Modelling variability of people's behaviour: time spent in different places in London

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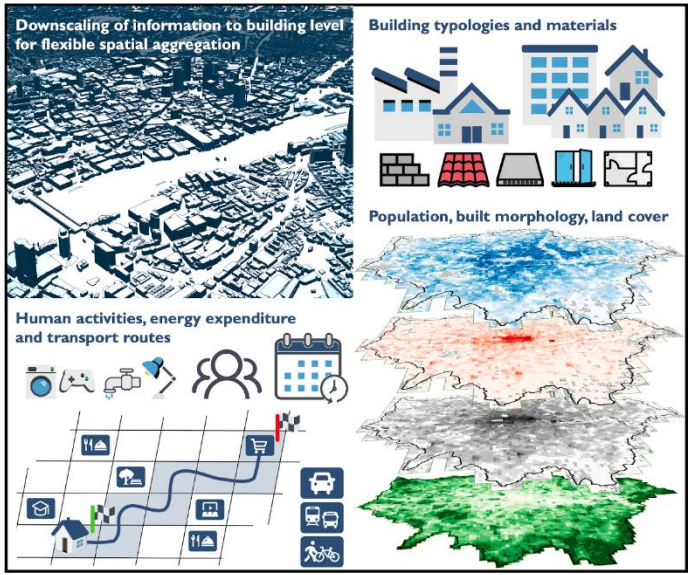
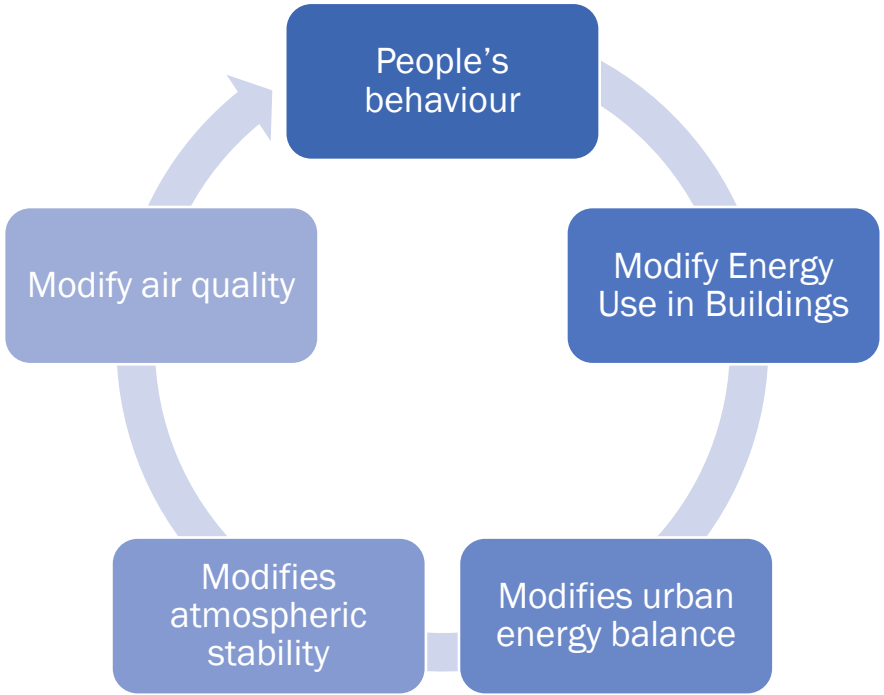


Research undertaken within NERC APEx (*Ben Barratt talk yesterday*), NERC ASSURE & ERC *urbisphere*

Introduction

Objective:

- to improve modelling of physical meteorological processes in urban areas by accounting for function
- to model how much time people spend doing different activities in different microenvironment (ME)



Approach to Model

People's behaviour:

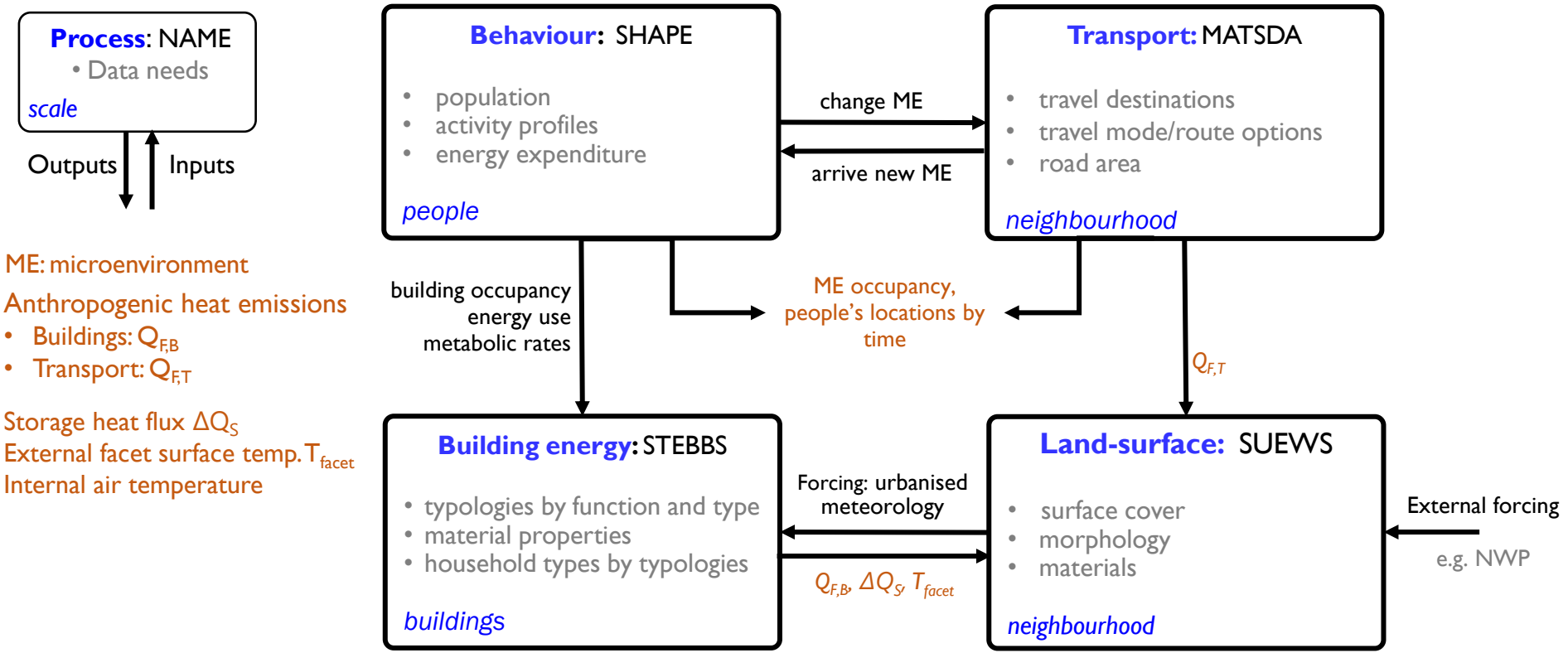
- Activities: cooking, exercising, working, travelling
- Location: outdoors, indoors, in homes, shops, offices etc.
- Vary with: demographics (e.g. age), time (e.g. within day, week)

Outputs include:

- Anthropogenic heat flux (Capel-Timms et al. 2020, *GMD*): Building energy, transport, metabolism
- Time spent in locations and ME

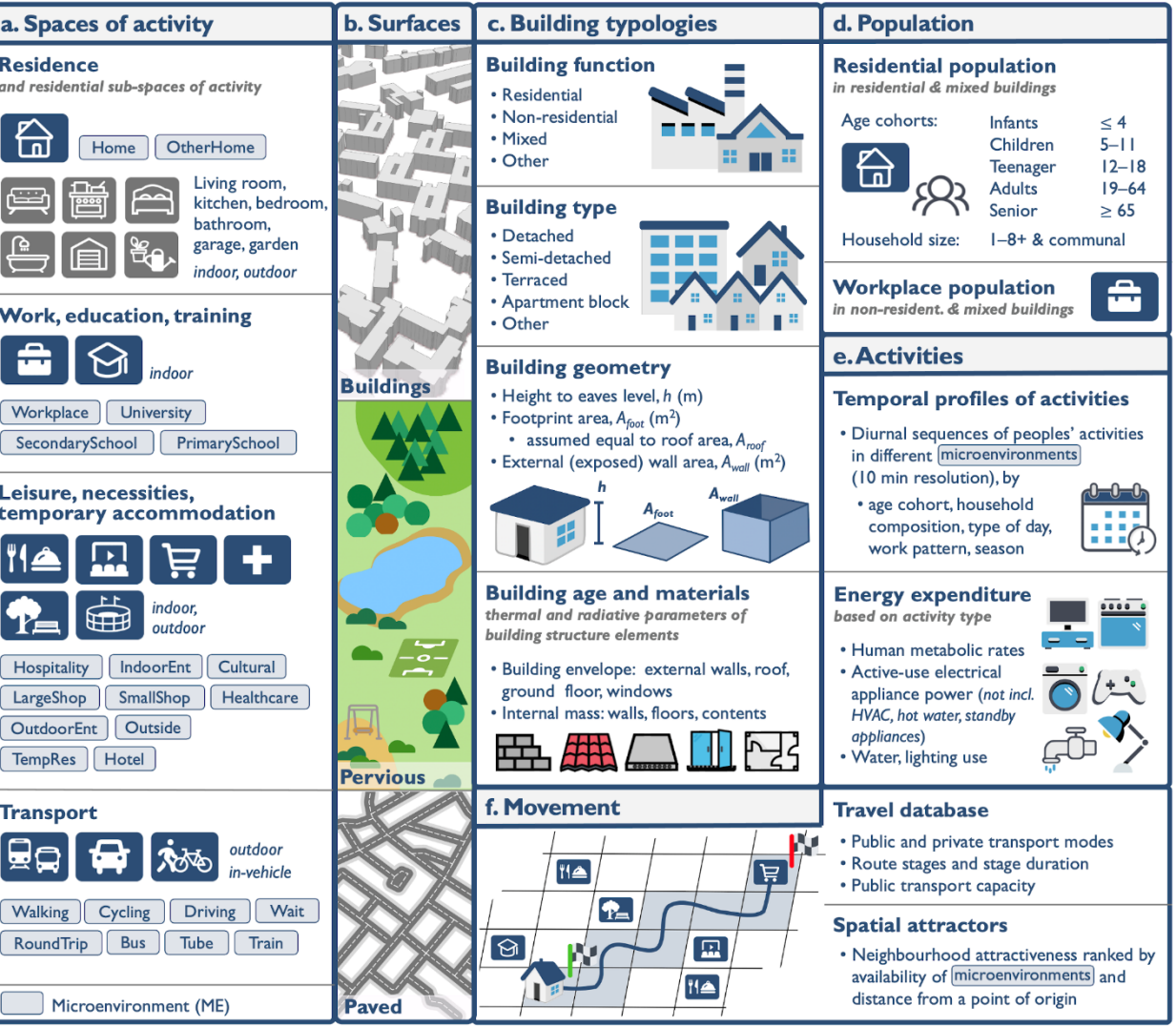
DAVE: Dynamic Anthropogenic actiVities and feedback to Emissions

Multi-scale model system



Many aspects of city varying

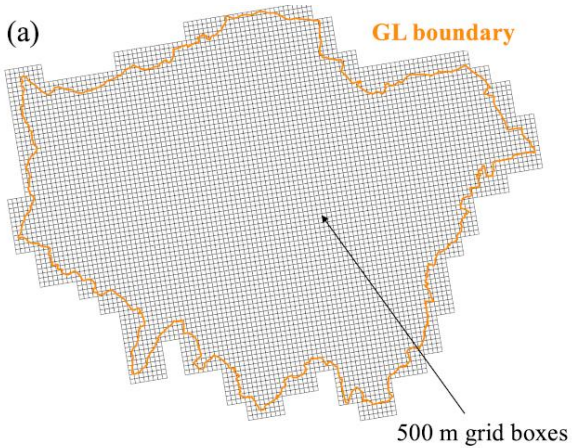
- Spaces of activity
- Land surfaces
- Building typologies
- Populations
- Activities
- Movement

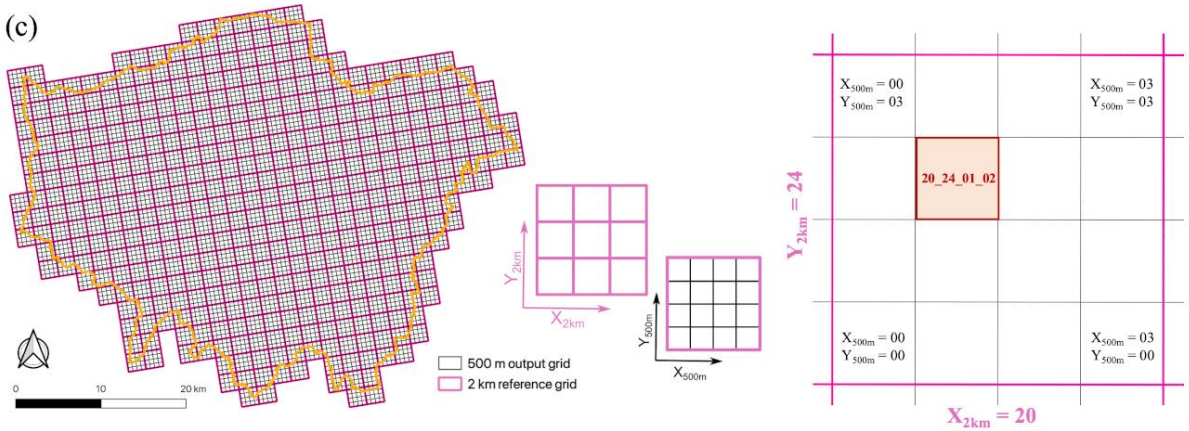


Hertwig et al. 2024: *in review*

Study area - London

- Mapping:
  - shown at 500 m x 500 m resolution
  - aligned with NAEI WRF modelling





Database development

MAPSECC: London

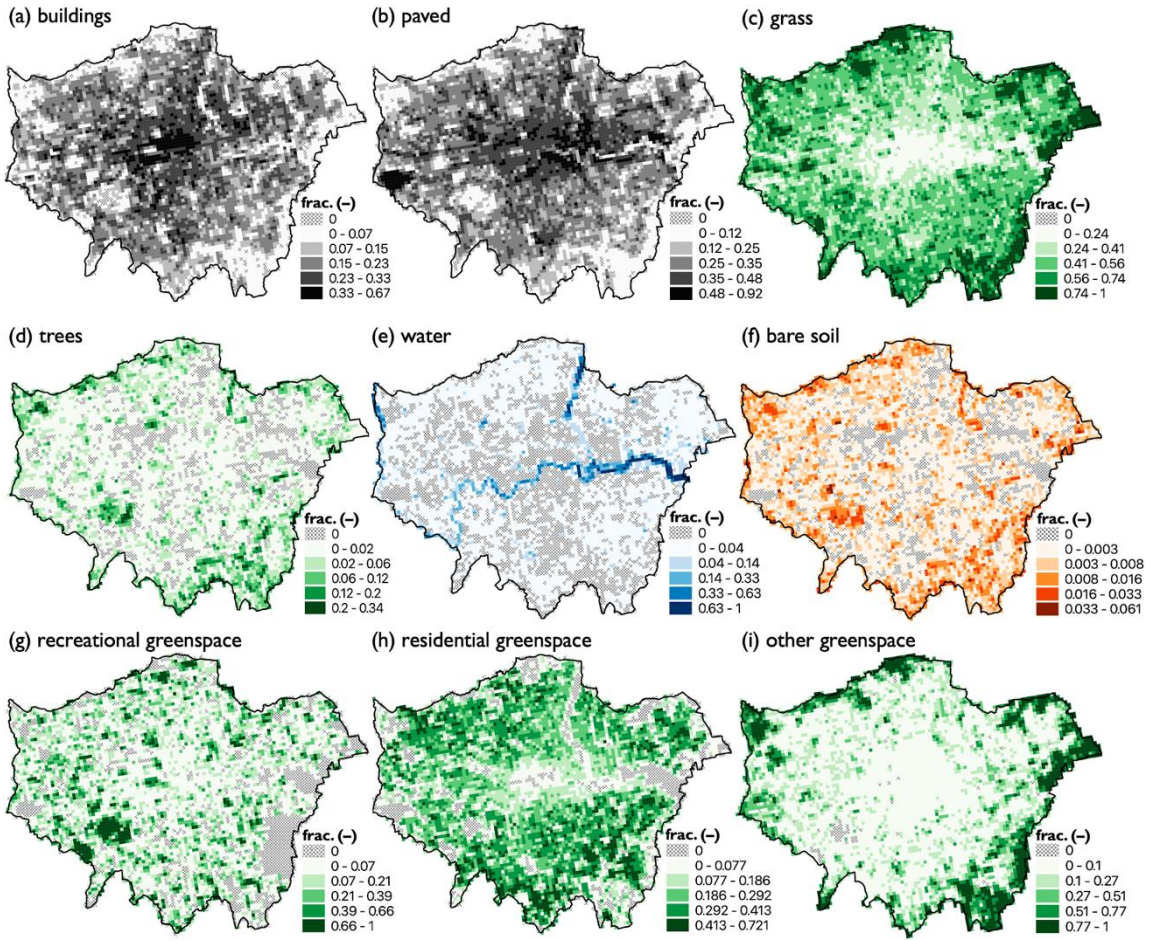
Multi-scale harmonisation **A**cross **P**hysical and **S**ocio-**E**conomic **C**haracteristics of a **C**ity region

Hertwig et al. 2024*: in review*

Land-surface: SUEWS

- surface cover
- morphology
- materials

neighbourhood

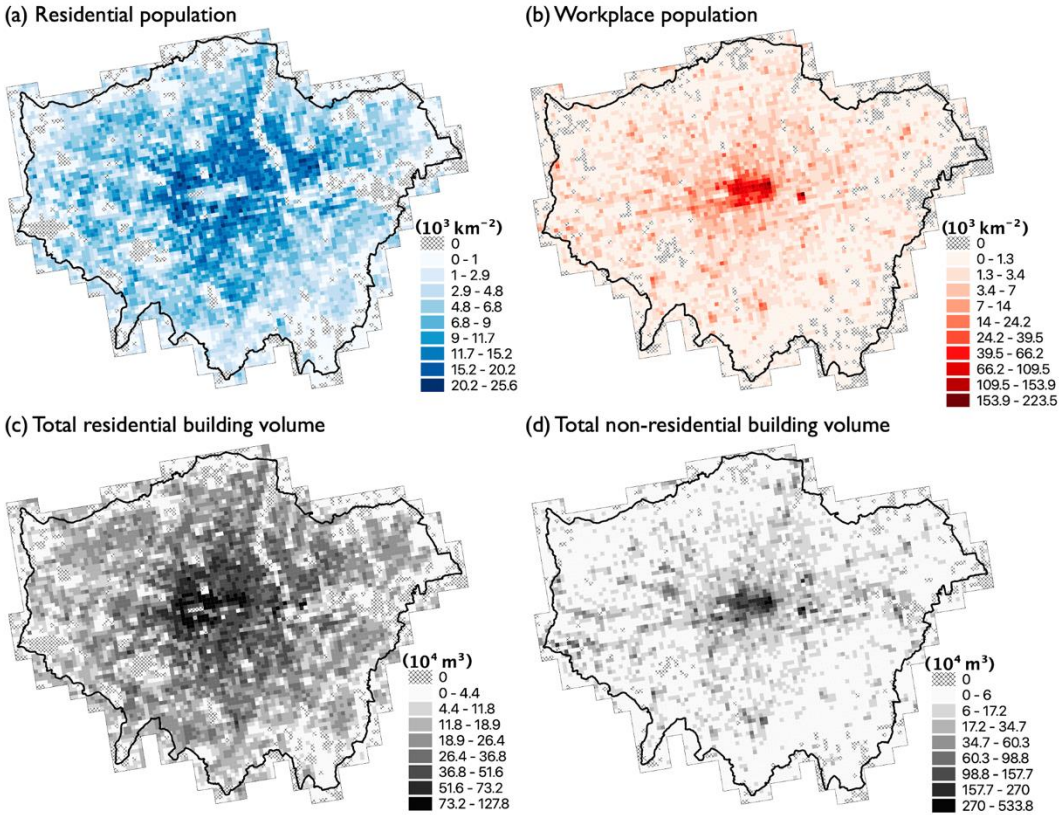


MAPSECC: London

- Where people are
- Where different types of indoor activities occur

Home

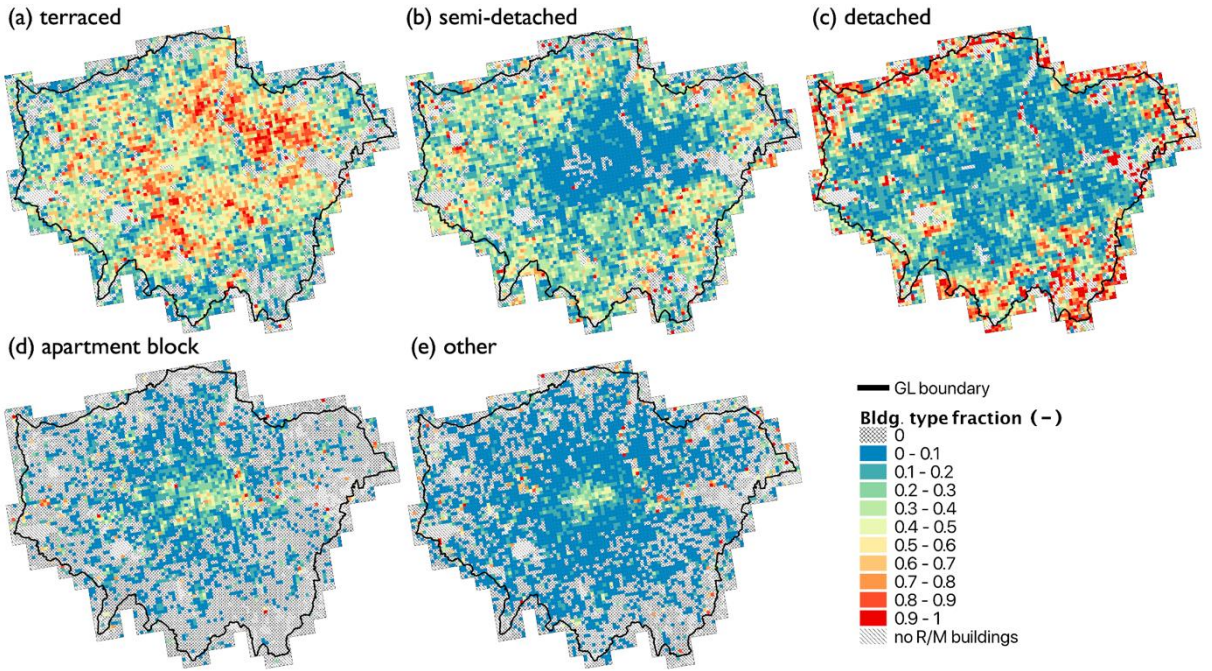
Work



MAPSECC: London

Residential building types differ

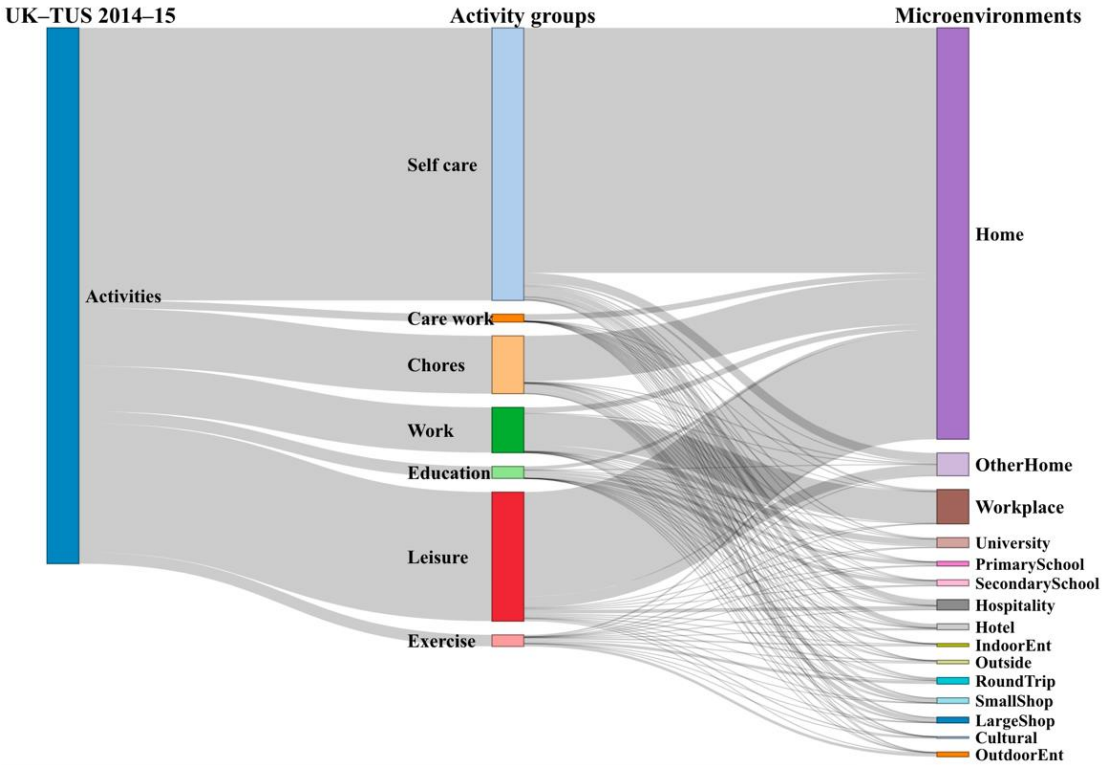
Simulated citizens
- assigned to different home building types
  - constrained by census data



Time Use Survey (TUS) Gershuny and Sullivan (2017)

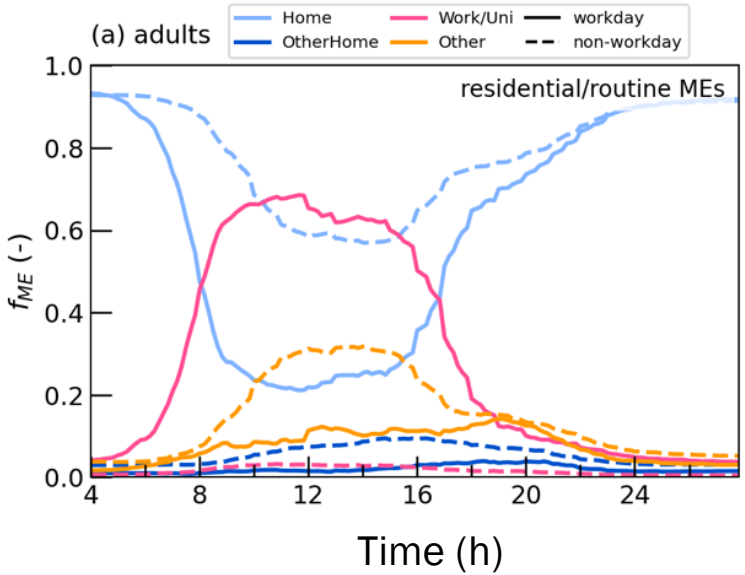
- Timestep: 10-min
- Age groups
- Household sizes
- Day types
- Seasons

TUS activities mapped to Activity Groups ME

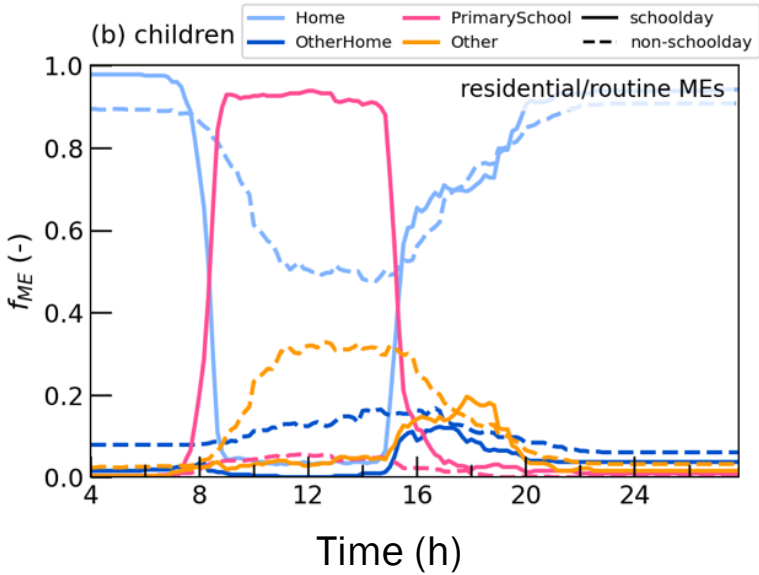


People spend their time in different locations: varies with age, day type, time of day

Adults: age 19–64



Children: age 8–11

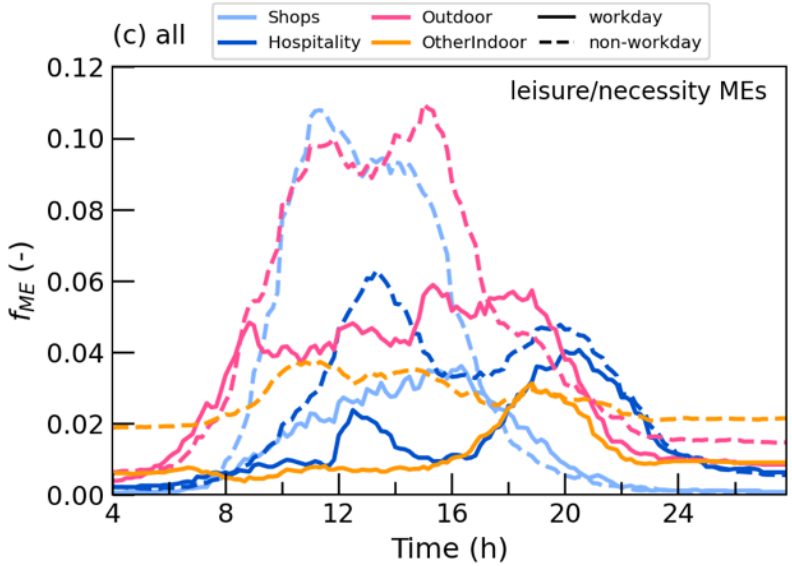


- Day type
  - Workday
  - Non workday

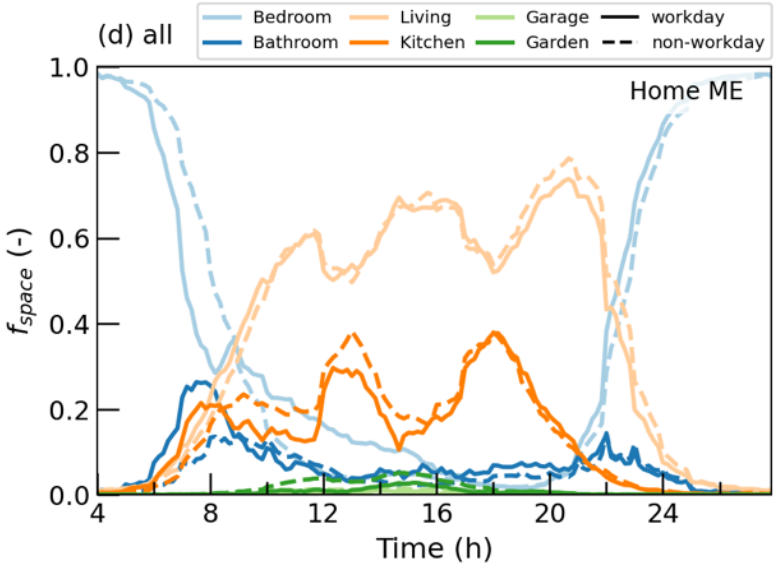
MAPSECC: London

- Activities in different Microenvironments

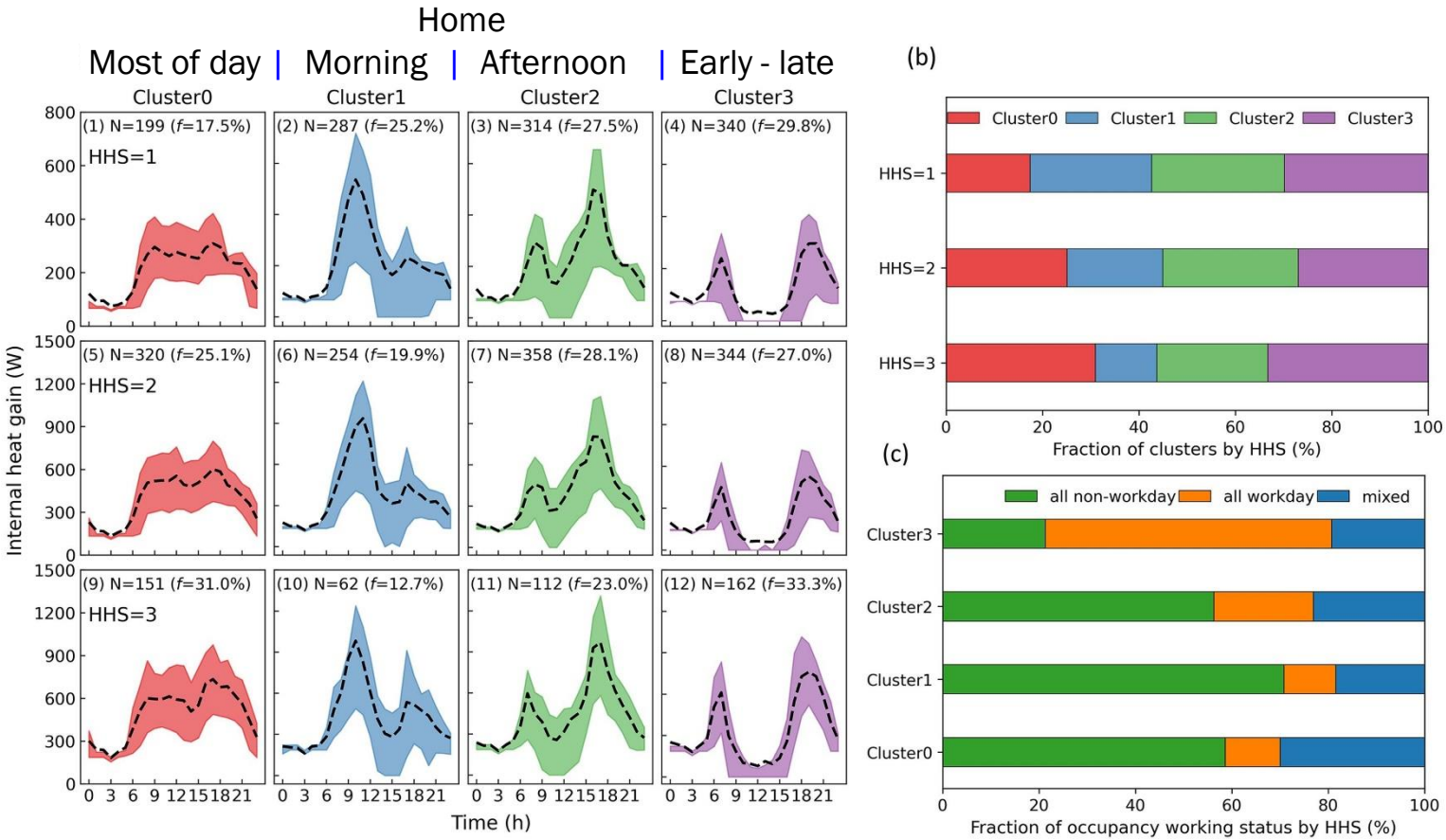
Necessity & leisure activities



Home ME



Behaviour differs by household size (HHS)



Liu *et al.* 2024 Energy and Buildings https://doi.org/10.1016/j.enbuild.2024.114668

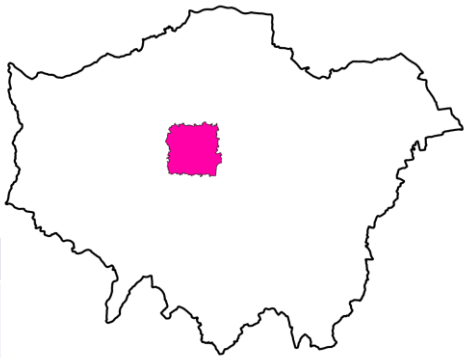
Model simulations

- Assess impact of travel decisions on time spent
  - by age group:
    - by mode of travel
    - at home

Group	Population (%)	Age (years)
Children	6	5-12
Teens	7	13-18
Adults	76	19-64
Seniors	11	65+
Total #	332,065	

Winter workday residents of central area of London (they can leave the area)

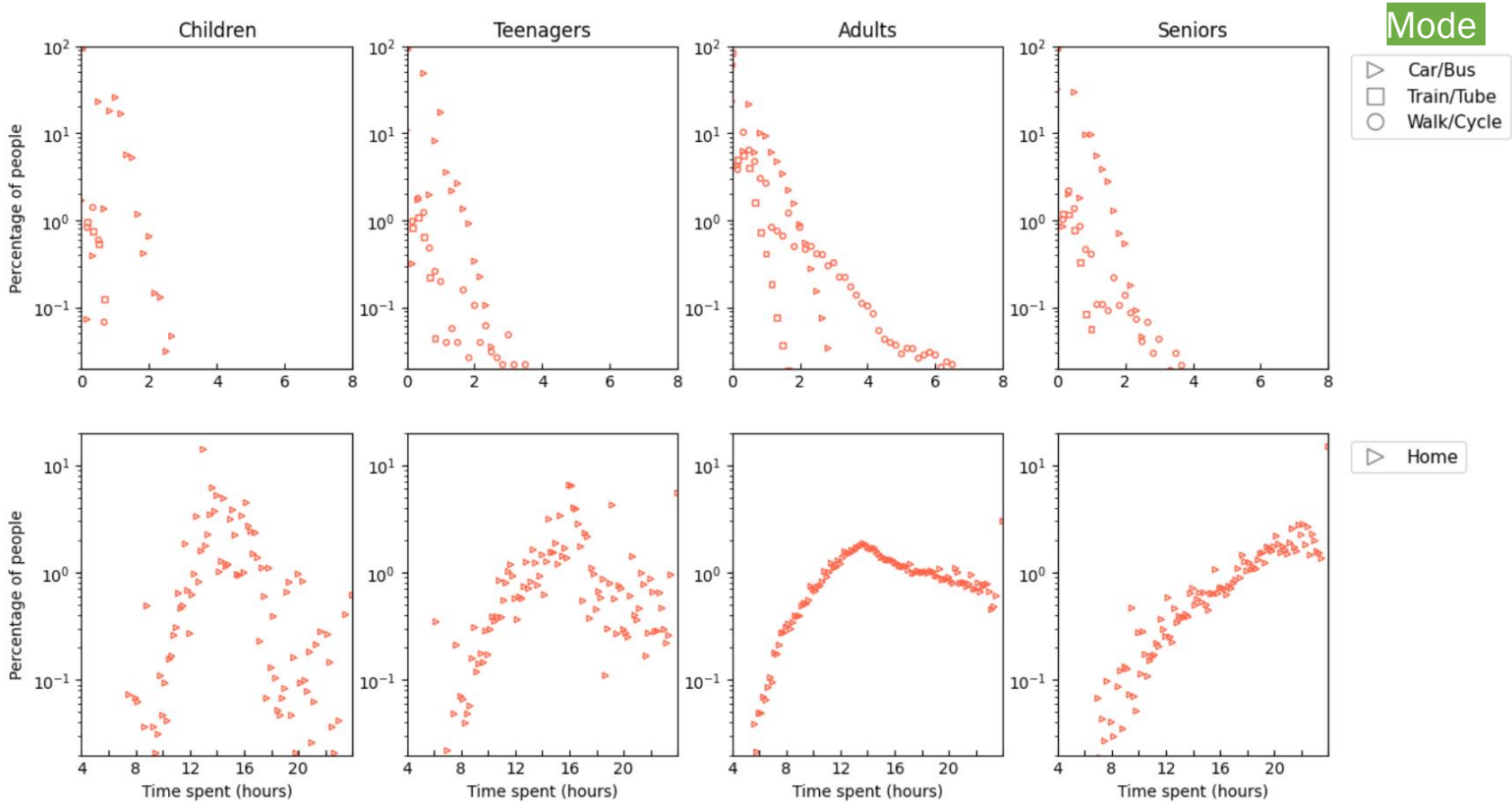
grids 119 0.5 km x 0.5 km



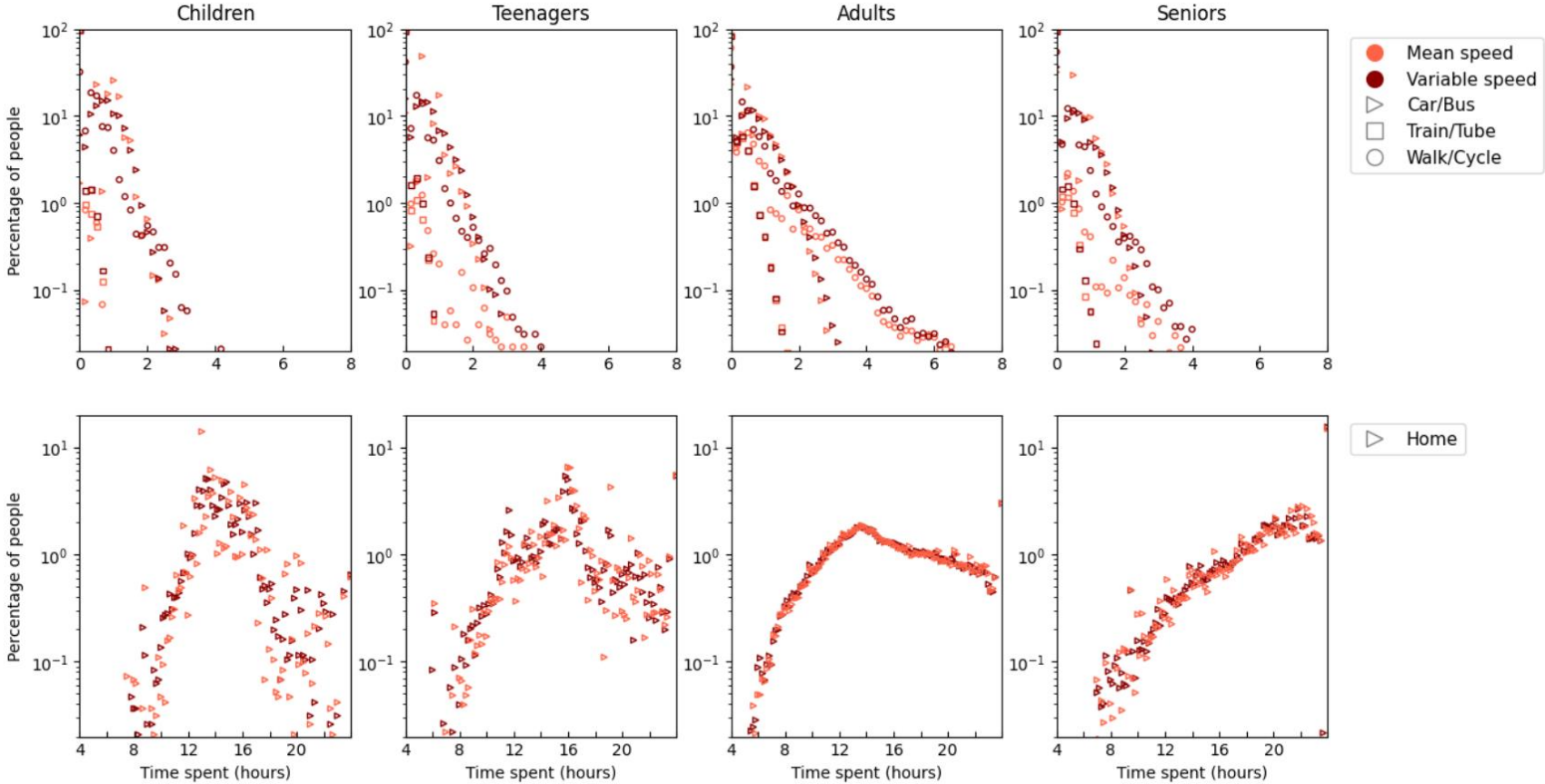
- People can use multiple modes to reach a destination
- Commute mode to/from work: same if available each day for an individual

Travel mode	walking	cycling	bus	Driving	train	tube
Speed: Average	constant	constant	Δ timetable	Same all day Δ by road type Δ by location	Δ timetable	Δ timetable
Speed: Variable	constant	constant	Δ timetable	Δ w/time of day	Δ timetable	Δtimetable
Fastest	Depends on route					
Slowest	Depends on route					
Most expensive	6	5	4	1	2	3
Cheapest	1	1	2	3	2	2

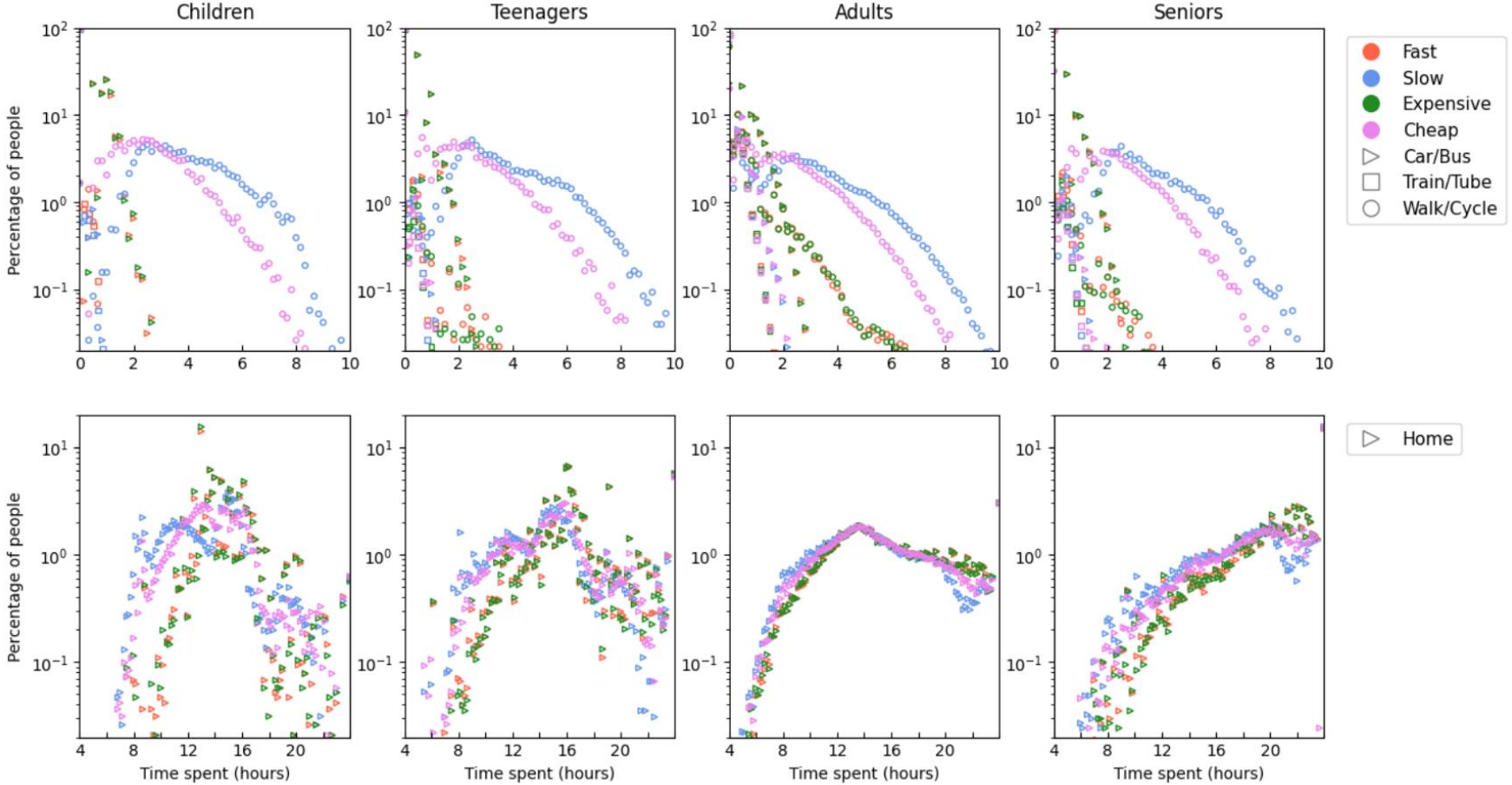
Fastest route chosen



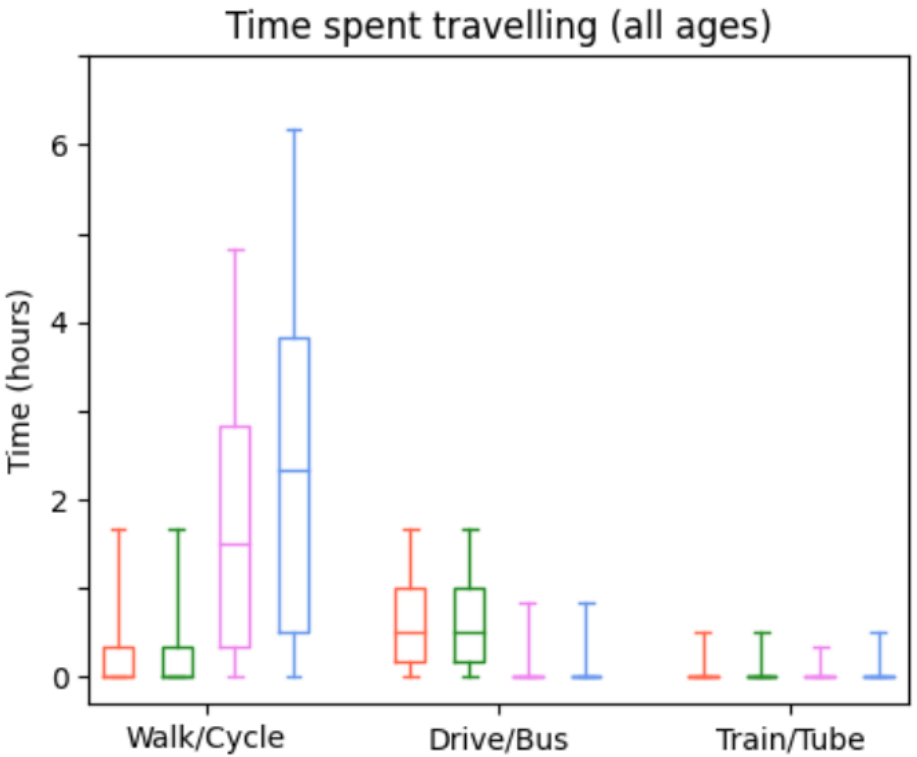
Impact of variable speed on mode choices

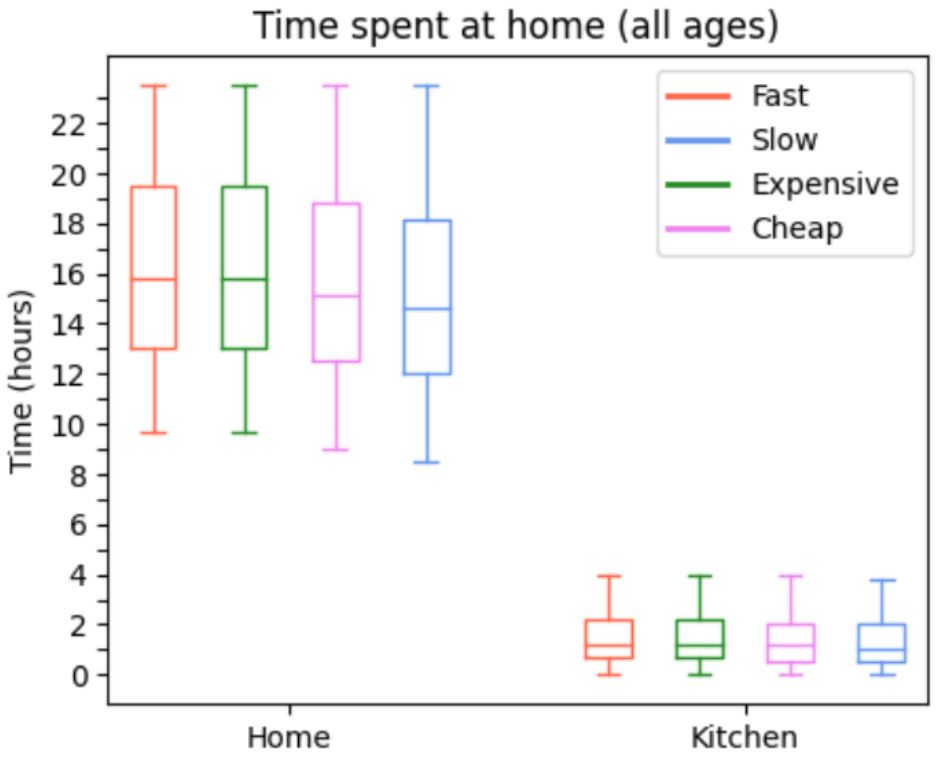


Impact of transport choice on time spent travelling and at home



Whole area


Time spent travelling (all ages)
Time (hours)
0
2
4
6
Walk/Cycle
Drive/Bus
Train/Tube


Time spent at home (all ages)
Time (hours)
0
2
4
6
8
10
12
14
16
18
20
22
Home
Kitchen
Fast
Slow
Expensive
Cheap

Final Comments

- DAVE
  - allows human activities to influence urban physical meteorology
    → inform air quality simulations
  - allows assessment of time spent in different locations and microenvironments by individuals
    → inform exposure assessments
  - allows what if experiments to be conducted