Three Weeks More Summer? How Crowdsourced Observations Could Enhance Urban Climatology

Matthew Fry & Dr. Timothy D. Mitchell

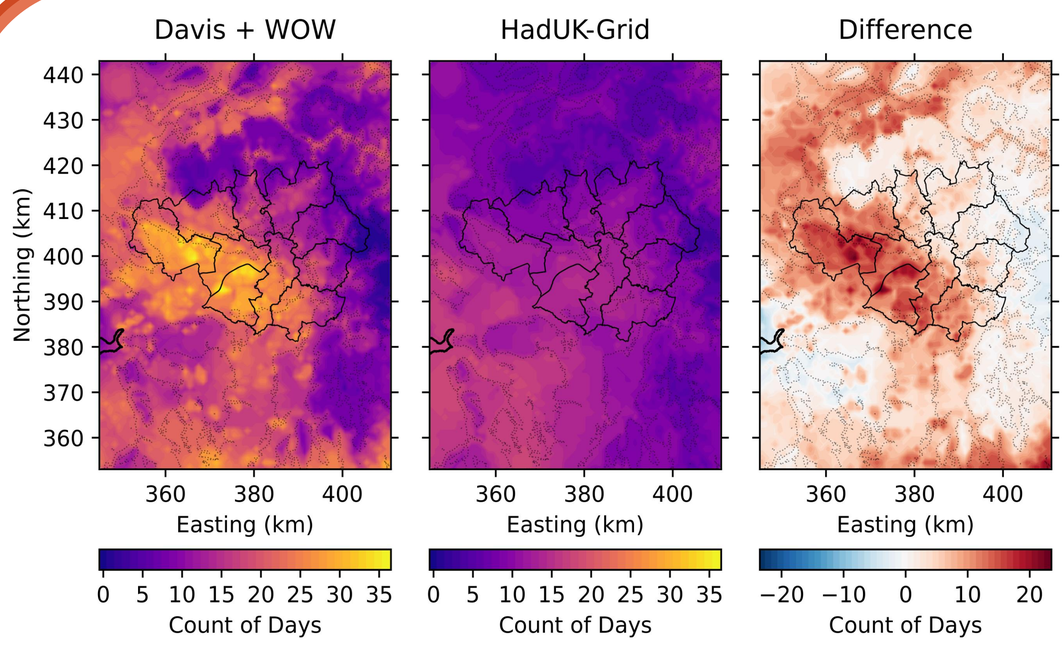

Fig. 1 – Number of "summer days" (T_{max} > 25°C) in 2020 in the crowdsourced grid (left), HadUK-Grid (centre), and the crowdsourced grids minus HadUK-Grid (right).

What happens if we include crowdsourced observations in climate grids?

• The centre plot of **Fig. 1** shows the count of "summer days" (where T_{max} exceeds 25°C) in 2020 from the current baseline, HadUK-Grid. Temperatures above this are associated with **excess mortality**, particularly for vulnerable individuals.

• The leftmost plot of **Fig. 1** shows the same metric from grids built using crowdsourced observations from citizen weather stations. In some areas, this metric is increased by as much as **three weeks** (rightmost plot).

• HadUK-Grid is currently used to bias-correct climate model projections. If a crowdsourced baseline was used instead, we would see a **substantial increase** across such hazard metrics both now, and in future scenarios; impacting future mortality, health, and public policy decisions.

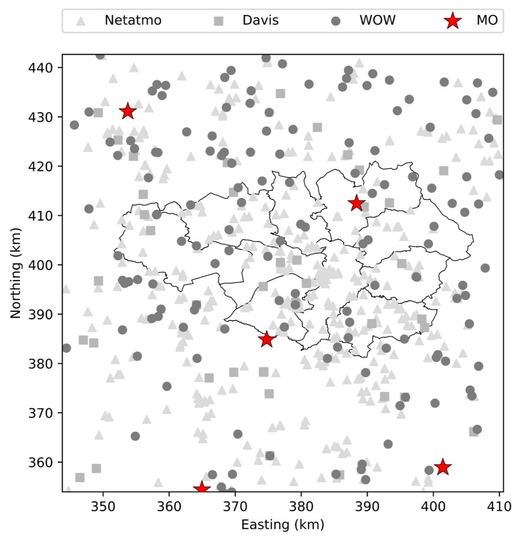

Fig. 2 – Netatmo, Davis, WOW, and Met Office sites around Manchester.

Why include crowdsourced observations?

• A long-standing challenge in urban climatology is to improve our observational basis. Climate information obtained from citizen weather stations, such as those in **Fig. 2**, opens the possibility to do just this.

• Current networks and baselines likely fail to capture urban warmth fully, particularly during heat events. If so, the services they support may under-estimate current and future heat hazard metrics.

• A greater density of observations allows us to more broadly sample the range of elevations, exposures, and microclimates in both rural and urban areas. The additional information this affords allows local-scale grids to be built, as done in this study for one year – 2020, one variable – temperature, in one UK city – Manchester.

What are the challenges?

• Reference networks comprise high-quality instruments in standardised exposures and conditions. Crowdsourced observations, meanwhile, may suffer from any combination of lags, radiative over-heating, non-standard exposures, intermittent reporting, false metadata, and more.

• Robust quality control is necessary to remove or correct problematic sites, but this must be applied carefully to avoid discarding the very information on extremes that is sought.

• The limited scope of this pilot permitted the use of both automated and manual methods to screen out problematic sites and values, e.g. **Fig. 3**.

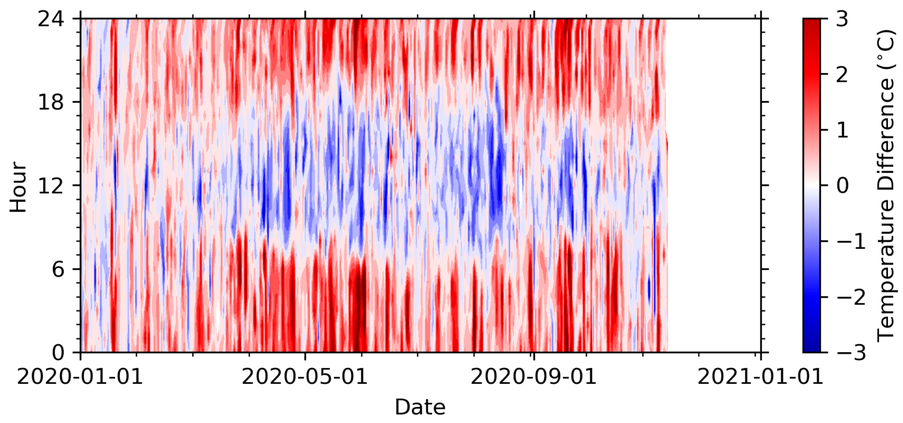

Fig. 3 - Comparison of mean hourly temperatures from a Davis site located on the northeastern shore of a large lake, versus the nearest Met Office site.

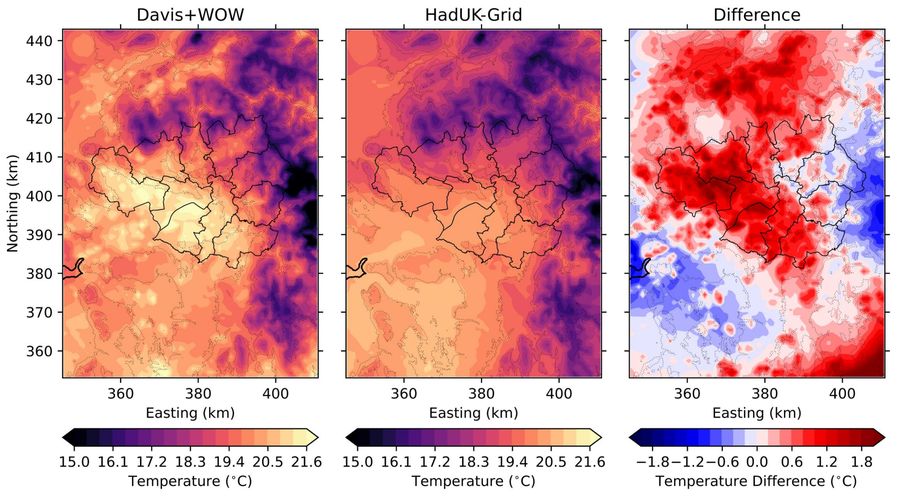

Fig. 4 – Mean daily T_{max} in summer (JJA) 2020 for the crowdsourced grids built from Davis and WOW (left), the standard HadUK-Grid (centre), and their difference (right).

How do the grids compare?

• Quality-controlled observations were interpolated onto a regular 1km grid. Regression equations relate the temperature to location, elevation, coast, and urban fraction, with a single fit for each day.

• Exploiting the greater density of crowdsourced sites allows us to capture domain-wide dependencies on elevation, coastal proximity or land use more precisely in space and more consistently in time.

• Generally, the crowdsourced grids capture a stronger elevation dependence (e.g. Pennines), as well as additional urban warmth in the city centre **(Fig. 4)**. Industrial parks can be identified as local temperature hot-spots, along with various outlying towns.

• Local spatial variations of **1-2 °C** in the mean summertime daily T_{max} are observed. On one of the hottest days, the crowdsourced grid was **4-5°C warmer** in some areas of Greater Manchester.

Met Office FitzRoy Road, Exeter, Devon, EX1 3PB, United Kingdom
Email: matthew.fry@metoffice.gov.uk