Can building insulation intensify extreme heat in cities?

Large-eddy simulation study on the effect of modernizing insulation of buildings on indoor and outdoor thermal comfort

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In Short

- What is the impact of building insulation on indoor and outdoor thermal comfort
- Preliminary work has shown that modernizing actions can lead to enhanced urban heat island during daytime
- Building- and turbulence-resolving simulation of city quarters in Berlin (Germany) and Boston (USA)

Over the past decades, the number of people in urban environments has continuously increased. In 2016, about 4 billion people (54.5% of the Earthâs human population) lived inside cities and their surroundings [1]. Due to the limited space, the concentration of people and the density of buildings have increased massively, resulting in a replacement of natural conditions, high energy demand, and increased air pollution. The most distinct effects of the urban environment are the well-known urban heat island, modification of the surface roughness, and increased aerosol emissions from traffic, industry and households. In order to ensure a future worth living in, our cities must be adapted to the drawbacks of a changing global environment with much higher temperatures. The interaction between urban areas and the atmosphere has thus received growing attention in urban climate research over the last decades [2],[3]. Numerical models are a useful tool to study the multitude of complex interactions in urban environments and they can also be used to estimate the effectiveness of these complex adaption strategies for climate change scenarios.

The main goal of the project is to investigate the feedback of modernizing insulation of buildings on indoor/outdoor temperatures and outdoor human thermal comfort in the urban canopy layer. For this purpose, a set of high-resolution Large-Eddy Simulations (LESs) will be conducted for an idealized summer heat wave. For this purpose, two city quarters in Berlin (Steglitz and Ernst-Reuter-Platz) and Downtown Boston (USA) are chosen that are representative for purely residential, mixed residential and office, and high-rise office environments, respectively. The simulations results will indicate whether building modernizing measures (insulation, air conditioning) have a potential feedback on the urban heat island and indoor temperatures on short and long time scales.

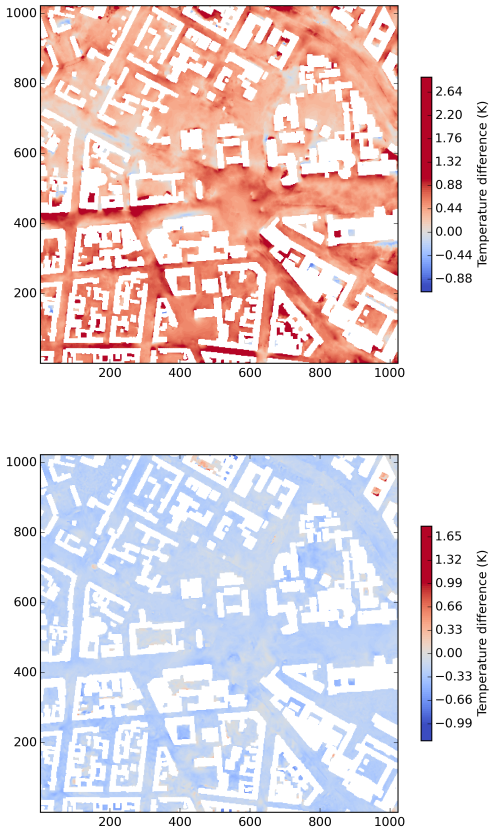

***Figure 1:** 2 m-temperature difference between full upgrade scenario and status quo simulation of Ernst-Reuter-Platz. Top: 1600 UTC, bottom: 0400 UTC.*

Figure 1 shows a prelminary results from simulations of Berlin Ernst-Reuter-Platz for a clear-day scenario in end of May. Displayed are the temperature changes during daytime and nighttime conditions due to a full building upgrade of all buildings within the domain. On a short time scale, the results indicate that during daytime temperature become higher by up to 3 K, while during nighttime there is slight cooling effect of up to 1 K. The planned simulations will extend this preliminary work by looking at a long summer heat wave of one week and also incorporating indoor temperatures and waste heat from buildings.

WWW

https://www.muk.uni-hannover.de/maronga.html

More Information

[1] United Nations, Department of Economic and Social Affairs, Population Division, https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf

[2] Oke, T. R., *Theor. Appl. Climatol.* **84**, 179–190, (2006).

[3] Kuttler, W., Oßenbrügger, J, Halbig, G. *Städte: Klimawandel in Deutschland*, Springer, 225–234 (2017).

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