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# How COVID-19 related policies reshaped organic aerosol source contributions in central London

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Improving air quality can potentially save millions of lives, given that 97% of the urban population in Europe is exposed to a higher annual PM<sub>2.5</sub> concentration than the World Health Organization guidelines (5 µg/m<sup>3</sup>) (WHO, 2021). As the largest city in Europe, London is on the front line to mitigate the health impacts of PM<sub>2.5</sub>. Knowledge of pollution sources is crucial to design the most cost-effective mitigation strategies. Positive matrix factorization (PMF) of Aerosol Mass Spectrometer (AMS) or Aerosol Chemical Speciation Monitor (ACSM) data is a powerful approach to quantitatively identify and apportion sources of organic aerosol (OA), which makes up over half of PM<sub>2.5</sub>. Using the most advanced PMF techniques (i.e., rolling PMF, ME-2, and bootstrap, Canonaco et al., 2021) by following the standardized protocol (Chen et al., 2022) could provide high-quality source information of OA.

The year-long Quadrupole ACSM (Ng et al., 2011) data from the roadside supersite in London Marylebone Road (51.523 N, -0.155 E) collected from Aug 1<sup>st</sup>, 2019, to Oct 22<sup>nd</sup>, 2020, provides us with a unique opportunity to investigate how COVID-related policies impacted human activities and, therefore, OA sources. The period covered the first COVID-19 lockdown (Mar 26<sup>th</sup>, 2020 to Jun 23<sup>rd</sup>, 2020) and the Eat Out to Help Out (EOTHO) Scheme (Mon-Wed during Aug 3<sup>rd</sup>, 2020 to Aug 31<sup>st</sup>, 2020) (Table 1), which was a British government scheme to support the hospitality industry during the COVID-19 pandemic (<https://www.gov.uk/guidance/get-a-discount-with-the-eat-out-to-help-out-scheme>).

Table 1 Dates of the COVID-related policies in London.

| COVID Policies | Date  |
|----------------|---|
| Pre-Lockdown   | Aug 1 <sup>st</sup> , 2019 – Mar 25 <sup>th</sup> , 2020  |
| Lockdown       | Mar 26 <sup>th</sup> , 2020 – Jun 23 <sup>rd</sup> , 2020 |
| Priori scheme  | Jun 24 <sup>th</sup> , 2020 – Aug 2 <sup>nd</sup> , 2020  |
| Post-Lockdown  | EOTHO scheme  |
|                | Aug 3 <sup>rd</sup> , 2020 – Aug 31 <sup>st</sup> , 2020  |
|                | After scheme  |
|                | Sep 1 <sup>st</sup> , 2020 – Oct 22 <sup>nd</sup> , 2020  |

Five OA factors were identified including hydrocarbon-like OA (HOA, traffic-related, 10.5% to OA), cooking OA (COA, 19.5% to OA), biomass burning OA (BBOA, 11.5% to OA), more-oxidized oxygenated OA (MO-OOA, 37.7% to OA), and less-oxidized oxygenated OA (LO-OOA, 20.8% to OA). All factors showed distinct diurnal patterns before, during and

after lockdown. It is worth noticing that the morning rush-hour peak for HOA and noon peak for COA both disappeared during the lockdown. Moreover, the EOTHO scheme elevated the COA mass concentration after the lockdown (Fig. 1) by 44.9 % but concentrations remained lower than those observed before lockdown. After the scheme ended, COA concentrations remained.

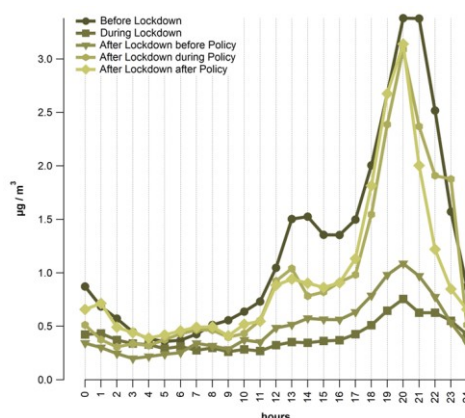


Figure 1 Diel cycles for cooking organic aerosol (COA) during different periods

This study demonstrated the power of rolling PMF in reflecting the influences of policies in human activities and therefore, OA sources. Special attention should be paid to cooking emissions (8.5% of total PM) in urban environment. Thus, it is important to continuously resolve OA sources to inform policymakers of the effectiveness of the policies.

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## References

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