MAX-DOAS measurements characterise Central London ozone pollution episodes during 2022 heatwaves

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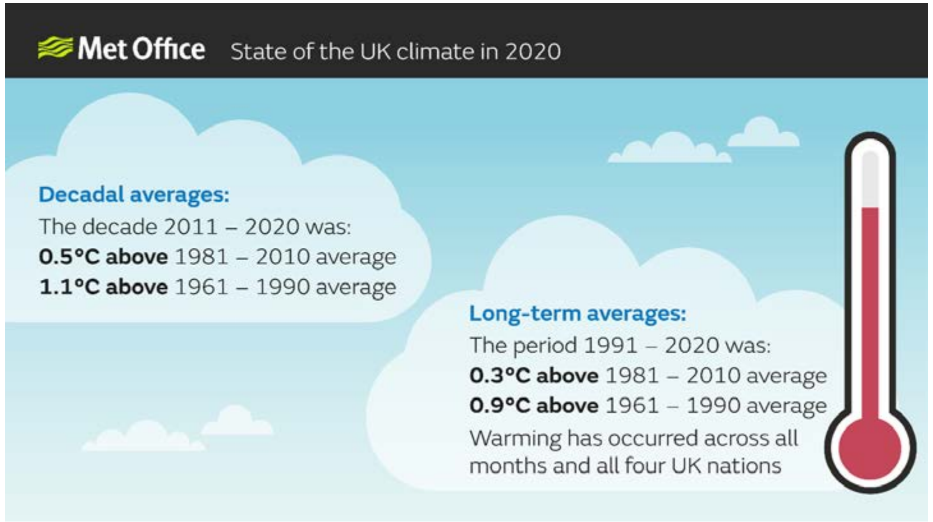
Heatwaves in the UK

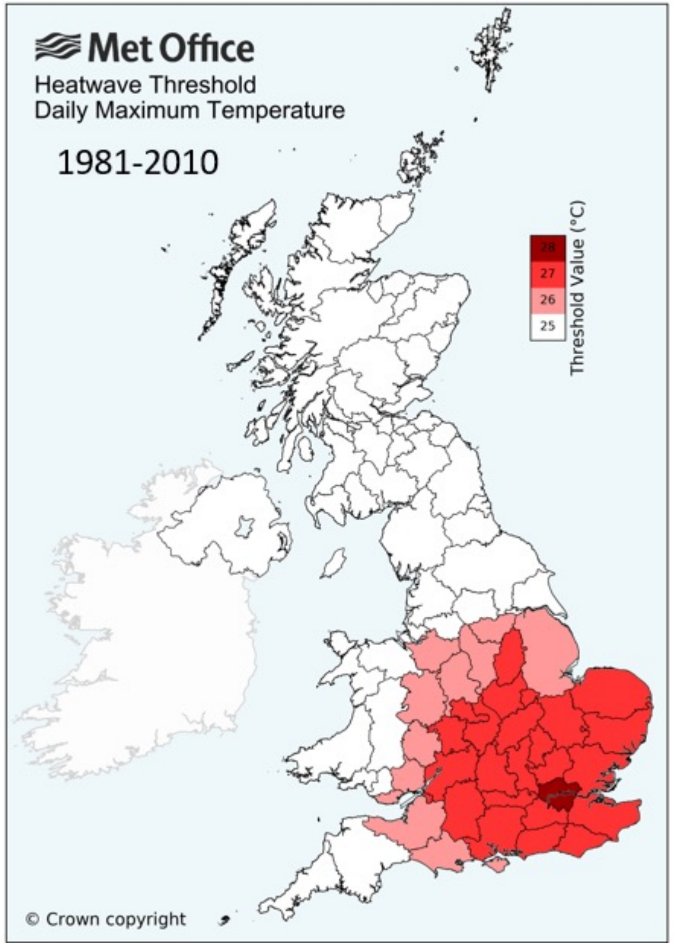
Surface temperature is > 28 °C for at least 3 consecutive days.

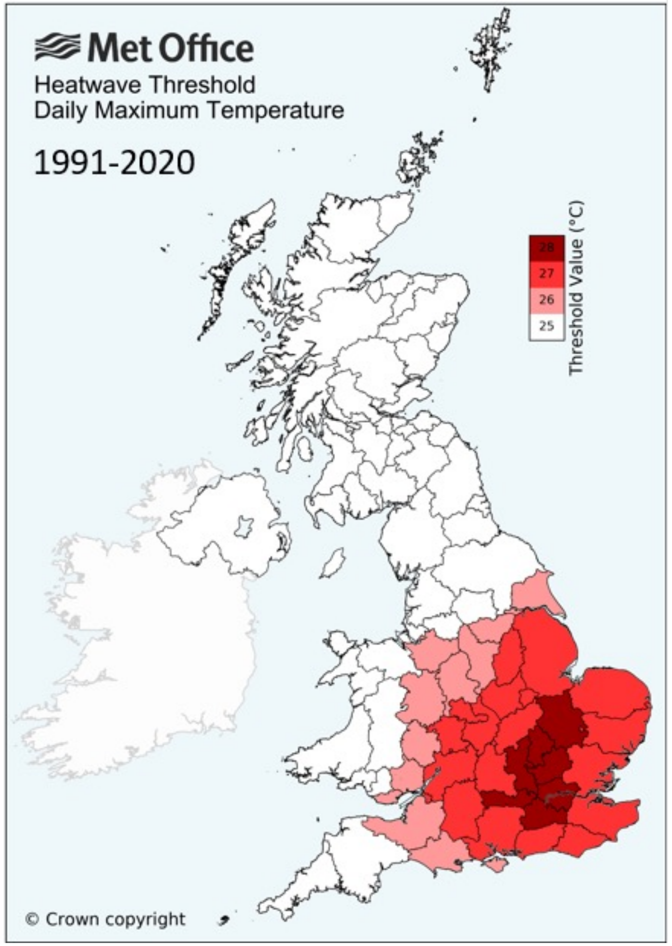
July 2022, London temperatures exceeded 40 °C for the first time on record.

Higher maximum temperatures and longer heatwaves.

Heatwaves cause ozone pollution episodes.







London Ozone Production

NO_x + VOCs ⇒ O_3

NO_x Saturated Regime

Transition Regime

NO_x Limited Regime

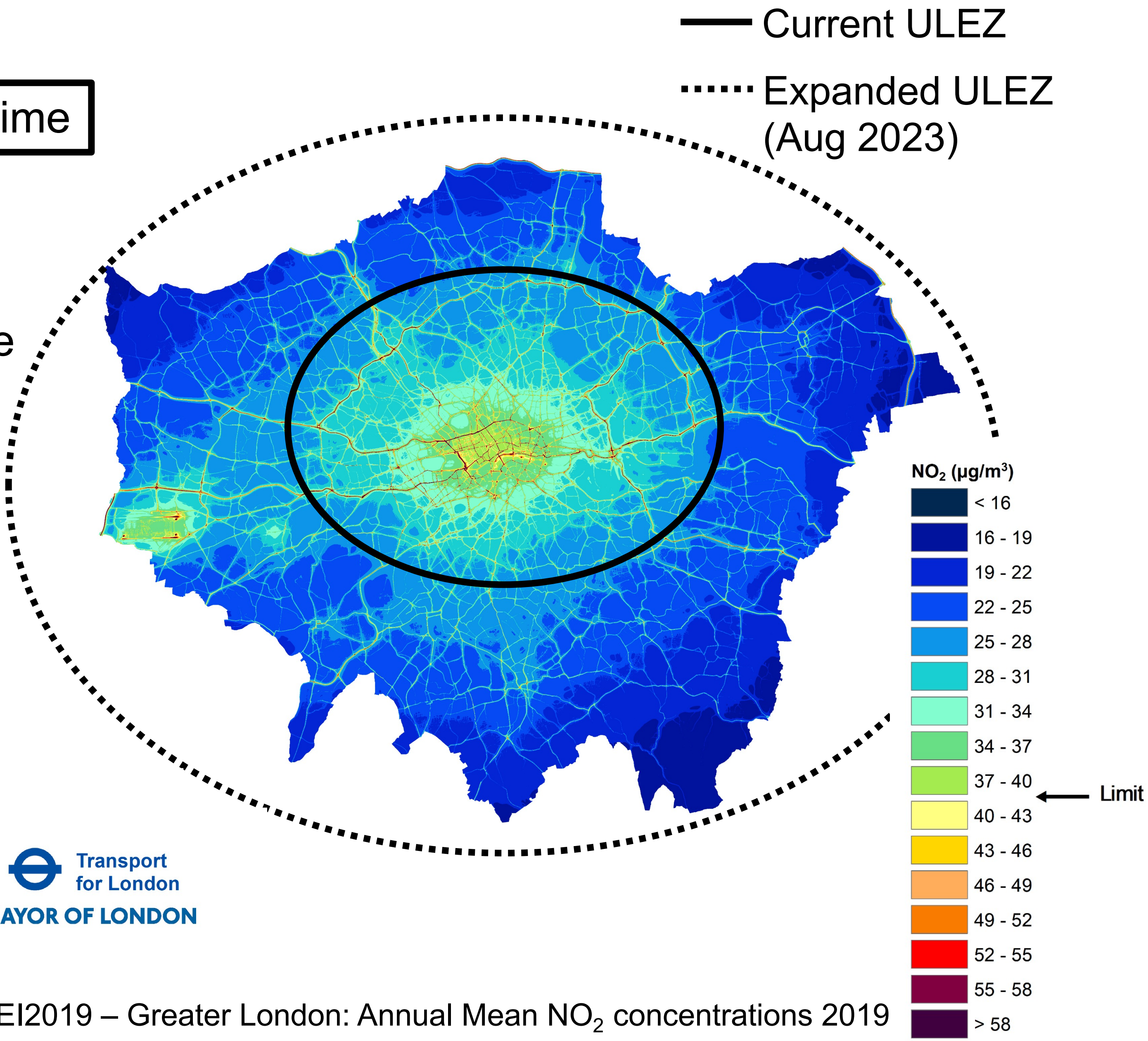
Ozone concentrations do not often exceed limits.

~ 20 ppb in Central London. [London Air]

NO_X is declining.

VOC concentrations increase during heatwaves.

Ozone pollution may become a problem.



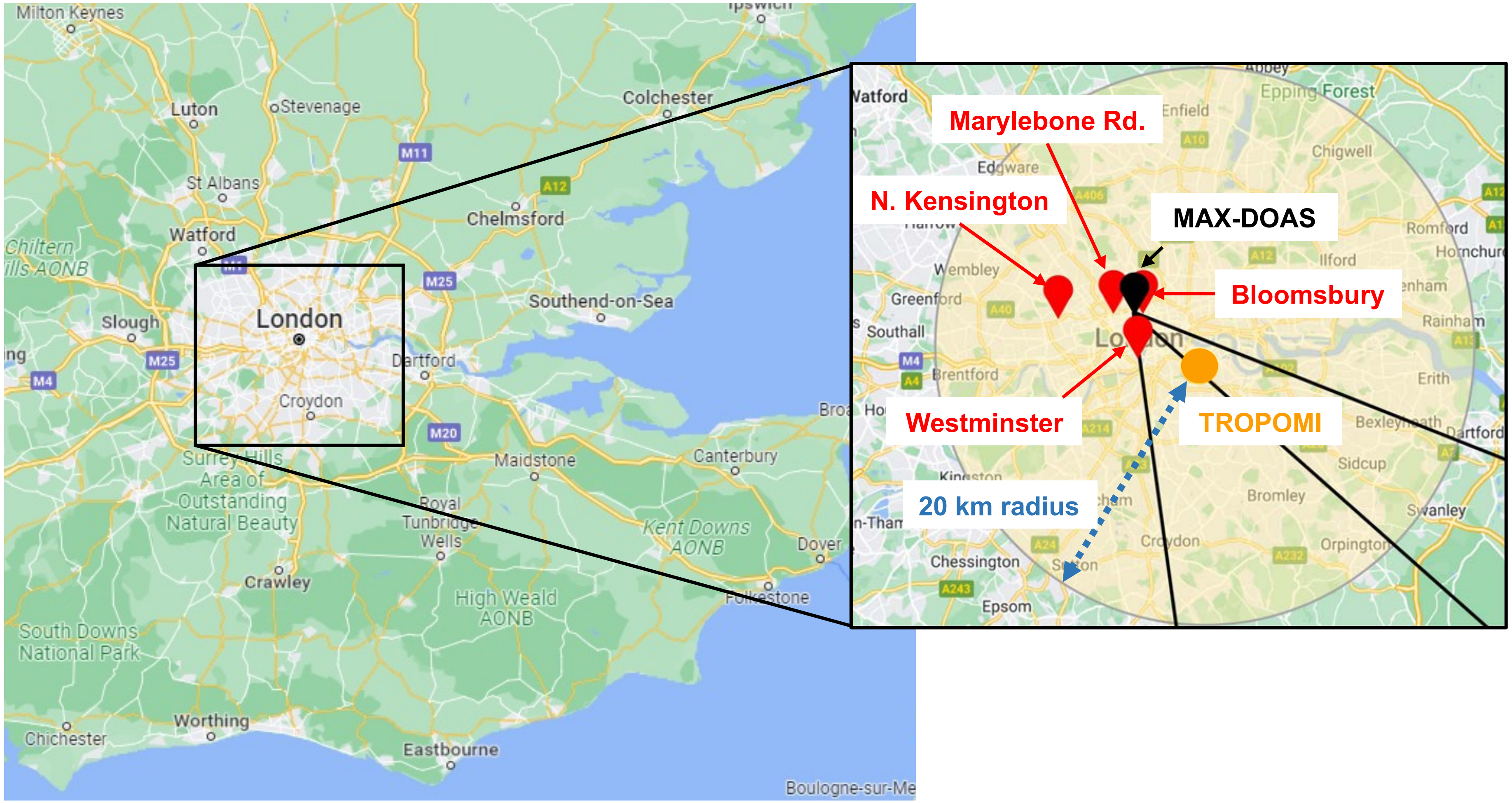
London Atmospheric Emissions Inventory, 2019

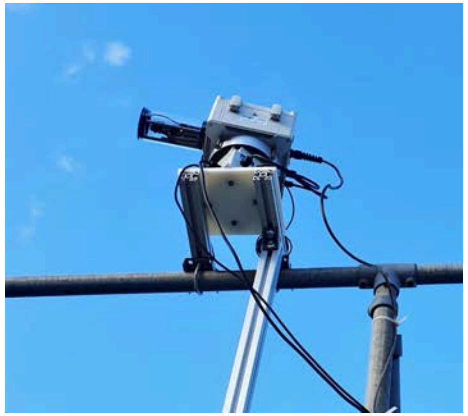
Transport for London

MAYOR OF LONDON

LAEI2019 – Greater London: Annual Mean NO_2 concentrations 2019

MAX-DOAS, TROPOMI and Surface Monitoring





MAX-DOAS, TROPOMI and surface sites used to diagnose the ozone production regime.

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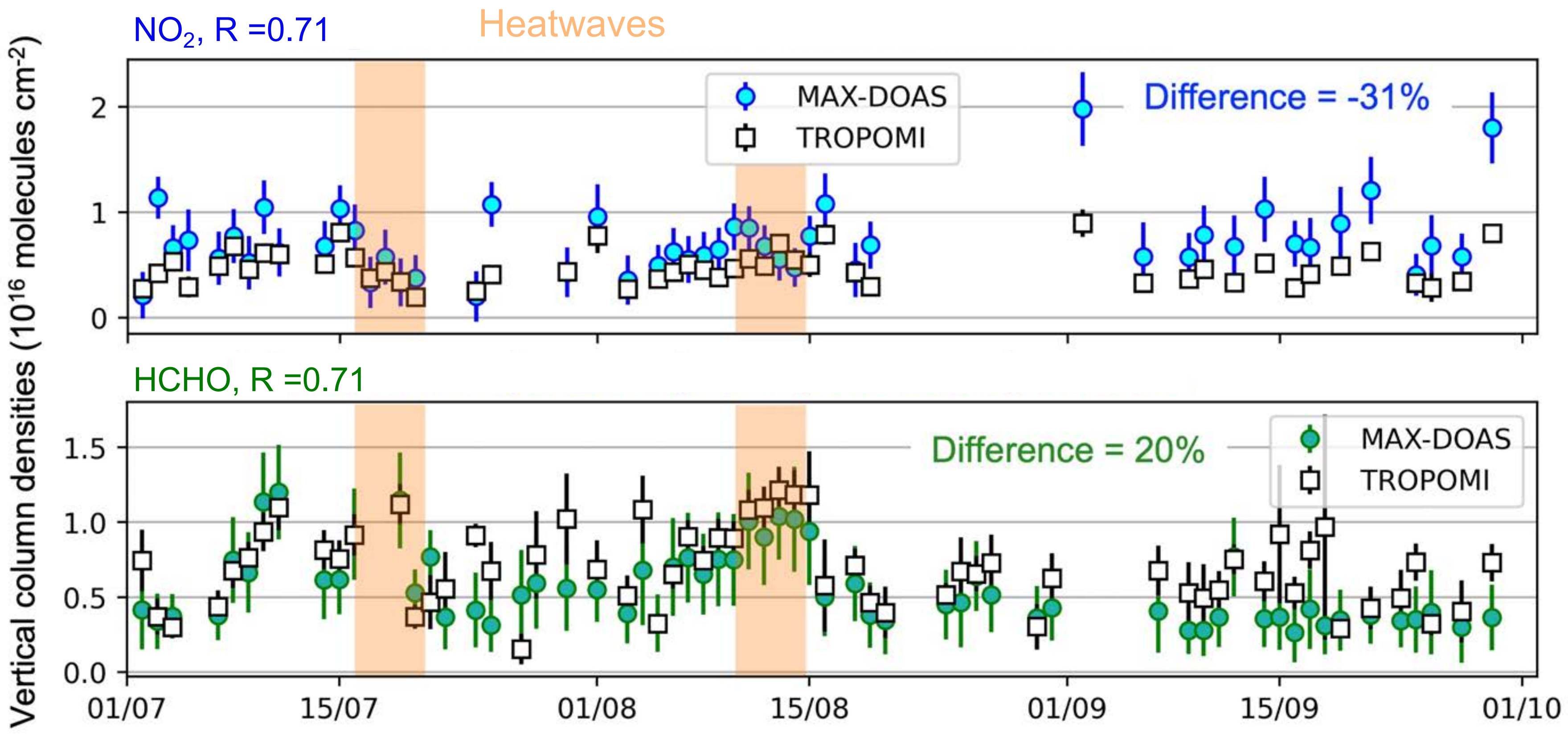
Evaluate TROPOMI with MAX-DOAS



Vertical column densities for NO_2 and **HCHO** are consistent between MAX-DOAS and TROPOMI (R = 0.71).

TROPOMI **NO_2** is 31% less than MAX-DOAS NO_2.

Like other comparison studies.

Horizontal dilution of **NO_2** by TROPOMI pixels.

TROPOMI **HCHO** is 20% more than MAX-DOAS **HCHO**.

Unlike other comparison studies.

Retrieval differences can account for systematic errors.

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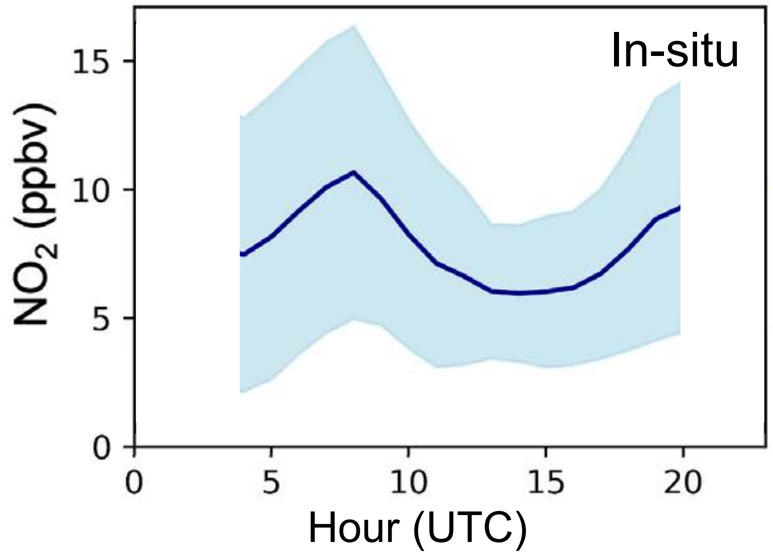
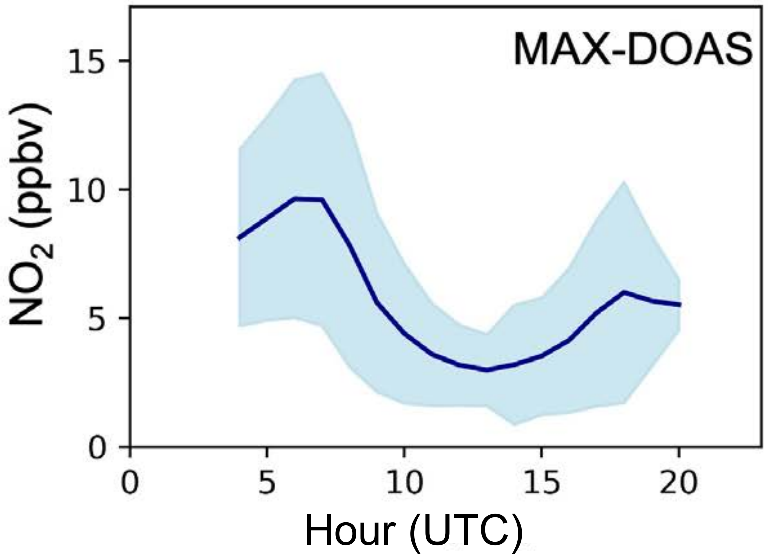
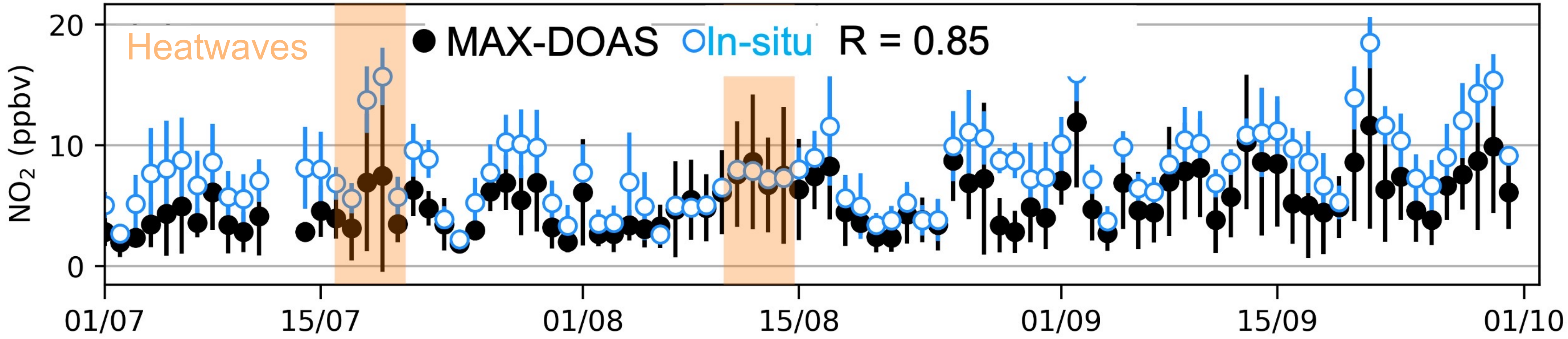
MAX-DOAS and Surface Site Observations of NO_2 Have Similar Variability





Morning peaks are similar for surface sites and MAX-DOAS.

Increase in efficiency of photolytic loss of NO_2 during the afternoon leads to differences in MAX-DOAS and surface observations.



MAX-DOAS and surface site NO_2 have consistent day-to-day (R = 0.85) and hourly (R = 0.69) variability.

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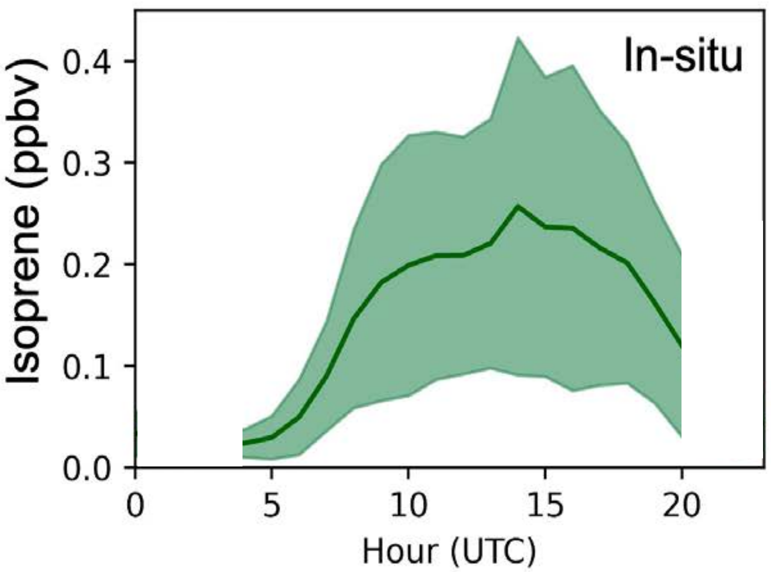
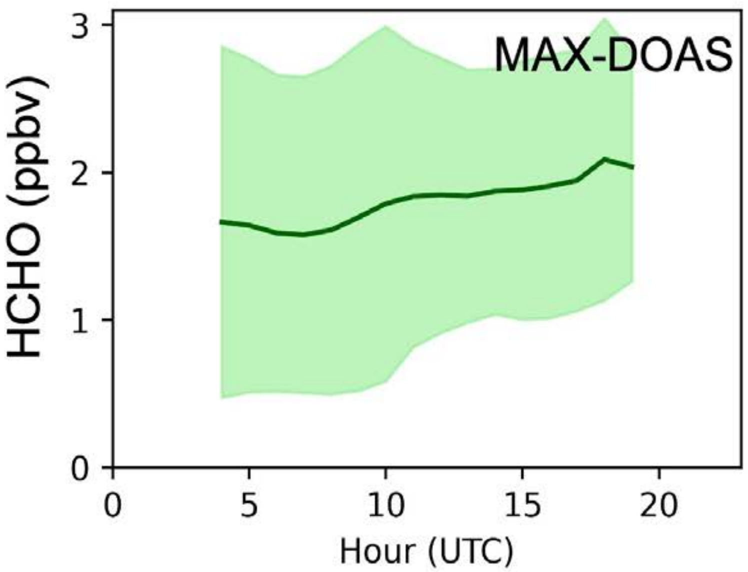
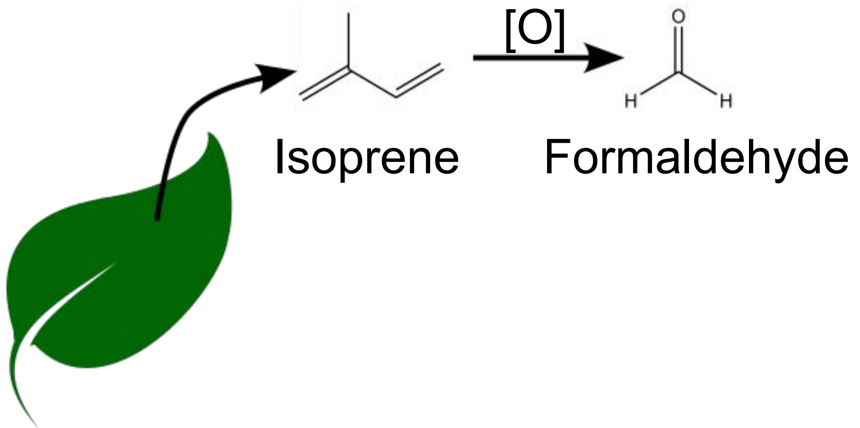
Isoprene Enhances VOC Concentrations During Heatwaves

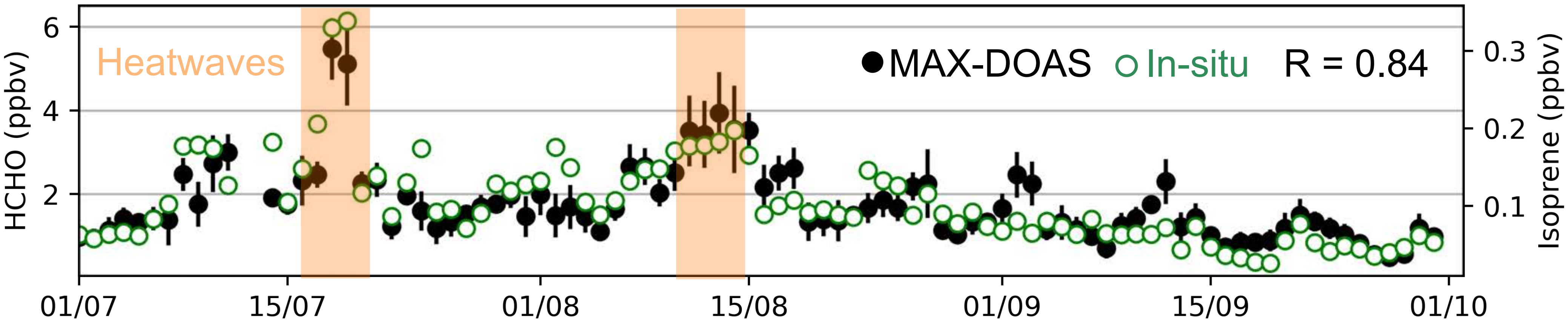




Isoprene emissions peak at midday.

Balance of sources and sinks keeps [HCHO] consistent.





Surface isoprene and MAX-DOAS HCHO have similar day-to-day variability (R = 0.84).

R.G. Ryan et al. 2023, under review.

Heatwaves Alter the Ozone Production Regime

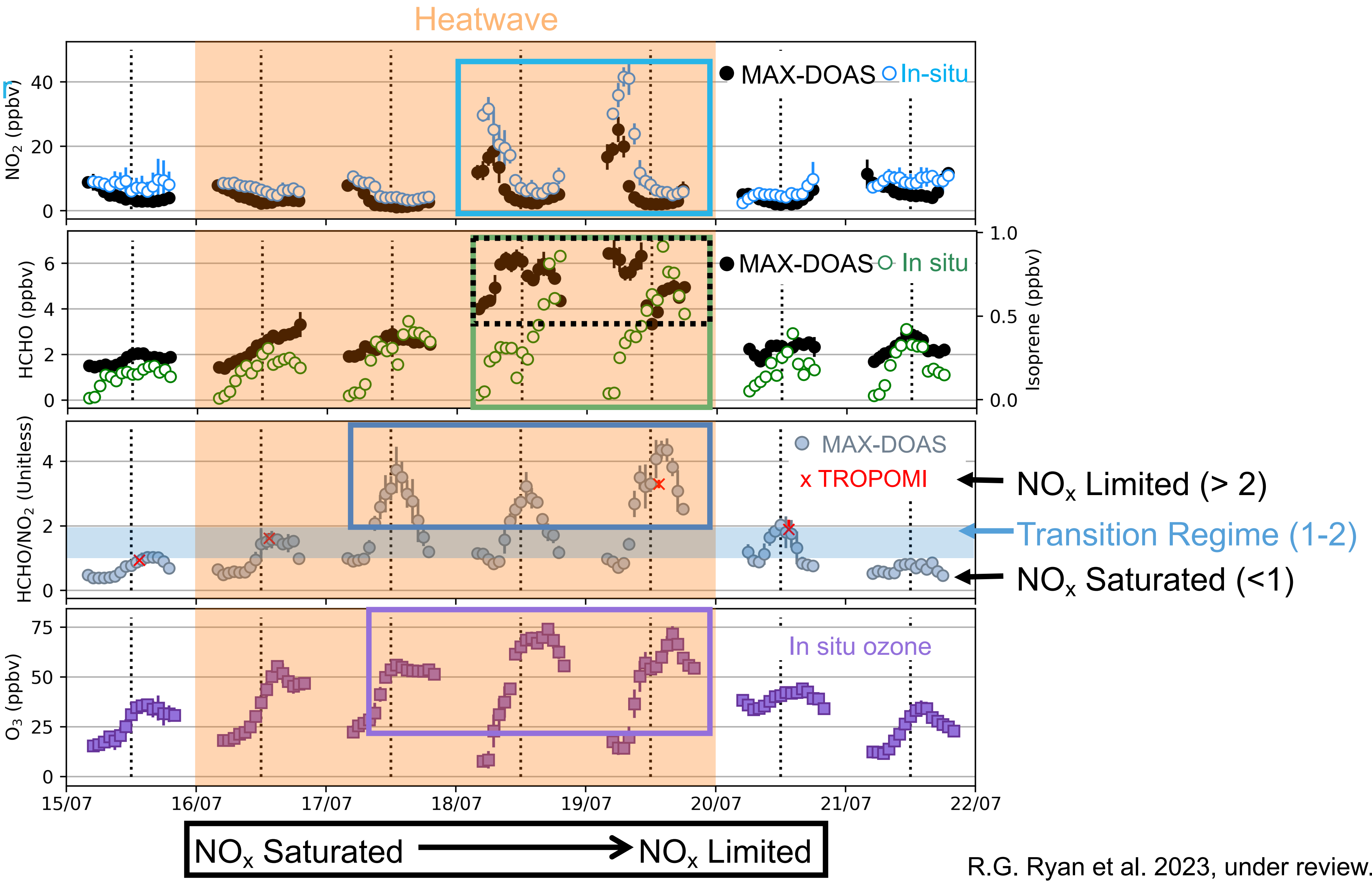
High pressure allows for overnight accumulation of NO_2.

Isoprene emissions increase.

HCHO concentrations peak.

Ozone production regime shifts to NO_x limited.

Surface ozone increases.



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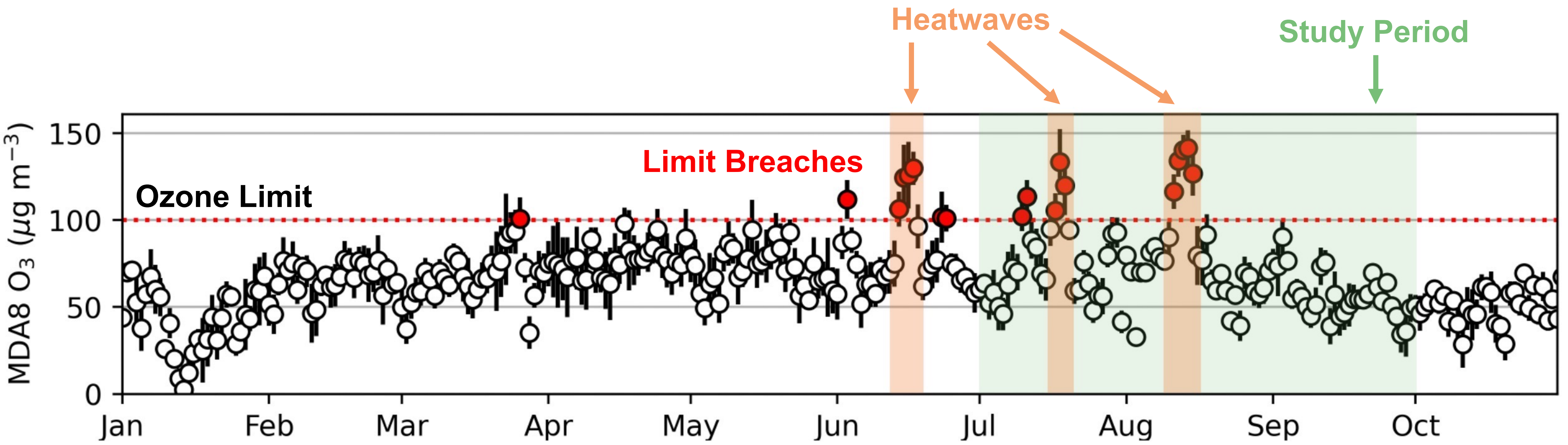
Ozone Exceedances are Linked to Heatwaves



All ozone exceedances are linked to a rise in temperature, with 67 % of breaches occurring during heatwaves.

R.G. Ryan et al. 2023, under review.

Conclusions and Further Work

Future increases in the number of ozone exceedances in Central London is highly likely.

TROPOMI retrieves NO_2 columns that are 31% less than MAX-DOAS and HCHO columns that are 20% more than MAX-DOAS.

During heatwaves emissions of isoprene increase and the ozone production regime shifts.

Forecasting and warning systems are required to mitigate harmful effects of heatwaves on public health.

We will continue to monitor the effect of heatwaves on Central London air quality and use this as a predictor for future climate.

We will evaluate HONO concentrations in Central London.

Ryan et al.: https://egusphere.copernicus.org/preprints/2023/egusphere-2023-24/
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R.G. Ryan et al. 2023, under review.