A multi-scale modelling approach to bring urban climate and weather into built environment

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With rapid global urbanization, more than 50% population now live in cities, and it will be projected to be 70% by 2050. Our living environment is exposed to overheating risk due to the combination of climate extreme, i.e., heatwave and urban heat island. You may recall the increasingly frequent hot summer in the UK, difficult to study, work in the daytime, and sleep at night-time especially when living in cities. Design of our buildings and cities needs to make a change. However, currently, there are lack of robust modelling tools to guide our built environment design by addressing the complex interaction between buildings and cities, and predict their performance in future climate.

This project brings together a supervision team of urban meteorologist, engineer and building designer. It is aiming to develop a novel integrated building-urban climate modelling framework considering the realistic building operation and two-way feedback between the building and city, and apply such multi-scale modelling tool to optimize the design under climate uncertainty/extreme.

Fig1 LEFT: People in South-Asia had to sleep on roofs during heatwaves due to poor building design; RIGHT: A massive of air-conditioner down a narrow back alley in Singapore- release more heat into urban atmosphere and further elevate the urban air temperature. http://www.airintelligence.co.uk/air-conditioning-changed-the-world/

Training opportunities:

The student will attend courses on related subjects (e.g., building energy simulation, building environmental design, urban microclimate, urban meteorology, numerical modeling, and climate change adaptation) at both the Department of Meteorology and School of the Built Environment at the University of Reading. The student will have the opportunity to receive training on robust design optimization method at the University of Alberta under UK-Canada Globalink Doctoral Exchange Scheme. The student will have the opportunity to attend urban

climate/urban physics summer school.

Student profile:
This project would be suitable for students with a degree in physics, meteorology or a closely related environmental or physical science. Good programming skills using MATLAB, Python, Fortran or other languages are desirable.

References:

Duan, S., Luo, Z., Li, Y. and Yang, X. (2019) The impact of building operations on urban heat/cool islands under urban densification: a comparison between naturally-ventilated and air-conditioned buildings. Applied Energy, 235. pp. 129-138.

Sun, T. and Grimmond, S. (2019) A Python-enhanced urban land surface model SuPy (SUEWS in Python, v2019.2): development, deployment and demonstration. Geoscientific Model Development, 12 (7). pp. 2781-2795.

Lin, H., Shu, Z., Wu, G, and Xu, Y. "Optimal Estimation in UDP-Like Networked Control Systems With Intermittent Inputs: Stability Analysis and Suboptimal Filter Design," IEEE Trans. Automatic Control, 61: 1794-1809

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