Understanding and managing airborne exposure in school environments

Professor Cath Noakes
School of Civil Engineering, University of Leeds
C.J.Noakes@leeds.ac.uk

Centre for Applied Education Research

LIFD Leeds Institute for Fluid Dynamics

UNIVERSITY OF LEEDS

Acknowledgements

- *Colleagues at Leeds*
- *Class-ACT study team (University of Leeds, Leeds Beckett University, Imperial College, Queen Mary University London, Centre for Applied Education Research)*
- *NCS PROTECT CIVOS study team (Imperial College, University of Leeds, UK Health Security Agency)*
- *OpenCFD Ltd (OpenFOAM), St Teresa's School and IMechE*
- *SAMHE study team (Imperial College, University of Cambridge, University of Leeds, University of York, University of Surrey, Stockholm Environment Institute)*

Supported by: Department for Education, Department for Health and Social Care, UK Health Security Agency

Funders: UKRI EPSRC, Department for Health and Social Care, UKRI Innovate, UK government

The challenge of education environments

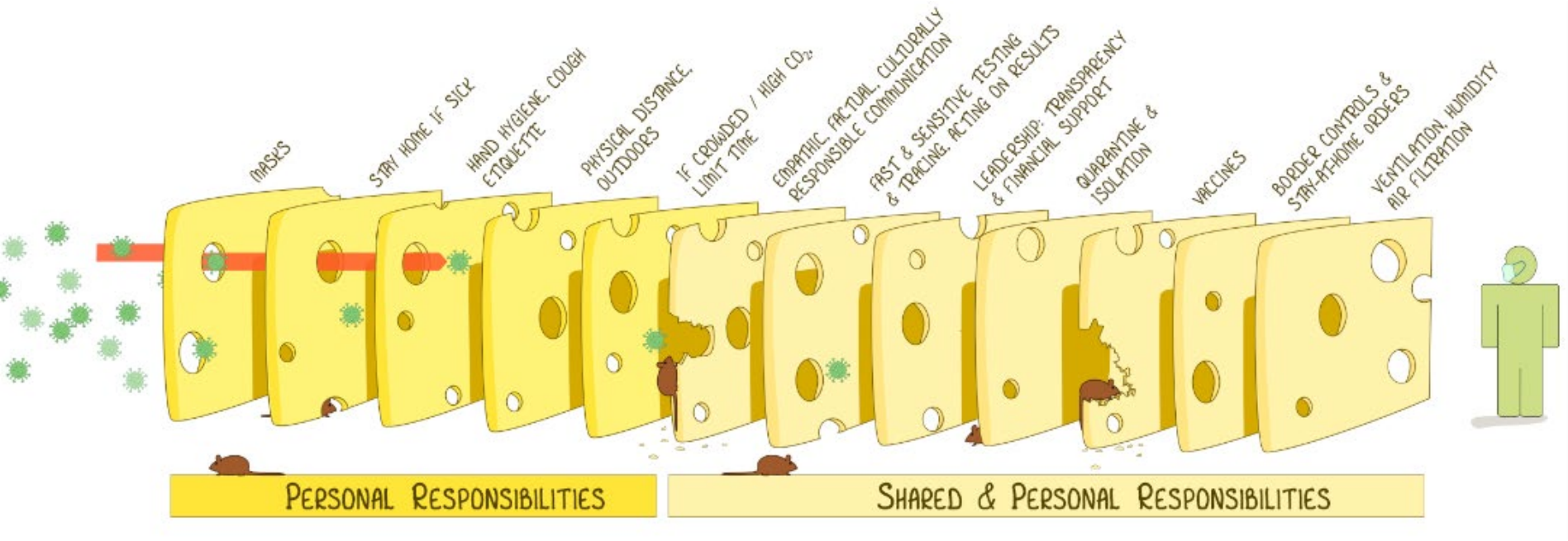
Environmental Factors

- High occupant density
- Highly shared spaces
- Long duration exposure
- Include higher risk activities (sport, singing)
- Often older/poorly maintained buildings
- Limited capacity for enhancing ventilation
- Noise, safeguarding, external air quality

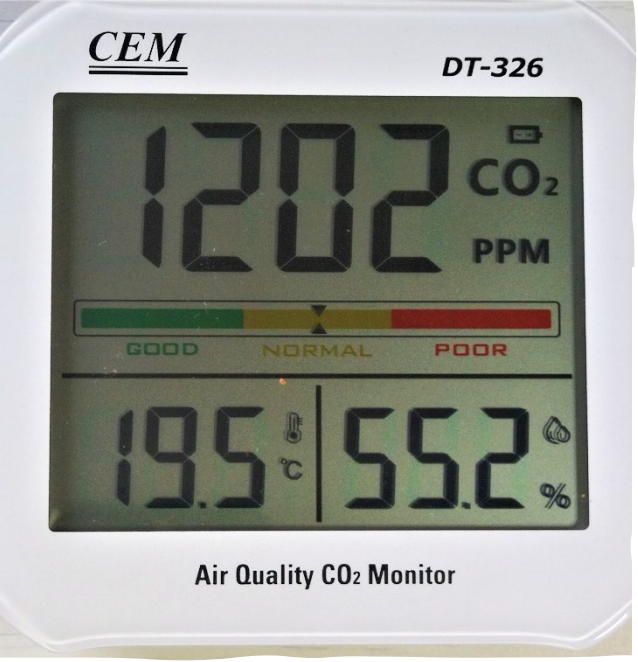
Population Factors

- Bring together large numbers of people
- Connect communities
- Closure/absence has wider health and societal impacts
- Not all parents can keep children home
- Resources and expertise vary significantly

Layered mitigations



Ian Mackay, virologydownunder.com



What does this look like for education?

1. Reduce the chance of infectious people being present

- Good communications about symptoms and cases
- Enable staff and students to stay home when sick
- Testing and vaccination

2. Good management of spaces

- Manage interactions – occupancy, pinch points, outdoor spaces
- Assess and maintain ventilation systems
- Actively manage natural ventilation using CO_2 monitors
- Good hygiene practices, masks in high prevalence

3. Enhancing environmental controls

- Installing or upgrading mechanical ventilation
- Adding air cleaning technologies (filter or UVC)

Evidence from education settings

Significant variation

- Some studies report no transmission, other report large outbreaks
- Less transmission reported earlier in the pandemic – caution, testing or variants?

Evidence for ventilation and air cleaning effects but hard to measure

- Georgia schools: 35% reduction with ventilation, 48% reduction with ventilation + air cleaning
- Italy schools: potentially 80% reduction in Mech Vent schools (pre-print)
- Marin country: transmission to 50% despite open windows and air cleaners, sometimes unmasked symptomatic teacher
- Several studies (pre-pandemic) show better ventilation associated with lower sickness absence, better cognitive performance

Multiple factors influence reports

- physical design, size, building systems, demographics, socio-economic factors, behaviours, community prevalence, test access, variants, chance effects….

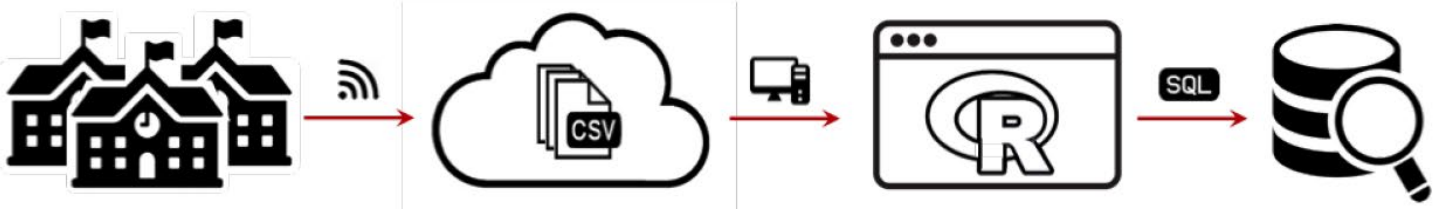
Managing Natural Ventilation

CIVOS: Changes In the Ventilation Of Schools

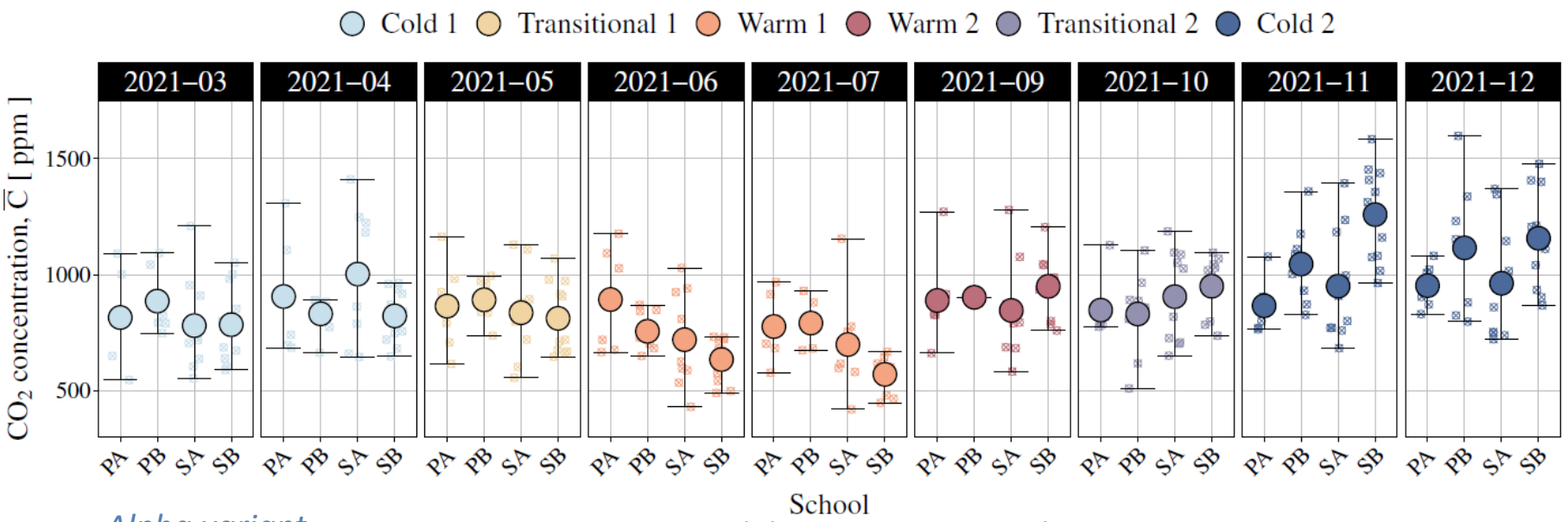
Can display monitors help with ventilation provision in UK classrooms?

Can changes be sustained over time ?

- **Phase 1** - unintrusive monitoring (temp, RH, CO_2) from March 2021
- **Phase 2** – visual monitors + training (2 schools) from Dec 2021
- 36 naturally ventilated classrooms across 2 secondary (11-16) and 2 primary (5-11) schools
- Large scale data collection + survey/focus group to understand behaviour



School and seasonal variation



Alpha variant - Emerging from winter lockdown

Summer delta wave

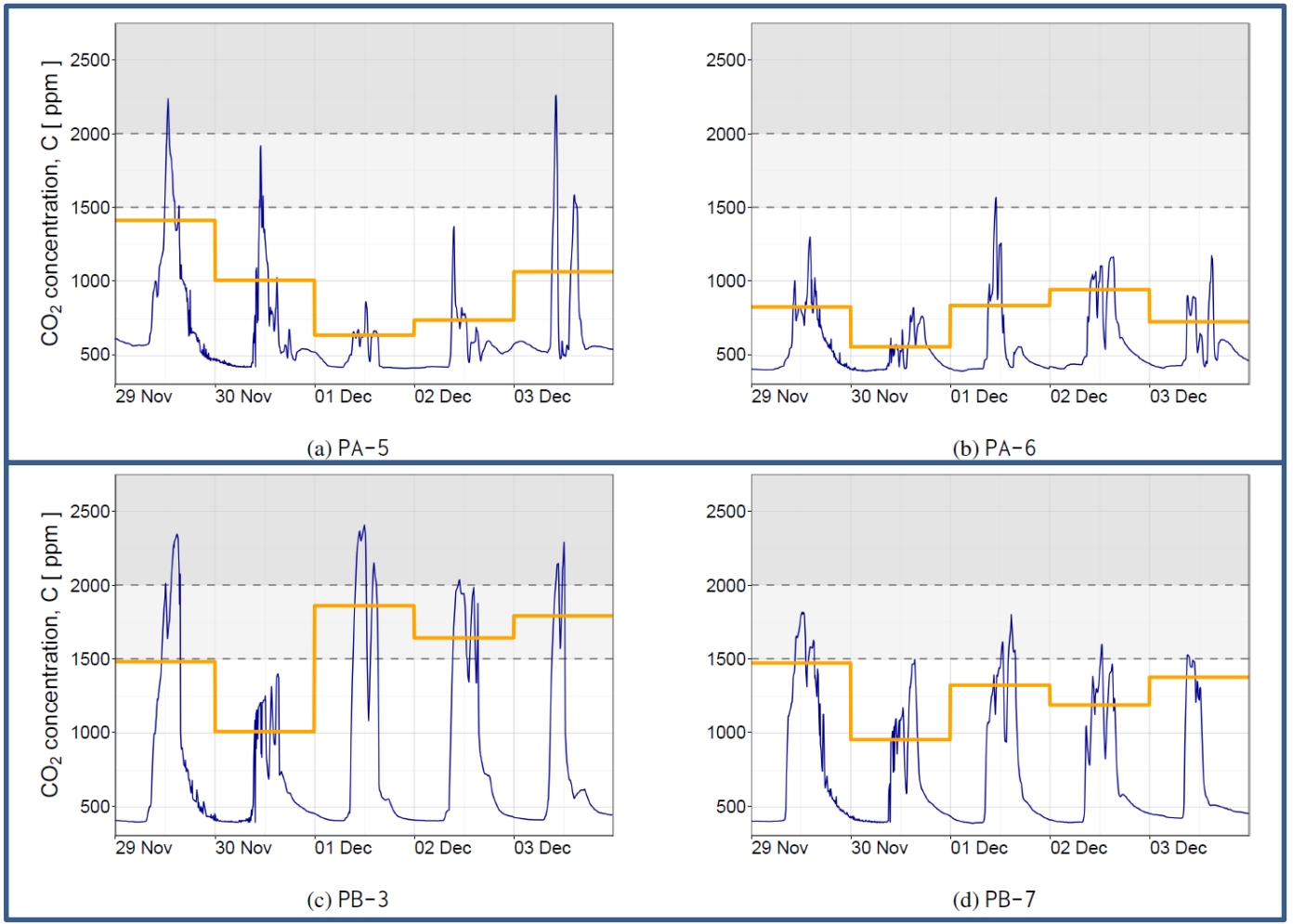
Delta cases remain consistently high

Omicron wave starts

PA, PB – primary schools (5-11)

SA, SB – secondary schools (11-16)

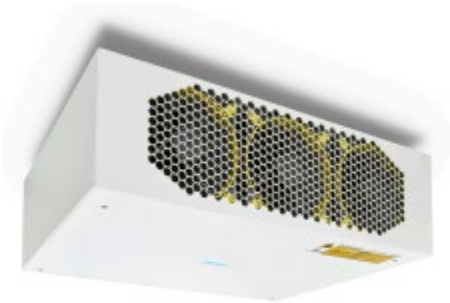
Classrooms vary even when notionally the same and next door to one another…

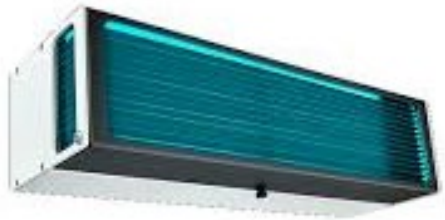


Impact of air cleaning devices

Class-ACT study

- 30 primary schools in Bradford – 540 classrooms
- Control group, filter unit group, active air UVC group
- Measuring IAQ parameters (T, RH, CO2, PM) in every room
- Measuring infection rates and absence including COVID
- Evaluating practicalities of implementing and using air cleaners





Centre for Applied Education Research

LEEDS BECKETT UNIVERSITY

Queen Mary University of London

UNIVERSITY OF LEEDS

Practical learning

Large scale deployment needs good planning

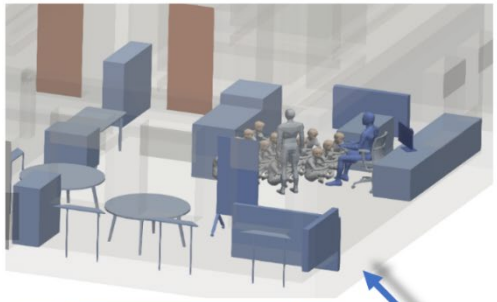
- Electrical power and installation
- Size and location
- Robustness
- Noise and heat load
- Day to day usability
- Running cost and maintenance needs
- Wider benefits for AQ and comfort

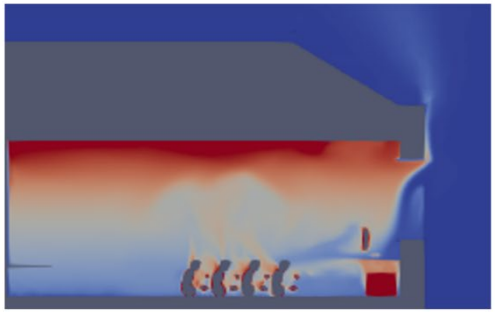
https://www.tes.com/magazine/analysis/general/covid-schools-ventilation-10-step-guide-using-air-cleaning-units

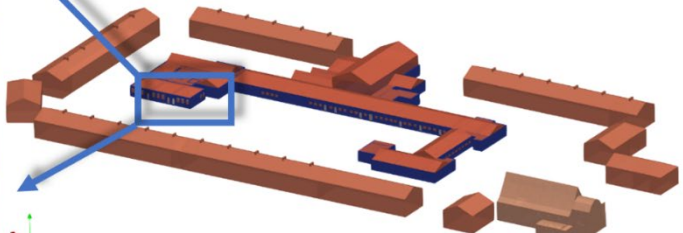
Engaging with schools

St Teresa's, Morden

- CFD analysis of school airflows
- CO_2 monitoring led by children
- Implementation of UVC recirc units







esi get it right

Institution of MECHANICAL ENGINEERS

Schools'

Air quality

Monitoring for

Health &

Education

RESEARCH IN SCHOOLS REQUIRES HIGH ETHICAL STANDARDS & GOOD GDPR PROTOCALS

INITIAL ENGAGEMENT

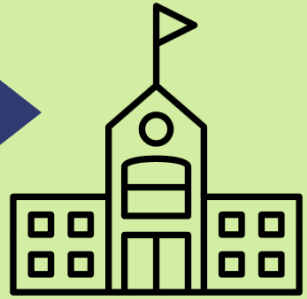
SAMHE monitors

- WiFi smart monitors gifted to 2,000+ Schools
- Teachers and pupils empowered to monitor their schools' air quality (in-room & via internet)
- Monitors gather IAQ (Indoor Air Quality) data

SAMHE Web App

- Co-design with schools for success
- Interactive visualisation of IAQ data for schools
- Deliver engagement via citizen science and fun
- Support teaching & deliver learning
- IAQ intervention support and assessment

SCHOOL COMMUNITIES



CONTINUED ENGAGEMENT via visuals, activities, games and monitor movement

POSITIVE CHANGE through IAQ data & knowledge

Imperial College London

UNIVERSITY OF CAMBRIDGE

SEI Stockholm Environment Institute

UNIVERSITY OF LEEDS

UNIVERSITY of York

Centre for Applied Education Research

GLOBAL CENTRE FOR CLEAN AIR RESEARCH
UNIVERSITY OF SURREY