

Low cost source apportionment of urban air pollution

Gordon Alison (GordonA@dustscan.co.uk),
Dimitrios Bousiotis (d.bousiotis@bham.ac.uk) and Francis Pope (f.pope@bham.ac.uk)

Problems with air pollution control

- Limited measurements
- Limited information on the sources of pollution
- A combination of cheap material and easy but established methodologies can help
- We are trying to establish and extend the applications of low-cost sensors in source apportionment studies



Setup and methodology

- Alphasense OPC-N3 as main sensor (approximate cost per unit is 250 GBP).
- Additional sensors
 - Aethalometer
 - Box Of Cluster of Sensors (BOCS)
 - Lung Deposited Surface Area
- K-means clustering and Positive Matrix Factorisation (PMF)
- Work with non-university partners

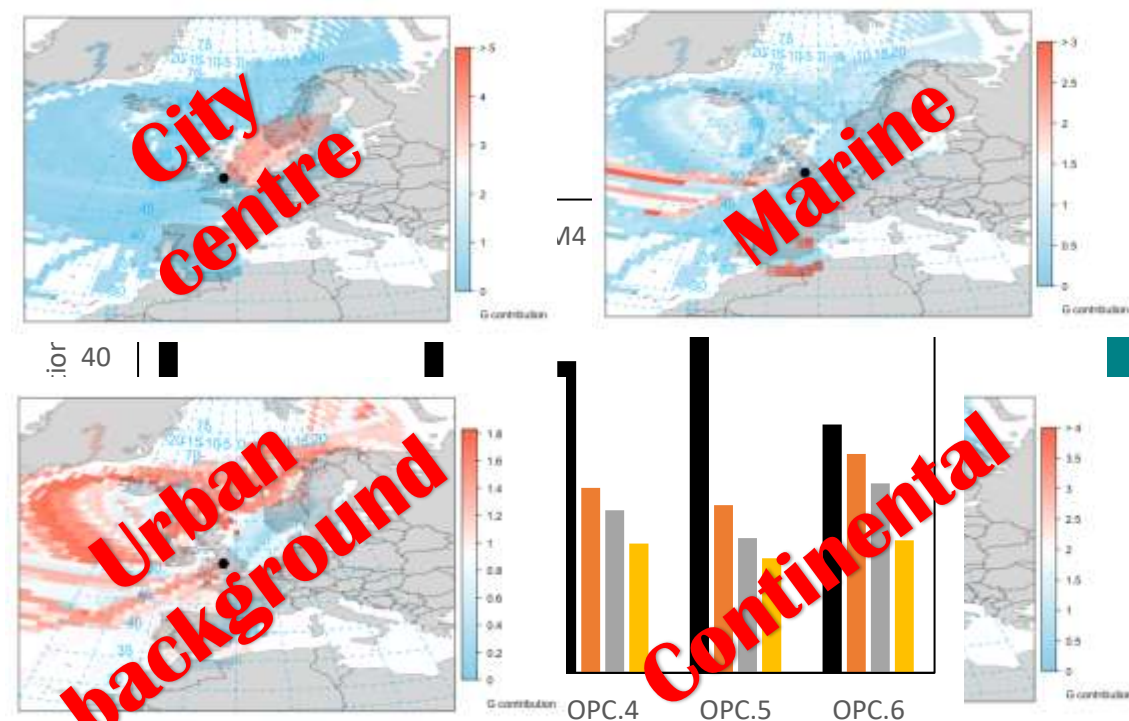


Testing at the Birmingham Air Quality Supersite

- Sources associated with Birmingham's city centre, the residential area near the University, the train station etc. were successfully separated.
- The PMF methodology further helped in identifying and quantifying the effect of the different sources

Bousiotis, D. et al., 2021. Assessing the sources of particles at an urban background site using both regulatory instruments and low-cost sensors – a comparative study. *Atm. Meas. Tech.*, 14(6), 4139–4155, <https://doi.org/10.5194/amt-14-4139-2021>

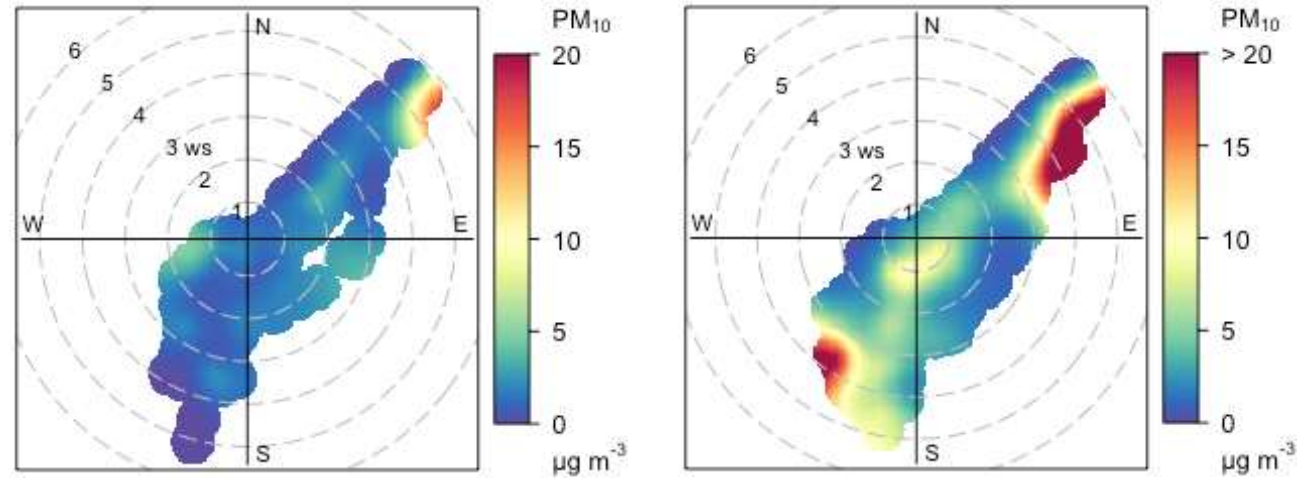
Bousiotis, D. et al., 2022. A study on the performance of low-cost sensors for source apportionment at an urban background site. *Atmos. Meas. Tech.*, 15, 4047–4061, <https://doi.org/10.5194/amt-15-4047-2022>



Applications in industrial sites - Curzon Street HS2 Construction Site



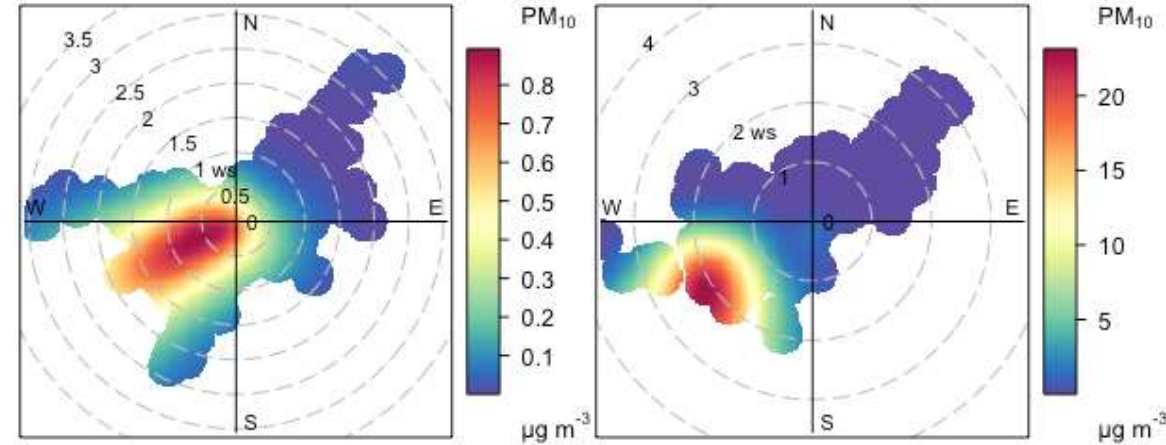
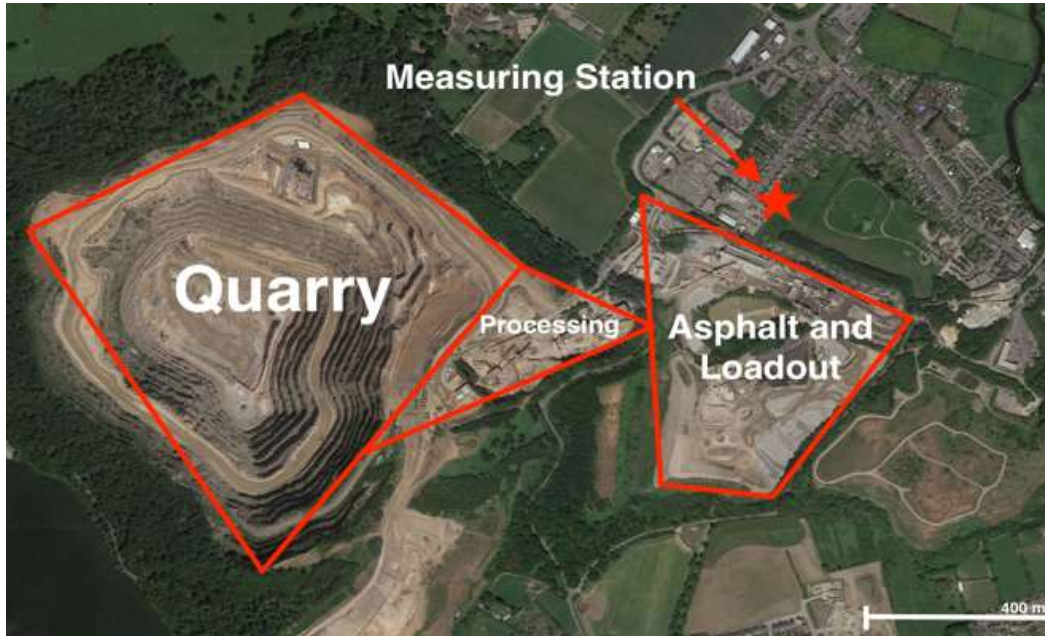
Estimated PM₁₀ concentrations for (a) non-working and (b) working hours for factor F4 at Curzon Street



Factor	Association
F1	Urban background 1
F2	Construction site 1
F3	Urban background 2
F4	Construction site 2
F5	Regional background (marine)

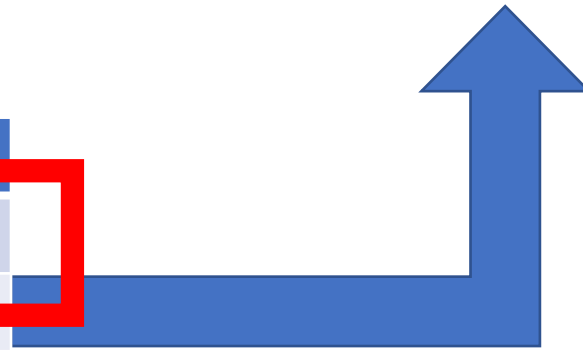


The Mountsorrel Quarry



Polar plots of the estimated PM_{10} concentration for F2 (non-working (upper) and working hours (lower))

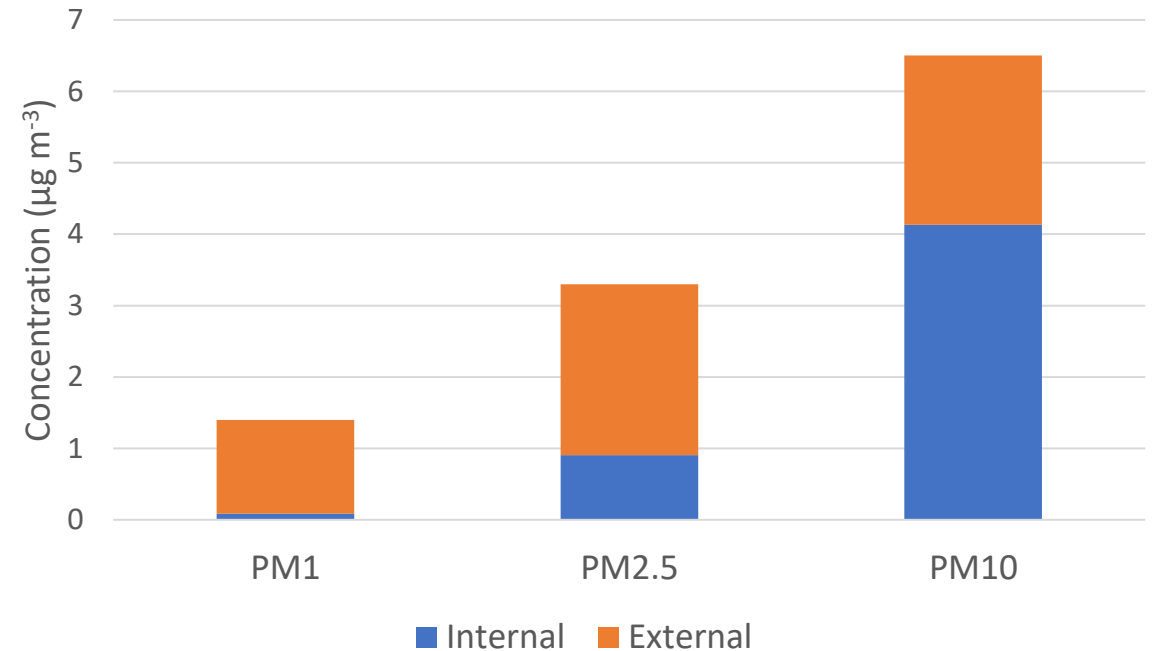
Factor	Association
F1	Urban background
F2	Quarry
F3	Regional background (marine)
F4	Undefined source (the nearby town?)



Bousiotis, D. et al., 2023. Towards comprehensive air quality management using low-cost sensors for pollution source apportionment, *npj Climate and Atmospheric Science*, NPJCLIMTSCI-01042 (in review)

Indoor applications

- A typical family house in a semi-rural area in Birmingham
- The nature of the room and activities done in it significantly affected the PM concentrations
- Using the PMF we assessed the daily exposure on an average work at home day separating the outdoor and indoor effect.

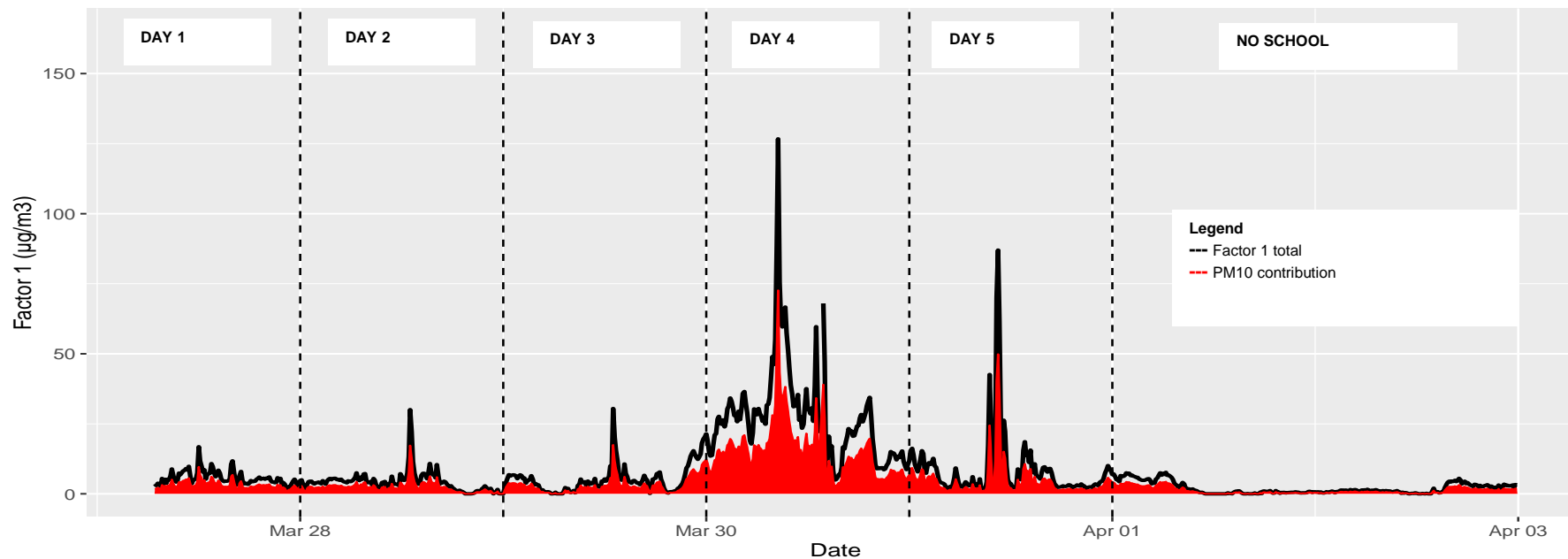


Estimated PM exposure of an average work-at-home day

Indoor applications (cont.)

- We have conducted a campaign at a school in Wales.
- The different sources of particles were identified and quantified.

Particulate Matter Contribution to Factor 1 (Indoor Cooking)



Measurements from the cooking class at the school.

More setups for more versatile measurements

- We studied the variation of the pollution sources affecting an area nearby the University at neighbourhood level.
- New setups were presented for both static and mobile measurements.
- Using the new setups more versatile measurements can be achieved and more complex areas can be studied.



Conclusions

- Despite their shortcomings low-cost sensors are capable for pollution source apportionment in several scenarios and help in having better and more cost-effective ways to deal with air quality problems.
- We have tried the methodologies successfully in several different environments. So far, it was not successful only for traffic related sources.
- In our latest application it successfully identified and apportioned indoor and outdoor sources in a typical family house.
- These methodologies will be used for the RI-URBANS project in Birmingham, in which new setups will also be tried.



TRANSITION
CLEAN AIR NETWORK



Thank you!



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