Improved quantification of future changes to UK City temperature extremes

Why this is important: Increasing summer temperatures in a warming climate will increase the exposure of the UK population to heat-stress and associated heat-related mortality. Urban inhabitants are particularly at risk, as urban areas are very sensitive to extreme temperatures and often significantly warmer than surrounding rural areas due to the urban heat island (UHI) phenomenon. For example, during the 2003 European summer heatwave, it was estimated that there were 2091 excess deaths in the UK, of which 52% were attributable to the UHI. By 2050, 90% of the UK population is projected to live within urban areas and it is therefore essential to understand how climate change will impact urban climates, particularly temperature extremes. To better understand the future exposure of urban inhabitants to heat-stress, it's important to use climate information produced by computer models that correctly quantify changes to the frequency and severity of temperature extremes. This will ensure that climate information provided to health agencies and urban planners to help mitigate future climate risks fully represent future changes in heat extremes within cities.

What the UKCR programme is doing: Work has been undertaken to better quantify the urban influence on present-day (1981-2000) and future (2061-2080) temperature extremes in UK cities. It utilised the latest UK Climate Projections (UKCP) which includes convection-permitting modelling (CPM) data at 2.2km resolution and similar to that used for operational weather forecast models. Importantly, this high-resolution model includes improved land-surface representation as well as a more sophisticated urban scheme that distinguishes streets and roofs to more realistically represent urban processes, thus providing credible climate information at the city-scale. A new urban signal extraction technique was developed, allowing the urban influence to be extracted for any urban area, regardless of its size or location and without the need to choose appropriate rural and urban reference points. This technique has been applied for daily maximum and minimum temperatures on each day in the present-day and future time-slices from the CPM data and the UKCP-RCM (12km) low resolution data, based on the Representative Concentration Pathway (RCP) 8.5 scenario. Comparing results from the two models has allowed an improved quantification of the urban influence on extreme UK city temperatures in the latest UK Climate Projections.

Results so far: The study found significant differences in the urban influence on temperature extremes in the RCM and CPM. For the present-day, the urban influence in the RCM is too large, leading to overestimation of the number of warm nights over urban areas, whereas the CPM correctly captures the number of warm nights compared with observations. For hot days, the RCM projects rural temperatures to increase by 8-9˚C across southern and southwestern UK and between 6-8˚C elsewhere, with rural areas warming more than urban areas by approx. 1-1.5˚C. However, in the CPM, urban and rural temperatures are projected to warm at similar rates, so the urban influence is unchanged. Importantly, the CPM also shows that peak urban temperatures are projected to increase more in the future compared to the RCM (for example by ~0.5˚C for London and Manchester). The CPM also shows a larger amplitude of diurnal cycles which could have implications for future building design. While absolute future changes in daytime urban temperatures tend to be larger in the CPM, night-time temperatures following a hot day are lower which allows greater capacity for urban inhabitants to recover from heat-stress. These are important findings that demonstrate the benefits of the CPM in providing more reliable information on future urban temperatures and subsequent impacts on the health of urban inhabitants. This information can help provide policy makers with improved advice on future risk and aid adaptation decision-making, helping build UK resilience to future changes in weather and climate variability.

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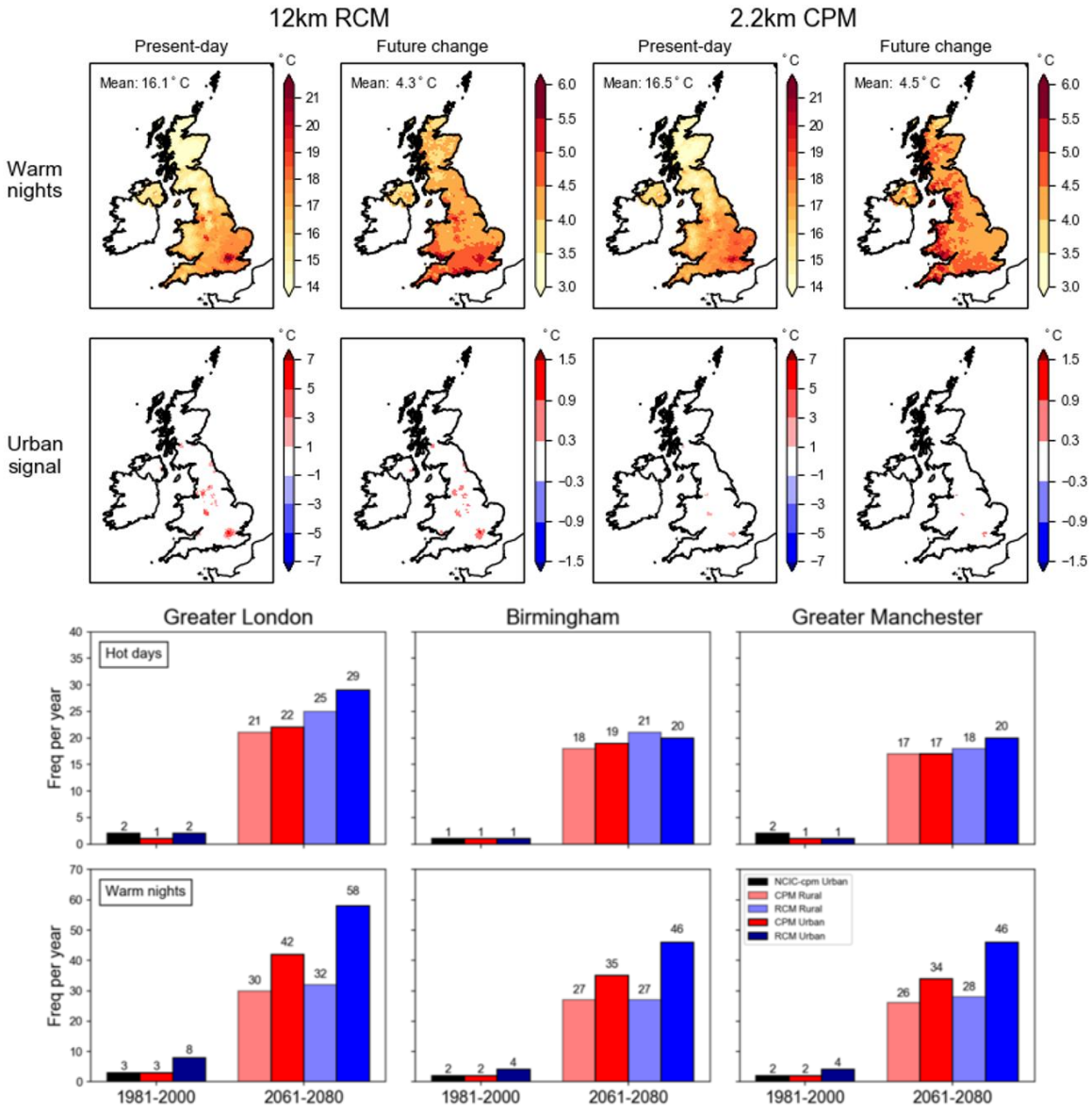

Frequency of hot days and warm nights for 3 UK cities between the RCM (12km resolution) and CPM (2.2km resolution) for 1981-2000 and 2061-2080.

What is next? The study has been written up and published in the journal Climate Dynamics and plans are in place to produce supporting communication materials to maximise uptake of the results by stakeholders. In future, the urban influence on extreme rainfall is being investigated, including urban impacts on convective initiation and storm morphology.

Reference: Keat et al., 2021, Climate Change over UK Cities: The Urban Influence on Extreme Temperatures in the UK Climate Projections, *Climate Dynamics*, Vol. 57, pp 3583–3597