# COUPLING BETWEEN DETAILED BUILDING ENERGY MODELS AND A DATA DRIVEN URBAN CANOPY MODEL
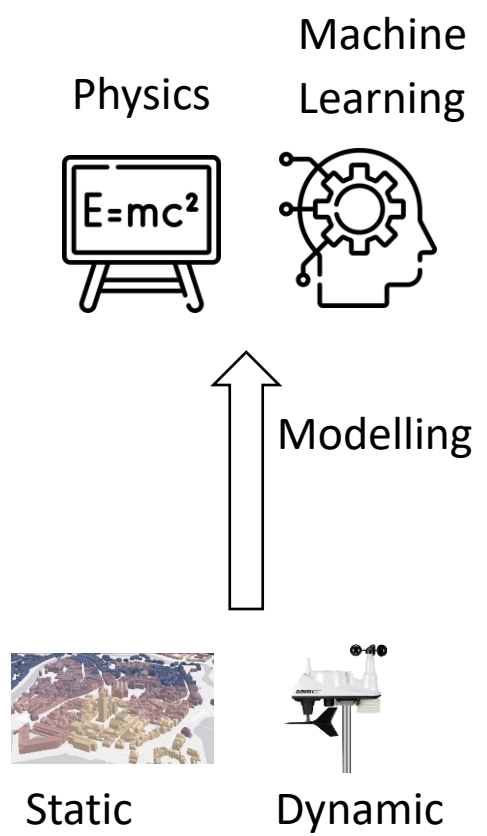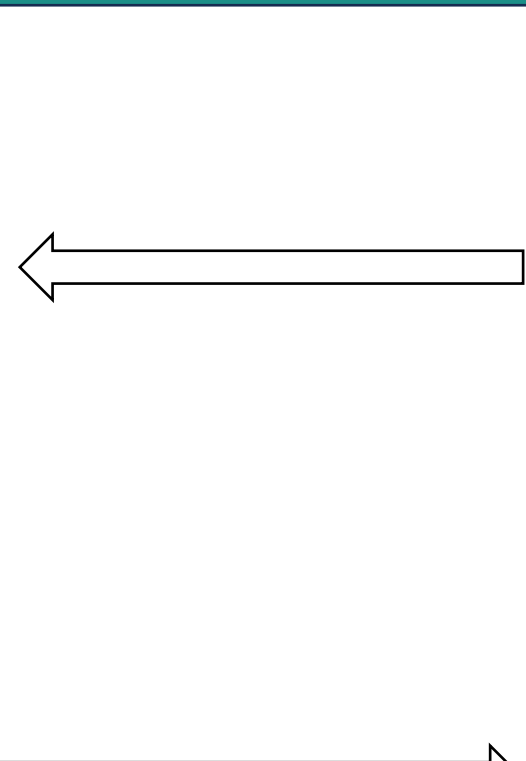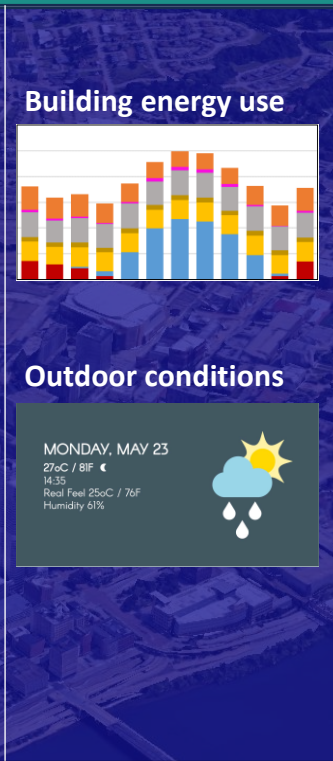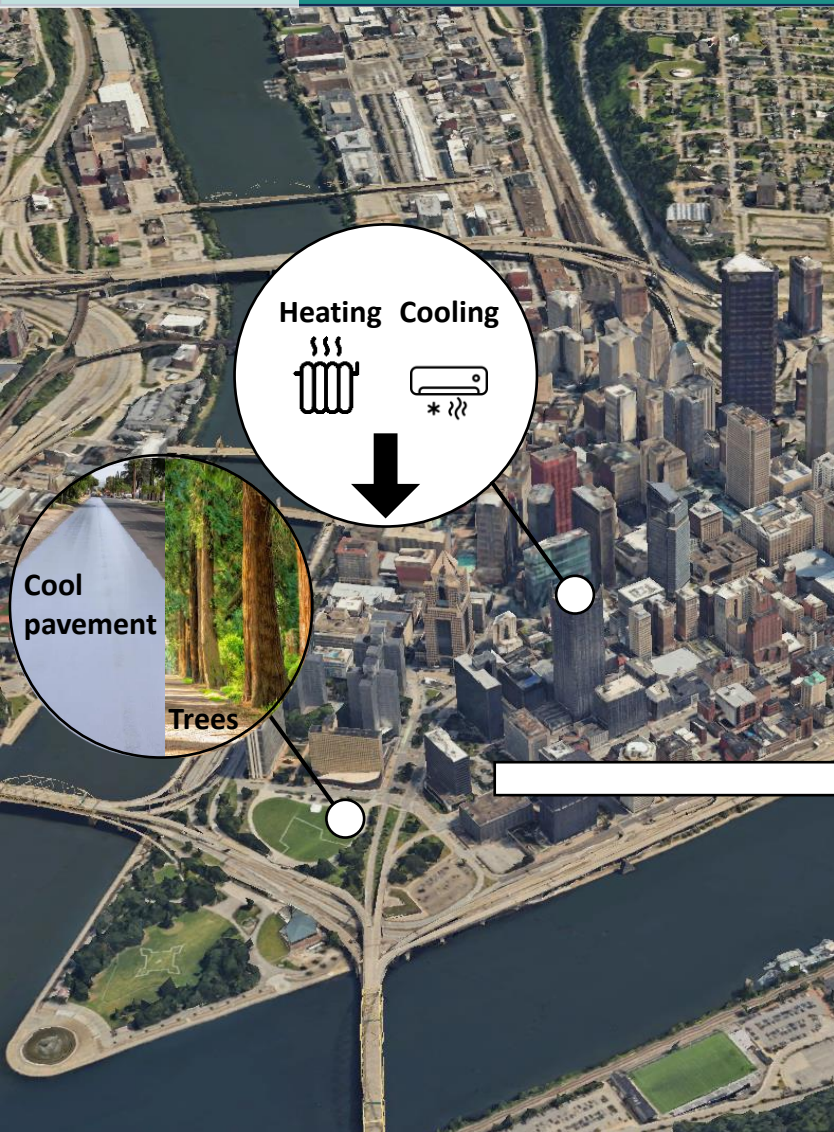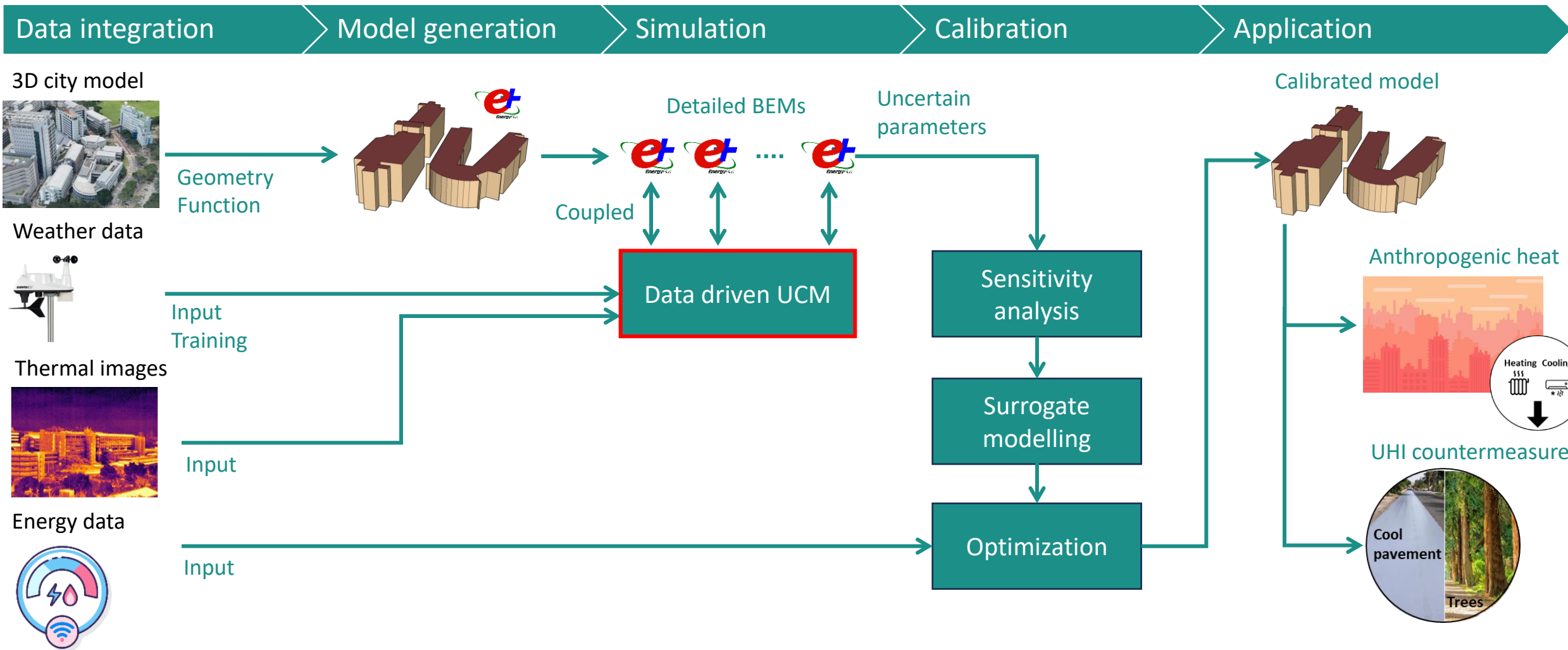
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in collaboration with Carnegie Mellon University, United States

Now    2030                                        2050

100 cities                                 All cities
in Europe                                  in Europe

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Building energy use

Outdoor conditions

MONDAY, MAY 23
27oC / 81F
14:35
Real Feel 25oC / 76F
Humidity 61%

Heating   Cooling

Cool pavement

Trees

Data extraction

Physics

Machine Learning

E=mc²

Modelling

Static   Dynamic

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## Physically-based approach

**Energy balance**

Oke et al. (2017)

**Low level of detail**
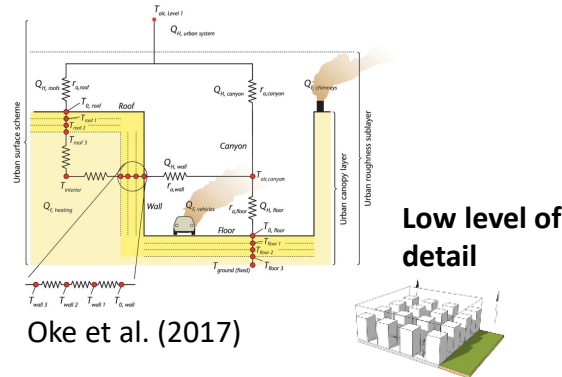
**Computational fluid dynamics**

Yap (2021)
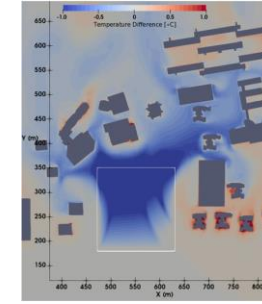
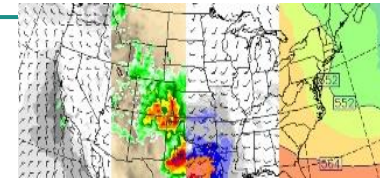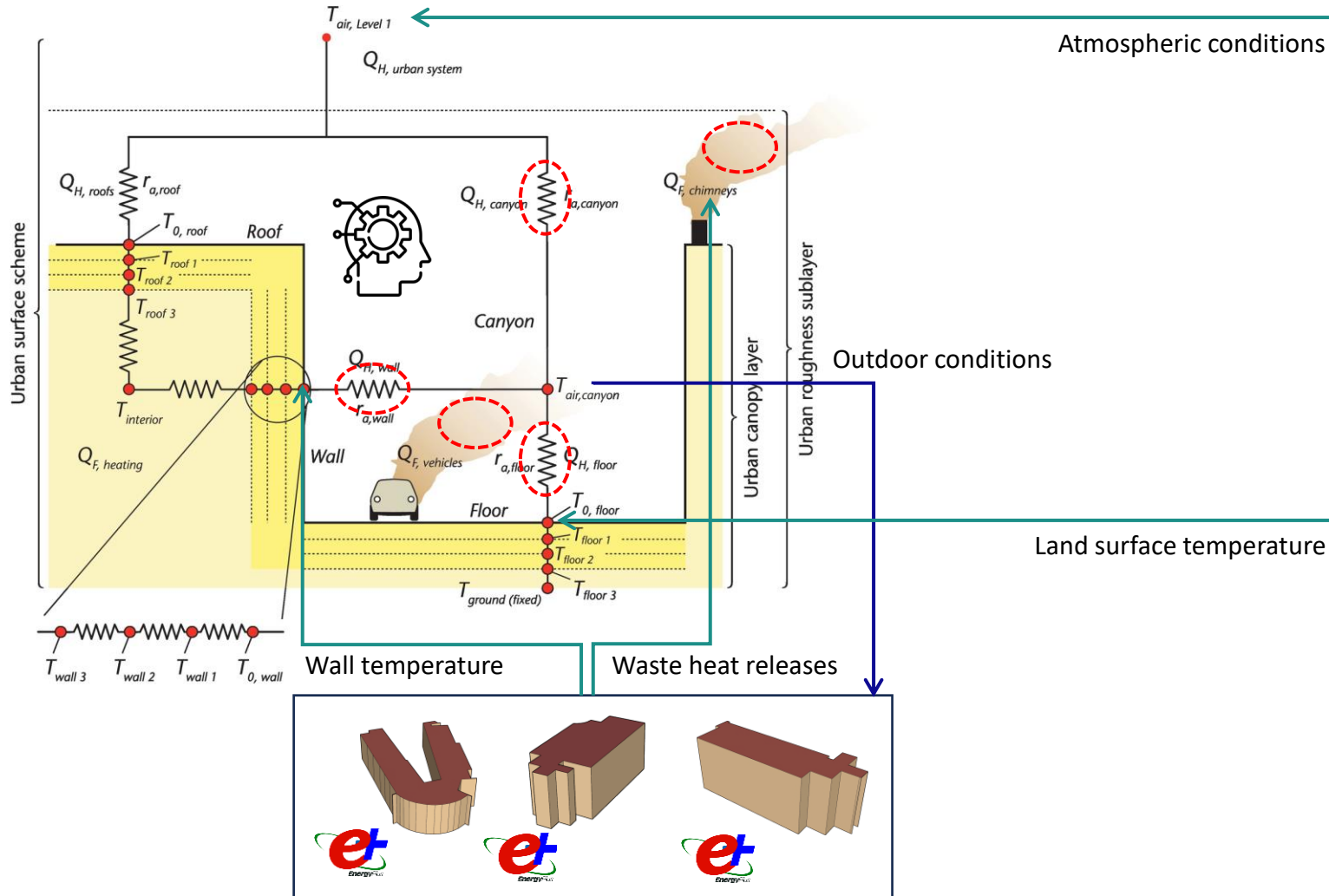**High computational cost**

## Data driven approach
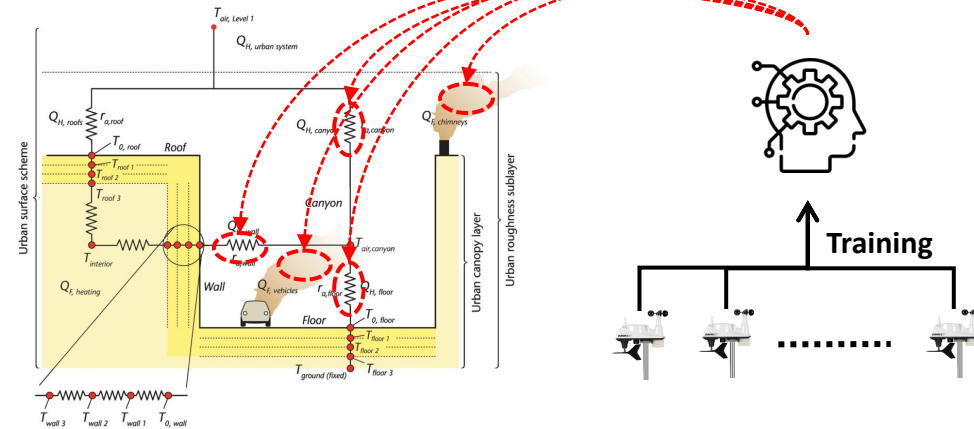
Training

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Atmospheric conditions

Climate model

Outdoor conditions

Thermal images

Land surface temperature

Wall temperature

Waste heat releases

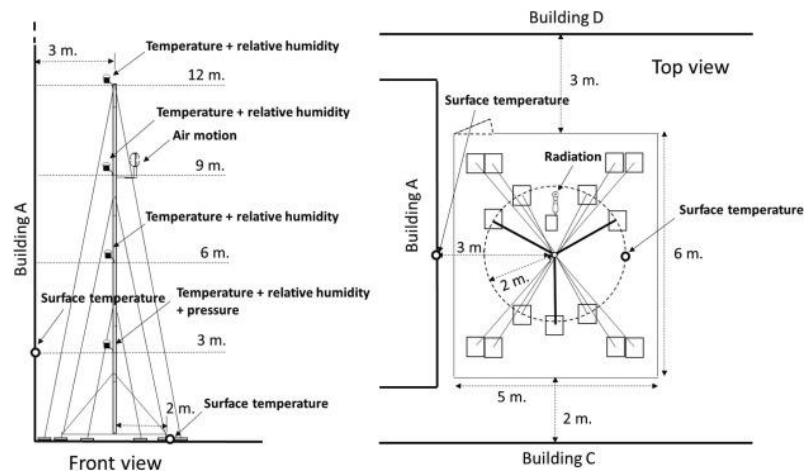Martin Fehlmann MIGUEL

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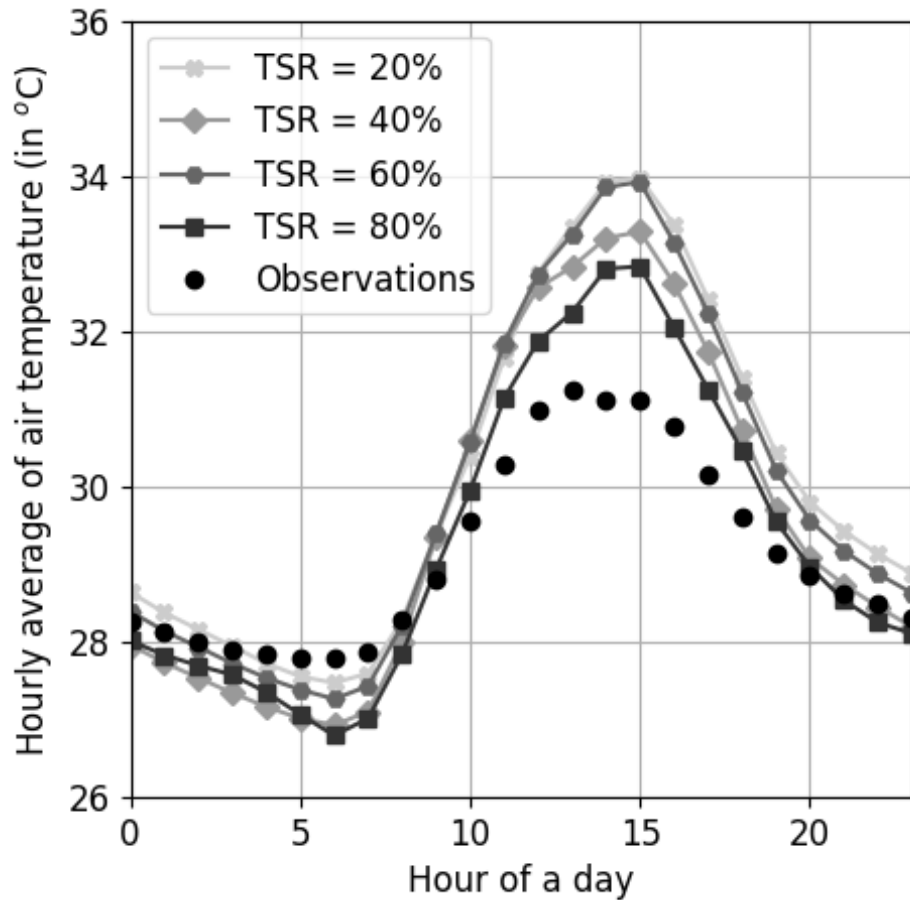
Singapore

NUS campus
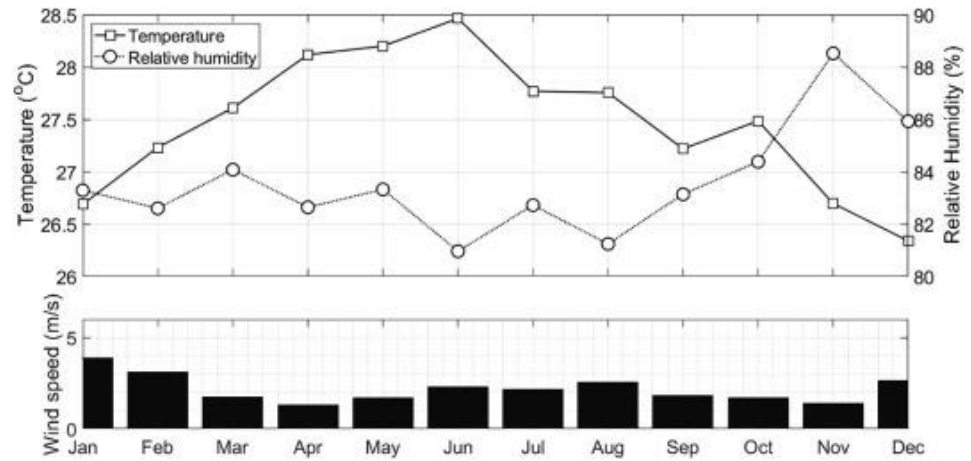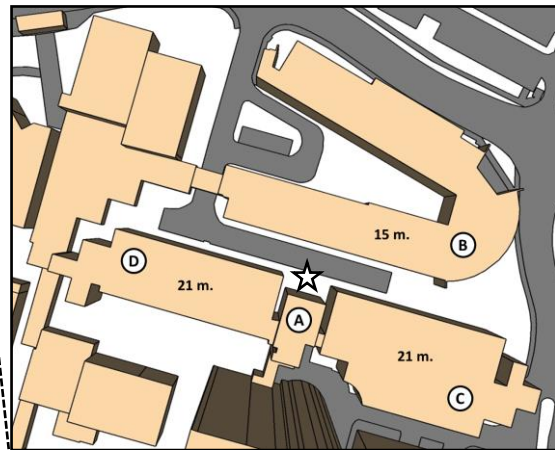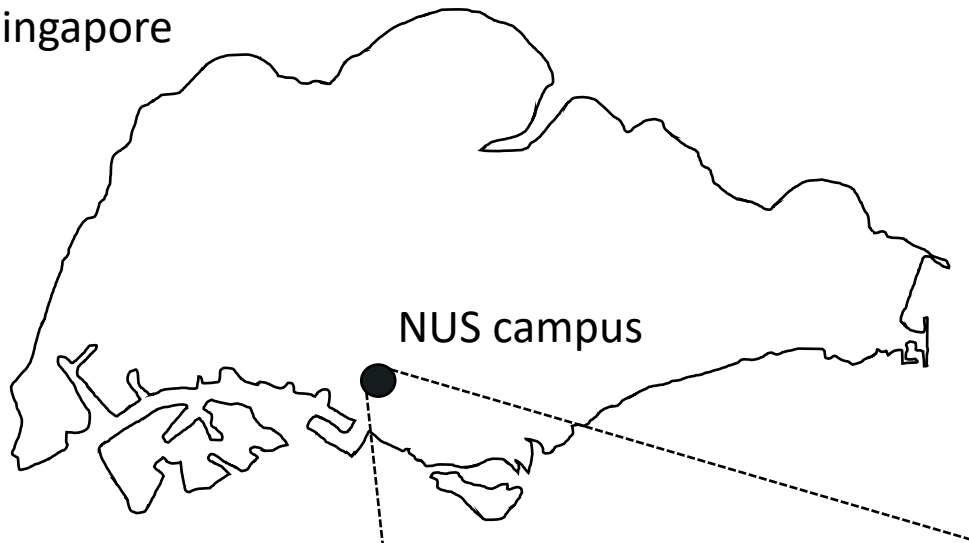
Miguel et al. (2021)

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| TSR | Temperature | | Humidity | | Size test samples |
|---|---|---|---|---|---|
| | RMSE (K) | MBE (K) | RMSE (g/kg) | MAE (g/kg) | |
| 20% | 2.24 | 0.93 | 6.80 | 5.90 | 8291 |
| 40% | 2.24 | 0.39 | 4.19 | 3.67 | 6219 |
| 60% | 2.31 | 0.80 | 5.46 | 4.76 | 4146 |
| 80% | 2.16 | 0.23 | 4.42 | 3.82 | 2074 |

TSR = Training Sampling Ratio

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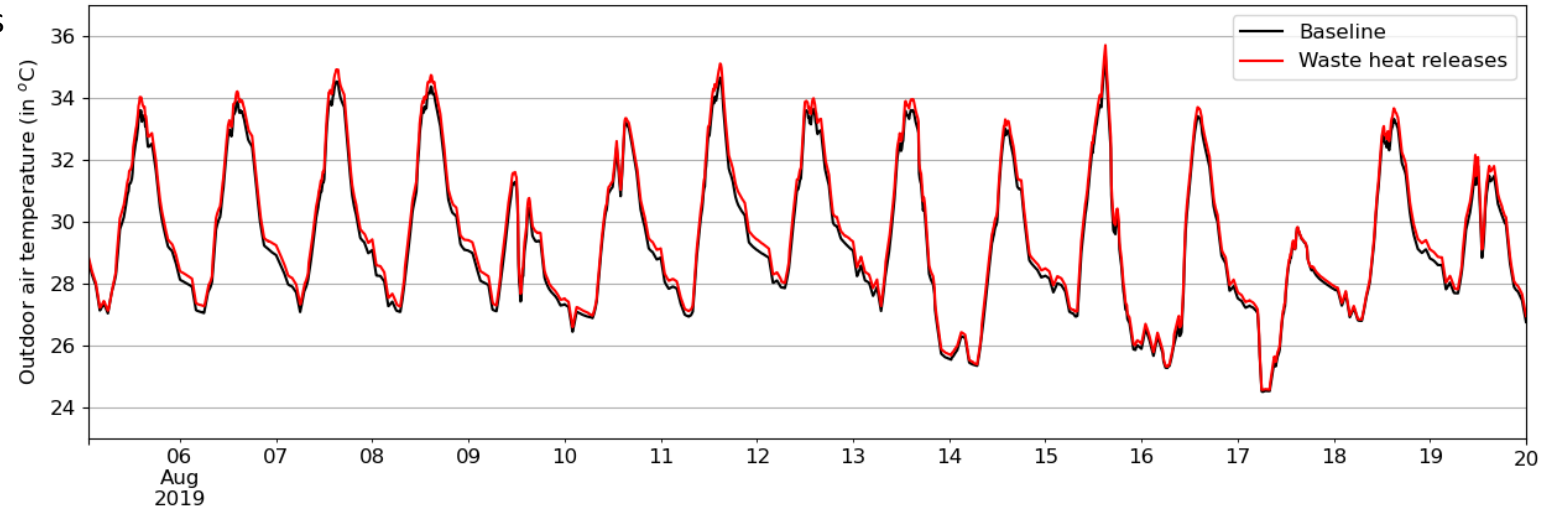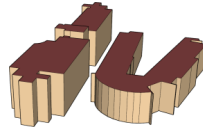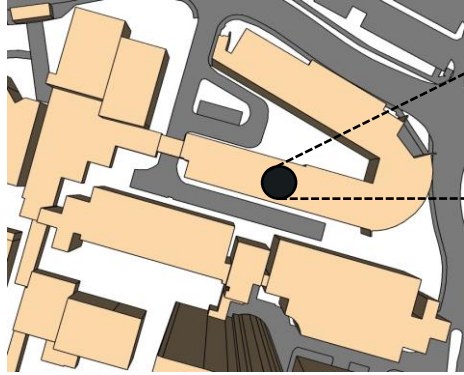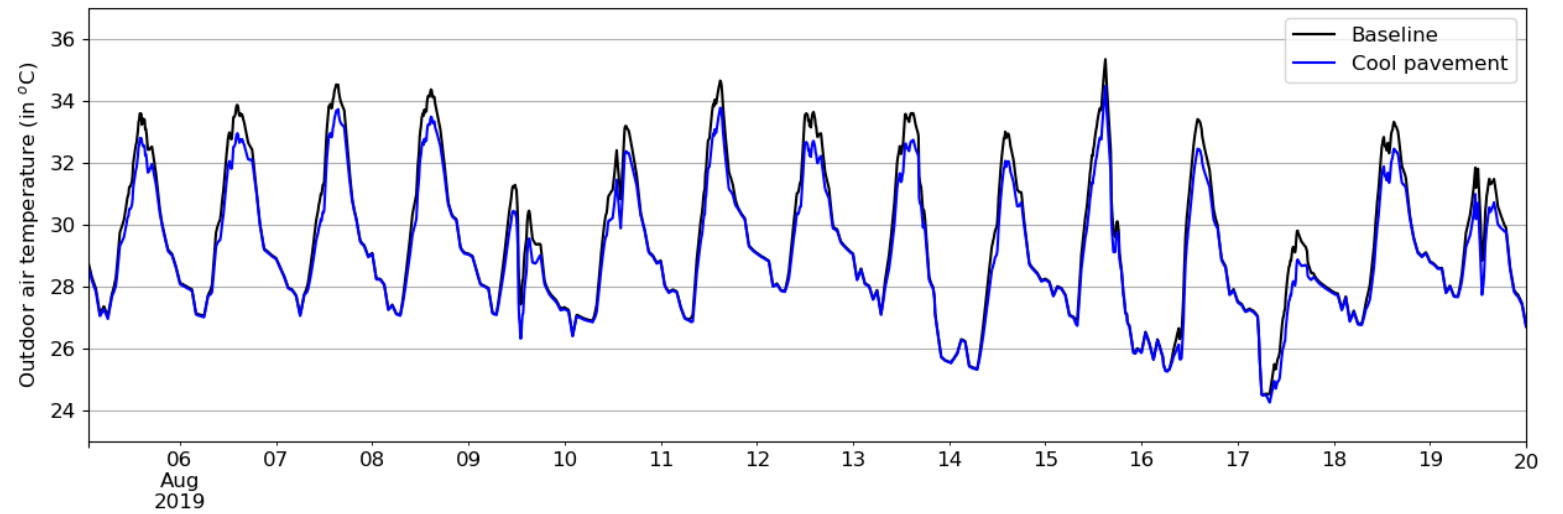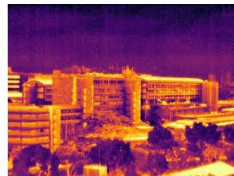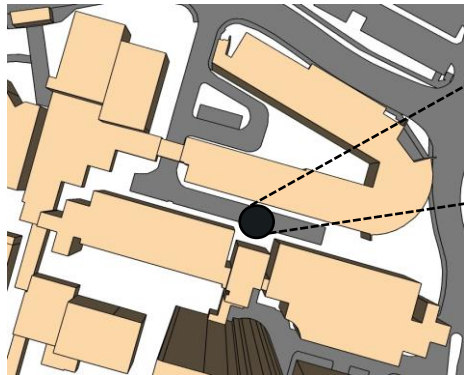
- A data driven urban canopy model can predict the outdoor air temperature with a similar accuracy than the CFD-based model of Miguel et al. (2021), but with a higher temporal resolution and considering urban geometry with a higher level of detail
- The model predicts the impact of waste heat releases and cool pavement
- The model can potentially consider more anthropogenic heat sources like traffic and countermeasures to UHIs like vegetation
- Interactions between buildings and outdoor conditions could be studied over a larger time horizon if the energy consumed by buildings was also evaluated by machine learning
- A full machine learning model to simulate interactions between buildings and the outdoor conditions could be of high importance to assess climate risk in a city

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