

An aerial photograph of a residential neighborhood in London during a major wildfire in summer 2022. Thick, dark smoke billows from the buildings, partially obscuring the sky and the surrounding landscape. The houses are densely packed, and the overall scene is one of devastation and emergency.

The drivers of urban wildfires in London, summer 2022

By Jamie John
Supervisor: Guillermo Rein

About me

- MEng Mechanical Engineering (2019-2023)
- 2023-2024: Editor-in-chief of Imperial's student newspaper
- 2024 -: Reporter at Financial Times



Motivation

- **2022** – heatwaves lead to wildfires in London
- **Prof Rein:** ‘Hot, dry spells dry out fuel’
- **This project:**
 - Quantify the relationship
 - Explain it simply
 - Highlight risk – useful to LFB?



Dagenham



Epping Forest



Upminster



Harrow



Wennington



Hounslow



LIVE SHIRLEY HILLS, SOUTH LONDON

Croydon



Twickenha

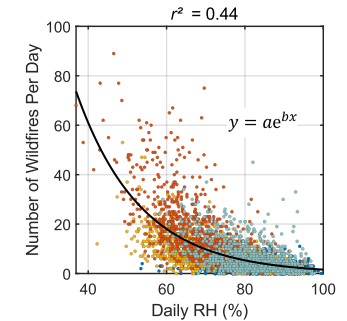
18/11/2024

Outline

1) LFB and MIDAS datasets



2) Stats analysis: How much can weather explain wildfire activity?



4) Heatwaves and wildfire risk



3) Vapour pressure deficit – linked to vegetation drying

The datasets



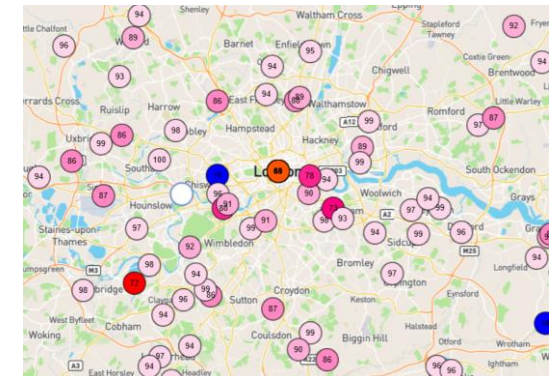
LONDON FIRE BRIGADE

- Records *all* fire incidents
- 2009-2022
- I identified 'wildfires'
- Pump hours
- Number of fires



Met Office

- Met Office MIDAS dataset
- Includes 2009-2022
- Daily weather data



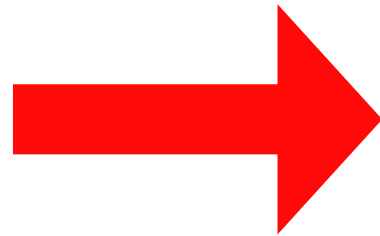


The LFB Data

18/11/2024

LFB Data – what is a wildfire?

- Fire occurring outdoors as a result of natural-fuel combustion
- Natural fuel - 'created by natural ecological processes'



LFB data

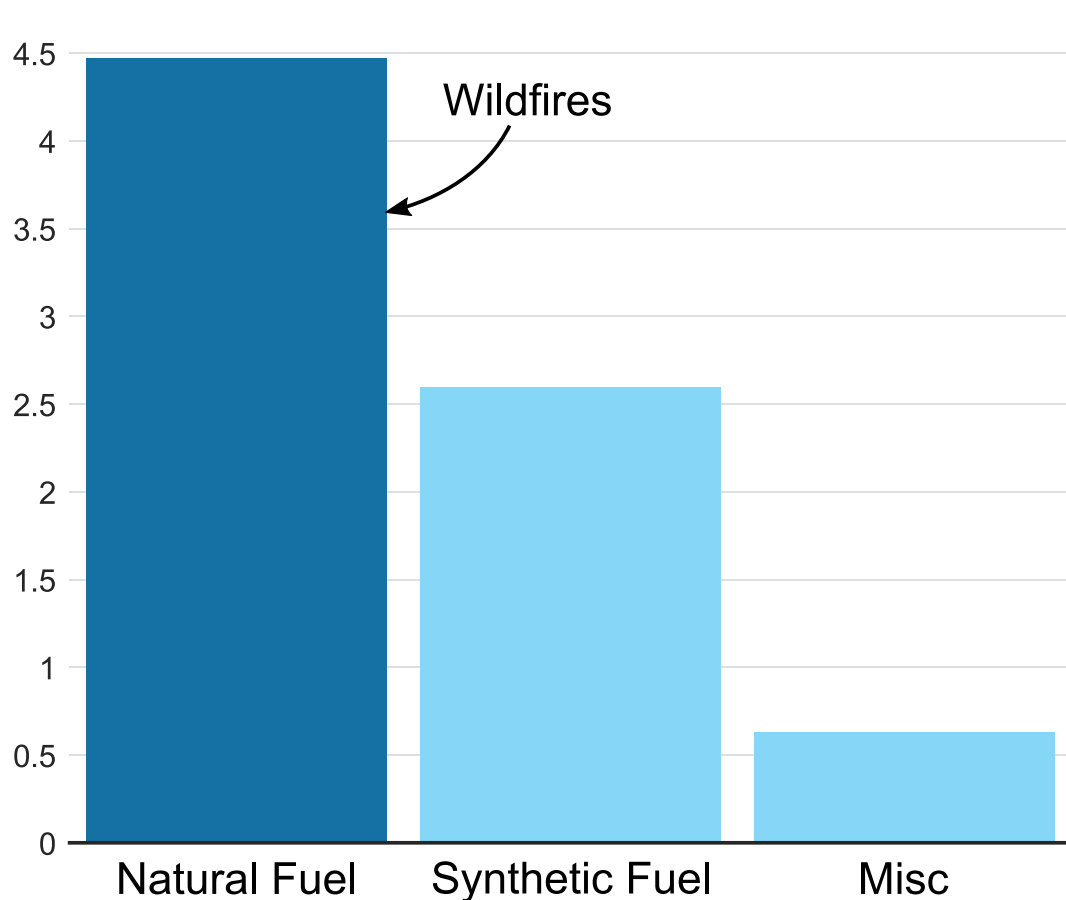
PropertyType:
→ 'Outdoor'

PropertyCategory:
→ Limited to natural fuels

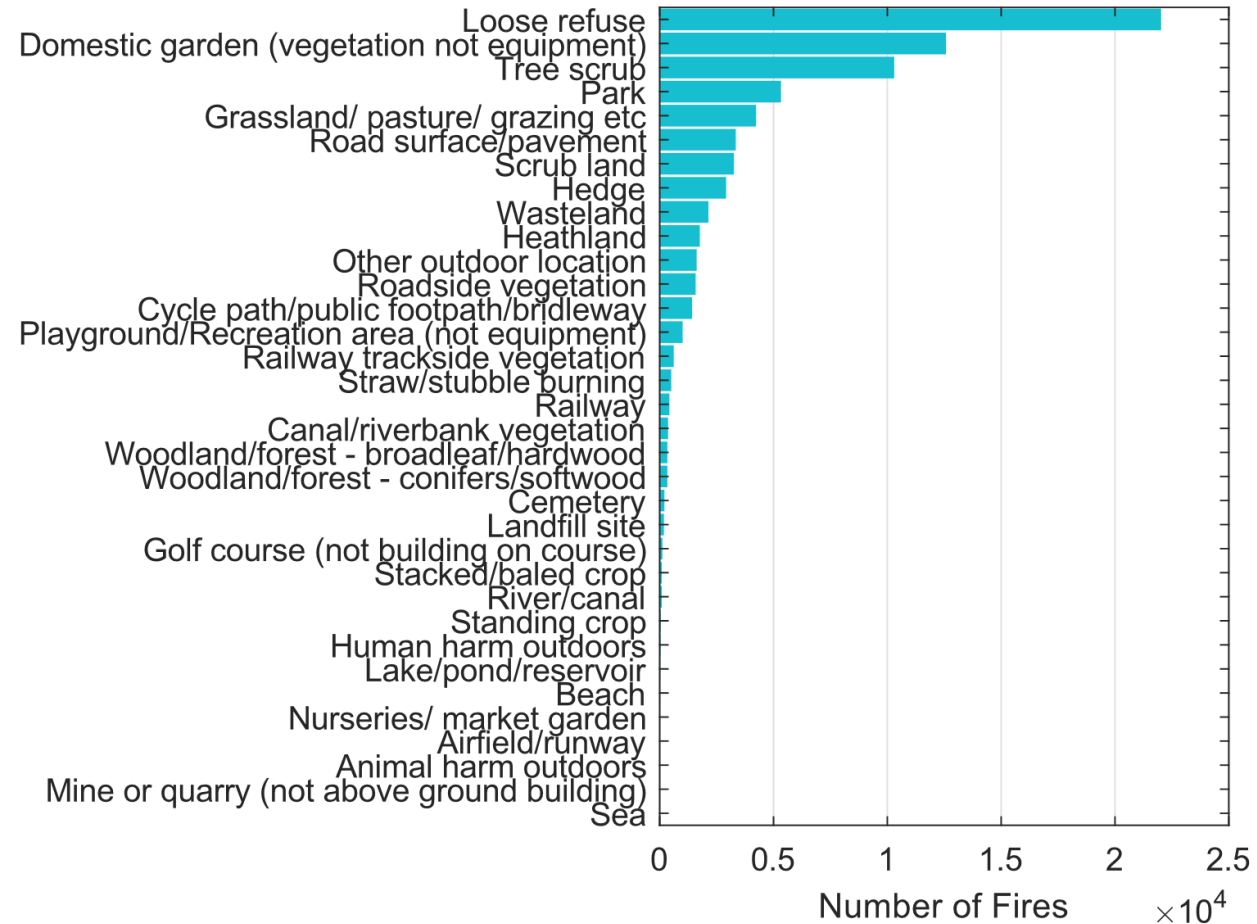
Defining a 'natural fuel'

Outdoor fire occurrence by fuel type

Number of fires ($\times 10^4$)

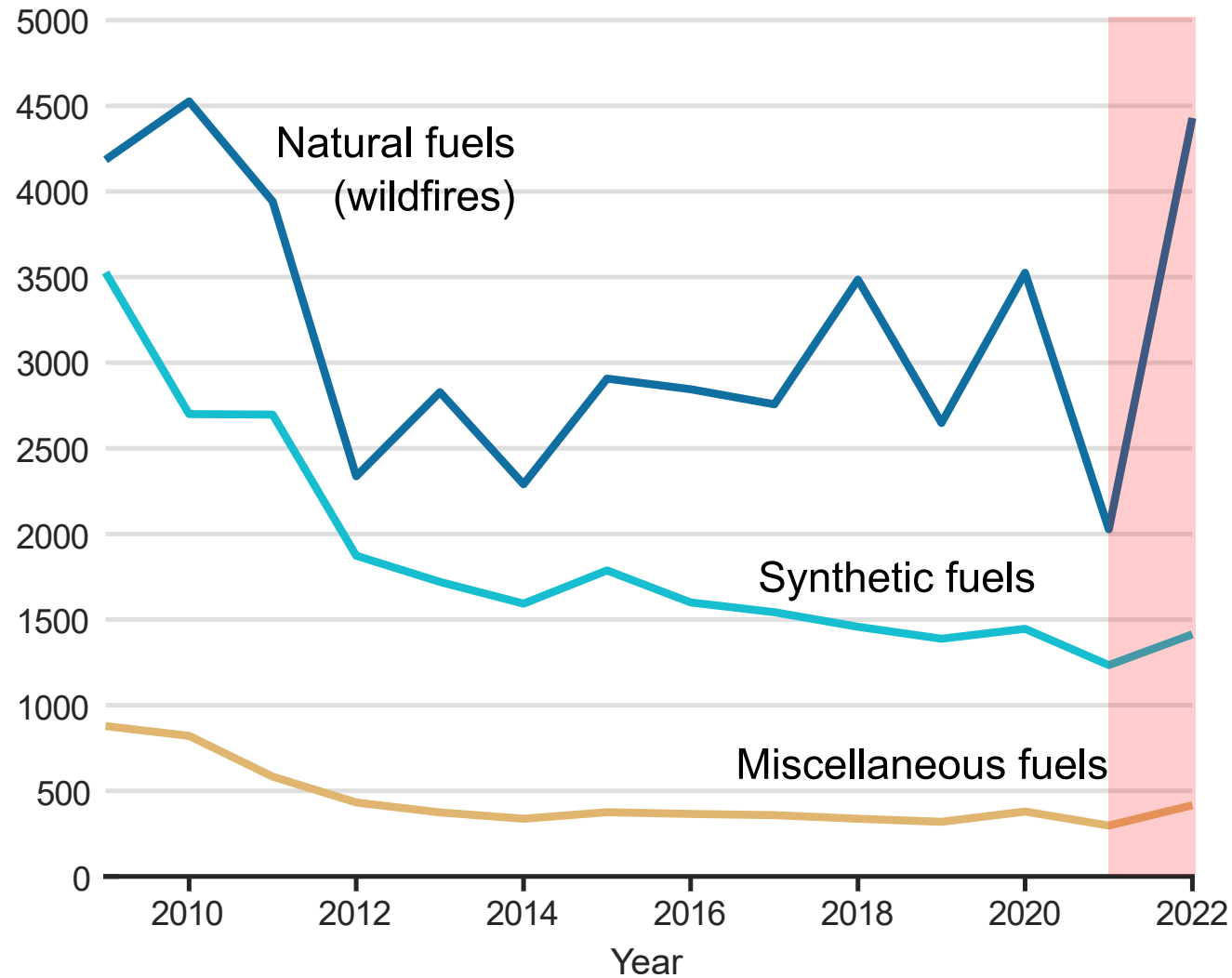


Outdoor fire occurrence by LFB 'Property Type'



Outdoor fire occurrence in Greater London by fuel type

Number of fires per year, 2009-2022



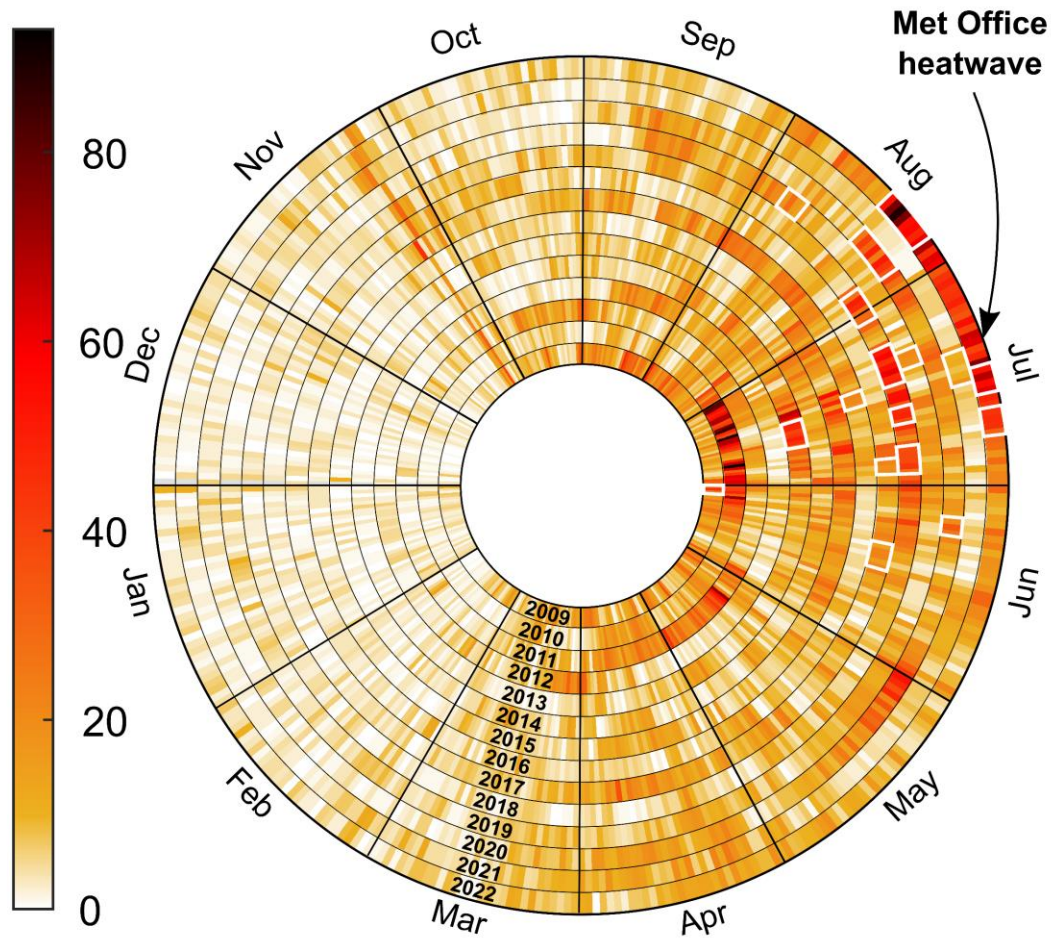
Jamie John. Source: LFB Incident Records

LFB Dataset, 2009-2022

- Isolated outdoor, natural-fuel fires
- Extracted 'pump hours' and 'number of fires'
- Summed up to get totals per day

LFB Dataset, 2009-2022

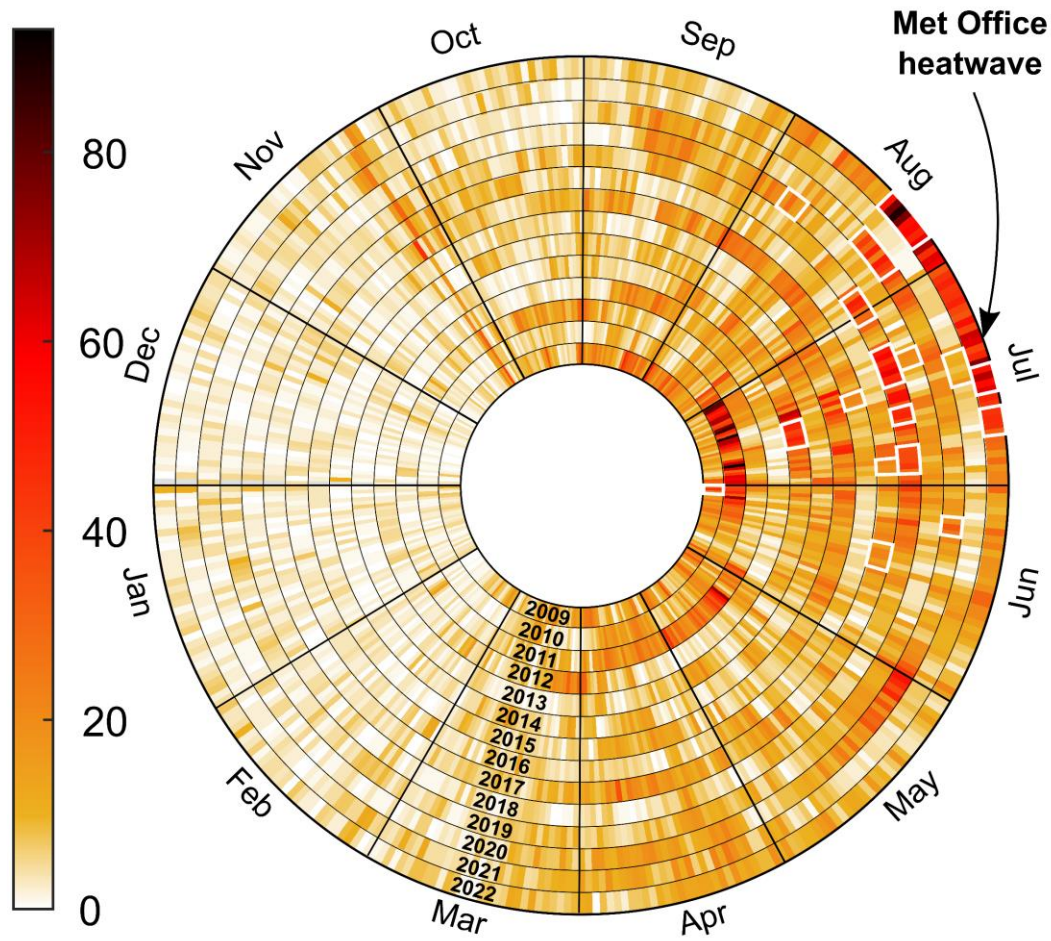
Number of Wildfires per Day



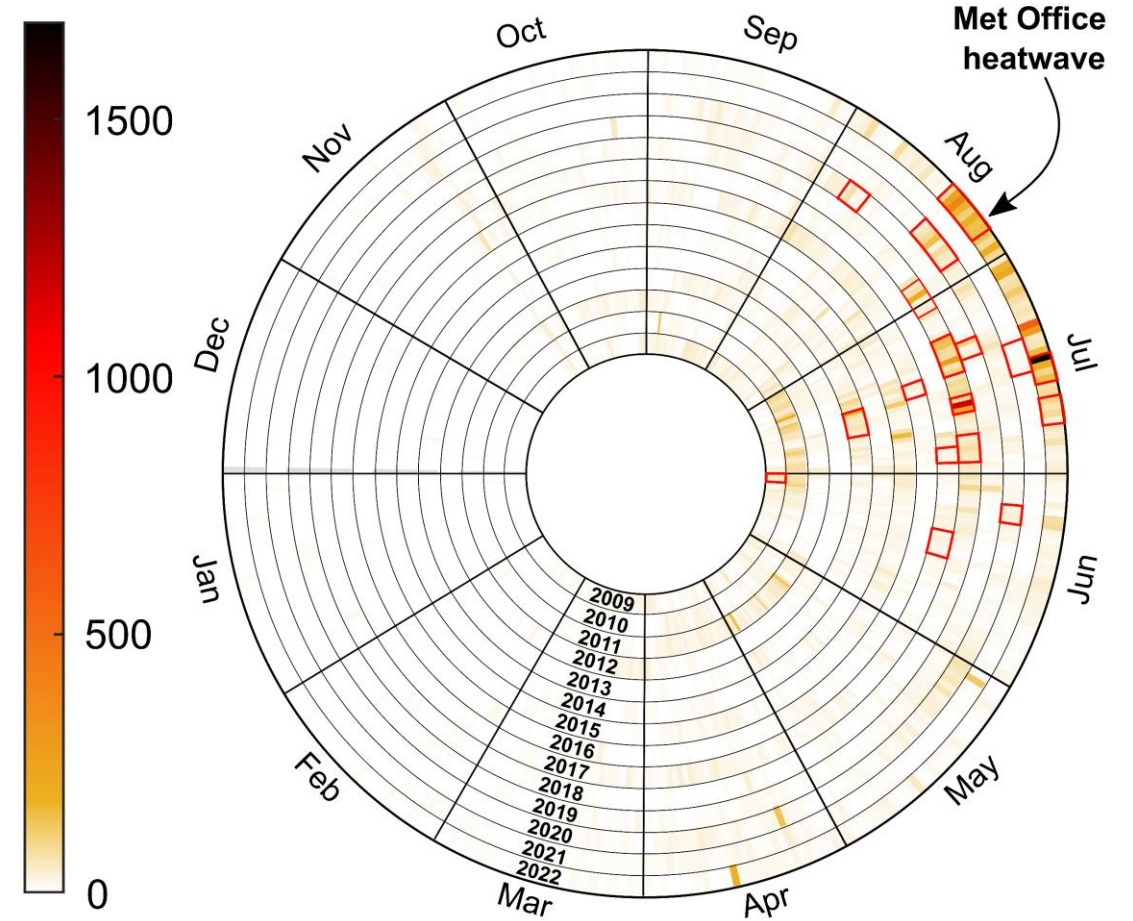
*Plot inspired by charts
of Tadas Nikonovas, UK
FDRS team*

LFB Dataset, 2009-2022

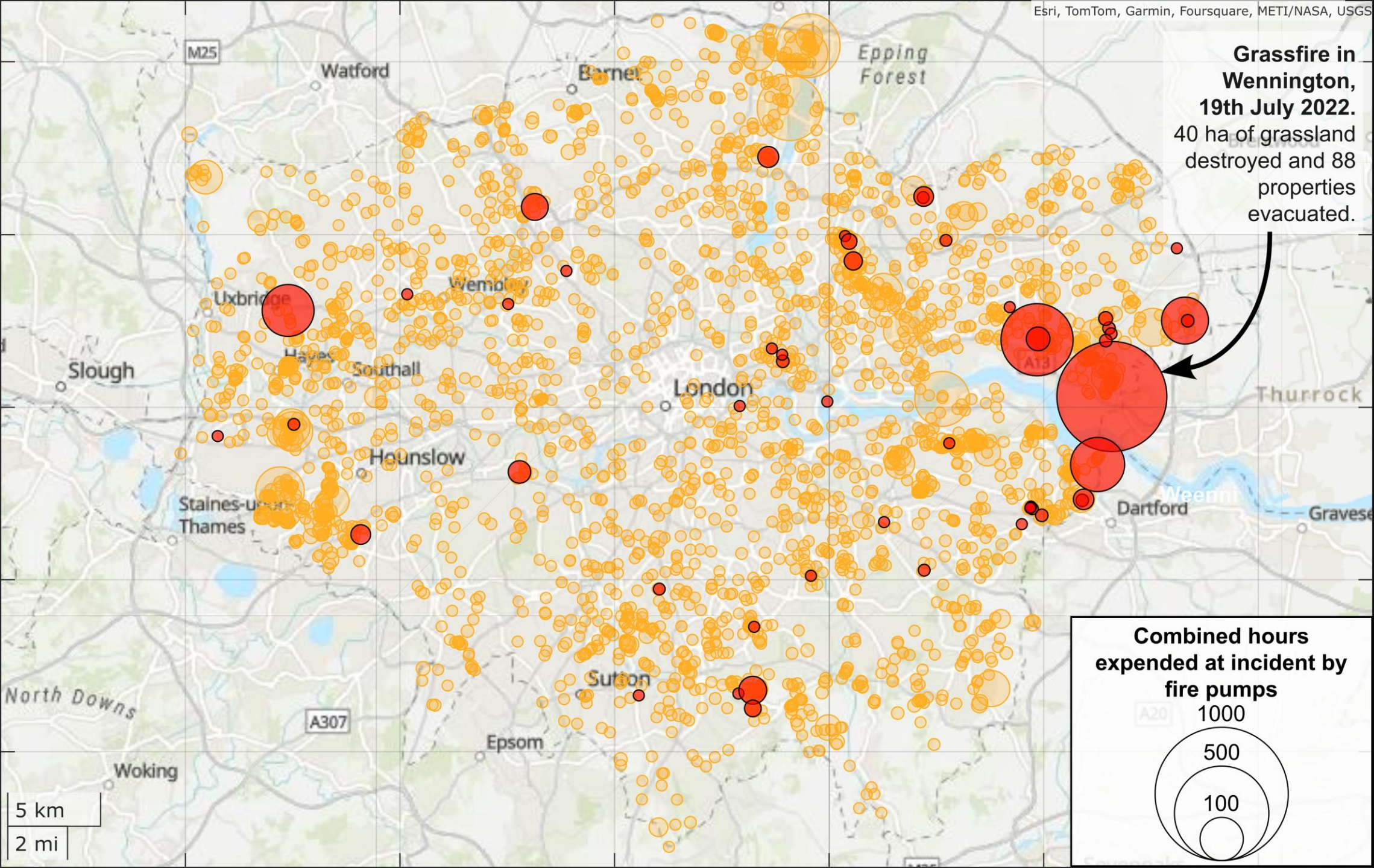
Number of Wildfires per Day



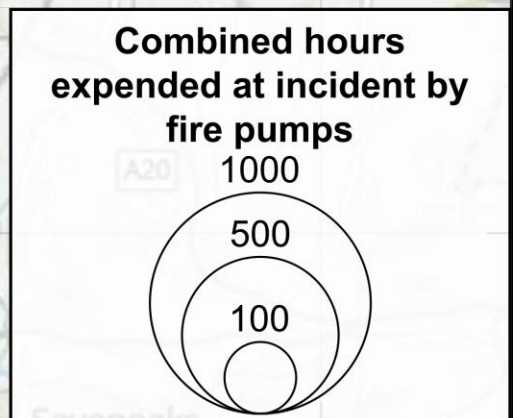
Pump Hours per Day



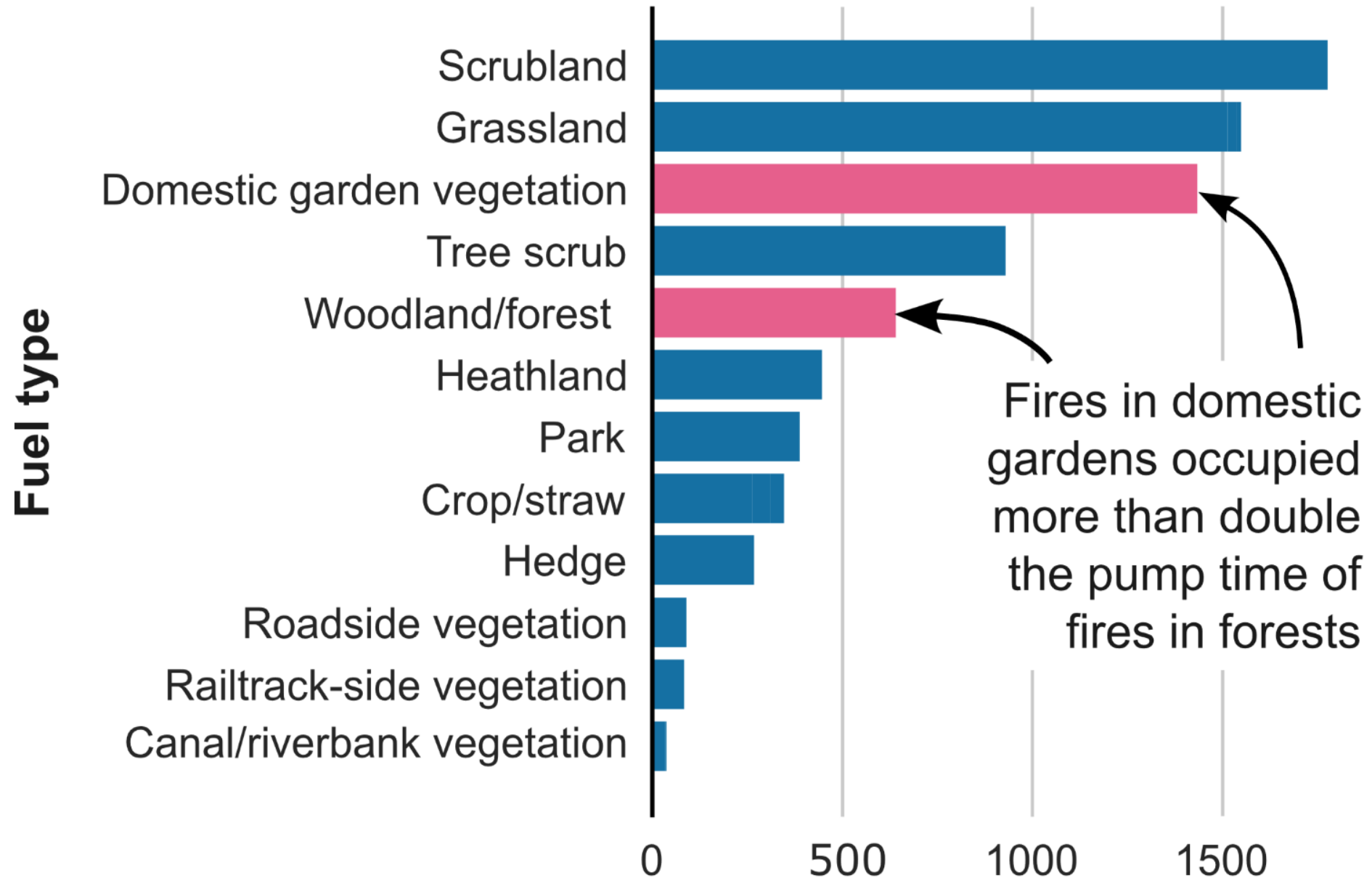
Grassfire in Wennington, 19th July 2022.
40 ha of grassland destroyed and 88 properties evacuated.



5 km
2 mi



Hours spent at summer 2022 wildfires by LFB pumps





Met Office Data

18/11/2024

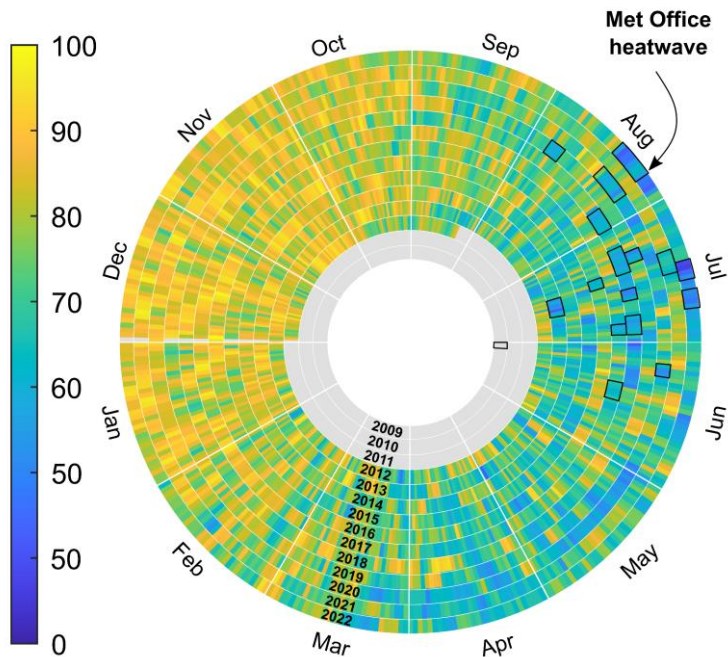
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Met Office Data

- Used Met Office Academic Dataset
- Greater London weather stations
- Extracted:
 - Max and min temperature
 - Relative humidity
 - Solar irradiation
 - Rainfall

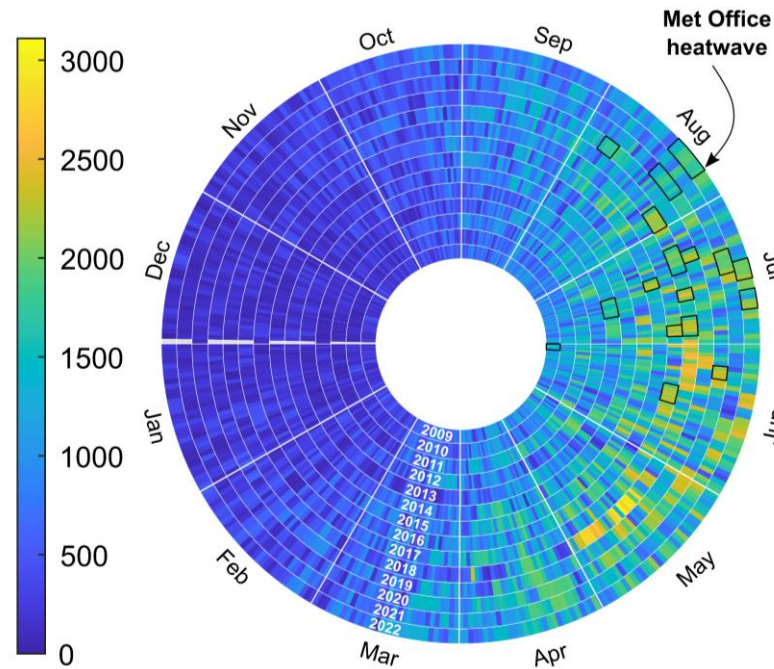
Met Office Data

Relative Humidity



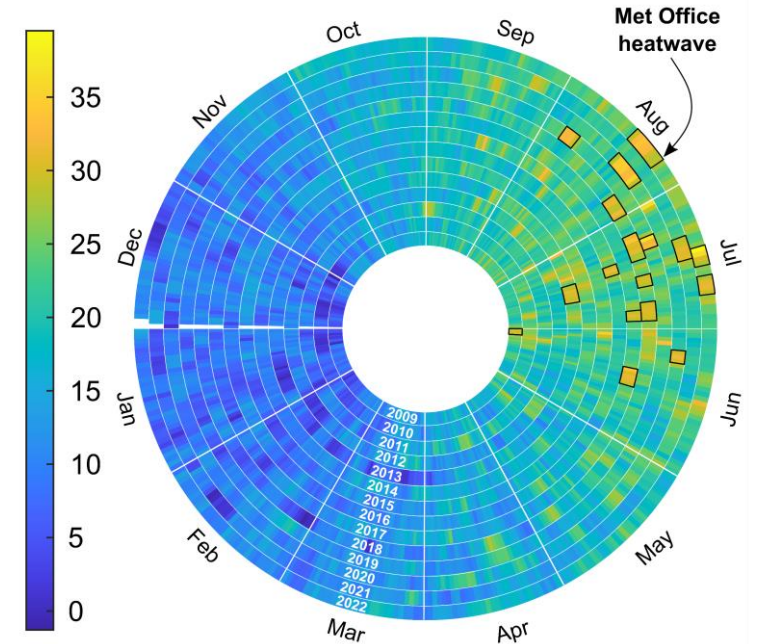
Jamie John. Source: Met Office MIDAS

Sunlight



Jamie John. Source: Met Office MIDAS

Max Air Temperature

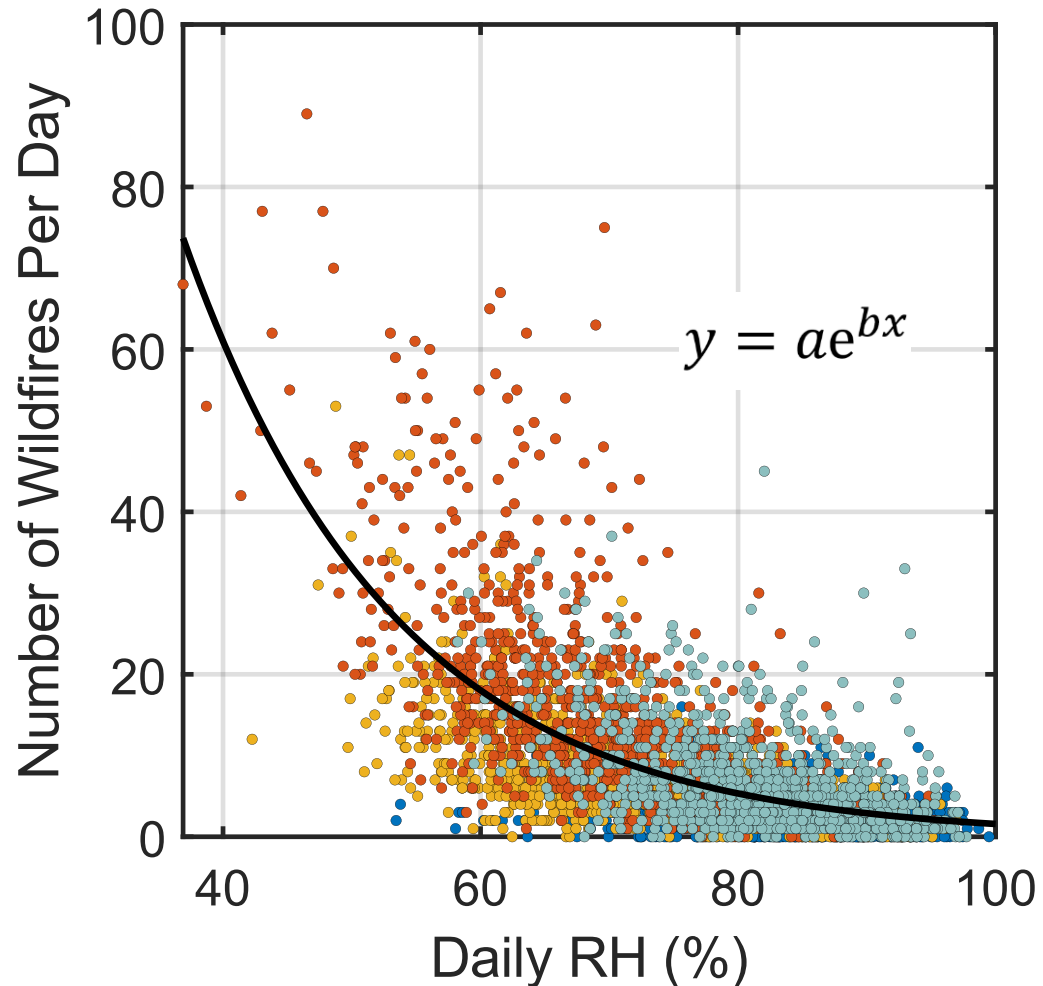


Jamie John. Source: Met Office MIDAS



Analysis

How well can weather explain wildfire occurrence?



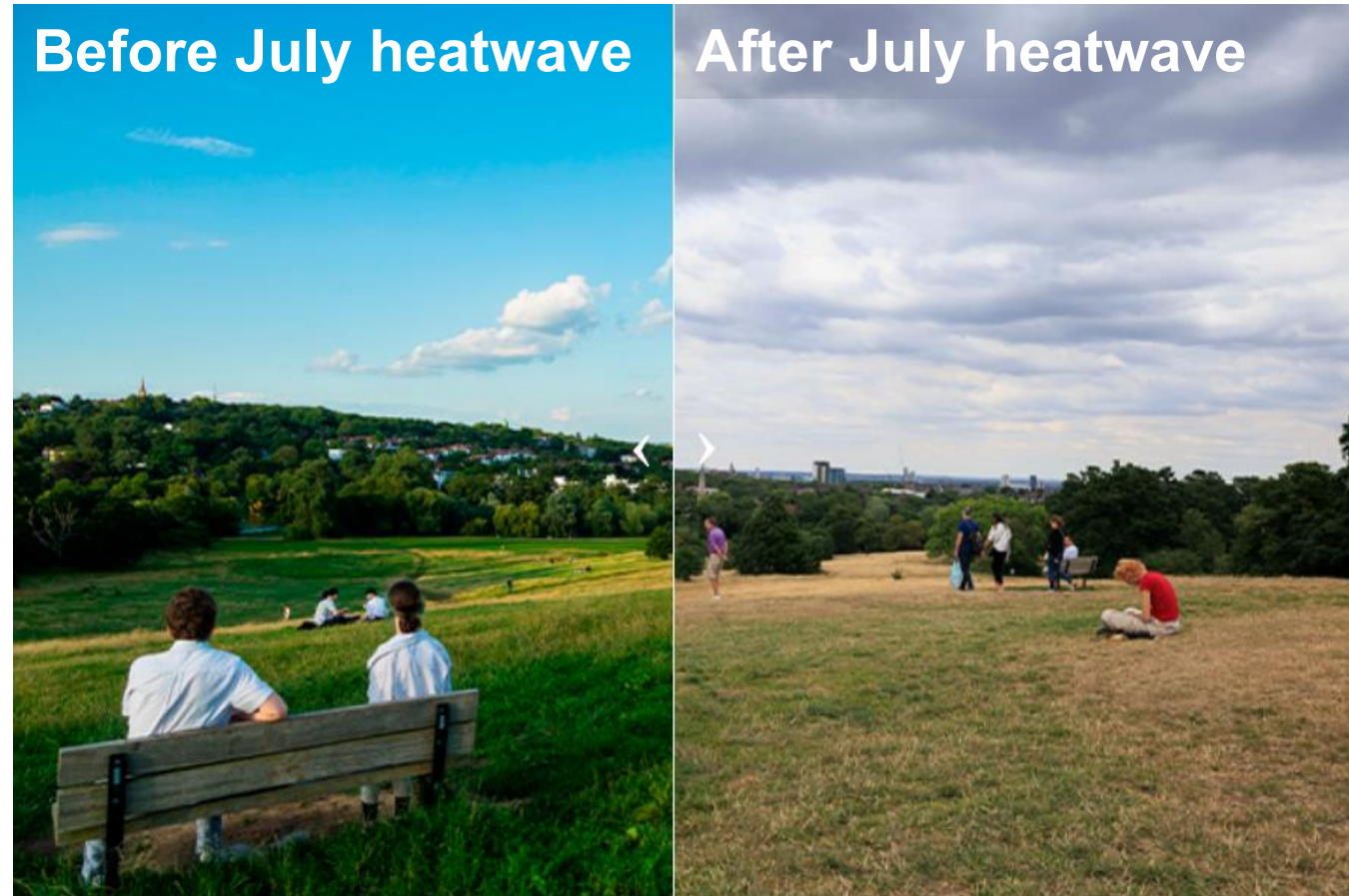
What % of variation in **no of wildfires** is explained by **weather** variables?

	Humidity	Max air temp	Sunlight
No of Wildfires	44%	42%	26%

Vapour pressure deficit (VPD)

- Measure of atmospheric demand for water
- Plant science:
 - Rate of evaporation from plants is proportional to VPD
- Better measure than relative humidity or temperature
- Urban environments?

Hampstead Heath, 2022



Vapour pressure deficit (VPD)

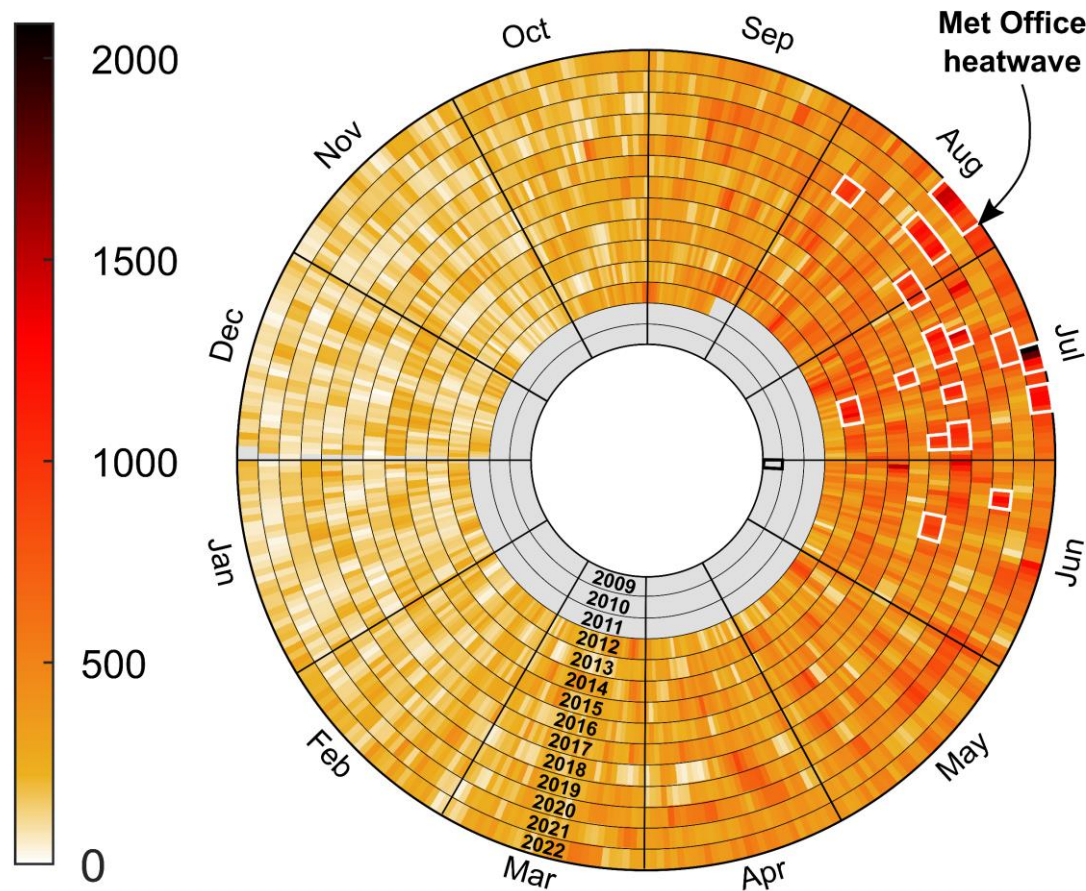
- Can calculate VPD from air temperature and relative humidity ϕ

$$e_{sat} = 610.7 \times 10^{7.5T_{air}/(237.3+T_{air})}$$

$$VPD = e_{sat}(1 - \phi)$$

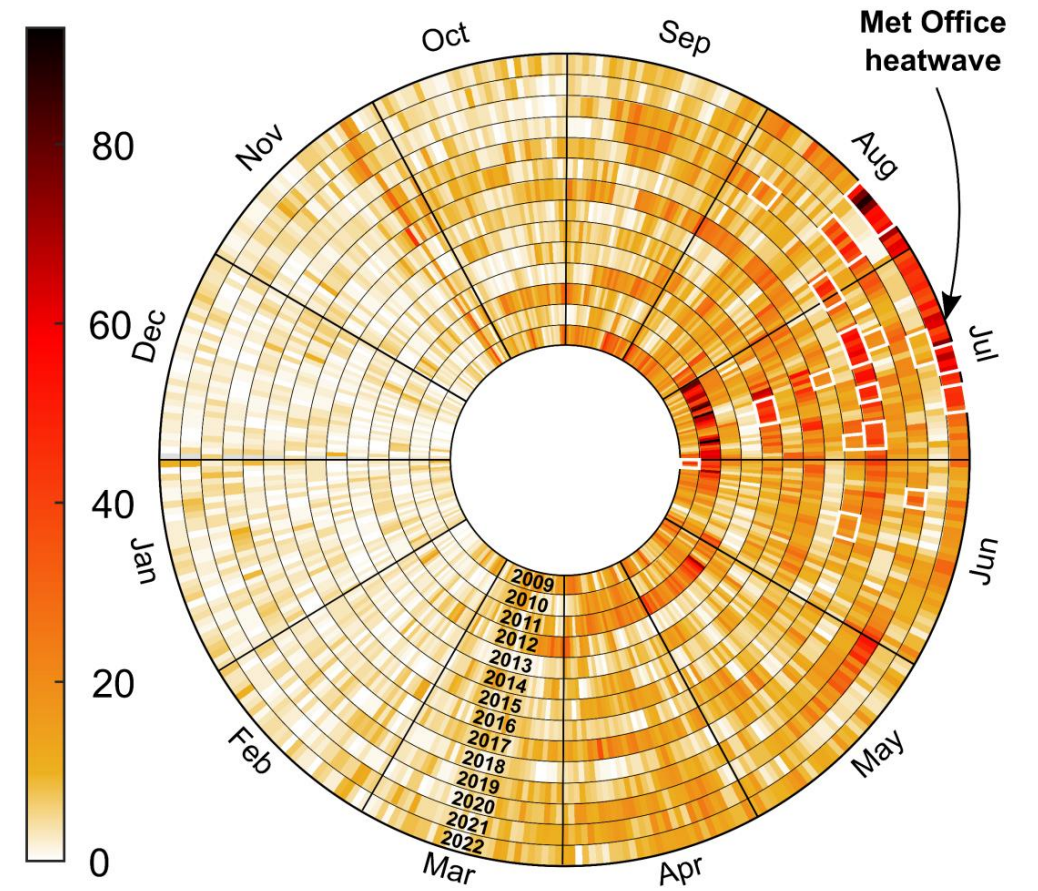
Vapour pressure deficit (VPD)

VPD (Pascals)



Jamie John. Source: Met Office MIDAS
18/11/2024

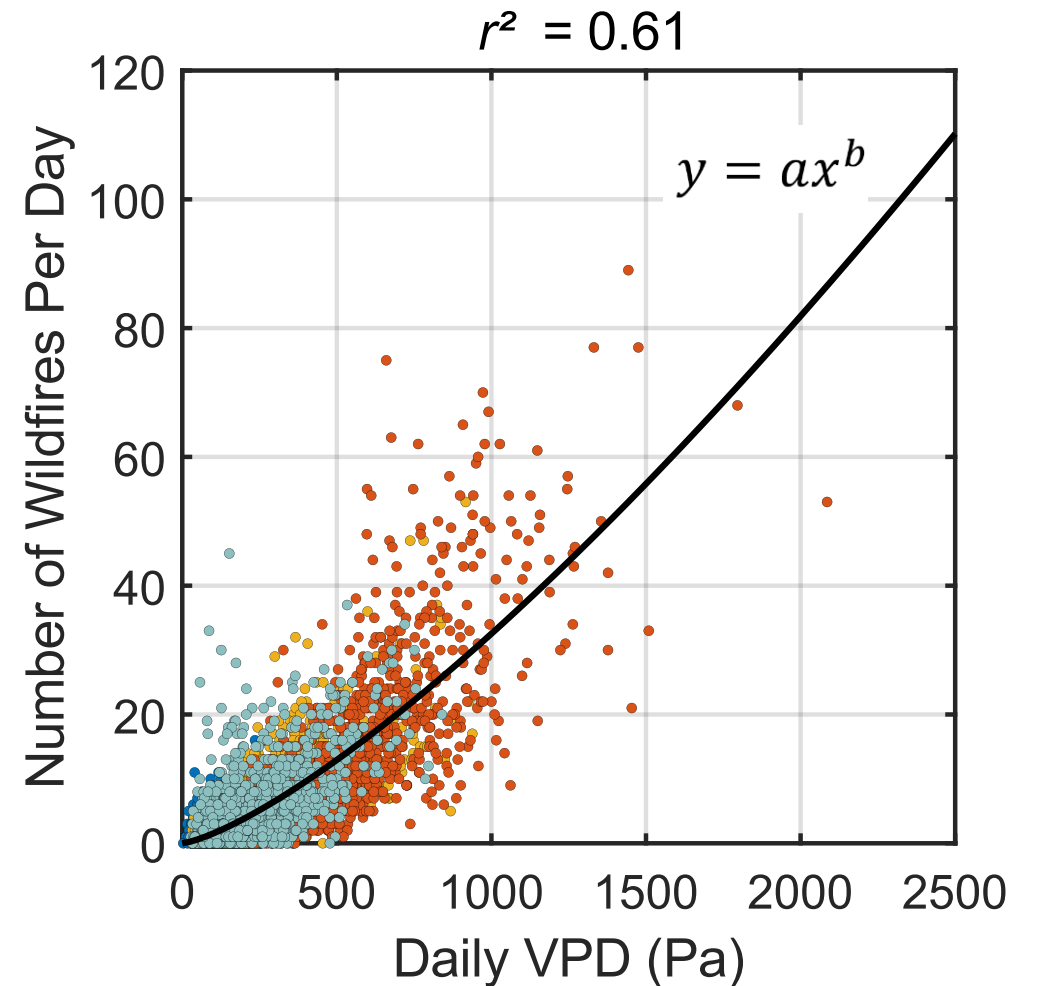
Number of Wildfires



Jamie John. Source: London Fire Brigade Incident Records

Vapour pressure deficit (VPD)

	Relative humidity	Max daily air temp	VPD
No of Wildfires	44%	42%	61%



An aerial photograph of a residential neighborhood. In the foreground, there is a grassy field with a few people walking. The middle ground shows a cluster of houses, some of which appear to be damaged or surrounded by smoke. The background consists of rolling hills and fields under a hazy sky. The overall scene suggests a significant event, such as a fire or a heatwave, affecting the area.

Heatwaves and Firewaves

Heatwaves and firewaves

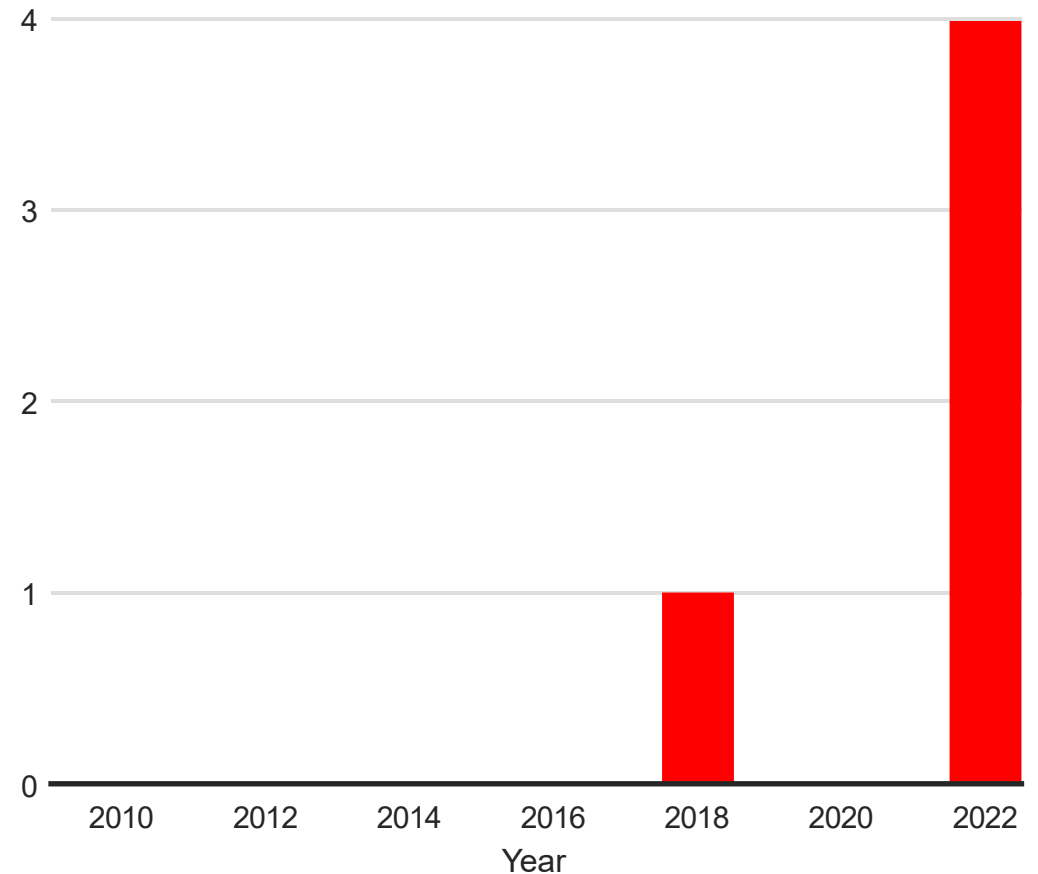
Can we use heatwaves to highlight periods of wildfire risk?

- 1) Define days of severe wildfire in London – ‘firewaves’
- 2) Find heatwaves using weather data and Met Office definition
- 3) Do heatwaves contain ‘firewave’ days?
- 4) Formulate our own metric based on fuel drying process

Firewaves

- **Firewave:** a day where
 - Pump hours is a statistical outlier
- **Statistical outlier if:**
 - Over three s.d. away from mean

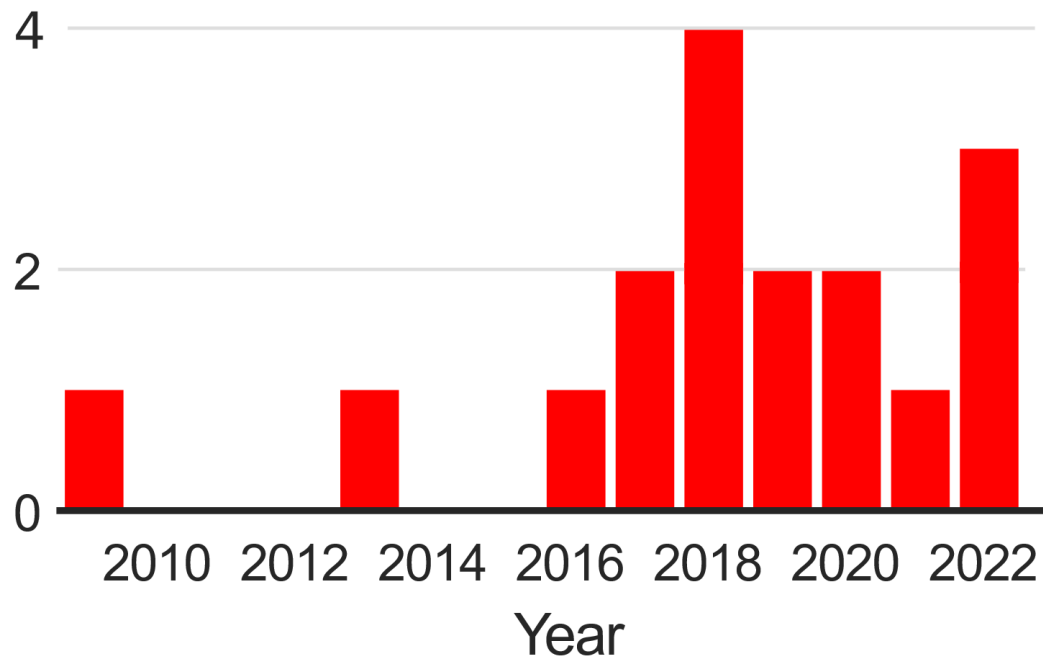
Number of firewaves, 2009-2022



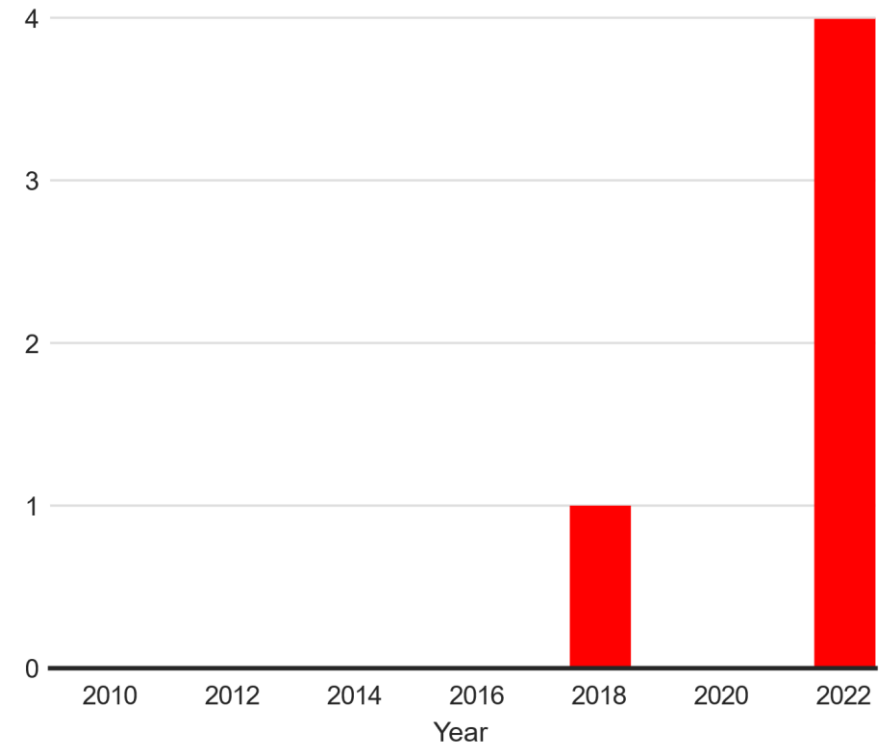
Heatwaves and wildfire risk

- Met Office definition – three days exceeding max daily temp of 28°C

Number of Met Office Heatwaves



Number of Firewaves



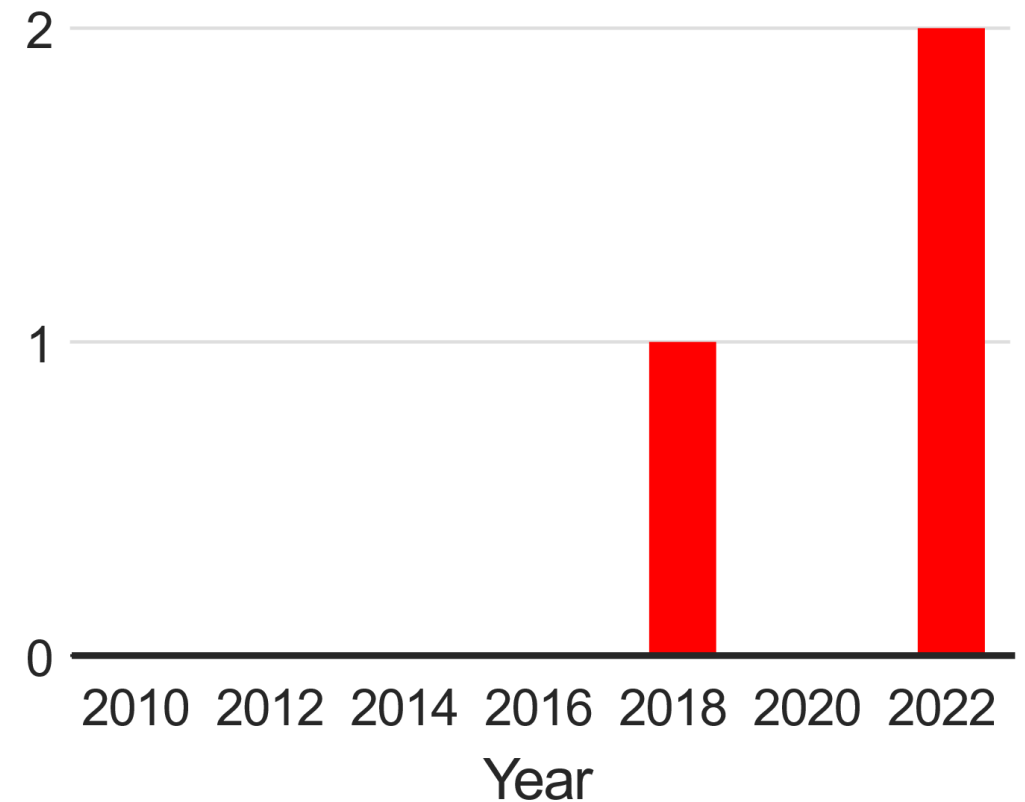
Heatwaves and wildfire risk

- What about another heatwave metric?
- Linked to fuels drying?
 - VPD
- ‘Tune’ definition to captures firewaves

‘VPD heatwave’

- VPD heatwave when:
 - Daily VPD exceeds **706 Pa**
 - For **10** consecutive days

Number of VPD heatwaves



Met Office vs VPD heatwave

- Firewave – severe day of wildfires for LFB

Heatwave definition	Heatwaves containing firewave days	Superfluous heatwaves
Met Office	2 (out of 5 possible)	15
VPD	3 (out of 5 possible)	0

Highlights severe wildfire risk!

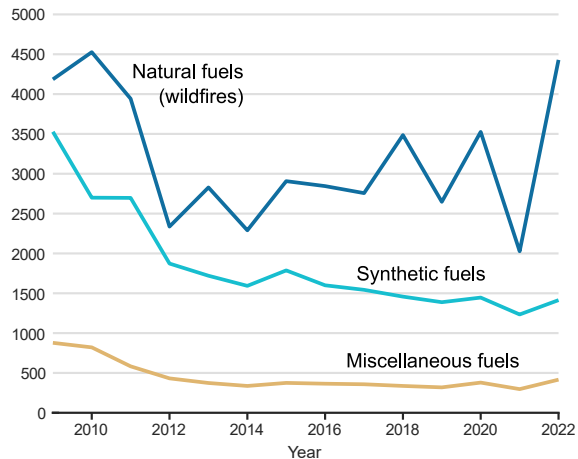


What have we achieved?

- Learned importance of VPD in *urban* wildfires
- Defined and identified firewave – severe day of wildfire for LFB
- Defined VPD heatwaves – identifies period of severe wildfire risk
- Could concept be used operationally?

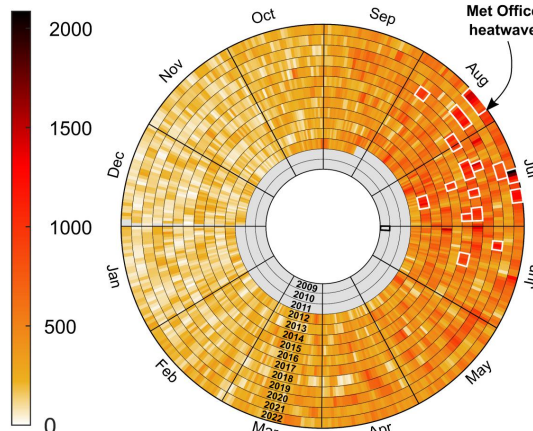
Outdoor fire occurrence in Greater London by fuel type

Number of fires per year, 2009-2022



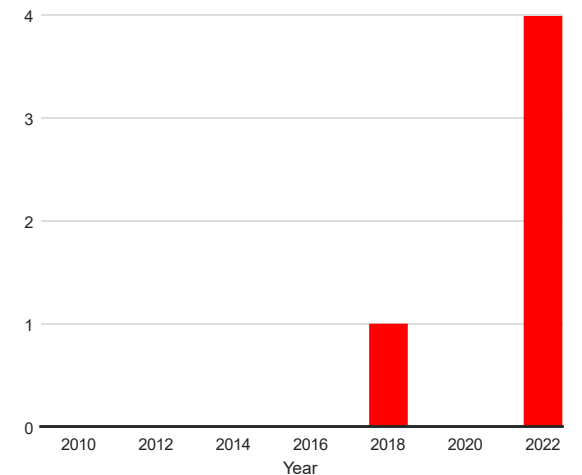
Jamie John. Source: LFB Incident Records

Daily Vapour-Pressure Deficit (Pa) in Greater London, 2009-2022



Jamie John. Source: Met Office MIDAS

Number of Firewaves, 2009-2022



An aerial photograph of a residential neighborhood. In the center, a large plume of white smoke rises from the ground, partially obscuring the houses. The houses are multi-story brick buildings with red roofs. The surrounding area includes green grass, trees, and a road. In the background, there are rolling hills and fields under a clear sky.

**Thank you for
listening**