Indoor AQ in Greater Manchester Homes and Homes Built to Future Standards

Thomas Bannan

Future Homes Team: Will Swan, Navaneeth Thamban, Rongrong Wu, Hugh Coe, Richard Fitton, Grant Henshaw, Gordon McFiggans, Mike Shaver, Maria Sharmina & many more

RESPIRE Team: Lucy Higgins, Congbo Song, Kirsty Vincent, Martin Clift, Cathy Thornton, Edward Johnstone & many more

CF Hub Team: Alexander Horsley, Sharon Weinberg, Gordon McFiggans & many more

INGENIOUS/HIP-TOX Team: Yunqi (Rikki) Shao, Aristeidis Voliotis, Dawei Hu, Gordon McFiggans Jacky Smith, Huda Badri, Simon O'Meara & many more

UoM Indoor AQ Work

The University of Manchester

Future Homes

Understanding IAQ in
Future Standard Housing
and in future environments

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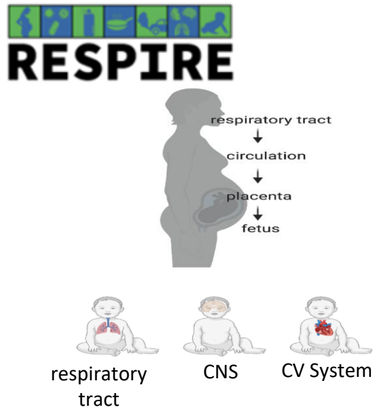
Understanding IAQ in Future Standard Housing and in future environments



RESPIRE

Relating Environment-use Scenarios in Pregnancy/Infanthood and Resulting airborne material Exposures to child health outcomes

CF Hub

Integrated Research Observation System for Clean Air

Ingenious

UnderstandING the sourcEs, traNsformations and fates of IndOor air pollUtantS

HIPTOX

Hazard Identification Platform to Assess the Health Impacts from Indoor and Outdoor Air Pollutant exposures

Indoor air quality in homes

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Lots of sources…

Lots to understand…

Total sample: 100

Commercial low-cost sensor (AirGradient)

- Carbon dioxide (CO_2)
- Particulate matter (PM)
- Total volatile organic compounds (TVOCs)
- Temperature
- Relative humidity

Questionnaire

- Building characteristics
- Occupant behaviour

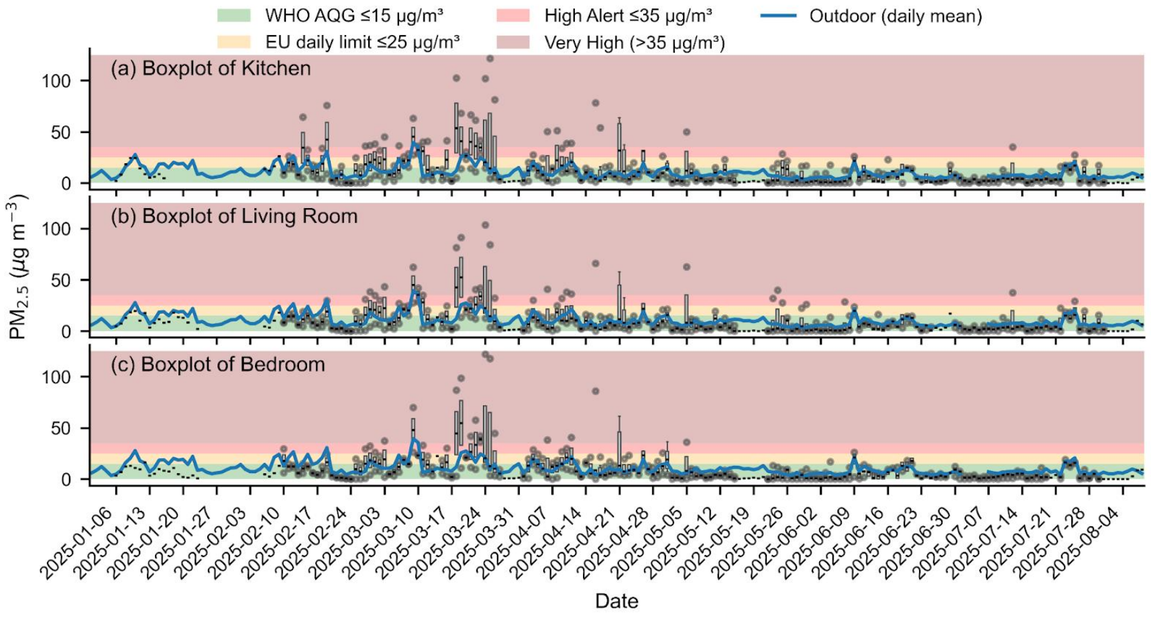
Participant information

- Demographic information
- Birth outcomes

CF Hub and RESPIRE Indoor Measurements

The University of Manchester

- High variability in pollutant levels across homes
- Driven by daily activities, ambient concentrations, housing type
- Cooking is a dominant source of indoor air pollution
- Marked seasonal differences in exposure patterns
- Concentrations almost always exceed WHO PM2.5 guidelines and are often above UK legal limits (outdoor guidance)



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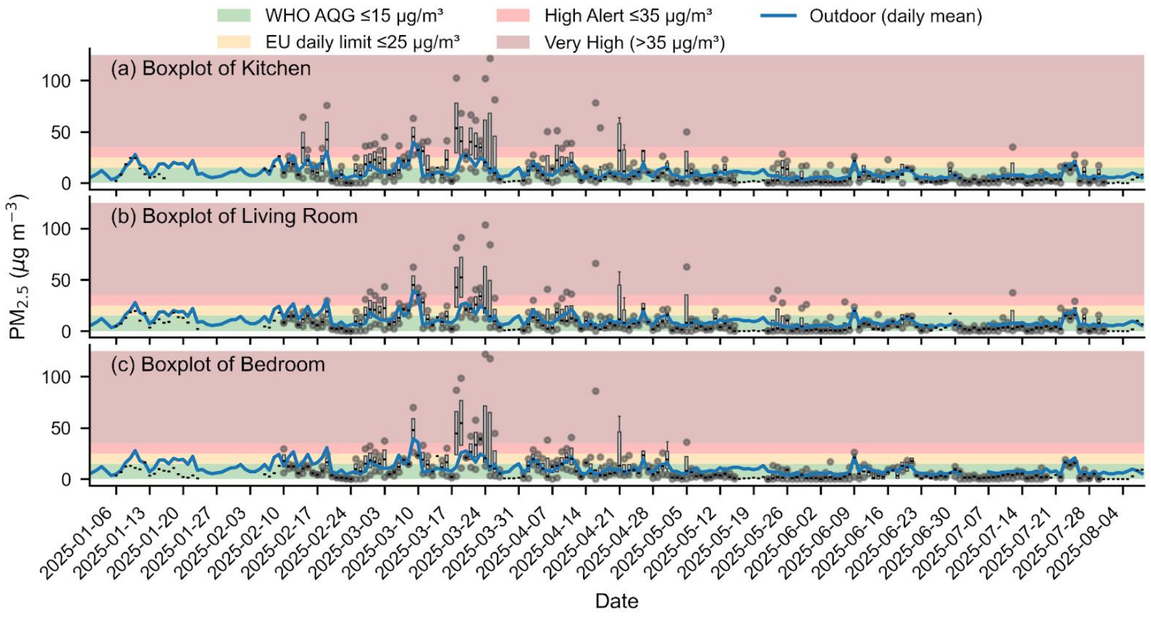
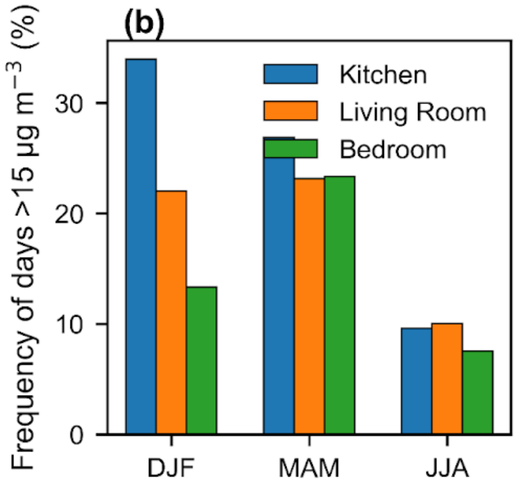
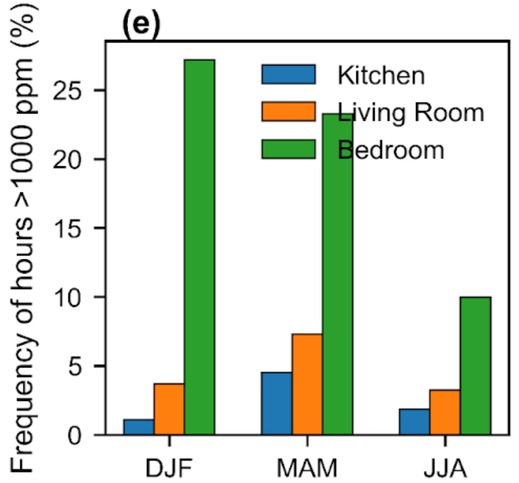
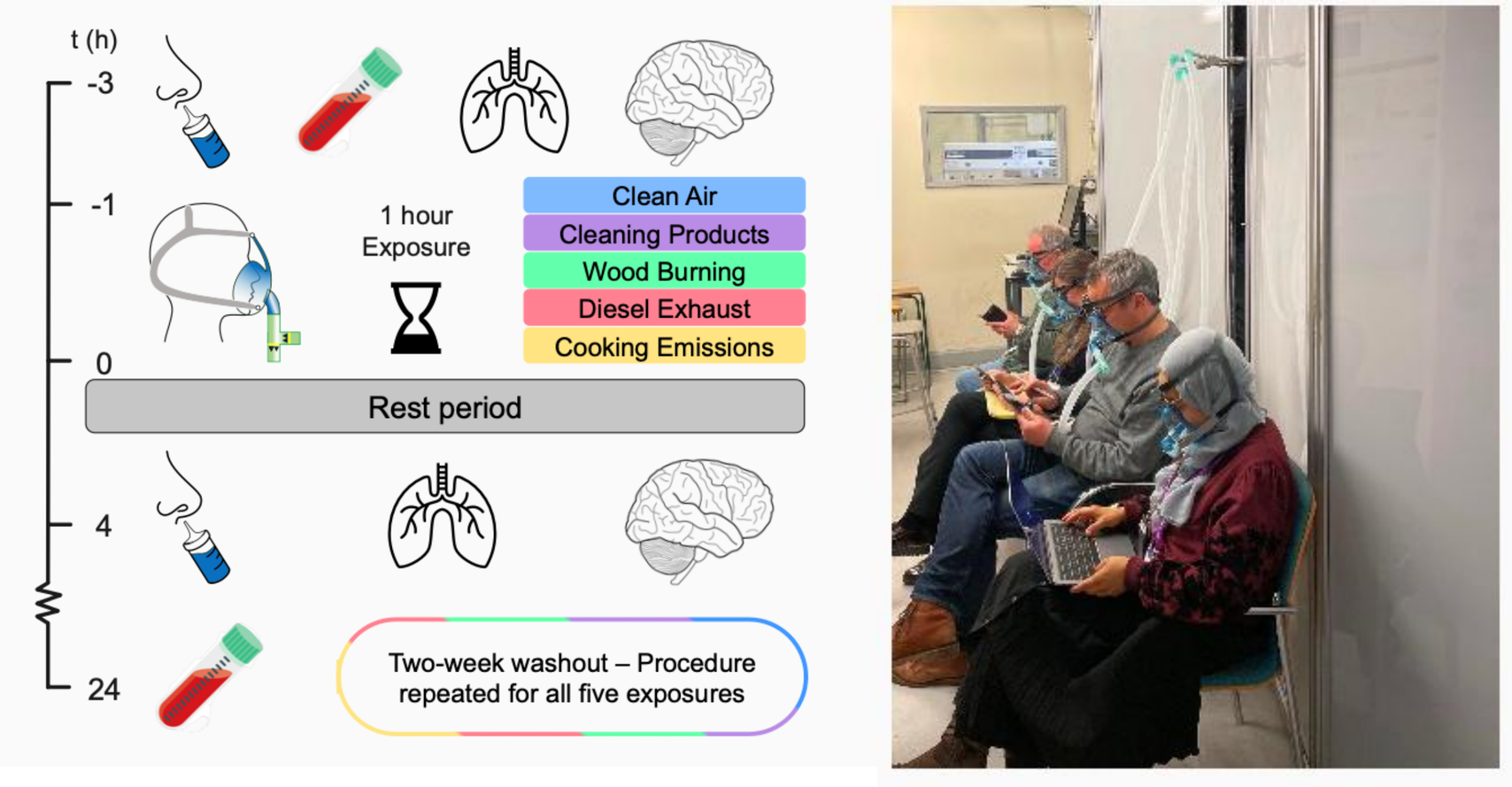






Chemical Fingerprinting of Indoor Sources



(i) an estimation of the differential health effects associated with different indoor air pollutant sources both now and for future indoor and outdoor AQ

(ii) a list of species for focus in future toxicological studies.

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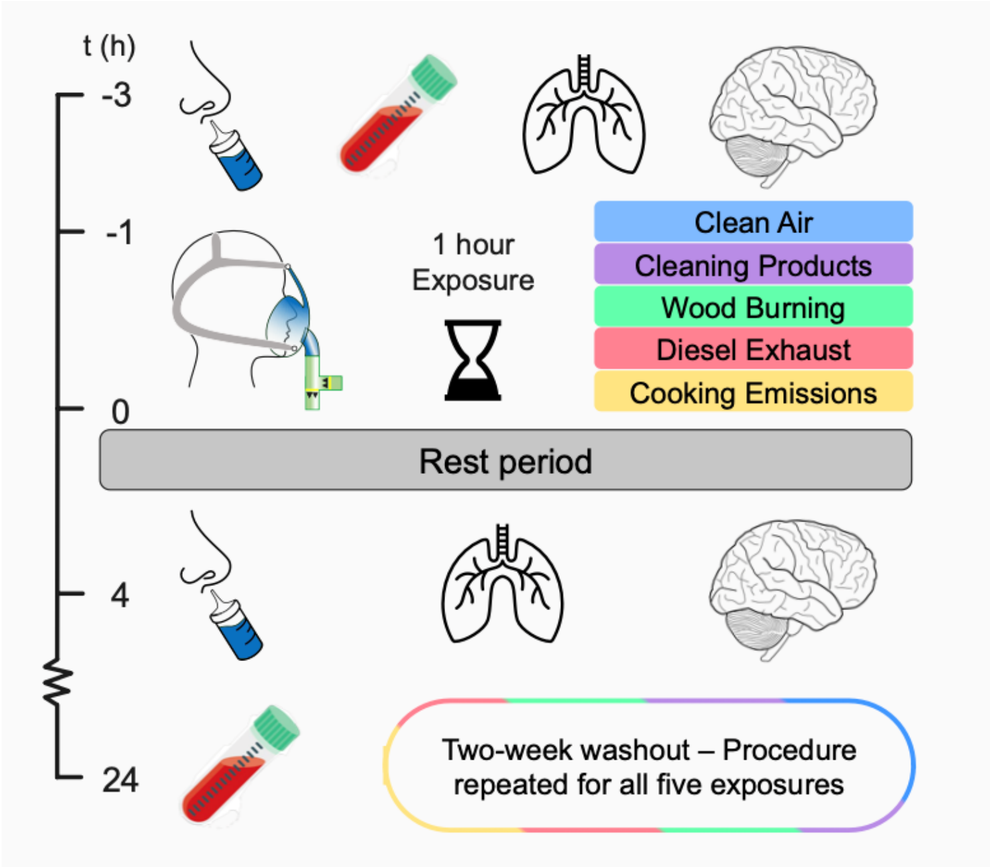

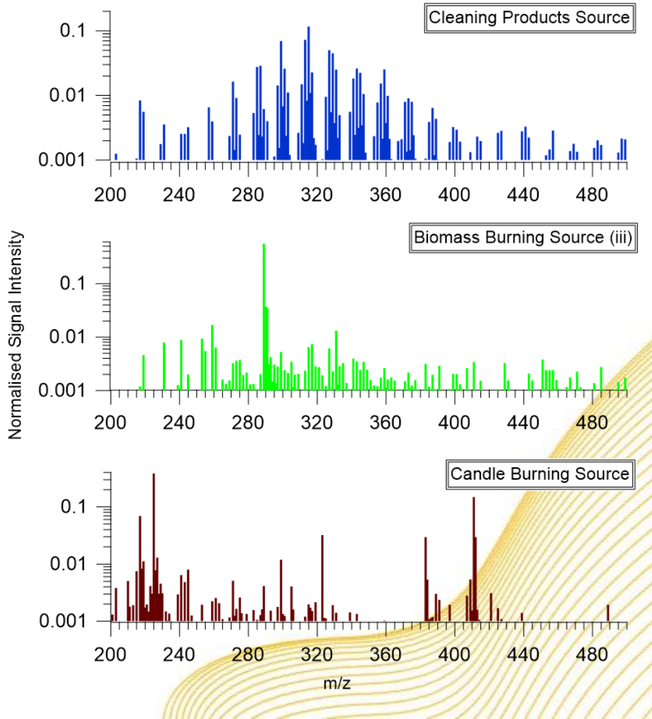

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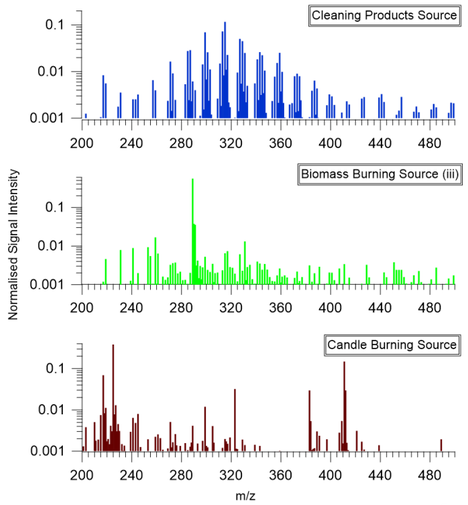
Chemical Fingerprinting in Real Homes

The University of Manchester



Indoor air quality in homes

Lots of sources...

INGENIOUS
Understanding Air Pollution in Homes

Chemical Fingerprinting in Real Homes

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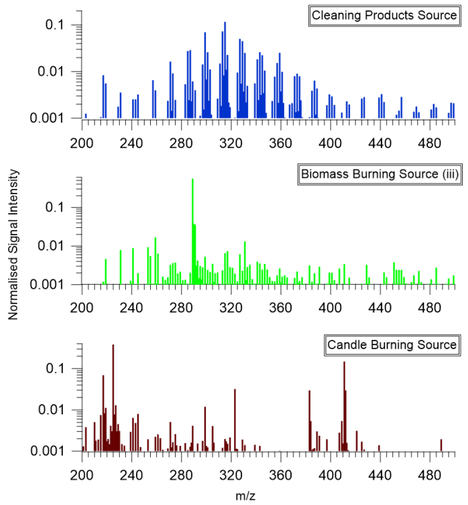
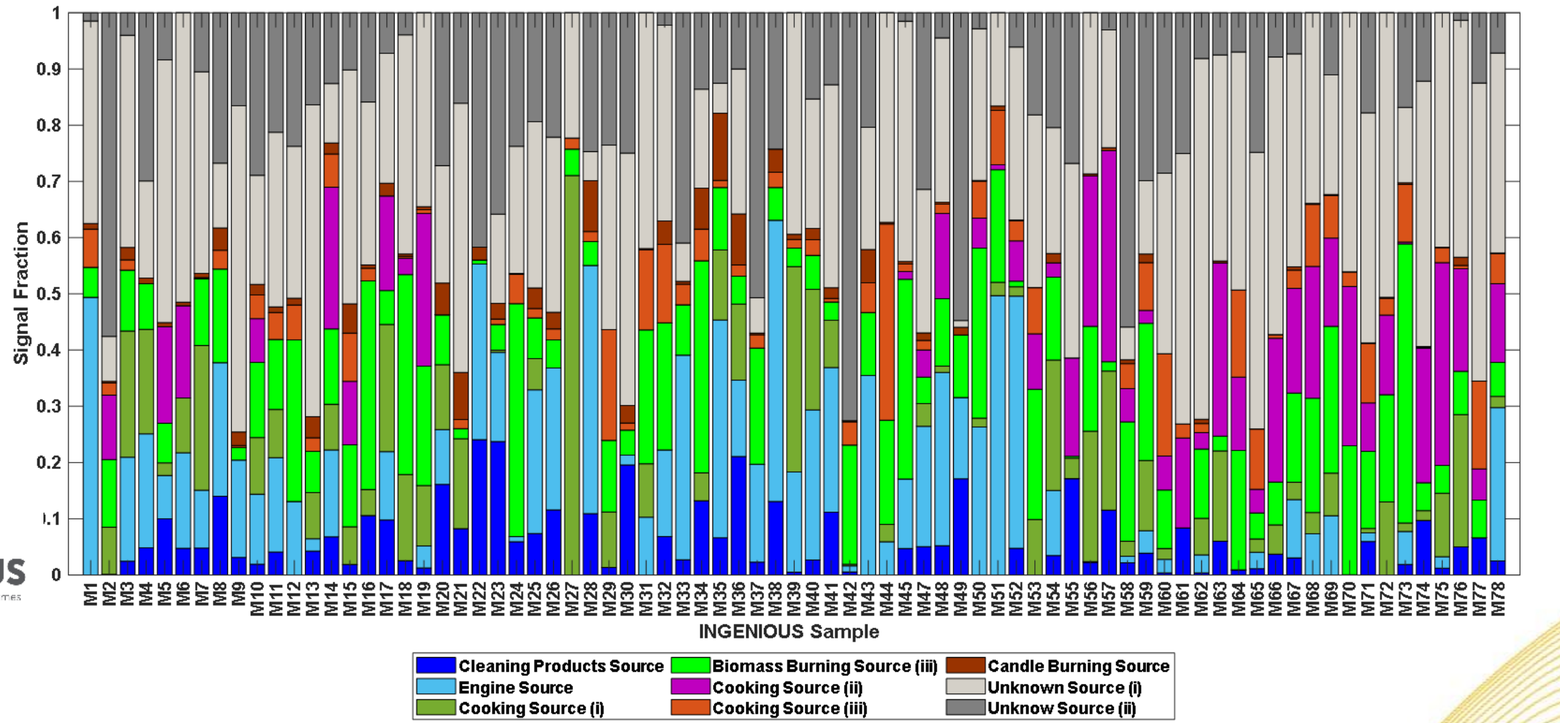




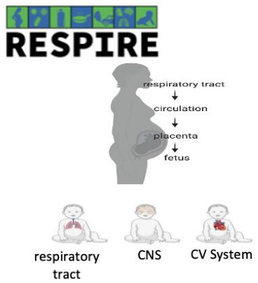
Indoor air quality in homes

Lots of sources…

INGENIOUS
Understanding Air Pollution in Homes

Unique cooking, cleaning, burning sources, chemical fingerprints identified

UoM Indoor AQ Work



RESPIRE

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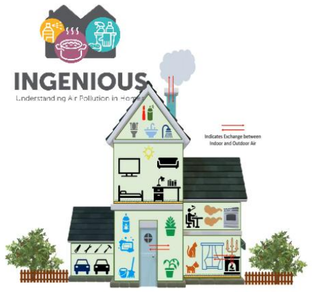

Ingenious

UnderstandING the sourcEs, traNsformations and fates of IndOor air pollUtantS

HIPTOX

Hazard Identification Platform to Assess the Health Impacts from Indoor and Outdoor Air Pollutant exposures

Insights from these projects:

- High variability in pollutant levels across homes
- PM levels well above that of the outdoor
- Driven by daily activities, ambient concentrations, housing type
- Cooking is a dominant source of indoor air pollution
- Marked seasonal differences in exposure patterns
- There are unique chemical fingerprints of individual sources
- These can be tracked and monitored in real time

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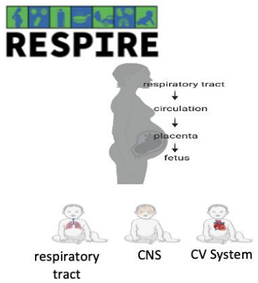

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- What can we do about it?
- How will homes built to Future Standards impact IAQ?
- How will future climates affect this?
- How do mitigations effect running costs?

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University of Salford MANCHESTER

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Future Homes

Support for the delivery of net zero new and existing homes

Climate Change Mitigation	Climate Change Adaptation	Energy Systems Transition	Digitisation

- **Performance** - Energy efficiency, systems and product performance
- **Occupant experience** - Indoor air quality, acoustics, overheating
- **Productivity** – new construction methods, digital delivery
- **Policy and regulatory issues** – barriers and drivers

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ENERGY HOUSE LABS

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What are Energy House Labs?

ENERGY HOUSE LABS

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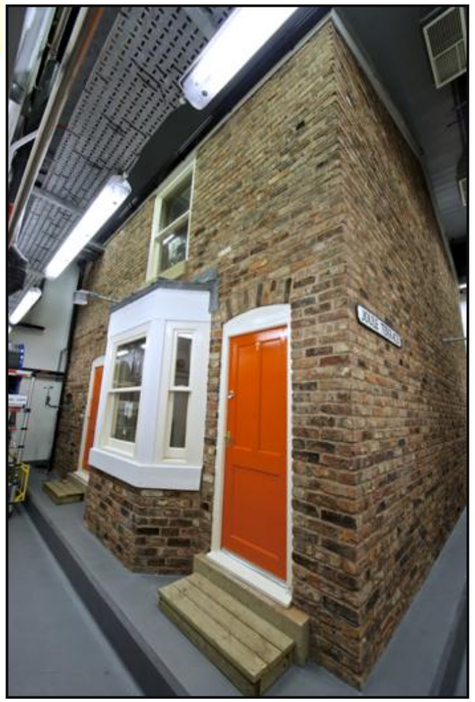
ENERGY HOUSE 1

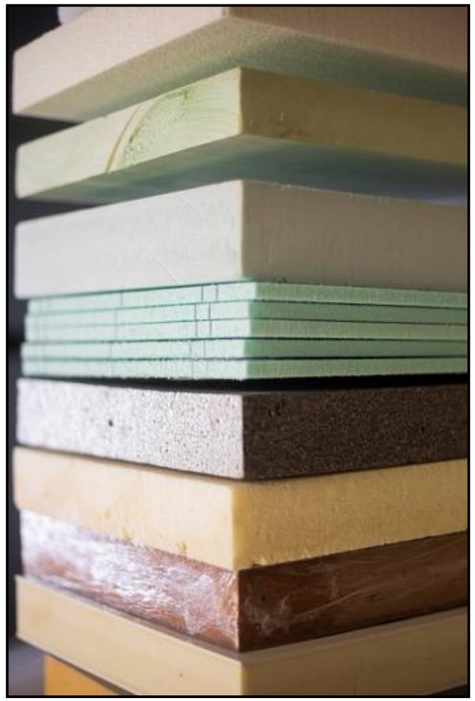
ENERGY HOUSE 2.0

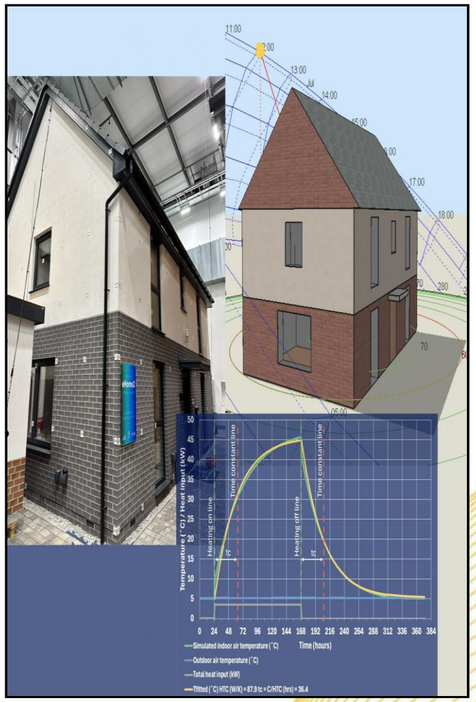
THERMAL MEASUREMENT LABORATORY

SMART METERS > SMART HOMES LAB

MODELLING LABORATORY



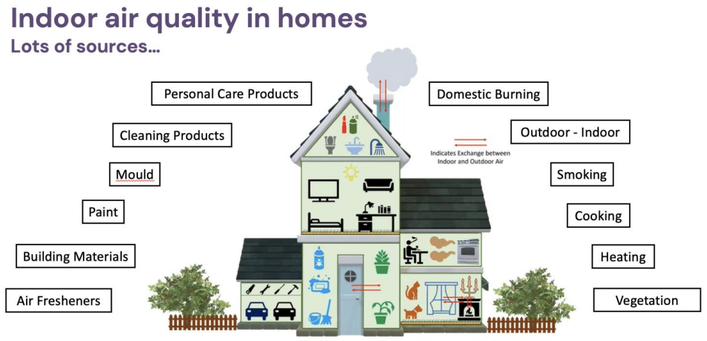


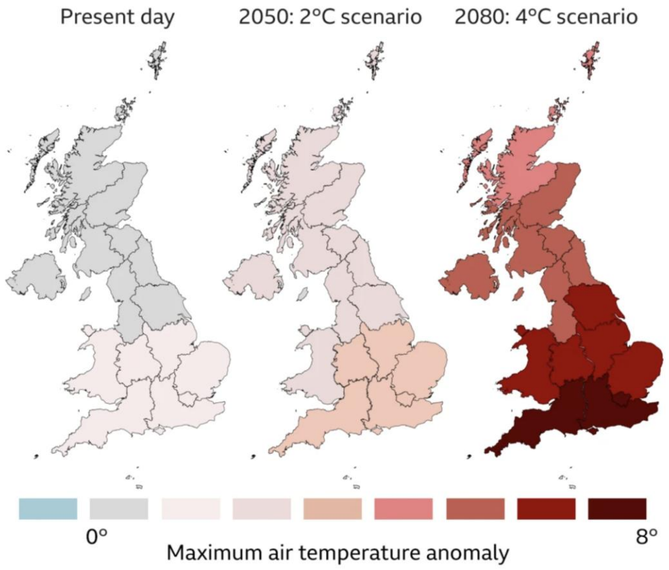


Environmental chambers with controlled temperature ranging from -24ºC to +50ºC and humidity

Future Homes Experiments

Understanding exposure…..

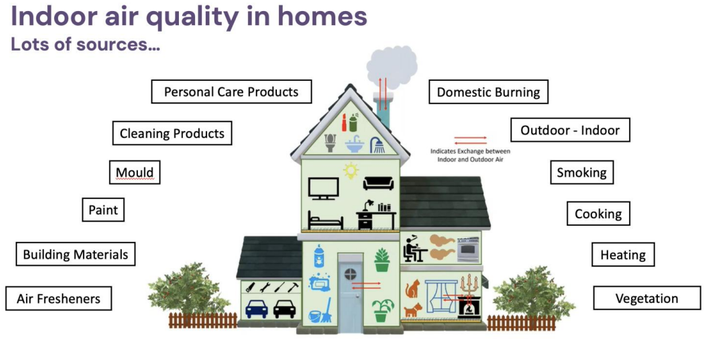


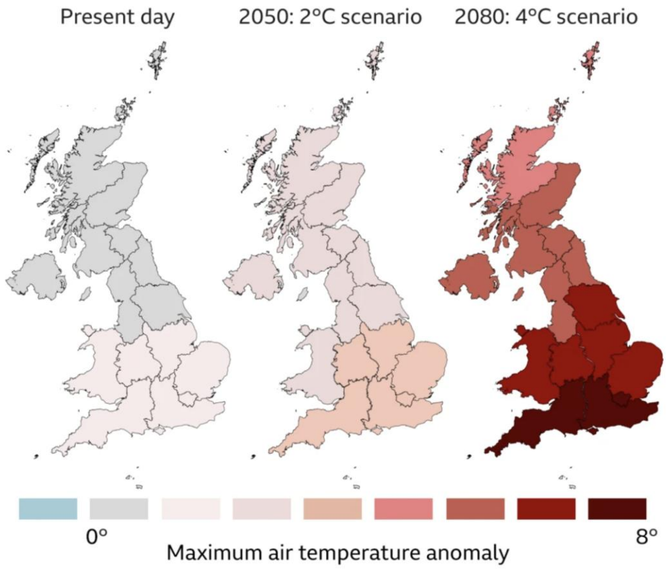


Future Homes Experiments

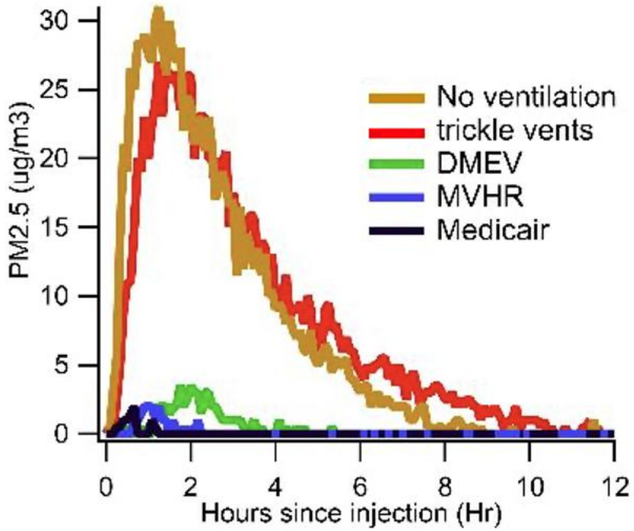
The University of Manchester

Understanding exposure…..





through controlled pollution releases



Active ventilation systems (DMEV, MVHR, Medicair) demonstrate significantly faster reductions in PM2.5 concentrations compared to passive approaches

Future Homes Experiments

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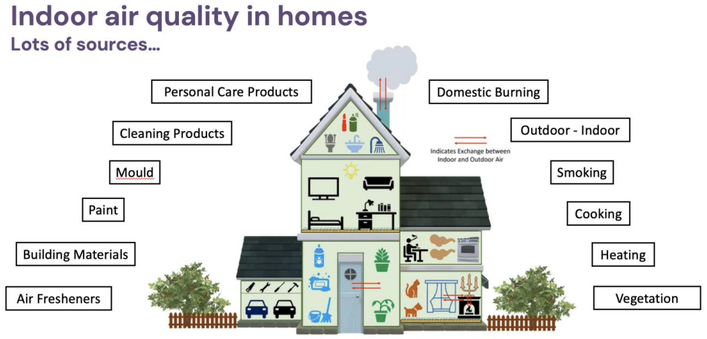

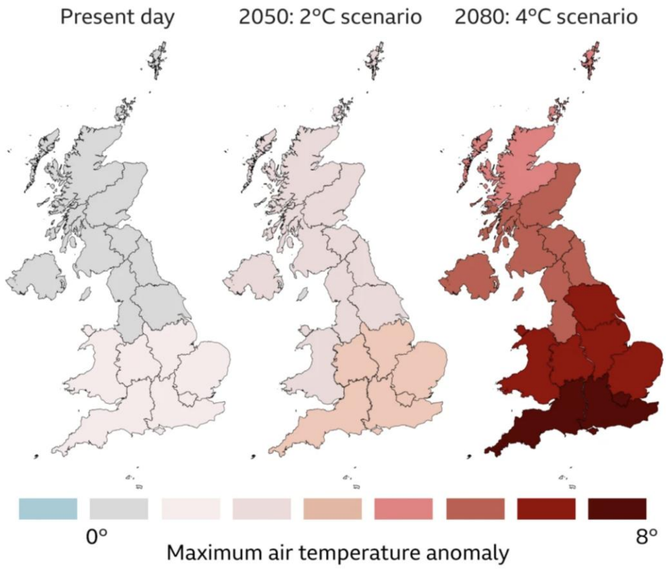

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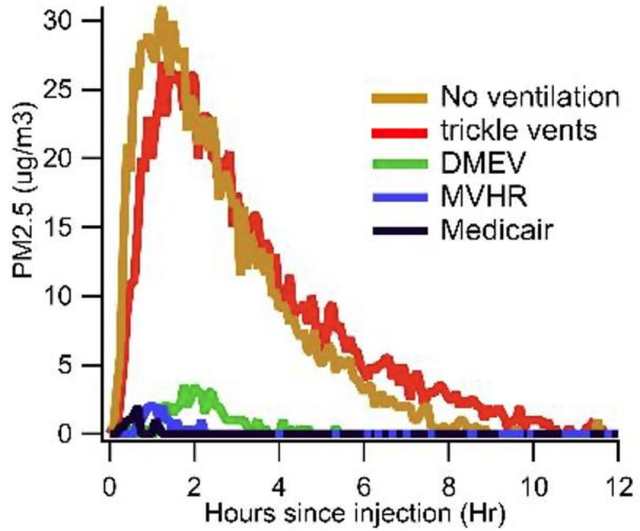

Active ventilation systems (DMEV, MVHR, Medicair) demonstrate significantly faster reductions in PM2.5 concentrations compared to passive approaches

+ detailed chemical fingerprinting

Future Homes Experiments

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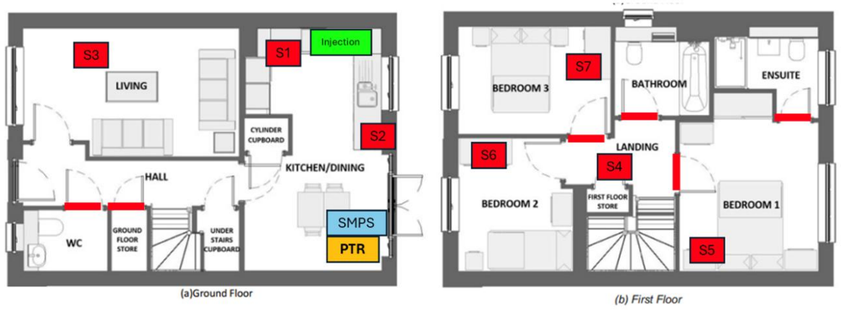
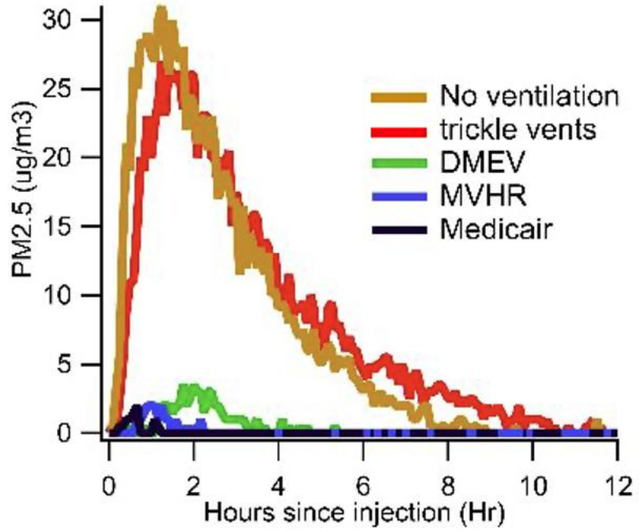
through controlled pollution releases





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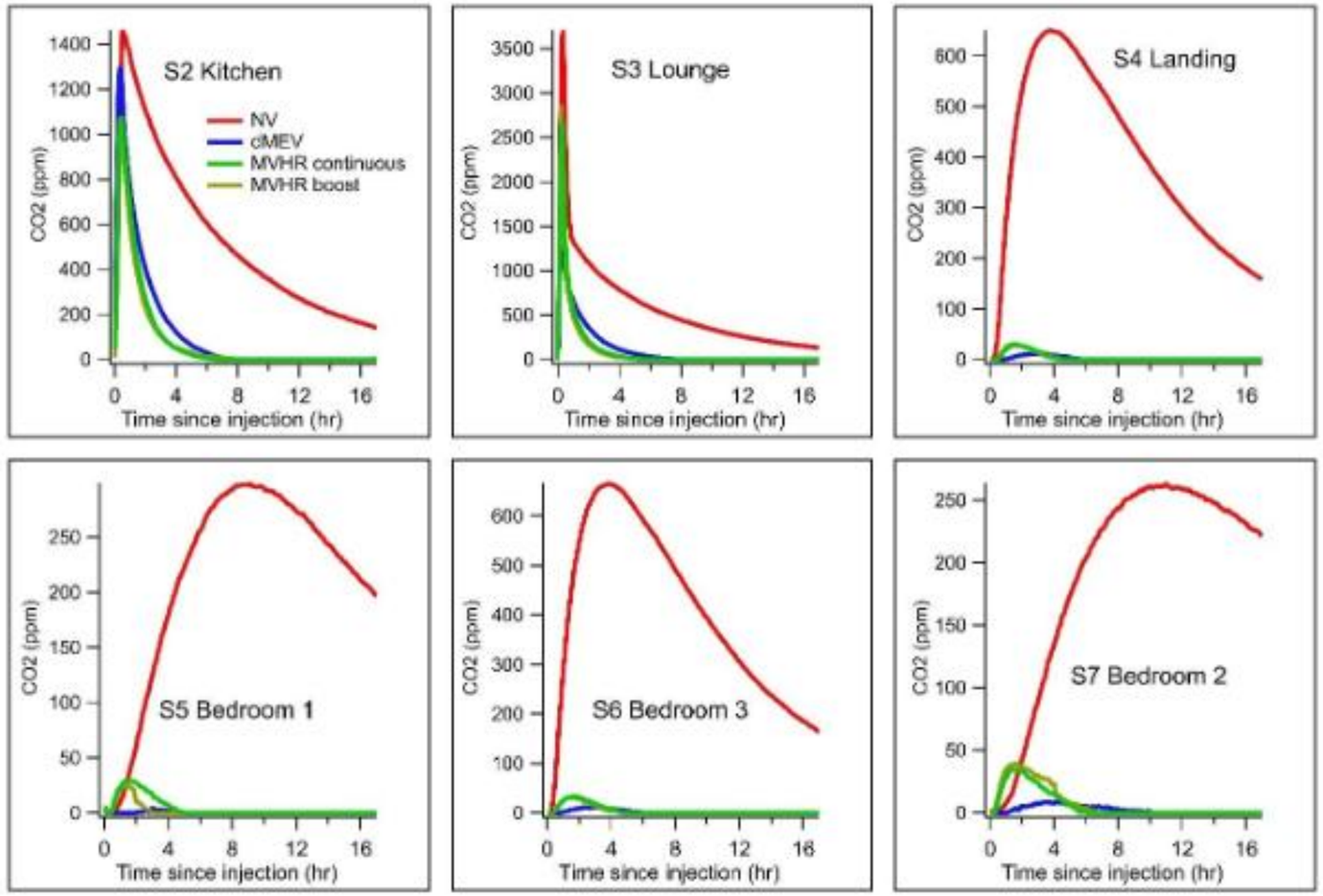
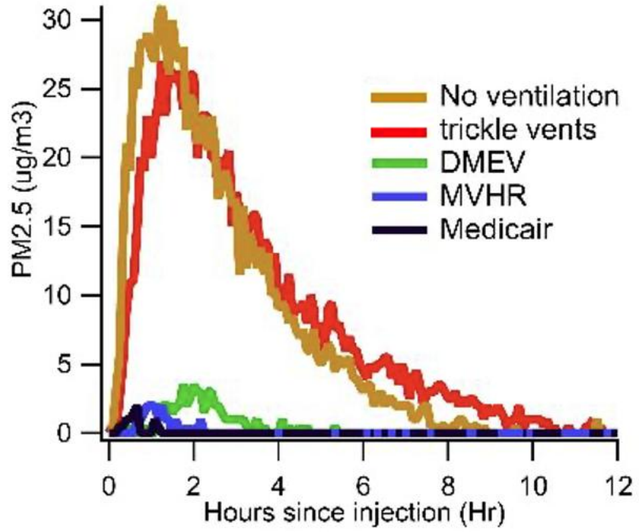


Hourly variation in the percentage reduction of accumulated CO_2 burden under various ventilation strategies, compared to the "no-ventilation" scenario, during controlled injection experiments. The x-axis represents the time since injection, in hours.

Future Homes Experiments

through controlled pollution releases



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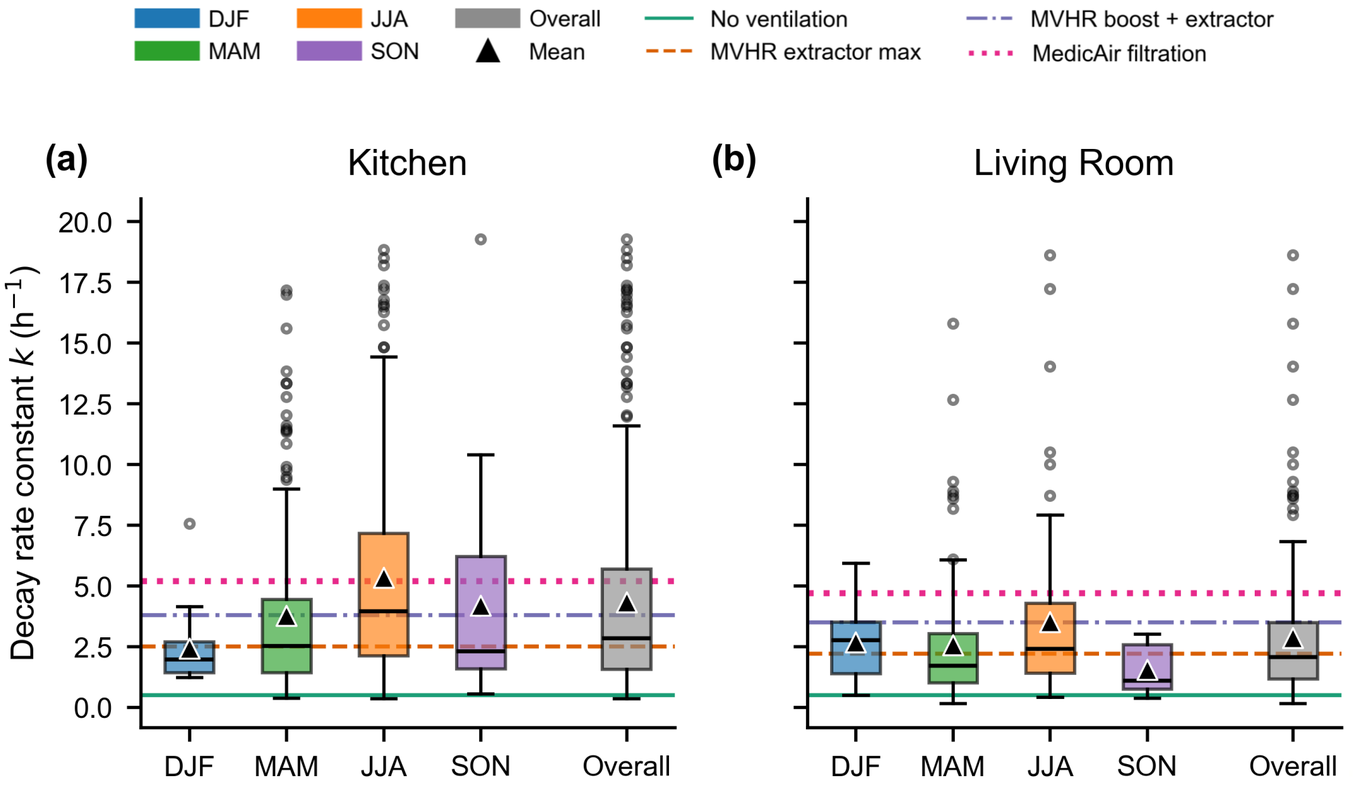
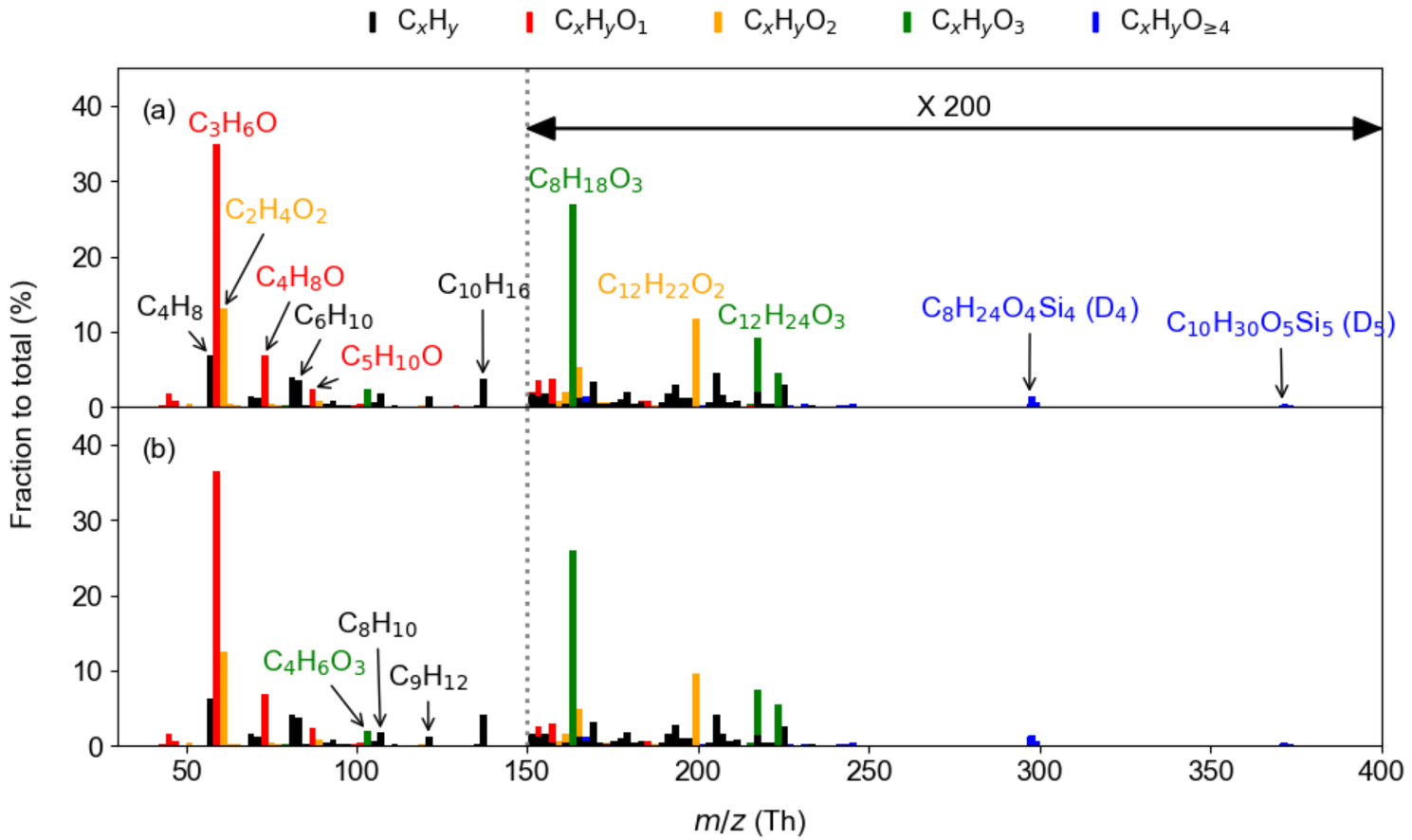


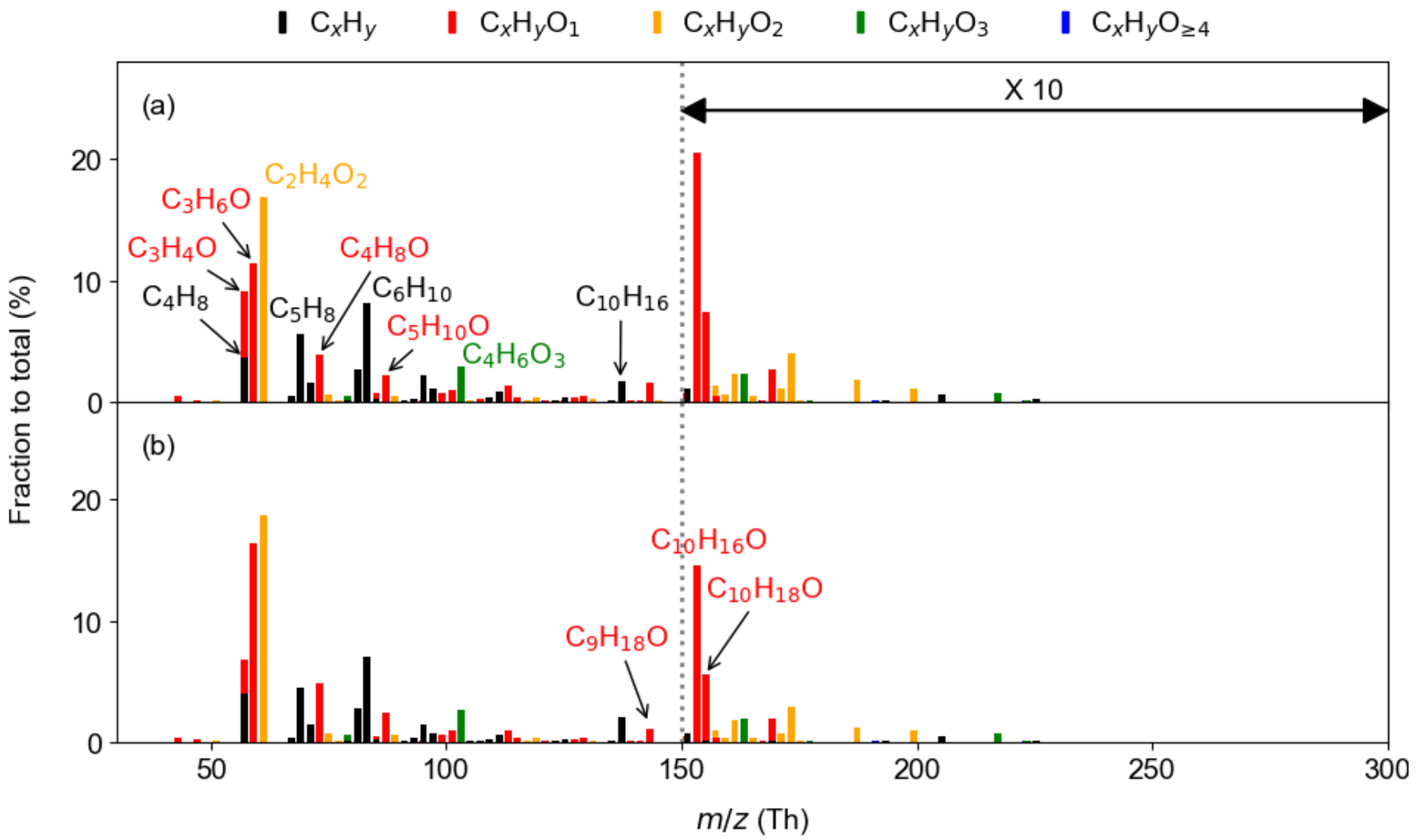
Ventilation considerations are very important in homes build to expected future standards!

Background Exposure



Average mass spectrum of VOC emissions from two reference measurements conducted on 10 August (a) and 11 August (b) 2024 without ventilation. The vertical y-axes represent the relative fraction to the sum of total signal intensities of compounds considered.

Cooking Emissions



Average mass spectrum of VOC emissions from two cooking experiments conducted on 12 August (a) and 13 August (b) 2024 without ventilations. The vertical y-axes represent the relative fraction to the sum of total signal intensities of compounds considered.

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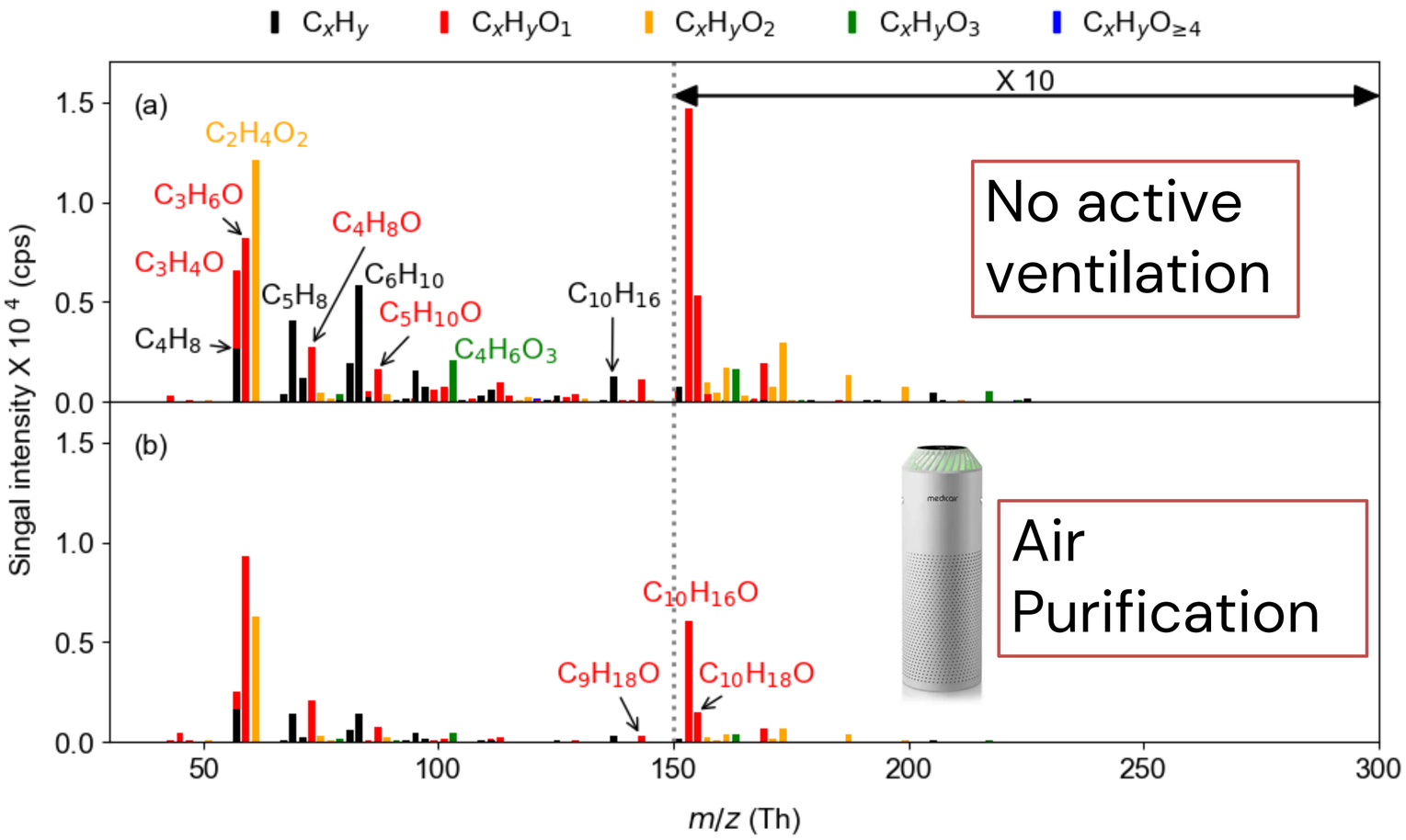
Cooking Emissions/Mitigations



Average mass spectrum of VOC emissions from two cooking experiments conducted on 12 August 2024 without ventilations (a) and on 16 August 2024 with MedicAir purifiers on (b). The vertical y-axes represent the absolute signal intensities of compounds considered.

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Summary

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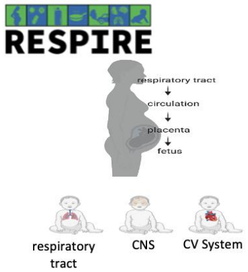

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