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Climate Change and Cities

Climate Change and the Urban Heat Island

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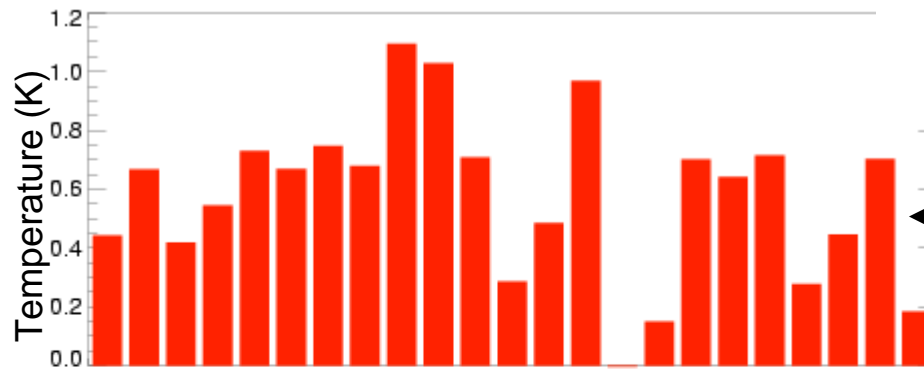
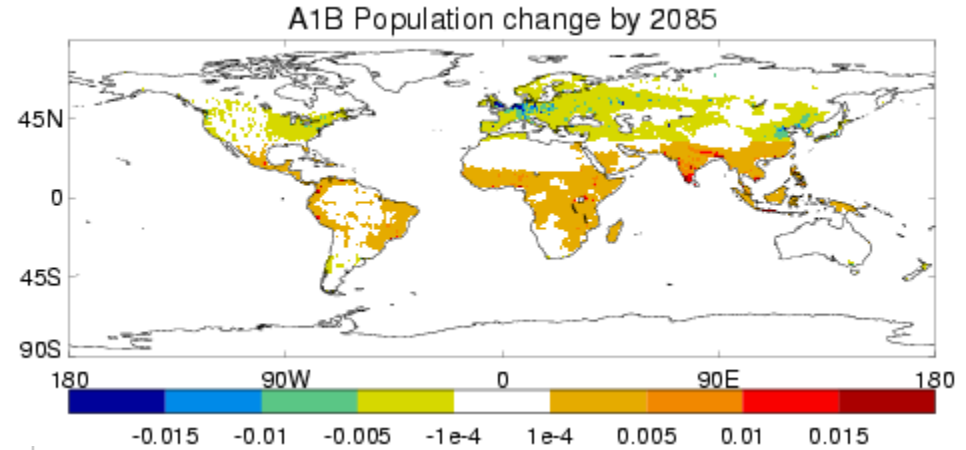
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This presentation covers the following areas

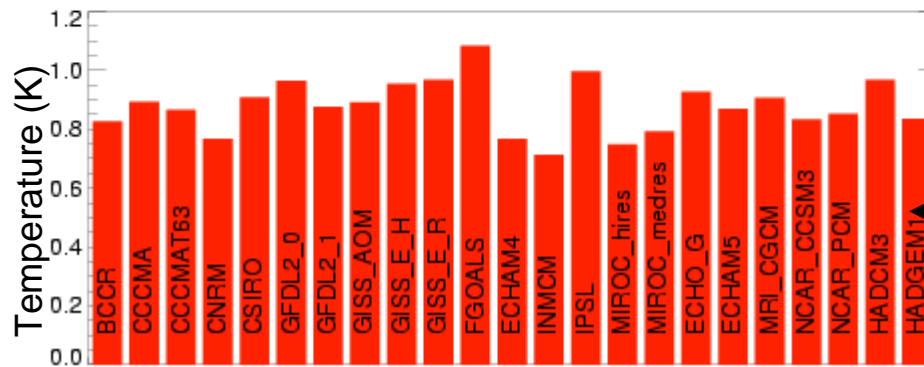
- Human exposure to climate stress.
- A simple coupled urban-climate model.
- Energy use and the urban environment.
- Cities in a regional climate model.



Population and Climate Change

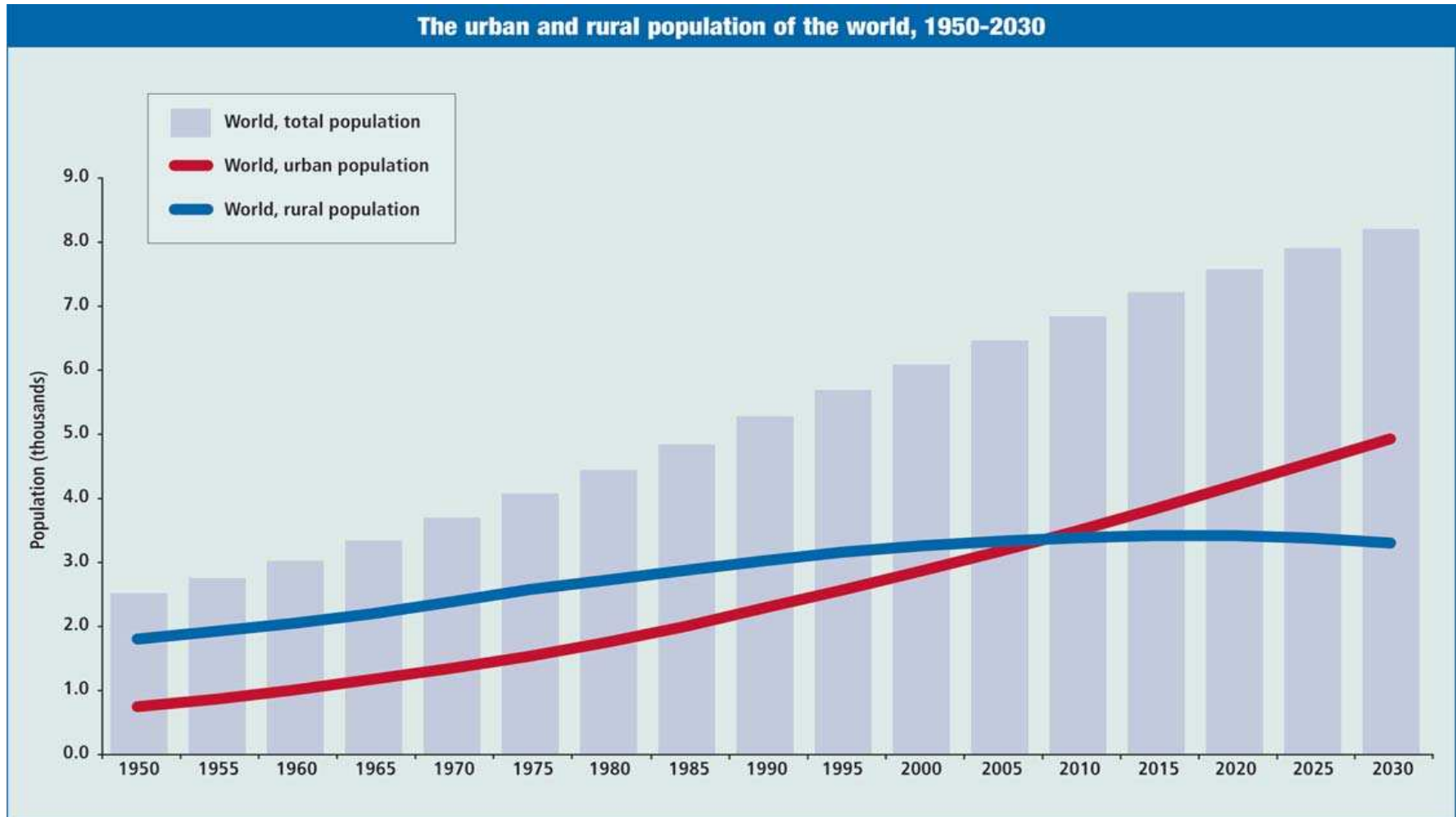


Population weighted climate change across AR4 (on top of $\sim 3^\circ$ global warming)



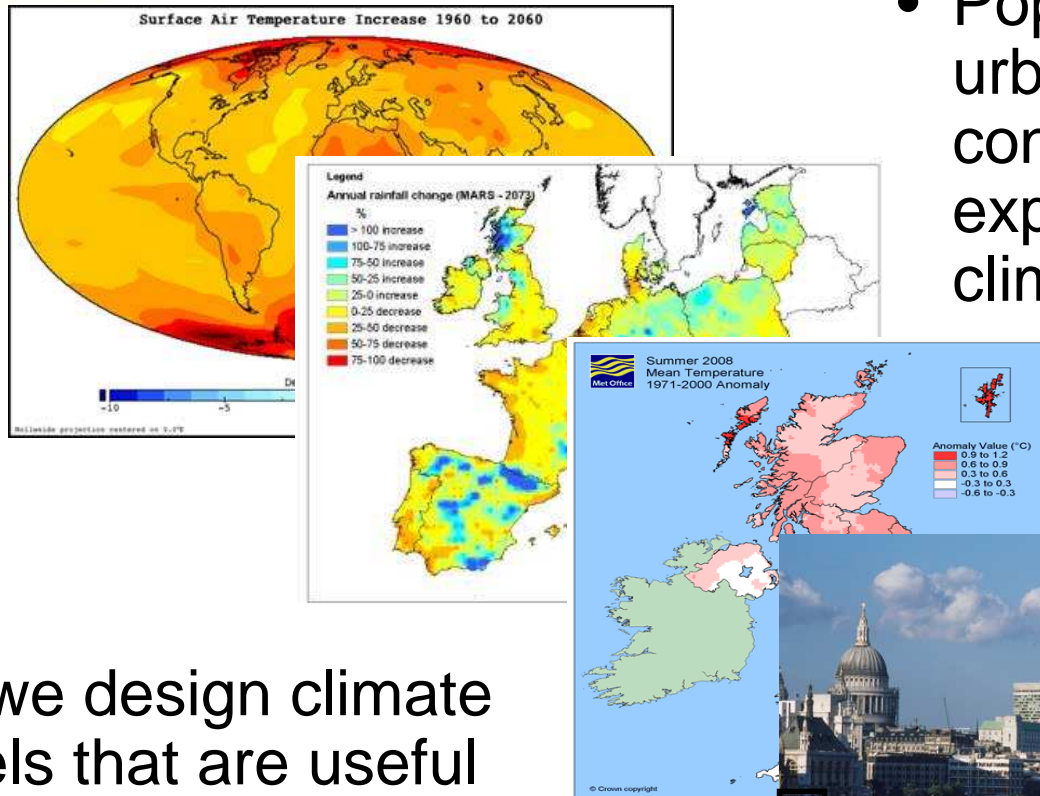
Change in human exposure due to population distribution change

Urbanisation trends



Human Exposure to climate stress

- Population dynamics and urbanisation will contribute to future exposure of humans to climate stress.



- Can we design climate models that are useful impacts and adaptation tools despite uncertainties?

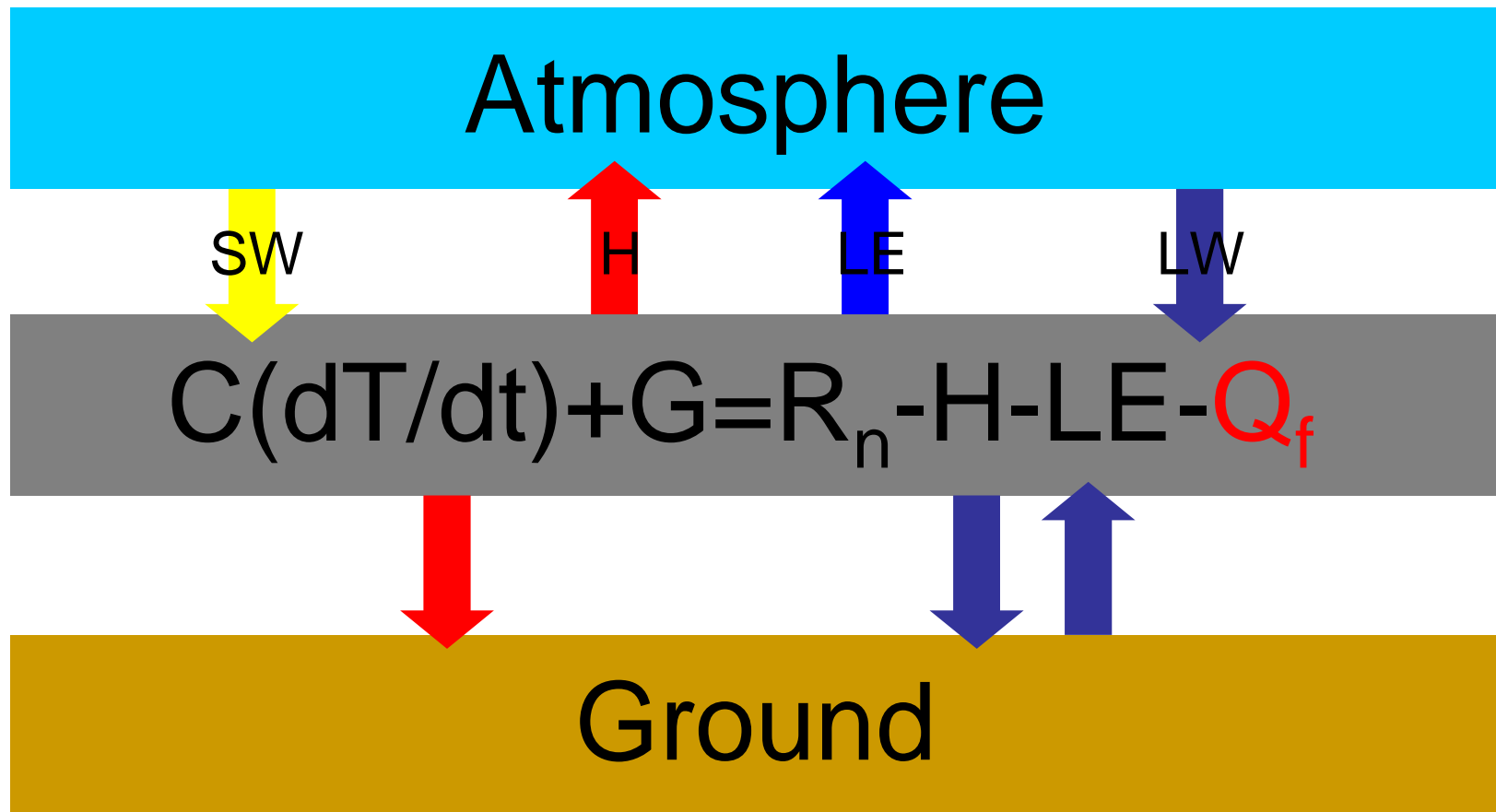




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A simple urban climate model

A simple urban scheme for a climate model

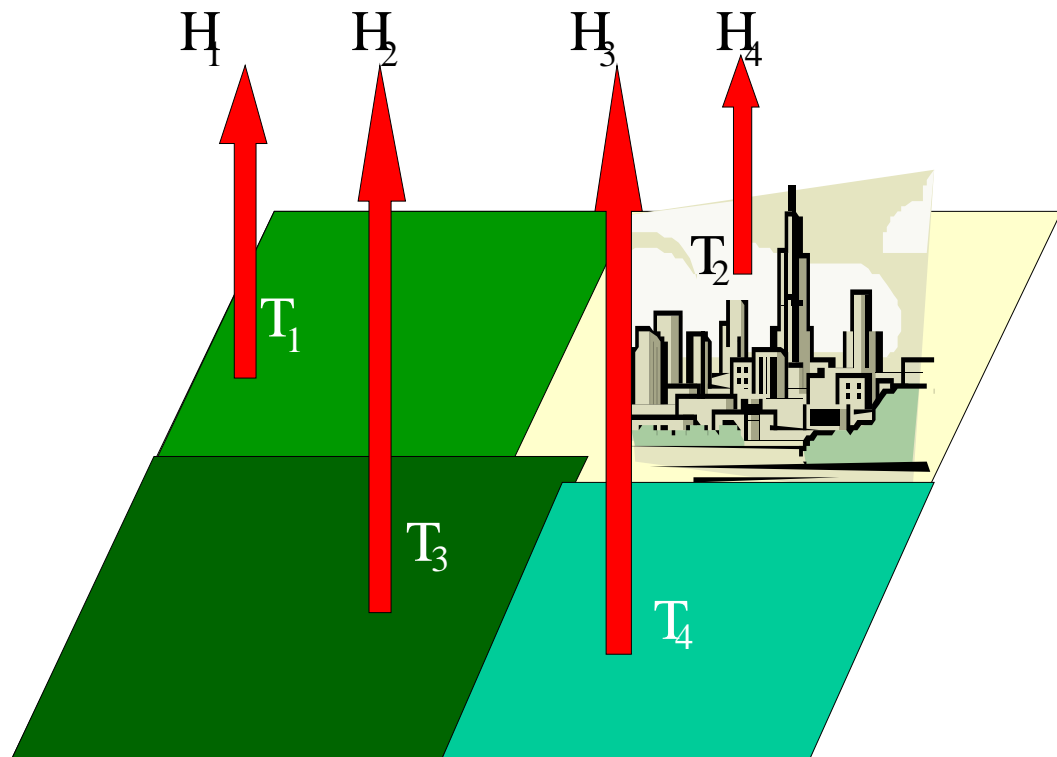


Best et al. 2006: Boundary layer Meteorology 118: 503-525

Subgrid heterogeneity

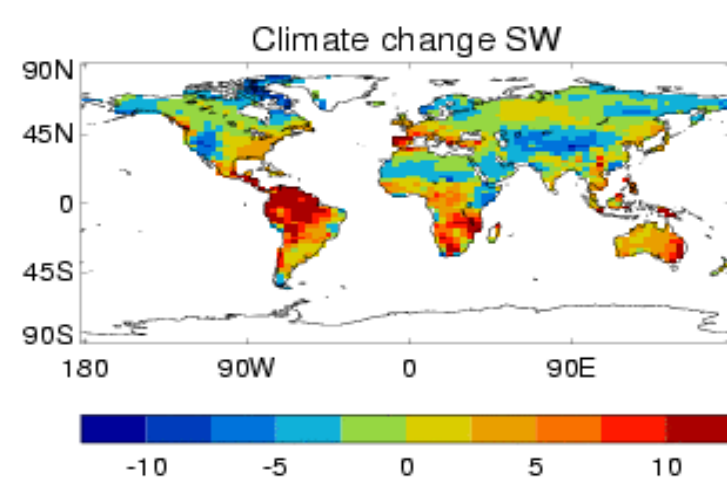
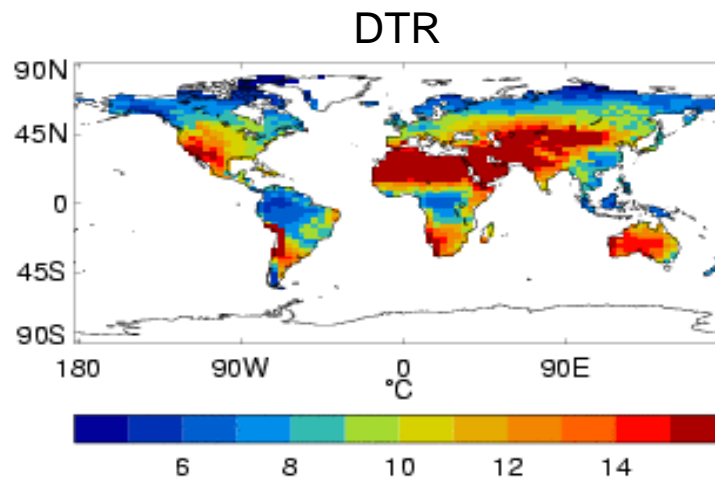
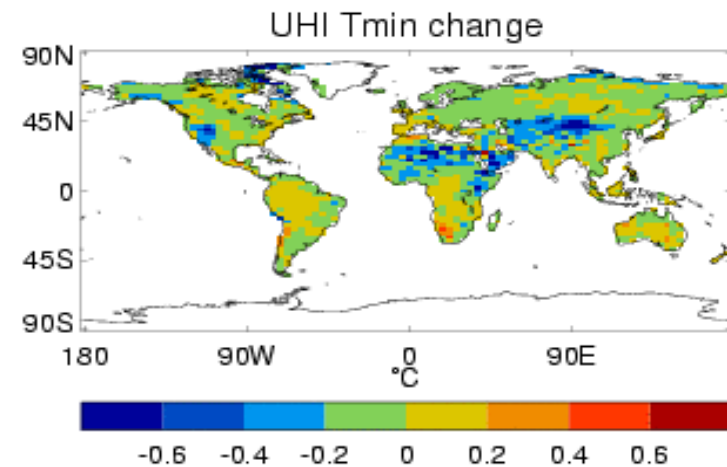
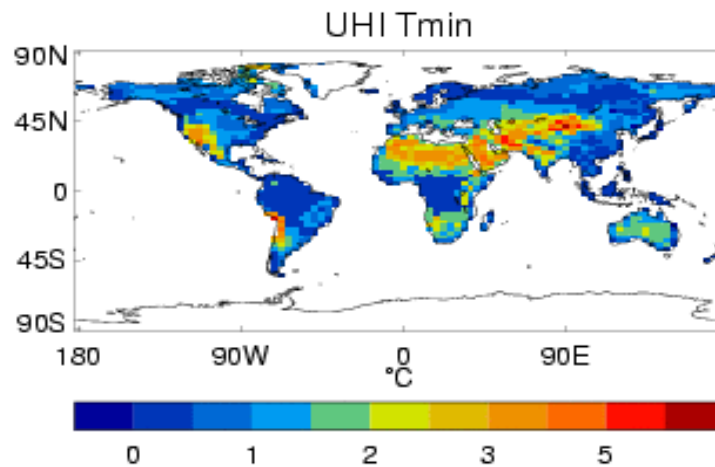
- Urban parameters:

- Albedo
- Roughness
- Heat Capacity
- Anthropogenic heat release
- Impervious



Essery et al. 2003: J. Hydrometeorology, 4, pp.530-543

Urban Heat Island responds to climate feedbacks not forcings





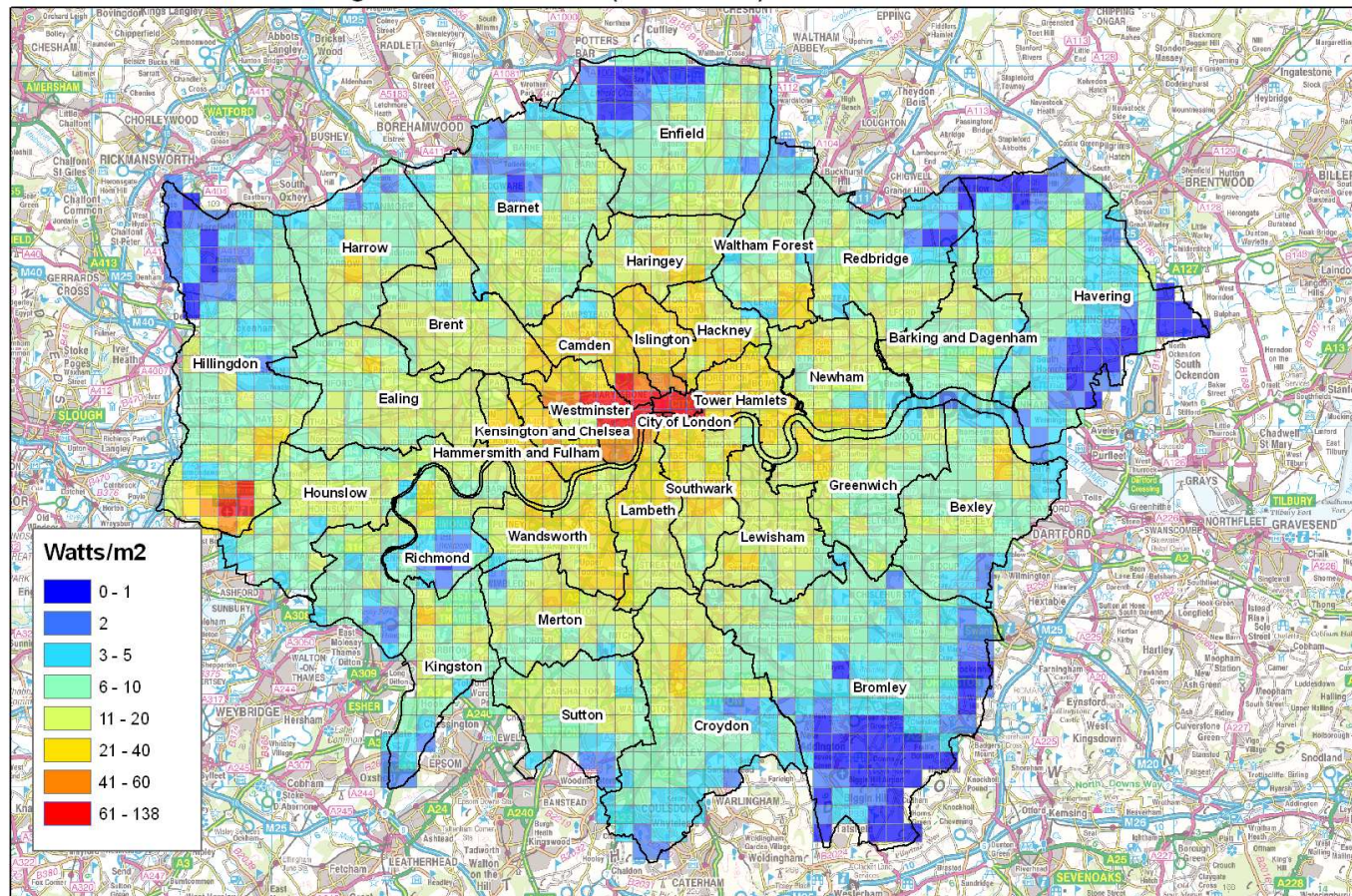
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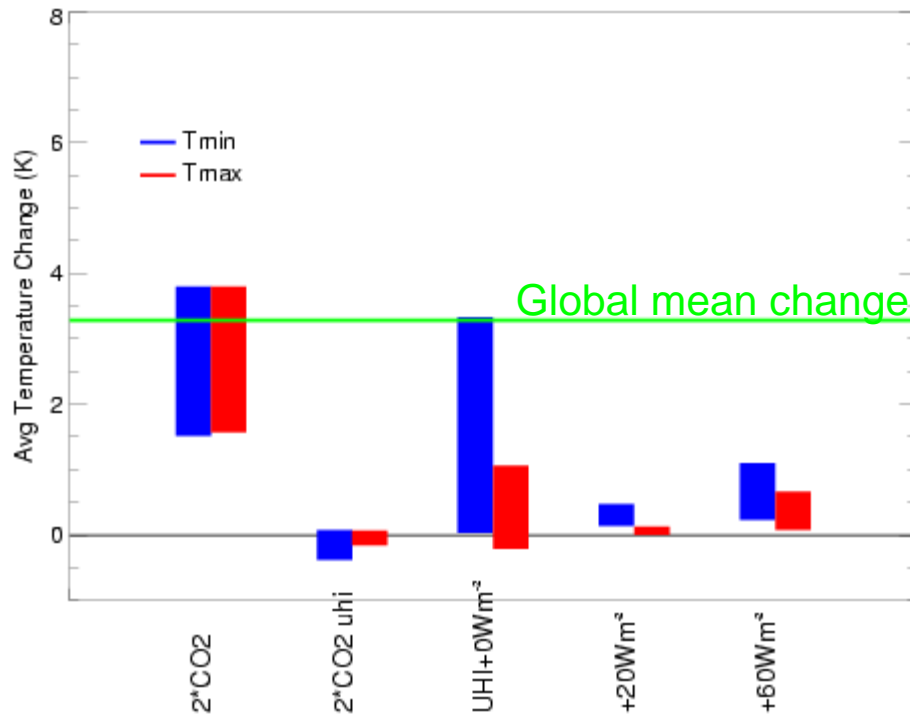
Energy use

Energy use and urban heat islands.

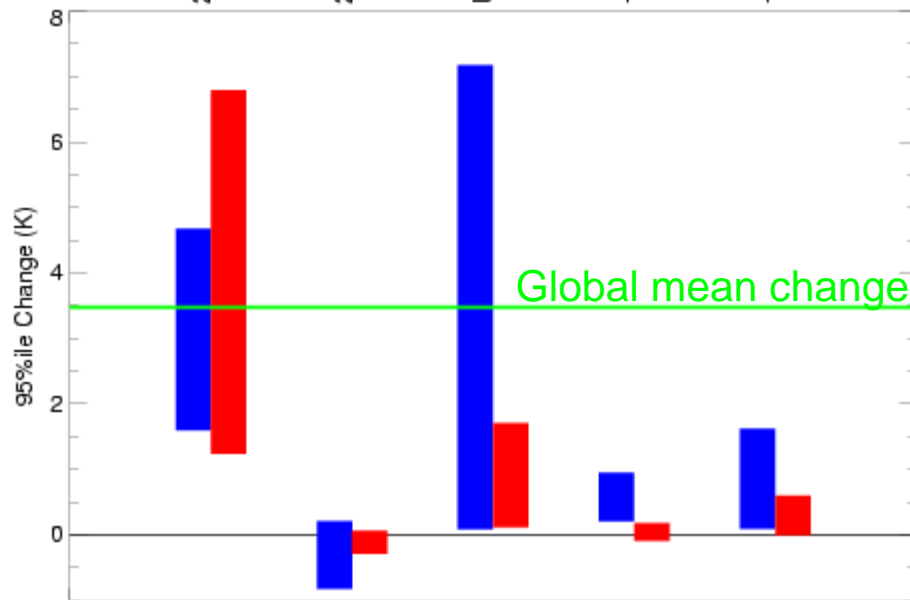
Total Annual Average Heat Release (Watts/m²)



Energy use data courtesy of London Energy and CO₂ inventory 2003

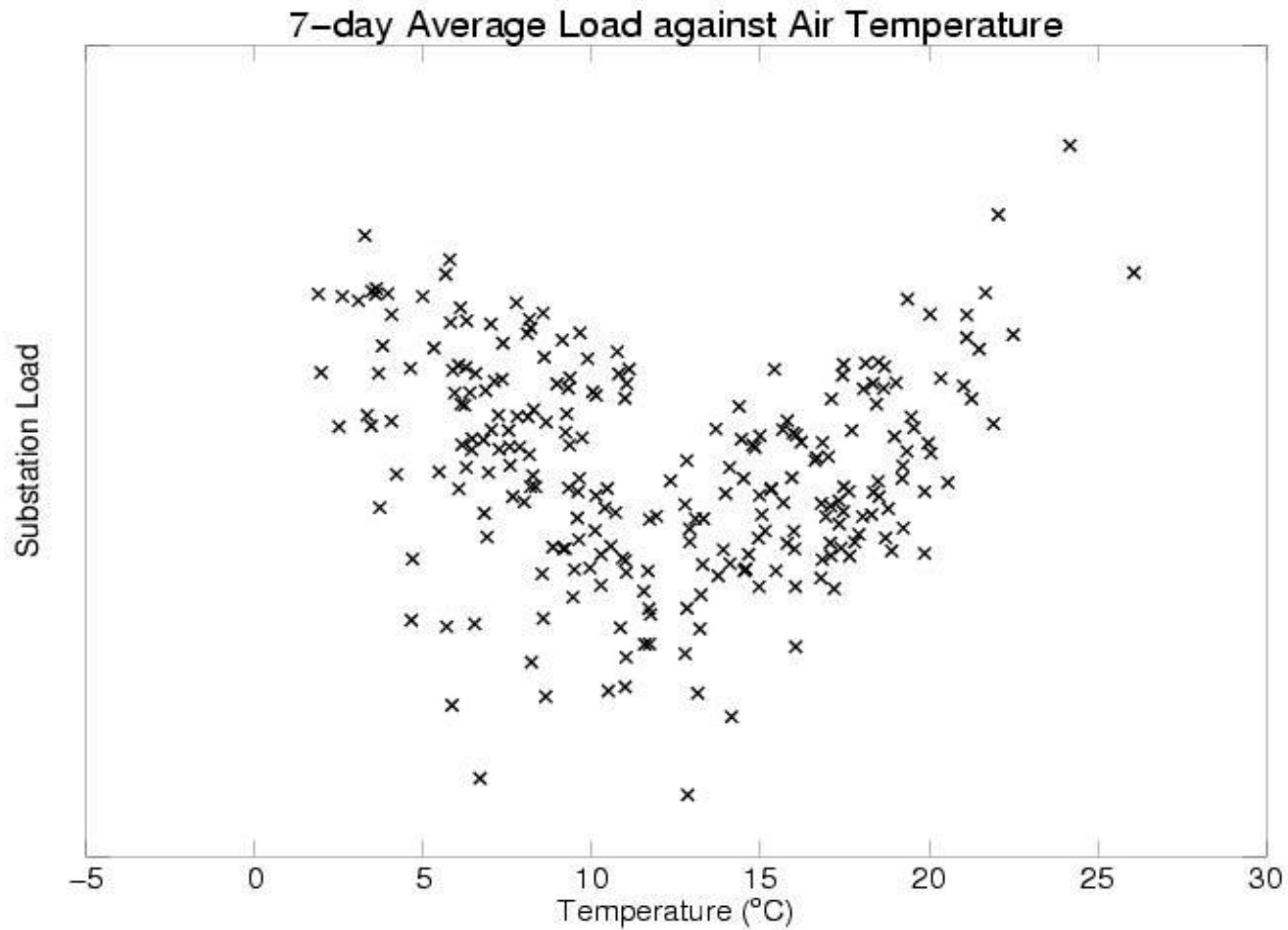


Change in average temp. in urban areas responding to global warming and urbanisation



Change in 95th %ile temp. in urban areas responding to global warming and urbanisation

Energy use and climate.



Energy use-climate-urban feedbacks



- Urban climates can change in response to climate change.
- Urban climates can change in response to local anthropogenic forcing.
- Local anthropogenic forcing can change in response to climate.

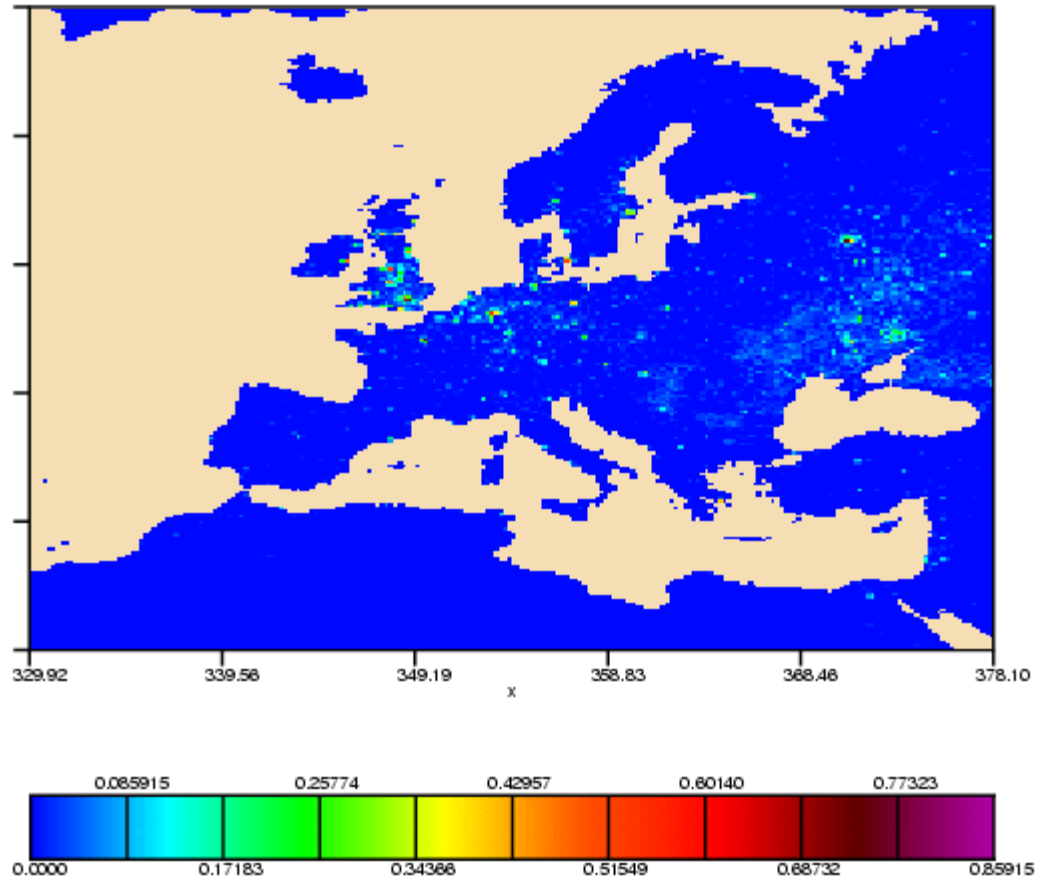
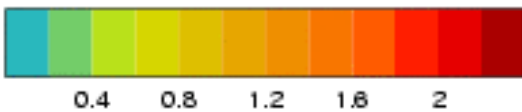
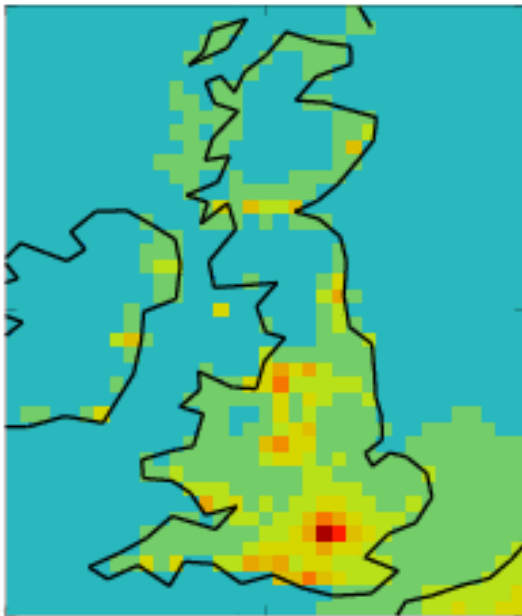


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Cities in a regional climate model

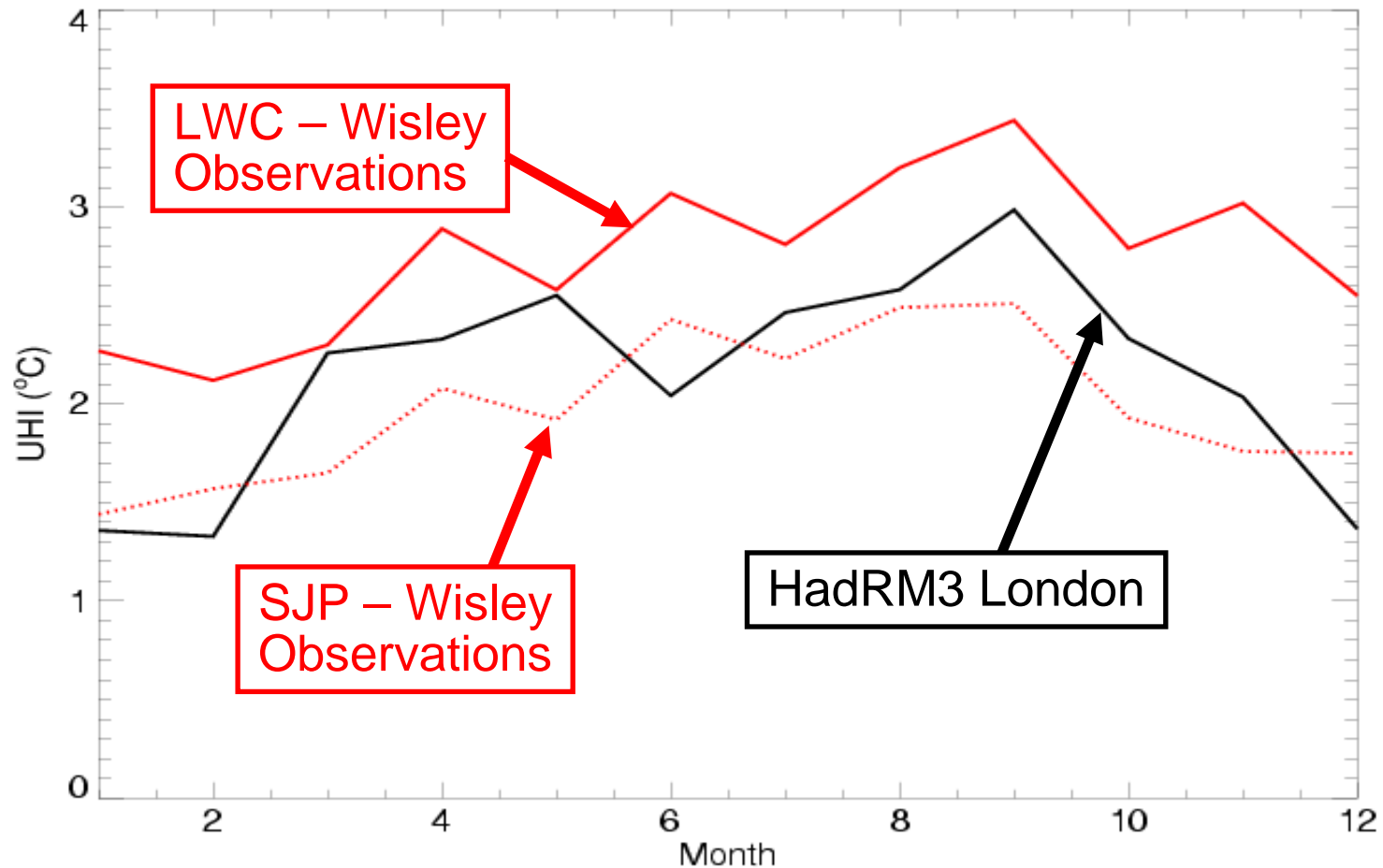
Urban heat islands in HadRM3.

Urban Heat Islands in HadRM3Q

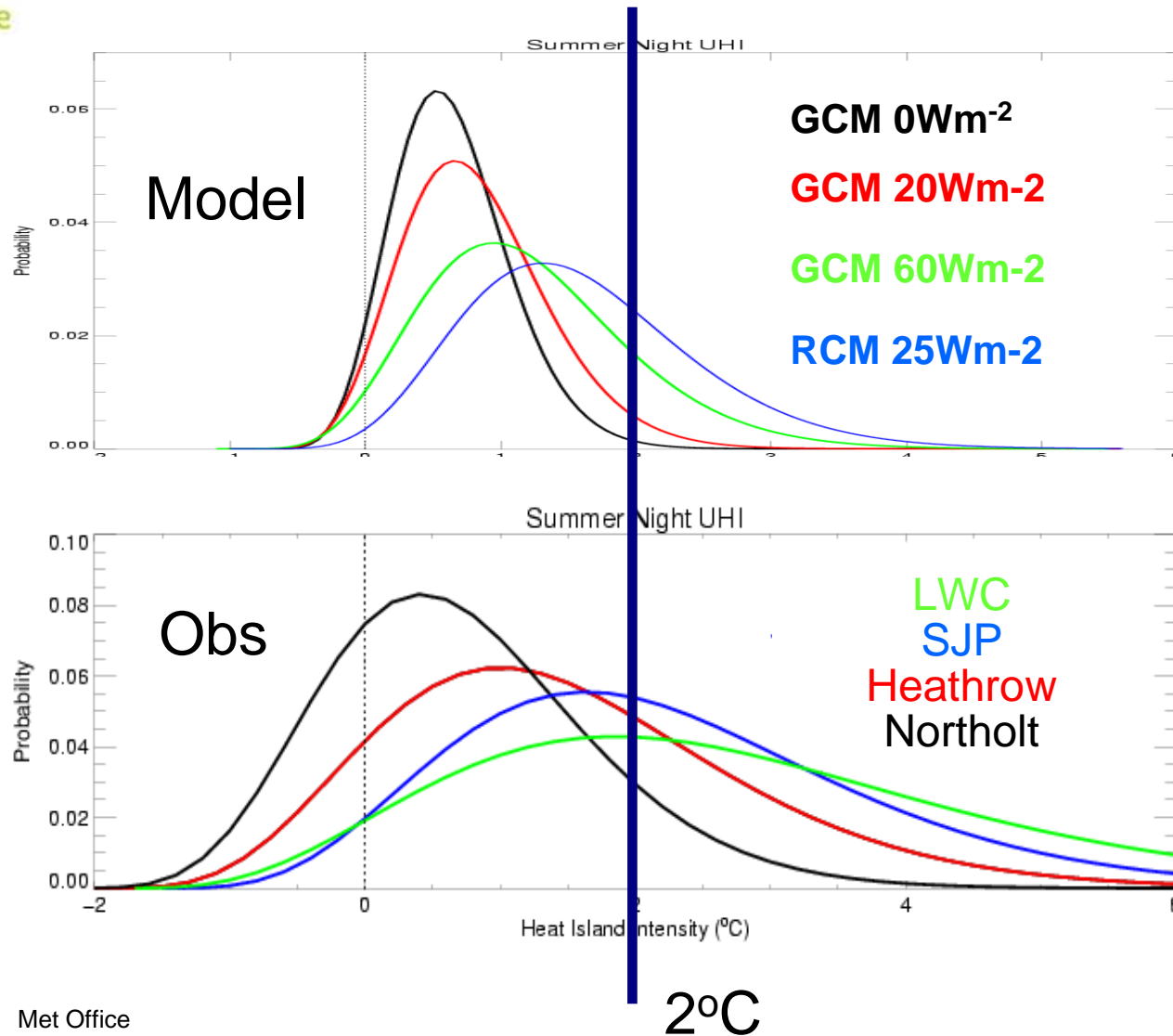


Urban surface type fraction for Europe

Seasonality and magnitude of a heat island simulated by RCM



Frequency distributions for UHI in London: simulated and observed



Anthropogenic heating and extremes.



- Large impact on occurrence of extreme temperatures.
 - No. hot nights no urban = 4.5
 - No. hot nights urban no heating = 11.1
 - No. hot nights urban + heating = 16.7
- Relatively small perturbations to the mean climate can have significant impacts on the occurrence of extremes.



Summary.

- Climate Change experienced by city dwellers will be driven by both global and local factors.
- Interactions between climate, local heat release, and the urban heat island may make some off-line or empirical urban models unreliable for climate change scenarios.
- Anthropogenic heating is critical for describing both the mean and extreme heat islands.
- Working to better represent the impacts of climate change on cities within the framework of climate models.