Efficiently Representing Thermal Processes in Urban Canopy Models

Mathew Lipson (UNSW) – m.lipson@unsw.edu.au
Melissa Hart (UNSW), Marcus Thatcher (CSIRO), Andy Pitman (UNSW)

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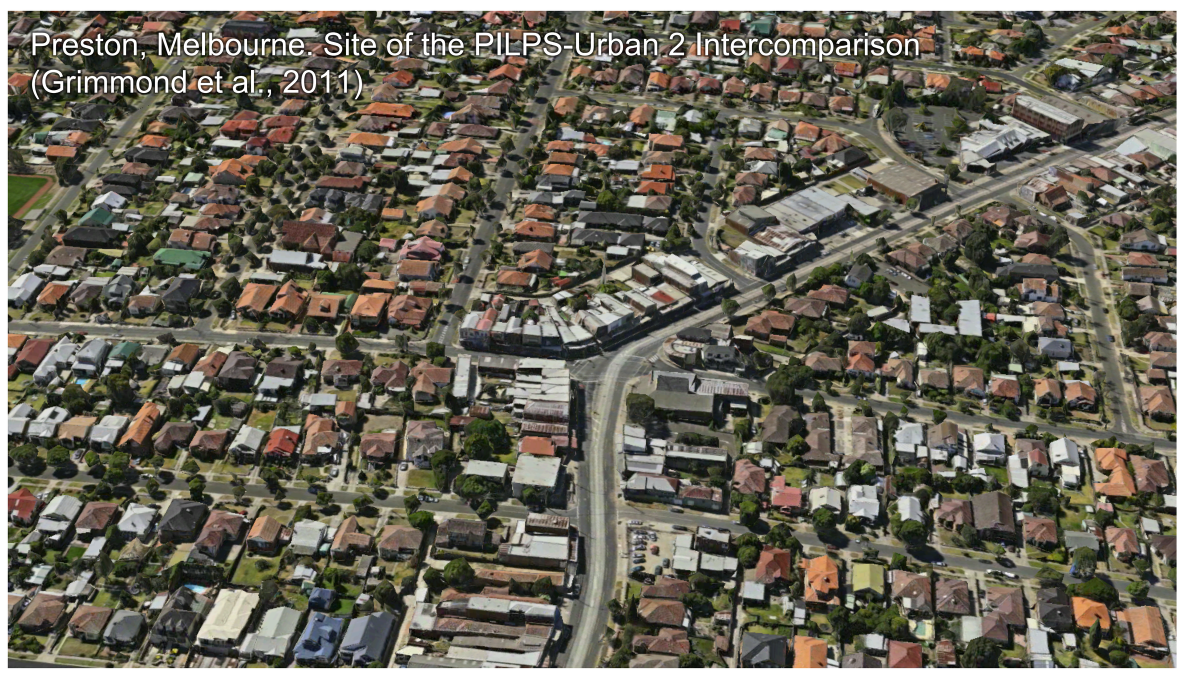
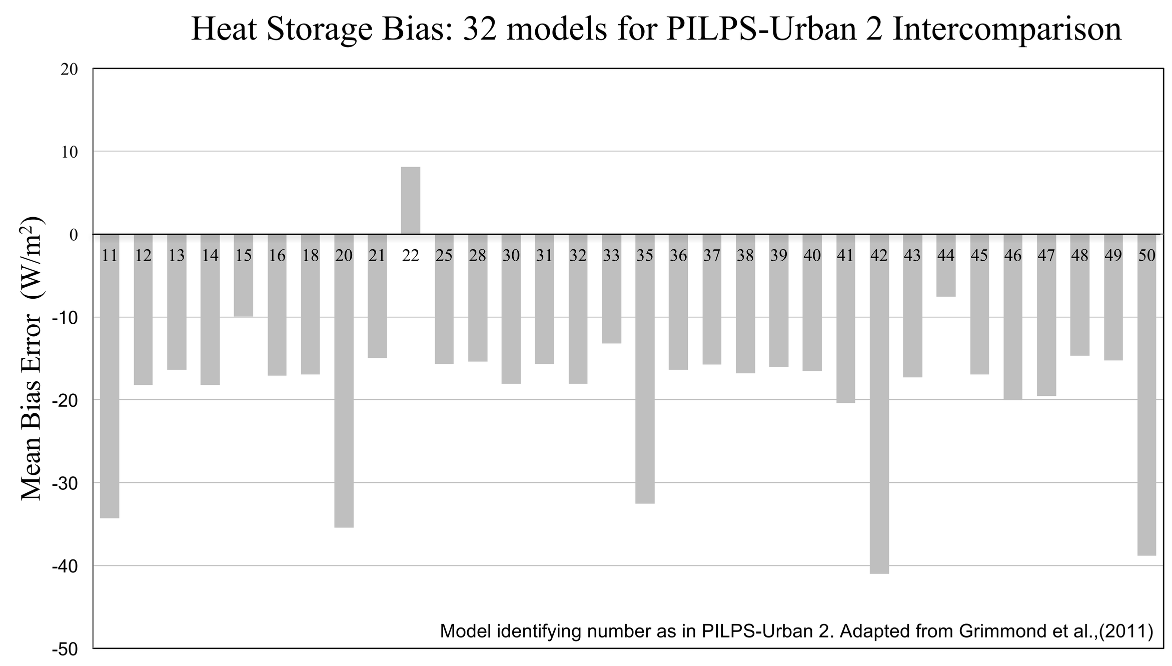


Background

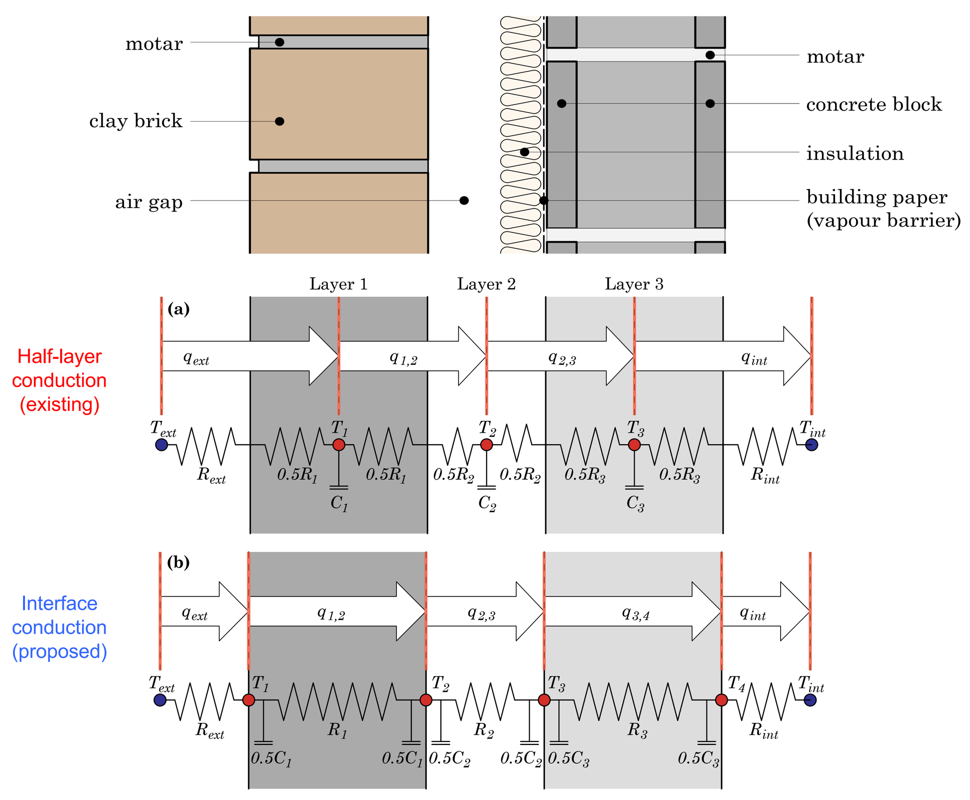
Models participating in the last urban intercomparison project significantly under-represented storage heat flux – why?

We are revisiting typical parameterisations in an urban canyon model to try to reduce heat storage flux errors and allow the use of more realistic wall/roof parameters.

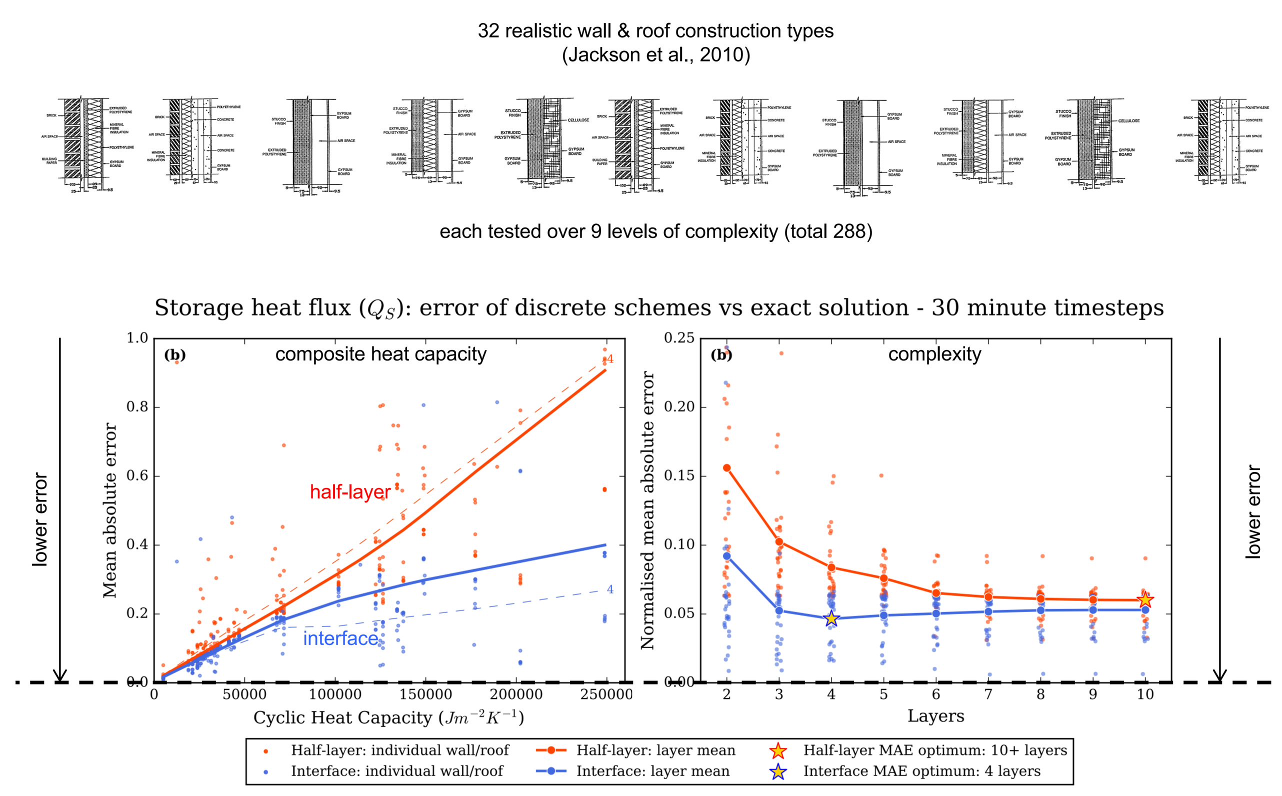


Part 1: New Interface Conduction Parameterisation

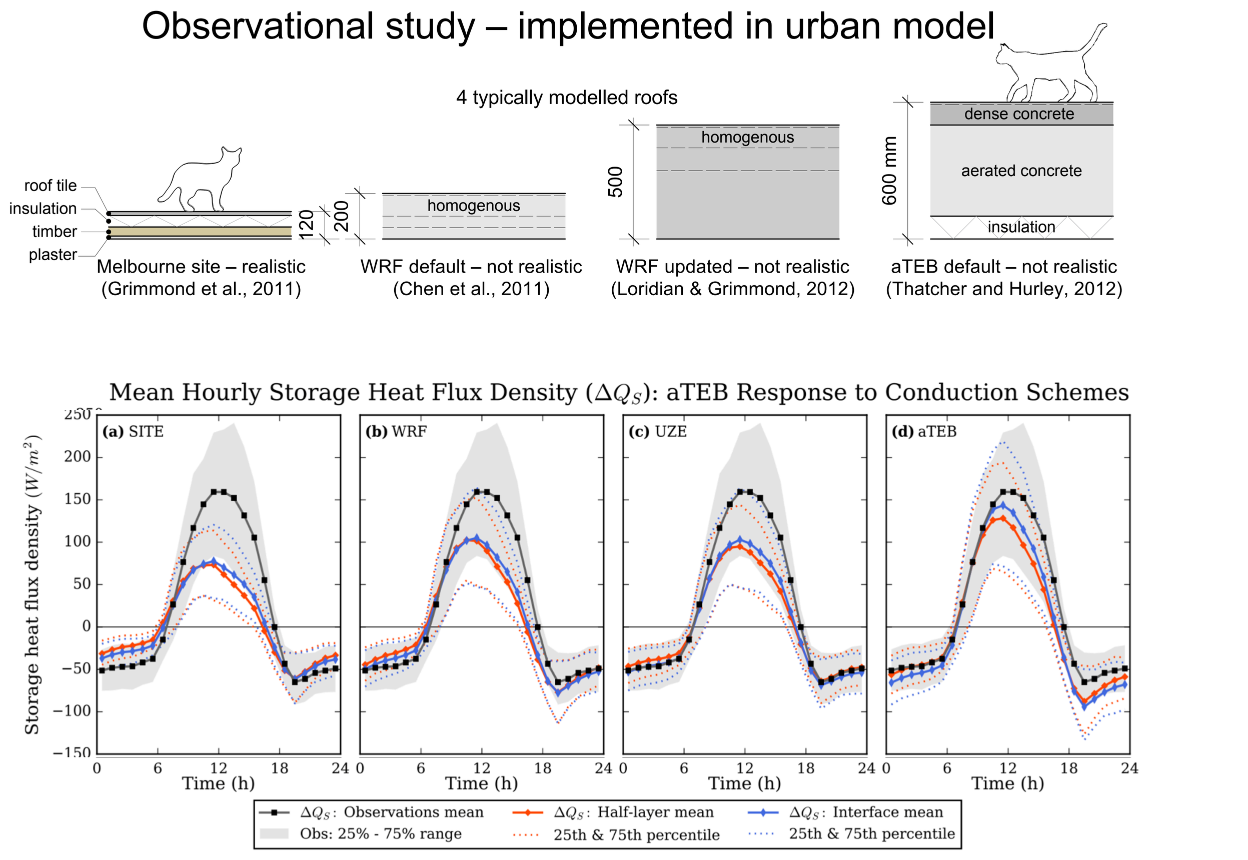
Two conduction schemes



Idealised study – conduction schemes vs exact solutions



Observational study – implemented in urban model

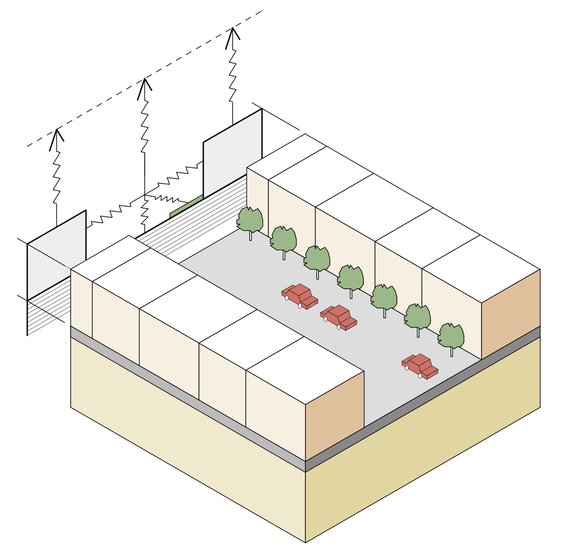


Lipson et al., 2016, Geoscientific Model Development Discussions (in review)

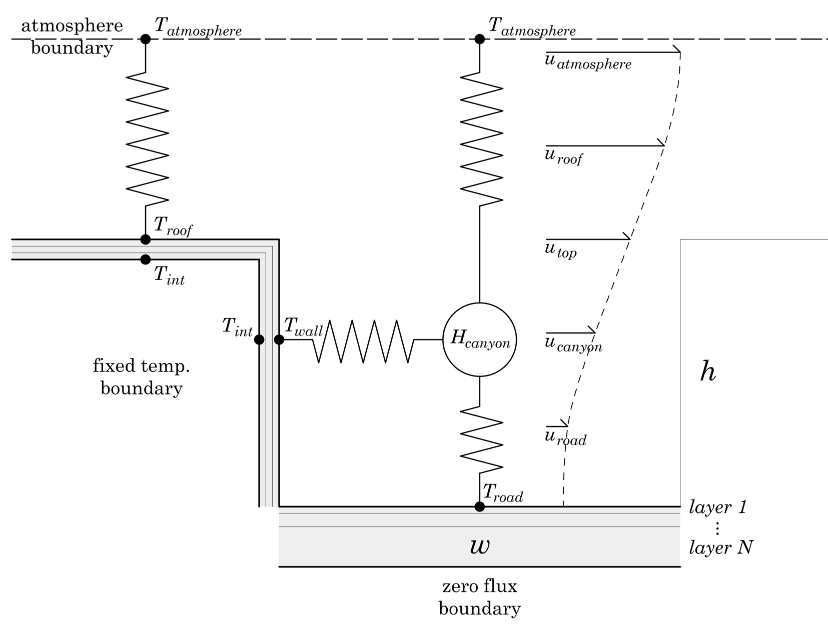
Conclusion: Interface scheme reduces heat storage errors compared with previous scheme, however storage still under represented, especially if using observed material parameters.

Part 2: Compare Aerodynamic Heat Transfer Parameterisations

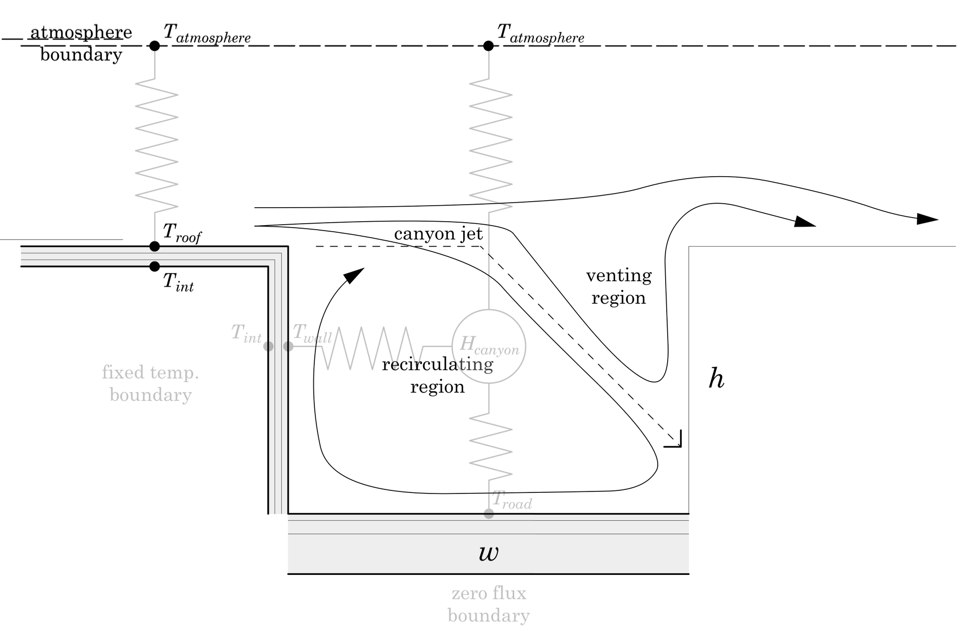
Using the Australian Town Energy Budget (aTEB) model (Thatcher & Hurley, 2012) …



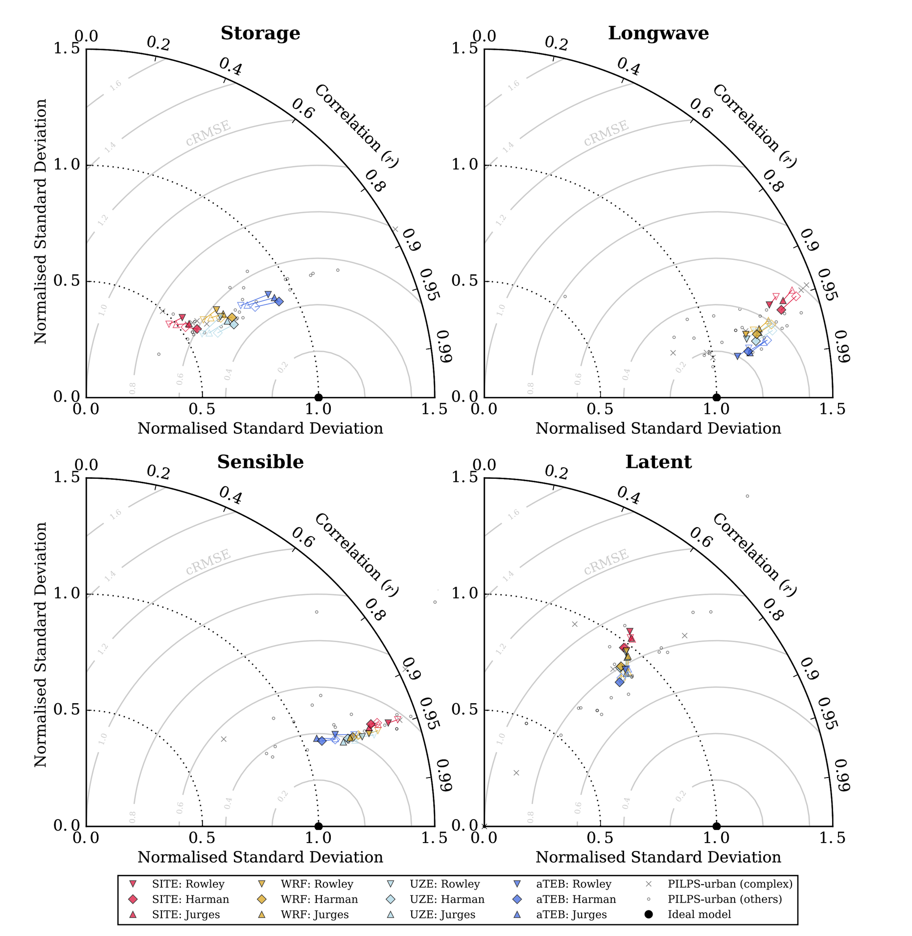
…we implement two common turbulent heat transfer schemes – the Jürges method (per Kusaka et al., 2001) and Rowley method (per Masson, 2000) …



…and compare with a less common turbulent heat transfer scheme – the Harmon method (per Thatcher and Hurley, 2012).

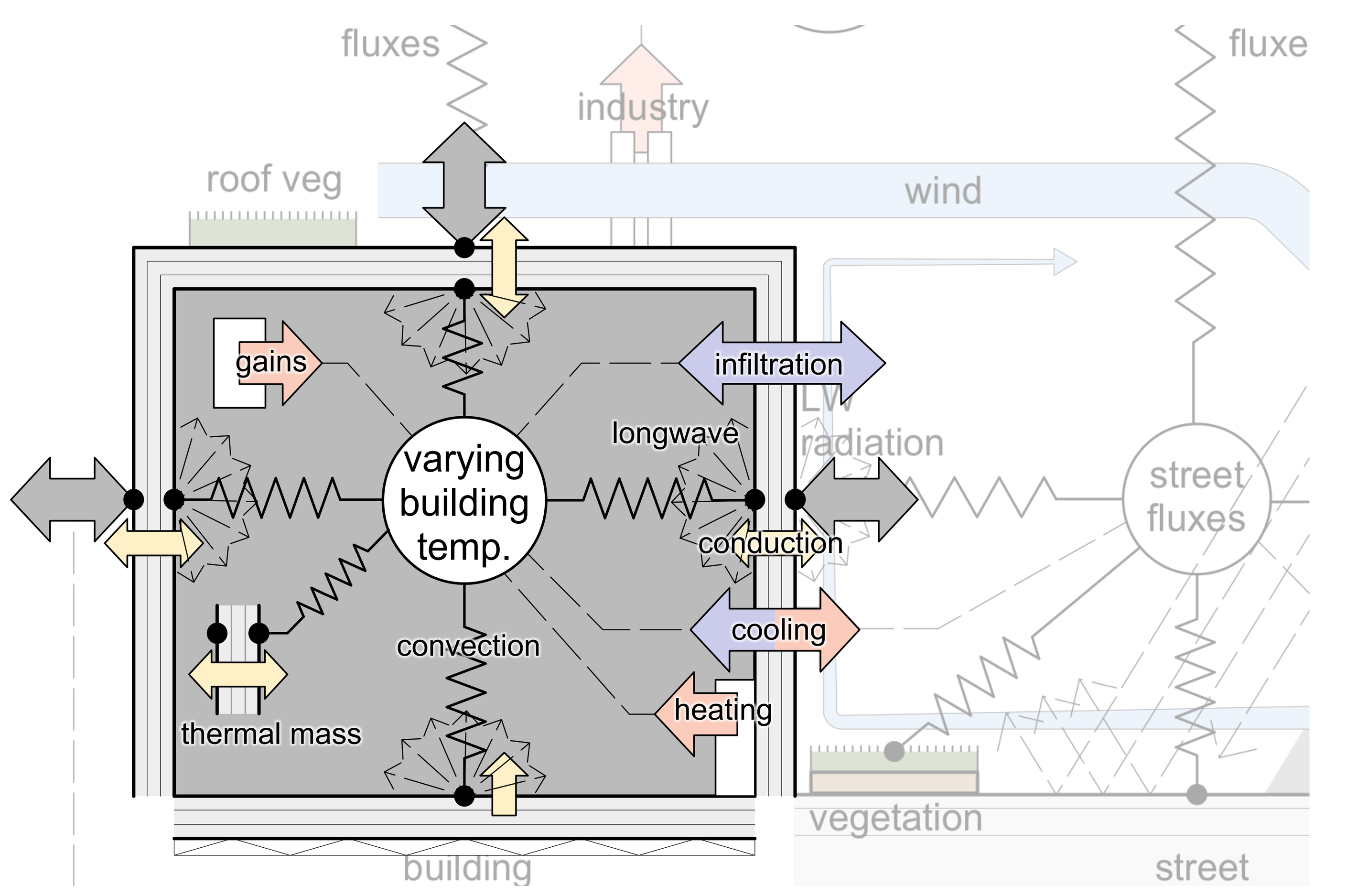


Taylor Diagram – response of fluxes to parameterisations



Conclusion: Harman scheme has overall best performance for this site, however groupings on Taylor diagram show material parameters and conduction scheme have bigger influence.

Part 3: Represent Internal Thermal Mass and Other Processes

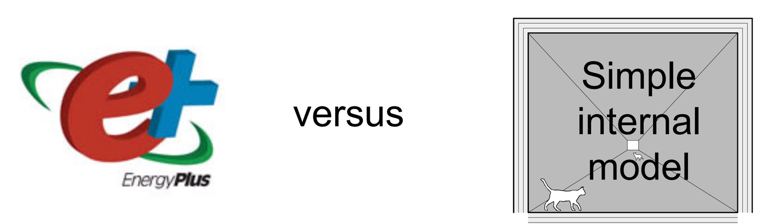


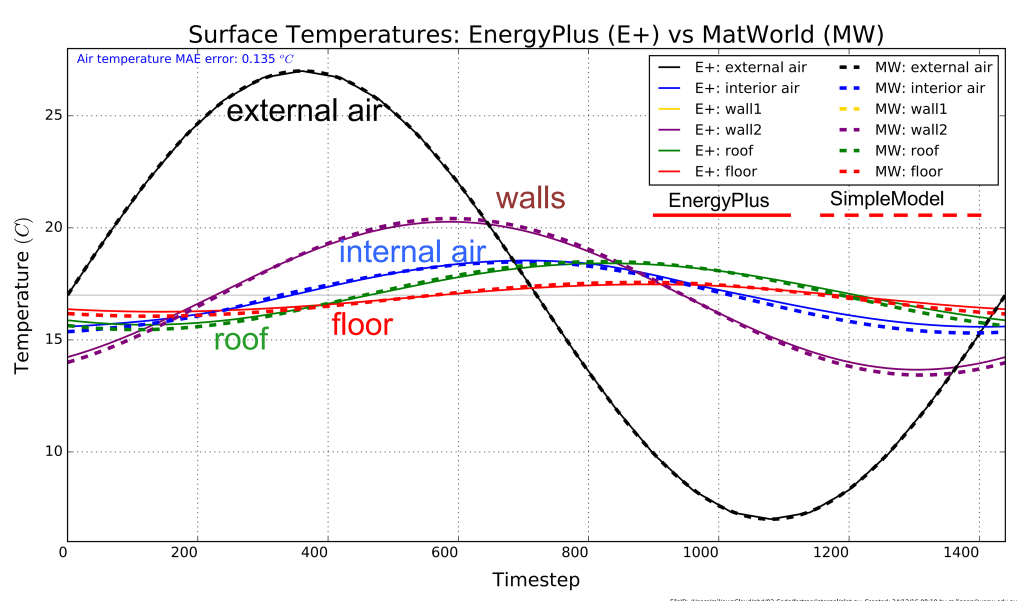
- aTEB currently represents the building envelope only. As such, for lowest model errors, roofs and walls need unrealistically high heat capacities.
- We are now adding internal thermal processes including internal mass to assess whether we can improve this.
- As each process is added, we compare output to the EnergyPlus building energy modelling system (DOE, 2016).

Work is ongoiong. Processes added so far:

- ☑ varying internal temperature (fully implicit)
- ☑ new conduction model (interface scheme)
- ☑ longwave radiation (infinite reflections)
- ☑ convective heat transfer (dynamic algorithm)
- ☑ internal mass (single block)
- ☒ internal heat gain
- ☒ infiltration
- ☒ heating and cooling

Internal surface and air temperature response





Preliminary Conclusion: Work still underway – so far simple internal model compares well with stripped down EnergyPlus 8.6 model.

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