POINT-BY-POINT RESPONSES

Ms. Ref. No.: EGUSPHERE-2023-24, doi:10.5194/egusphere-2023-24.
Title: Measurement Report: MAX-DOAS measurements characterise Central London ozone pollution episodes during 2022 heatwaves
Journal: Atmos. Chem. Phys. Measurement Report

Responses to RC#1:

Ryan et al. provide an interesting and thorough report of the deployment of a MAX-DOAS instrument in central London and use its measurements to explore impact of the 2022 heatwaves on NO2 and HCHO concentrations, and subsequent effects on O3 production. The measurements are also compared with TROPOMI overpasses when available and highlight the complementary nature of the new measurements. The O3 production section is of wider interest in terms of urban air quality policy, as the authors note, with reference to the UK's goals of reducing NO2 emissions.

The paper is well written and formatted, and subject to some minor comments, should be accepted for publication in ACP.

Minor comments:

ca. figure 8 / lines 380 – the ratio between in-situ isoprene and HCHO appears to dramatically change during the 18th July. It would be interesting to have some discussion as the why this is, especially as the increase in HCHO happens before the increase in isoprene. I suspect it has something to do with the location of Marylebone Road relative to the MAX-DOAS view.

The reviewer comment prompted us to revisit the isoprene daytime mean and hourly data shown in Figures 6 and 8. Almost 24 hours of data are missing from 18 to 19 July that we now gap fill with values derived from the strong linear relationship between isoprene concentrations at Marylebone Road and London Eltham sites (R = 0.83). The orthogonal distance regression fit we use, for isoprene in ppbv, is: $\text{isoprene}_{\text{Marylebone}} = (0.23 \pm 0.004) \times \text{isoprene}_{\text{Eltham}} + (0.039 \pm 0.002)$. This gap filling ensures that isoprene data shown in Figure 6 are more representative of daytime means and that we can assess temporal variability in isoprene/HCHO ratios in Figure 8. Updates to the manuscript include the methods detailing the approach we use to derive values when Marylebone Road observations are missing (Section 2.4, lines 270-274), values in Figures 6 and 8, analysis of the data in the manuscript (lines 412, 429-30, and 503-509), comparison to peak isoprene during the 2003 heatwave (line 582), and the Data Availability statement that data on the UCL Data Repository also includes the gap filled isoprene data (https://doi.org/10.5522/04/21610533).

We now state that the large increase in HCHO on 18 July is likely due to accumulation of HCHO during very stagnant conditions and that daytime mean isoprene/HCHO values are the same during the period plotted in Figure 8 (updated figure pasted below). Ratio values are 89 ± 43 pptv ppbv^{-1} on 15-17 July and 89 ± 56 pptv ppbv^{-1} on 18-19 July. This suggests that the seemingly dramatic change in the ratio in the original manuscript is spurious. We also mention that HCHO yields from isoprene oxidation should be routinely high in London, due to sustained concentrations of NO_x > 1 ppbv (lines 508-509).

The diurnal profile of isoprene in Figure 7(c) is not affected by the additional gap-filled data.

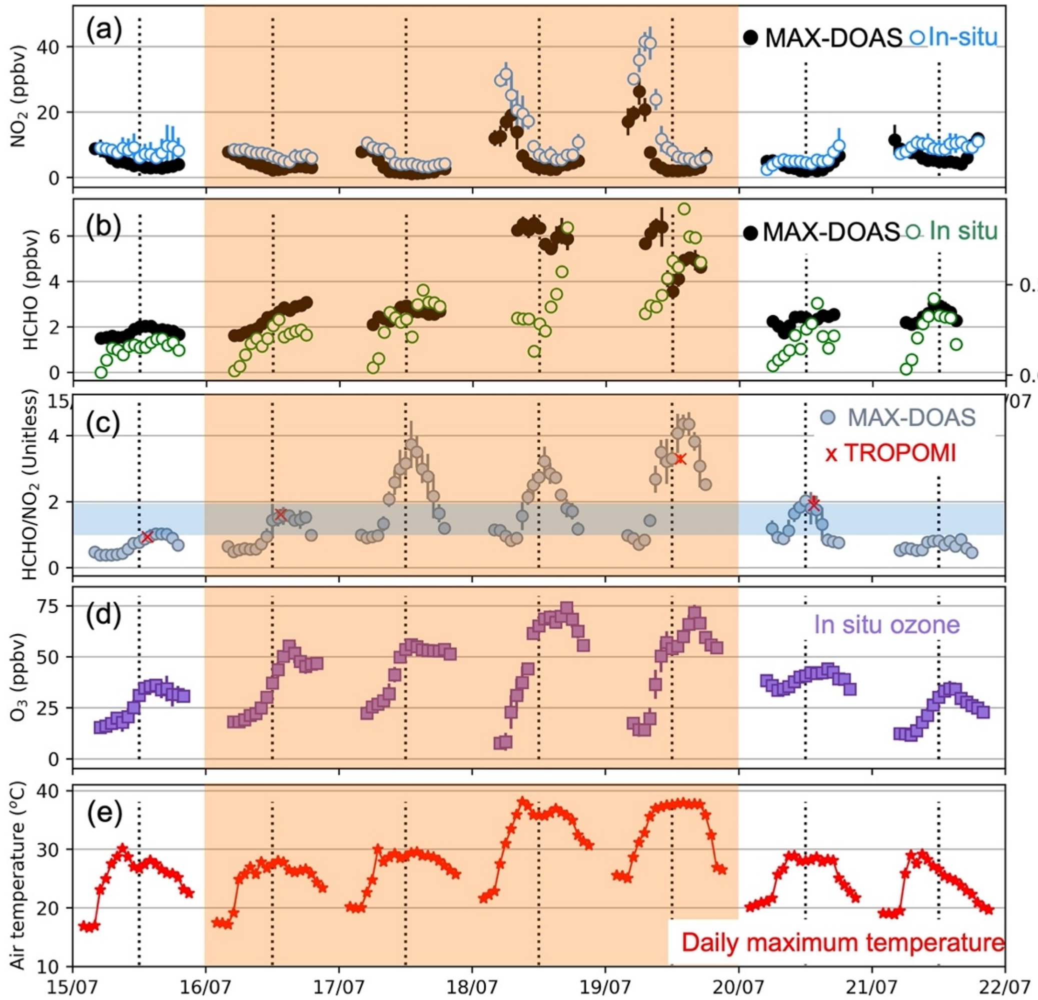


Figure 8. Comparison of hourly mean observations during the July heatwave. Panels and features are the same as in Figure 6, except individual points are daytime (MAX-DOAS solar zenith angle < 90°) hourly means for 15-21 July 2022 and error bars are standard deviations of multi-azimuth hourly means for MAX-DOAS and site means for in situ NO_2 and ozone. Vertical lines show noon UTC as a guide. Additional data in (c) are collocated TROPOMI HCHO:NO_2 means (red crosses) and standard deviations (red error bars). MAX-DOAS and TROPOMI vertical sensitivities differ in (c).

The lowest MAX-DOAS layer is described as ~55m, but the instrument is located at 60m above ground, and all elevation angles are listed as positive inclinations. Is this correct? Adding some information to section 2.1 for clarification would be useful.

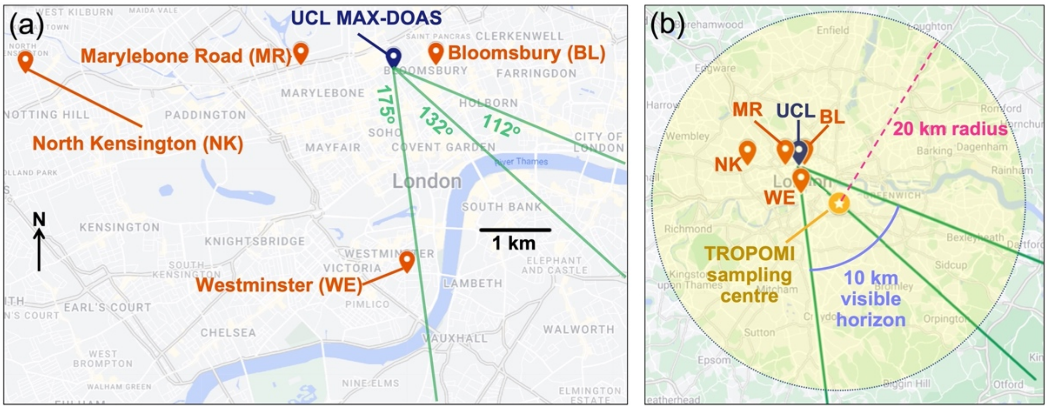
We have updated text in the manuscript to ensure it is clear that the vertical grid extends from 0 to 8 km above ground (line 147), that the instrument is located at 60 m and so is above the lowest retrieval layer (lines 149-150), and that negative viewing angles have been added to the measurement sequence, but after the period of interest in this work (lines 148-149). We briefly discuss the influence of these on information content (DOFS) in the NO_2 vertical column (lines 317-319).

The reviewer comment also aided us in identifying that our initial interpretation of the RAPSODI grid as starting from the instrument altitude was not correct. Given that the lowest retrieval layer lies below the instrument altitude, we now estimate a near-surface concentrations of HCHO and NO_2 as the mean of the lowest 2 retrieval layers (lines 150-152). We use this to compare to the surface network in situ observations. In the comparison, we remove data with limited information from the observations, identified as DOFS summed over the lowest 2 retrieval layers less than 0.2 (lines 201-202). This has negligible effect on MAX-DOAS near-surface NO_2 and leads to very minor changes in comparison of MAX-DOAS near-surface HCHO and surface isoprene (Figures 6(b), 7(d) and 8(b)).

Technical comments:

Figure 1 a – the labels collide with the location pins in some cases – adjust spacing to fix.

Issue addressed. Updated figure pasted below. The caption is unchanged.



The "DOFs/DOFS" initialism's "s" character is inconsistently capitalised throughout the manuscript.

All are now consistently DOFS.