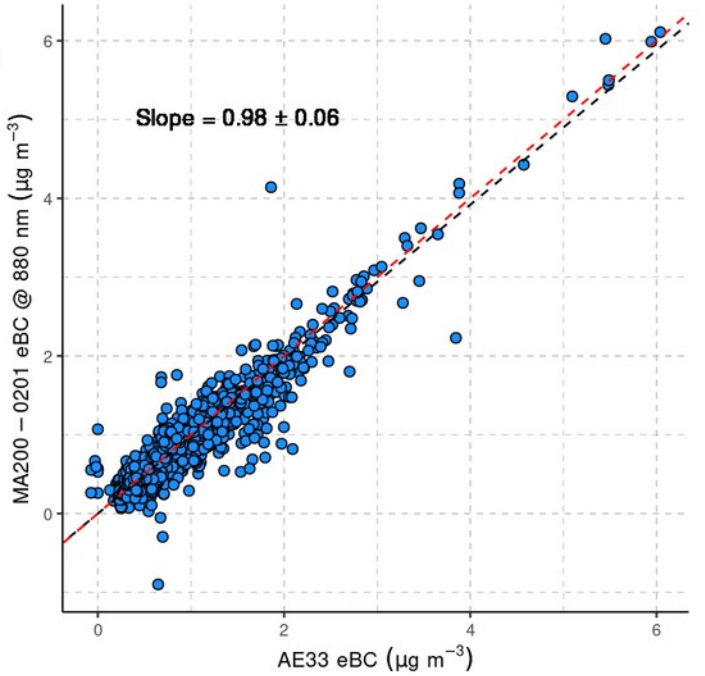
MA200 vs AE33: eBC







- 5 minute averages – Total Least Squares linear regression
- eBC from MA200 (internal firmware, C_{ref} = 1.3) are less scattered compared to MAAP
- Unit 0191 is biased, less than when compared to the MAAP

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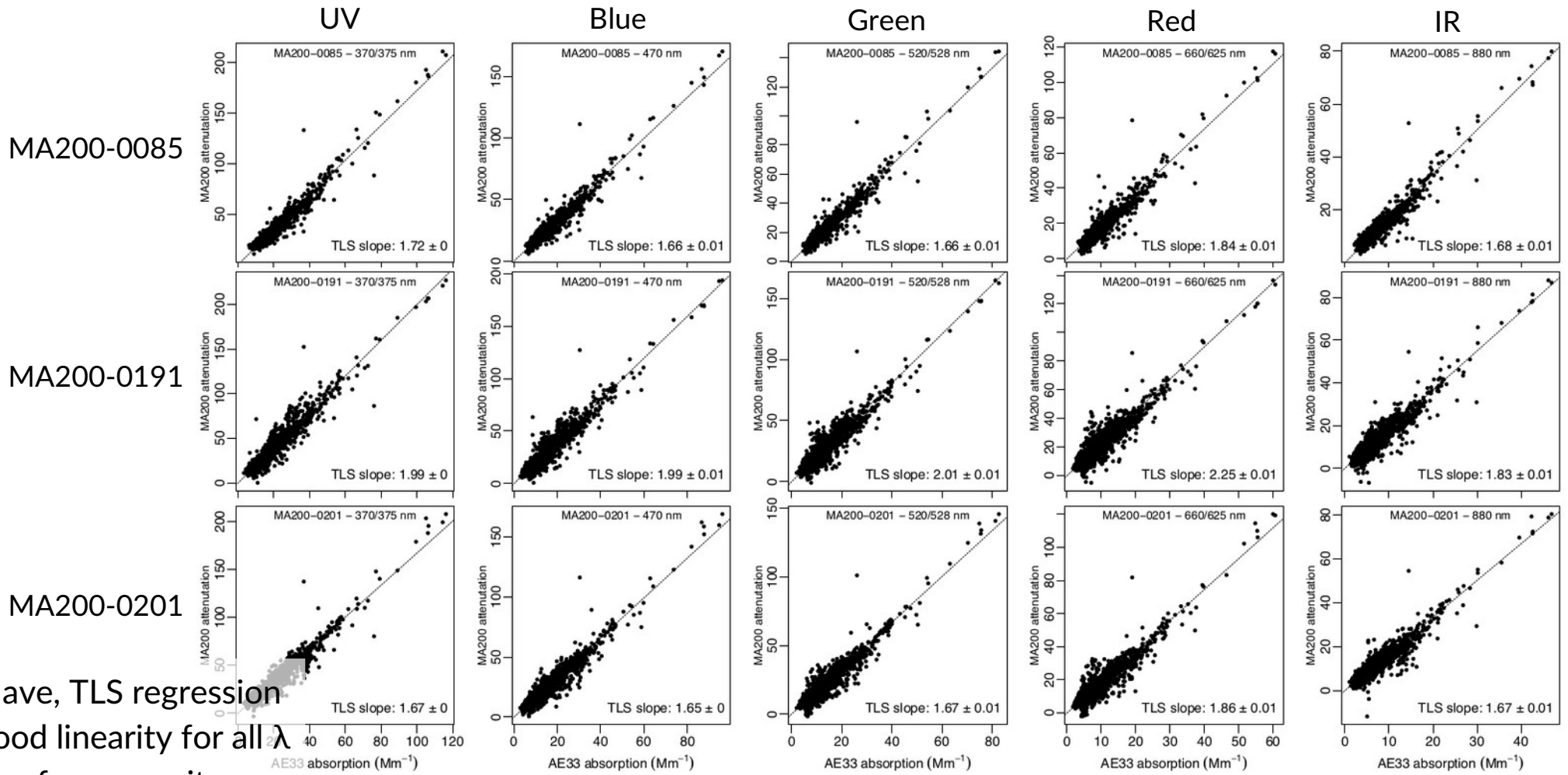
MA200 vs AE33: atn vs abs – Total Least Squares



- 5’ ave, TLS regression
- Good linearity for all λ
- Bias for one unit

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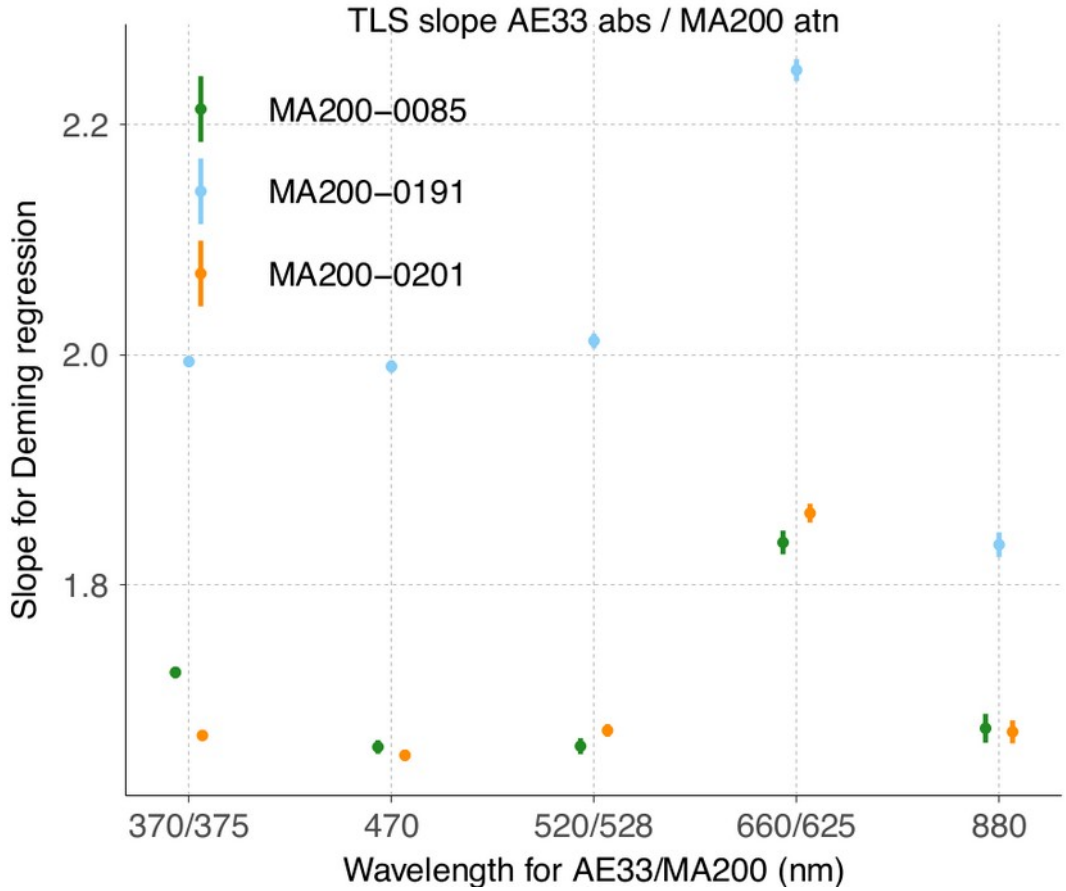
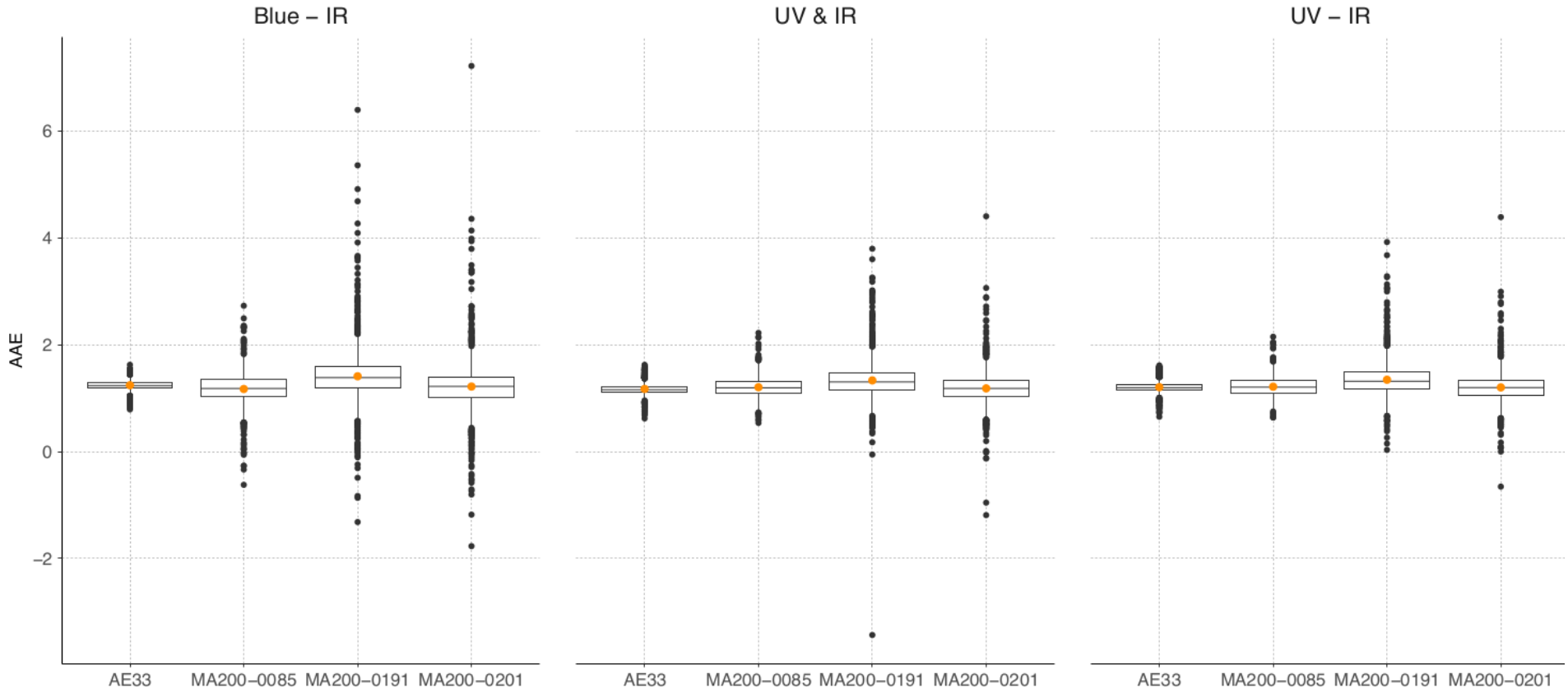
MA200 vs AE33: atn vs abs – Total Least Squares



- 5’ ave, TLS regression
- Good linearity for all λ
- Bias for one unit

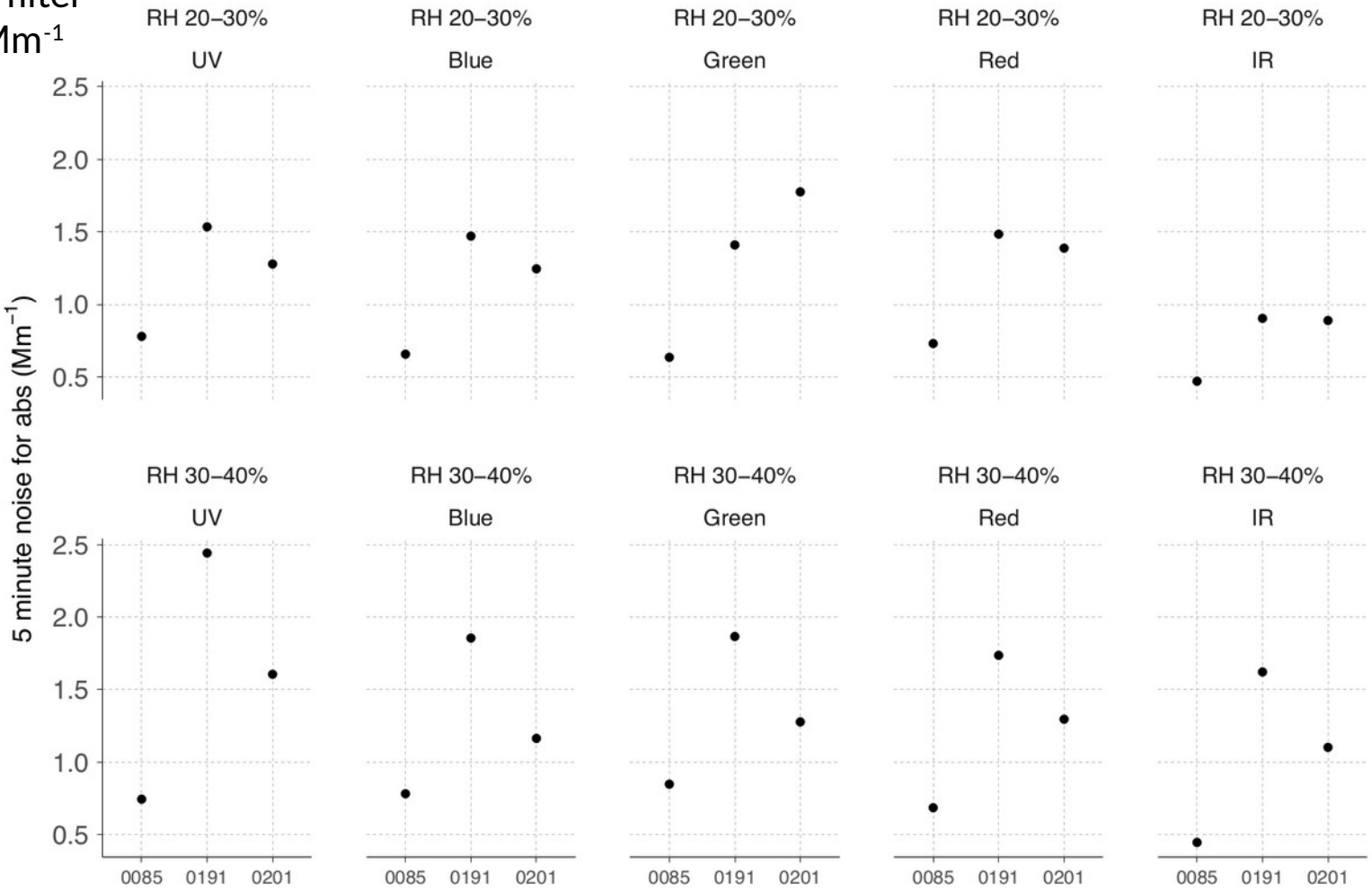
MA200 vs AE33: AAE



- Mean bias of ~1 / 2% for 0085 and 0201, and of 12% for 0191

MA200 5-minute noise (1 σ)

- 9 hours sample from a HEPA filter
- 1σ noise in abs 0.44 – 1.62 Mm^{-1}
- 1σ noise lower for IR
- 1σ in eBC 44 – 160 ng m^{-3}
- The influence of RH is sensor-dependent



MA200 default C_{ref} = 1.3

MAC: 10.12 m^2 g^{-1}

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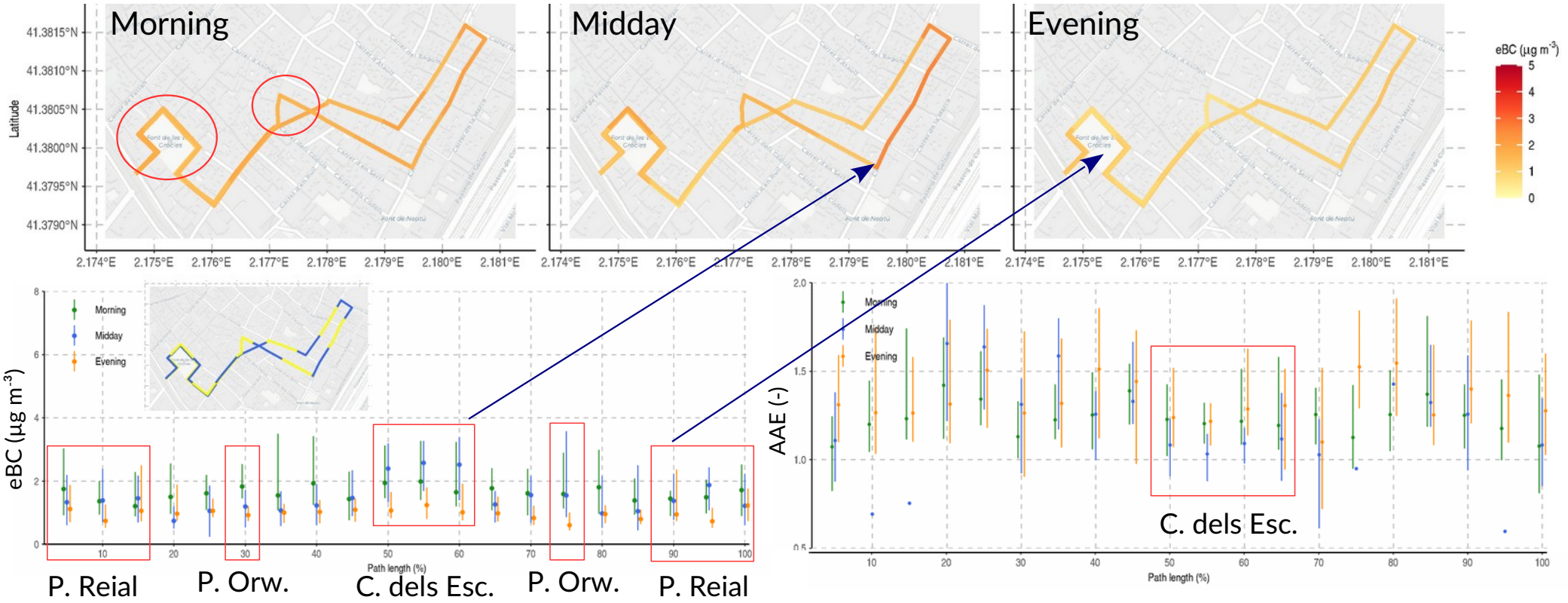
MAPPING

eBC mapping result: Low Emission Zone



- Larger variability in squares: Plaça Reial in the evening, Plaça Orwell at morning and midday
- Higher medians in C. dels Escudrelles (traffic?): traffic's signature with AAE ~ 1 (evening)

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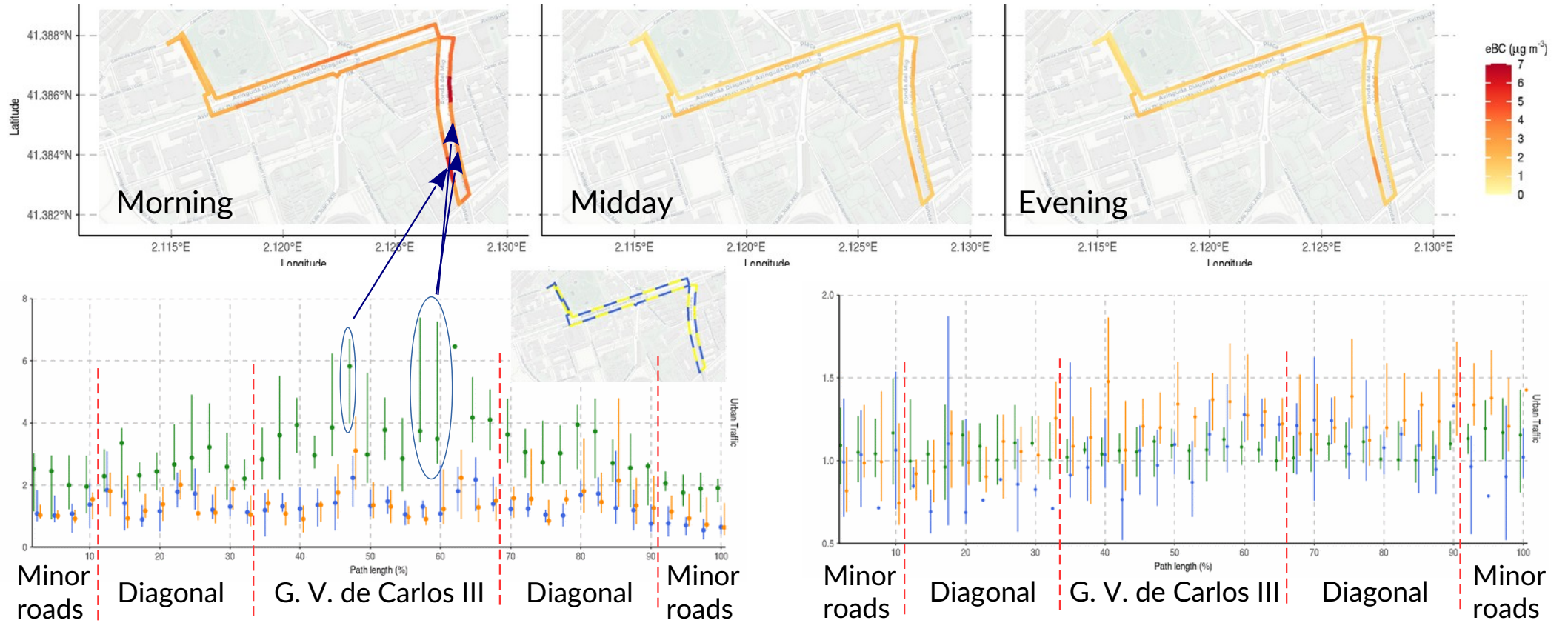
eBC mapping results: urban traffic



- Gran Via de Carlos III: - larger eBC compared to other segments - 1 segment with higher values all day
- Generally lower eBC in minor roads
- AAE closer to 1 in the morning and in the G.V. • AAE increases throughout the evening

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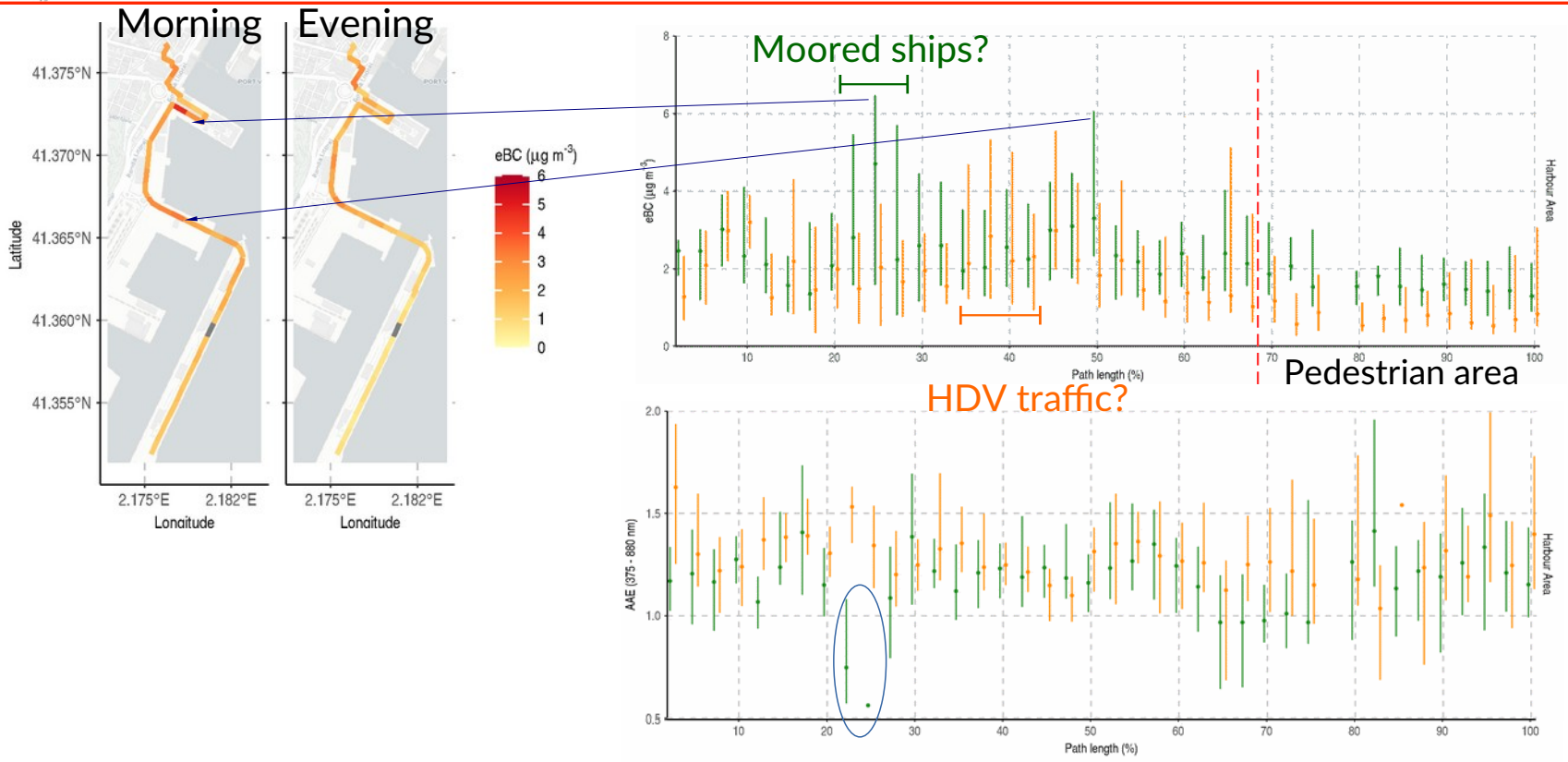
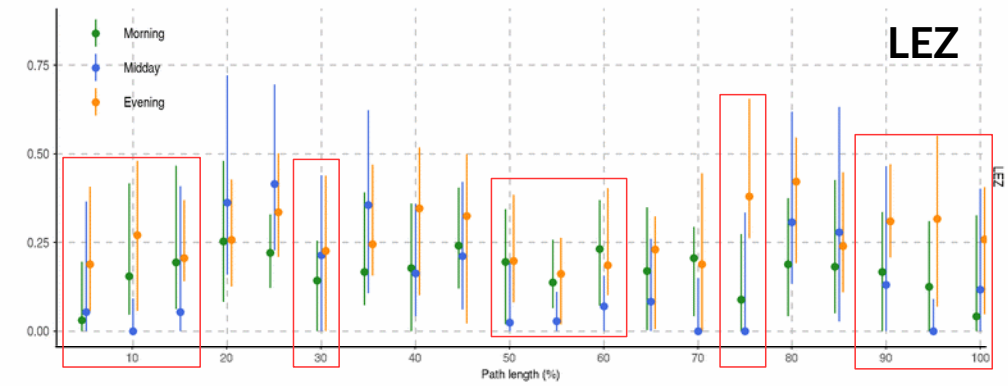
eBC mapping results: harbour area



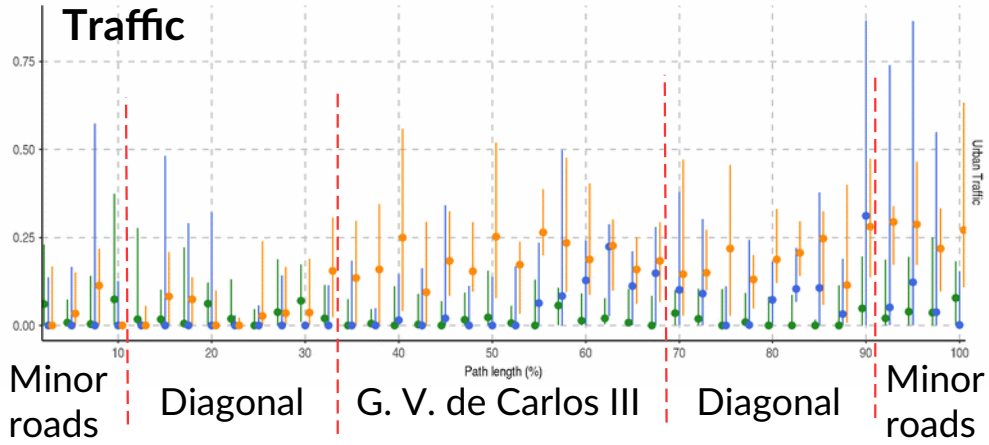
- Generally lower levels in the evening and in the pedestrian area
- Peaks around some docks (moored ships?)
- Similar AAE in morning and evenings • AAE higher in the evening

Share of absorption at 375 nm by non-eBC

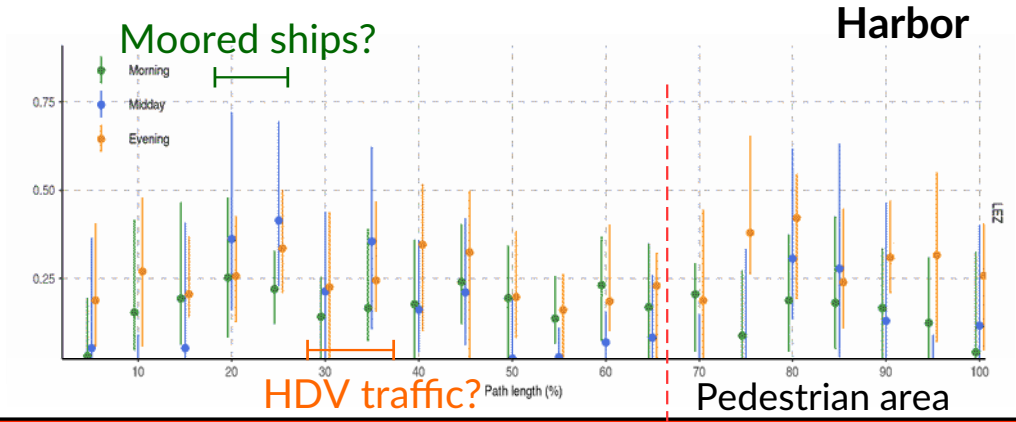
- **LEZ**: lower share of non-eBC at midday across the whole path, besides few segments
- **Traffic**: Different non-eBC share between the two sides of the Diagonal and in the minor streets (C. de Keynes, C. de J. Girona)
- **All routes**: higher share of non-eBC at evening



P. Reial P. Orw. C. dels Esc. P. Orw. P. Reial



Minor roads | Diagonal | G. V. de Carlos III | Diagonal | Minor roads



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Conclusions

- Intercomparison:
  - MA200 are suitable for mobile measurements in urban areas
  - Individual MA200 should be verified for instrumental bias (as any other device)

- During the campaign:
  - the signature of road traffic to ambient aerosol in specific sites was quite clear
  - hints of a signature of ship emissions on ambient aerosols
  - hints of a signature of cooking emissions on ambient aerosols in the LEZ

GRAZIE PER L'ATTENZIONE

Grazie ai volontari che hanno aiutato a mappare

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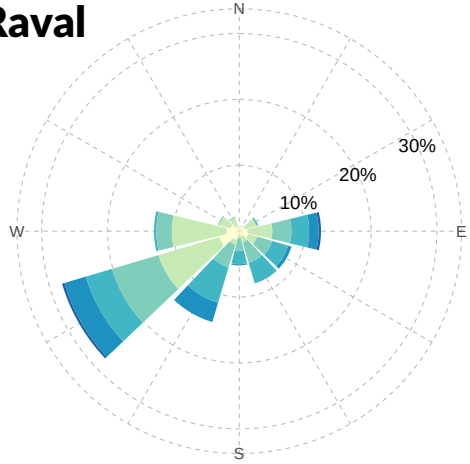
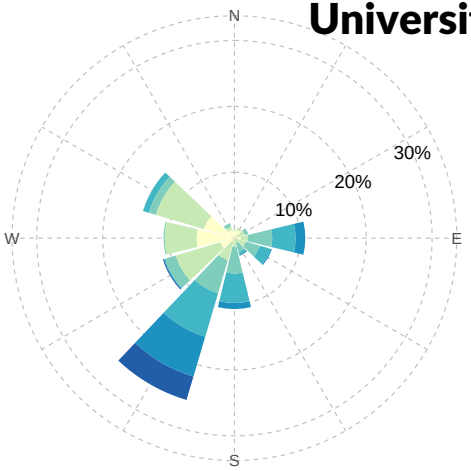
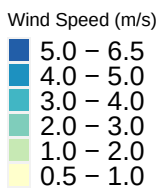
Meteorology

Raval



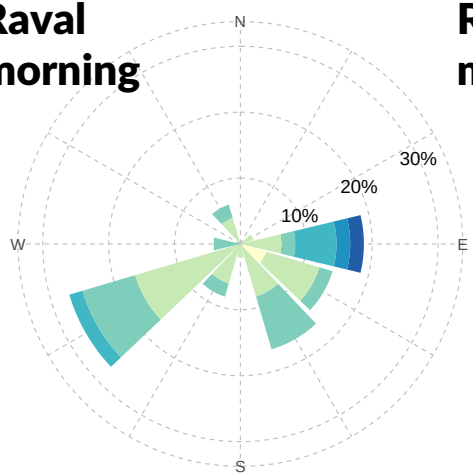
University



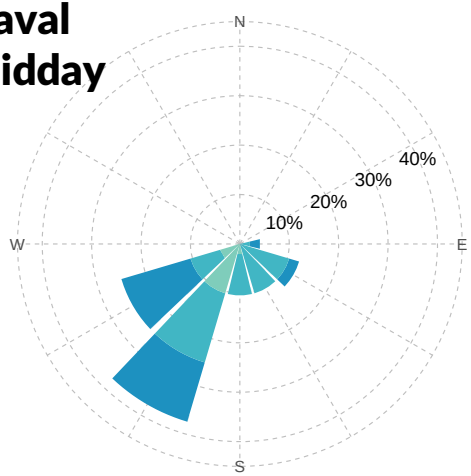


Mean wind rose during the campaign at the Raval (city center, 1.3 km from the sea) and in the University area in the inland, at ~6 km from the sea, closer to the hills.

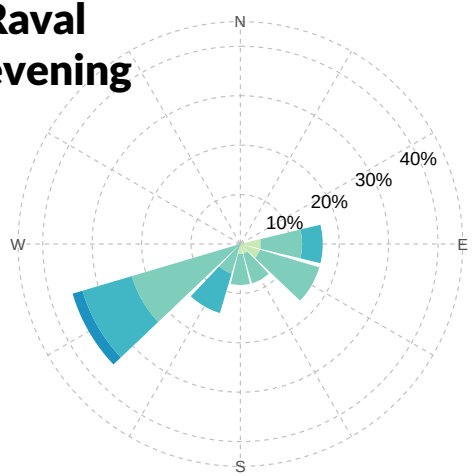
Raval morning

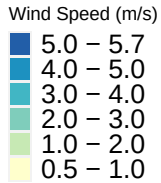


Raval midday



Raval evening





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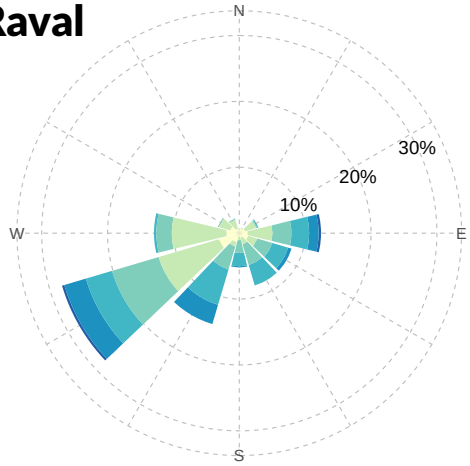

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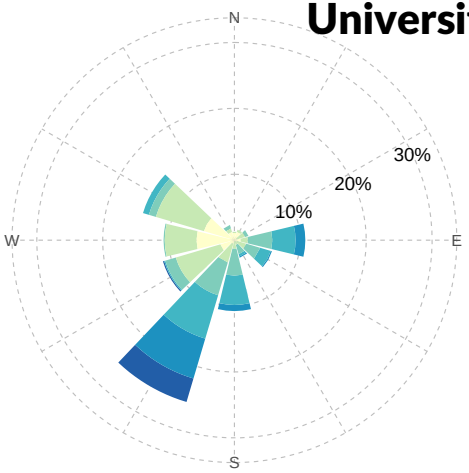

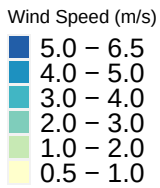

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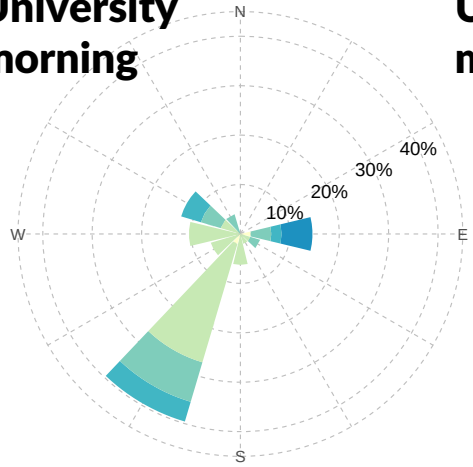
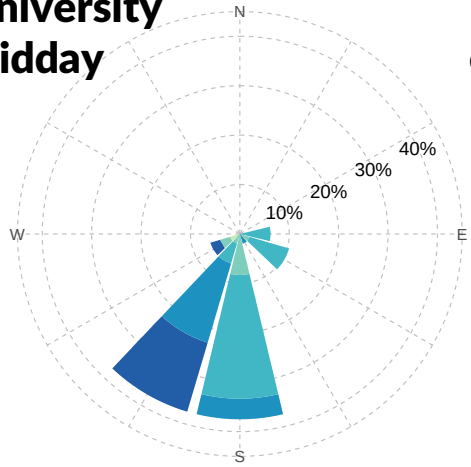
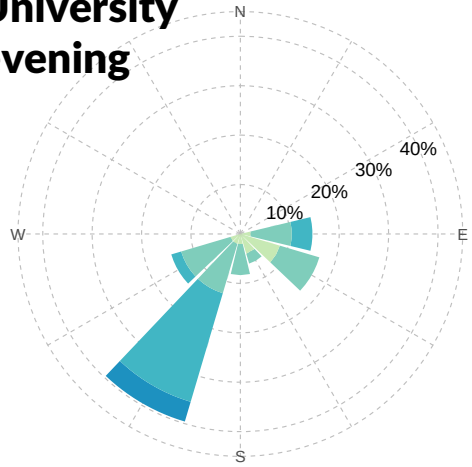
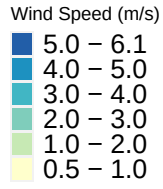


University midday



University evening





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