

# PROVIDING PROJECTIONS OF URBAN CLIMATE CHANGE: A NEW SPATIAL WEATHER GENERATOR FOR URBAN AREAS



ARCADIA FACTSHEET 2  
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*The spatial and temporal scale of climate model outputs is often inconsistent with that required for climate change impact studies. More spatially explicit climate projections can be produced by incorporating downscaling techniques that account for local climatological features. This factsheet describes a new spatial weather generator developed for urban areas and the benefits of using such a model for climate impact assessments.*



## Context: The UKCP09 Weather Generator

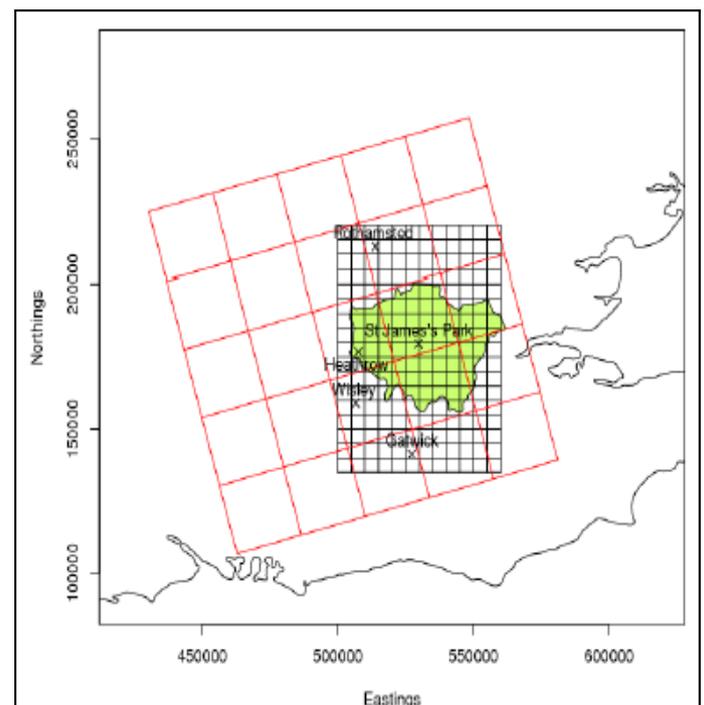
- ◆ The UK Climate Projections (UKCP09) provide climate information for the UK designed to help those needing to plan how they will adapt to a changing climate.
- ◆ The UKCP09 have been complemented through the application of a Weather Generator (WG) which provides daily and hourly time series of weather variables for present and future conditions at a 5km<sup>2</sup> grid resolution (fig. 1).
- ◆ The WG has been well validated against observed data from 1961-1990.
- ◆ The WG can be used to explore a range of emission scenarios and future time-periods.
- ◆ However, the UKCP09 WG does not simulate some extremes well, and does not provide spatial consistency in time across neighbouring grid cells.
- ◆ Therefore, as part of the ARCADIA project the WG has been updated to address these issues, and has been customised for specific application to urban areas.

## Spatial Urban Weather Generator: Improved representation of extremes

- ◆ The WG has been updated to provide improved reproduction of extreme hourly rainfall, extreme temperatures and heatwave persistence.

## Spatial Urban Weather Generator: Spatial consistency

- ◆ In the updated WG spatial fields of weather variables, which reflect both recurrent spatial patterns caused by topography and buildings and spatial dependence in weather driven by weather systems, have been considered.
- ◆ This is important so that information on daily weather events across London, and potential risk hotspots, can be provided.
- ◆ For example, the number of heat related deaths per daily heat event, or an assessment of mortality during specific heatwave events, can be assessed.



**Fig. 1: Spatial WG for urban areas. Black: WG domain for London at 5km<sup>2</sup>. Red: Regional climate model from UKCP09 at 25km<sup>2</sup>.**

## Spatial Urban Weather Generator: The effect of urbanisation on London's climate

- ◆ Those living within urban areas are also particularly vulnerable to high temperatures due to the Urban Heat Island (UHI) effect, whereby temperatures are higher than in surrounding rural areas due to the heat storage of paved and built up areas, reduced radiative cooling efficiency, and waste heat from buildings, transport, and social activity.
- ◆ The effects of urban heat, due to urban land use and anthropogenic heat emissions, is incorporated in the temperature data in the updated WG (fig. 2).
- ◆ This allows the potential effects of different proportions of urban land cover and emissions of waste heat on urban climate to be explored.
- ◆ In the WG heat release accounts for ~15% of the average summer night UHI and ~42% of the average winter night UHI.
- ◆ The UHI effect results in greater changes in extreme temperatures in urban areas compared to rural areas under future projections of climate change (fig.3).
- ◆ This is beneficial as whilst past studies have highlighted the potential impacts of the UHI on climate related risks in urban areas it has not been considered explicitly in the scenarios.
- ◆ As such, these studies are likely to underestimate temperatures and impacts in urban areas.

### Benefits of using the spatial urban weather generator

- ◆ The updated WG has been extensively evaluated and validated.
- ◆ It allows the user to generate city-scale climate change scenarios consistent with the UKCP09.
- ◆ Inline with the UKCP09 the WG provides probabilistic projections which capture climate model uncertainty and natural variability.
- ◆ The WG facilitates high resolution modelling of climate and extreme weather events, such as heatwaves and extreme rainfall events, important for assessing climate related risks at a city-scale.
- ◆ The WG allows the exploration of the impacts of different future climate and urban development scenarios (e.g. reduced urban coverage and/or heat release and increasing urbanisation).
- ◆ Similarly, the effects of different adaptation policies such as urban greening, and benefits in terms of avoided climate impacts, can be explored and used to inform policy.

#### For additional information see:

- ◆ UK Climate Projections Website:  
<http://ukclimateprojections.defra.gov.uk/22540>
- ◆ ARCADIA Website:  
[www.arcc-cn.org.uk/project-summaries/arcadia/](http://www.arcc-cn.org.uk/project-summaries/arcadia/)

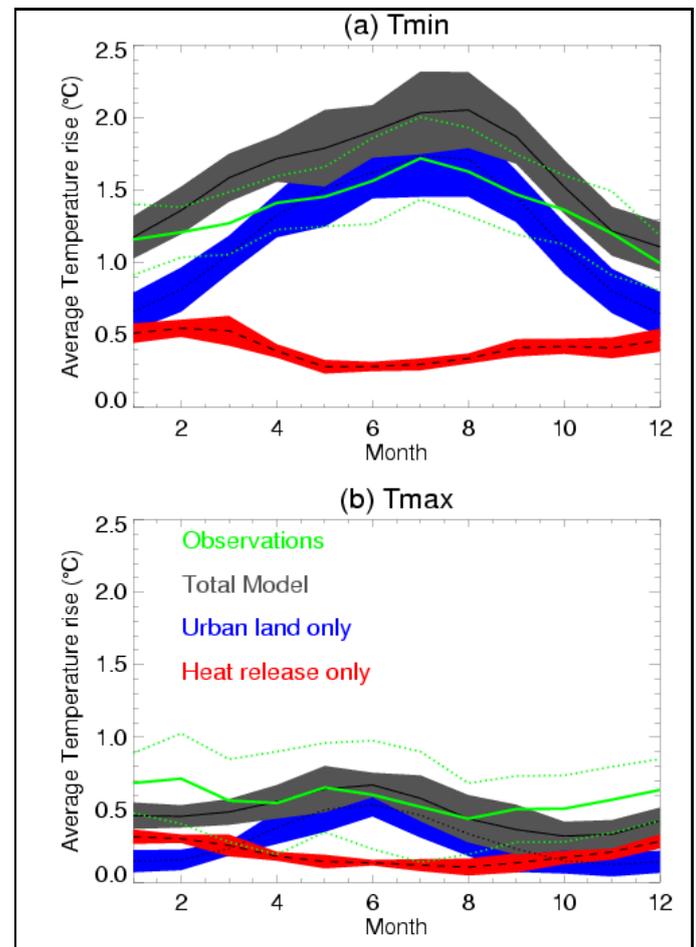


Fig. 2: The effect of urbanisation on London's climate

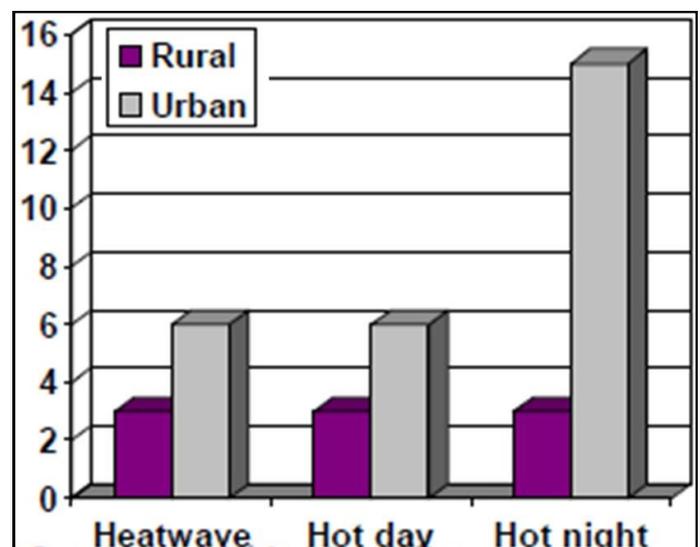


Fig. 3: Simulated increase in number of extreme days by 2050