MAGIC CIRCULAR

Envisaging a world with zero carbon cities

AN UPDATE ON THE MAGIC PROJECT

ISSUE NO. 04 | JANUARY 2018

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UNIVERSITY OF CAMBRIDGE

Imperial College London

UNIVERSITY OF SURREY

Welcome to the 4th edition of the MAGIC Circular. Since our last update we've been busy gathering measurements at our test site in Elephant and Castle, and trying to replicate the findings in physical simulations and theoretical models. It's a complex and interesting site in a busy part of London, enabling us to consider factors like the effects of tall buildings and nearby street canyons as well as the behaviour of building occupants. You can read updates from our research team below, highlighting some of our most interesting findings so far.

With the start of a new year, we're making plans for 2018. We're hoping to find a new test site where we can build on what we've already learnt at Elephant and Castle. If you'd like our team to monitor your naturally ventilated building then please get in touch. There's more on what we've got planned for 2018 in the Looking Ahead section. In the meantime, we'd like to take this opportunity to wish all our partners and friends a productive year ahead.

The MAGIC project is a collaboration between the Universities of Cambridge, Surrey and Imperial College London, looking at the impact of urban flow on the potential for the increased use of natural ventilation in buildings. The project is supported by a number of academic and industrial partners, such as Dyson, Arup, Breathing Buildings, Reading University and IAP China, but we continue to look for collaborators and to develop our relationships with current partners.

Professor Paul Linden,

Lead Investigator

University of Cambridge

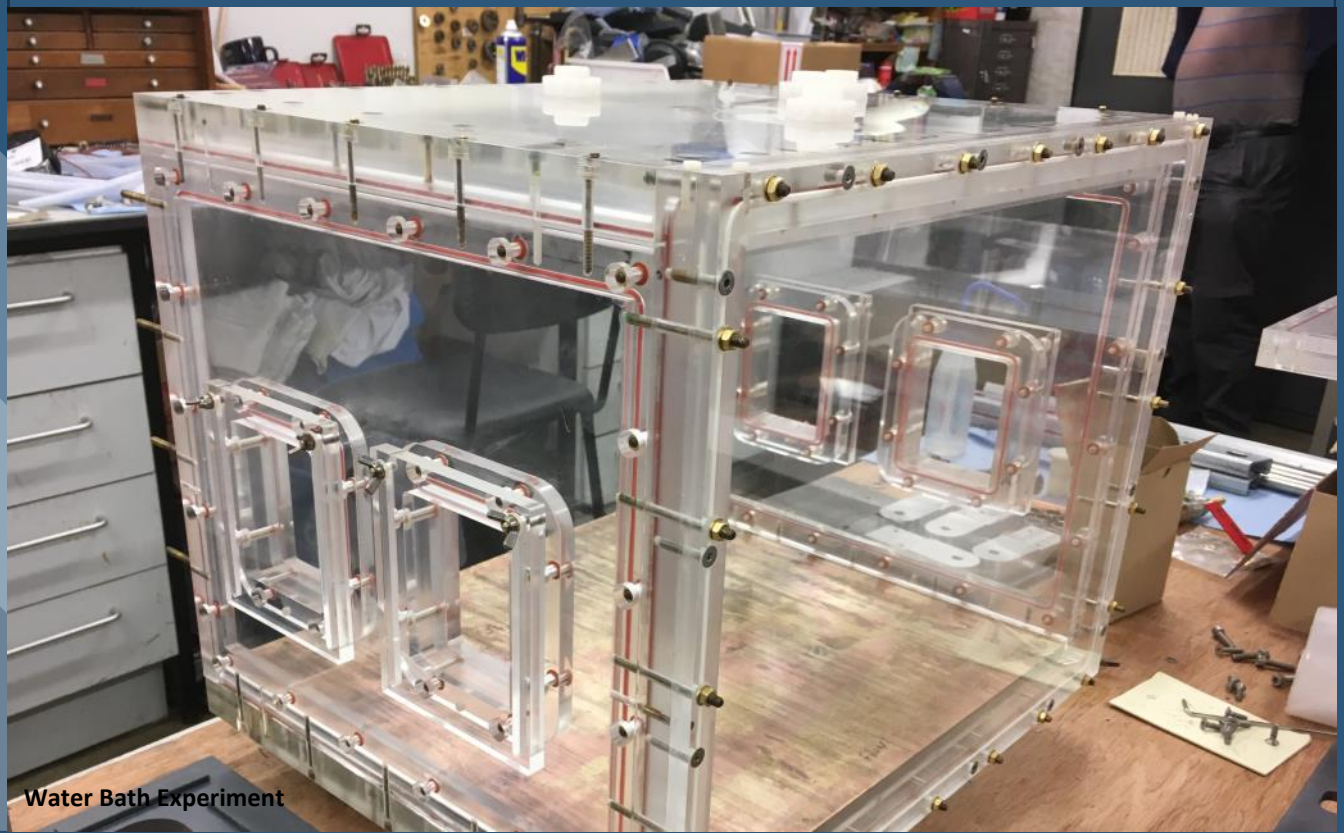
RESEARCHER UPDATES

DR SHIWEI FAN, UNIVERSITY OF CAMBRIDGE: Sensor Development

Data monitoring at our test site in Elephant and Castle has been running at full-tilt over the last few months. So far, the picture is complex. We're seeing that even in a small office room, the temperature can be strongly stratified, and this stratification appears to affect the levels of pollutants that occupants experience. We're also able to identify key 'mixing' events, such as opening windows, that upset this picture, but we need to dig deeper to fully understand what is happening. The levels of CO_2 we're recording are linked closely to room occupancy – as expected CO_2 levels are significantly higher inside than outside during the week when people are using the room. We'll use all the information we've gathered at Elephant and Castle to hone the design for our next monitoring experiments in 2018.

DR MEGAN DAVIES WYKES, UNIVERSITY OF CAMBRIDGE: Building Ventilation

I am building a water bath experiment that is dimensionally similar to the real test site, including a heated floor to represent indoor heat gains from occupants and equipment. We've had to fix a few leaks, but we are now up and running! The main focus is to look at how wind and buoyancy affect ventilation rates. My findings will help us to build a theoretical model able to characterise the transport of pollutants into and out of a room when both wind and buoyancy are significant.



Water Bath Experiment

RESEARCHER UPDATES

DR WILL LIN, UNIVERSITY OF SURREY: Wind Tunnel

I've been working at the EnFlo Meteorological wind tunnel at Surrey, where we have recreated the area around the test site, shrunk down by 200-times. We're simulating external natural airflow to understand its impact on natural ventilation. A characteristic of Southwark, the home borough of the test site, is a large variability of building forms, which adds to the complexity of modelling the external wind environment. So far, we've found tall buildings greatly affect the wind patterns in this borough and these differ from the typical expected atmospheric wind behaviour. We've seen that external pressure variation, related to the action of rapidly-changing winds, is an important factor in the natural ventilation of our monitored building.

DR HUW WOODWARD, IMPERIAL COLLEGE LONDON: Atmospheric Modelling

I've been looking at pollution dispersal at the micro-scale. It's heavily dependent on features such as building and street geometrics and, particularly at low wind speeds, traffic induced flow and turbulence. We can now model traffic with instantaneous emissions in Fluidity by coupling the emissions model with PTV Vissim. This provides "realistic" driving motion, giving a reasonable representation of real-world, instantaneous emissions. Some early traffic simulations in Fluidity demonstrate how emissions can travel upwind within the wake of vehicles. Simulations of street canyon geometries have also revealed some interesting flow features.

DR ROSSELLA ARCUCCI , IMPERIAL COLLEGE LONDON: Data Assimilation Modelling

My data assimilation work means we can already improve the accuracy of predictions from the Fluidity model by one order of magnitude. Going forward it will also enable us to optimise many areas of our work with MAGIC - where we should place sensors to get the best data, for example.

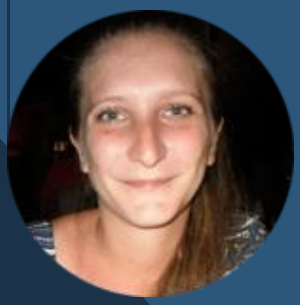
DR DUNHUI XIAO, IMPERIAL COLLEGE LONDON: Reduced Order Modelling

I am developing a non-intrusive reduced order model (NIROM) that provides much faster computations than the full Fluidity model. The most exciting development is that using Deep Learning a NIROM can be constructed without modifications to the original simulations, allowing for a more flexible application of reduced order models. I am currently applying this approach to develop a NIROM for the test site.

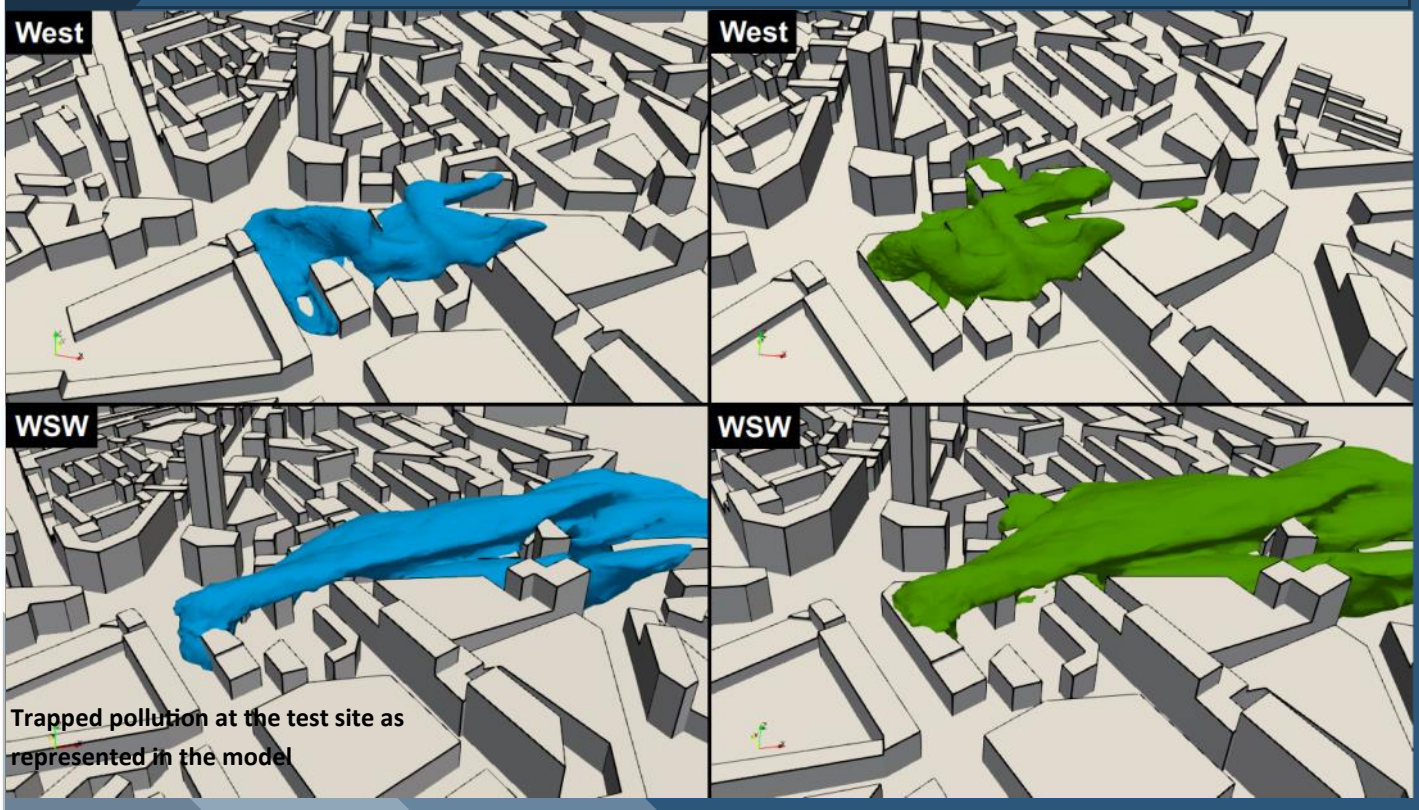
DR JIYUN SONG , UNIVERSITY OF CAMBRIDGE: Building Energy Performance

I'm looking at how to achieve a thermally comfortable and energy efficient indoor working environment through natural ventilation rather than air conditioning for hot periods. I'm modelling the impact of different natural ventilation conditions on internal air temperature and building energy consumption via the EnergyPlus model. Our test site has thrown up some interesting findings. For example, cross ventilation has a greater cooling effect than single-sided ventilation, and skylight ventilation seems to be less effective than either of these. The next step is to study the impact of outdoor air conditions on the energy saving potential of the test building, since high concentrations of outdoor pollutants might discourage the occupant's window opening behaviour and limit the use of natural ventilation.

DR LAETITIA MOTTET- IMPERIAL COLLEGE LONDON: Building Modelling



I use the Fluidity model to simulate Will's observations from the EnFlo wind tunnel. Over recent months, we have improved our tool for automatically generating the 3D mesh of a complex urban environment so that now the terrain can be taken into account. Our work highlights the impact that tall buildings have on the way pollution is spread around an area. Looking at our test site, when wind comes in from the west, pollution becomes trapped around the site, because of its location in the wake of a tall building upstream.



Trapped pollution at the test site as represented in the model

LOOKING AHEAD

Looking ahead to 2018, the MAGIC team will be building on last year's research and gaining more input from our external partners, to make sure our outputs support industry in a practical way. Some of the things we're looking forward to include:

- Identifying the location for our second field study location. We're looking for a naturally ventilated building to begin monitoring in Spring/Summer 2018. We're still searching for the perfect location, and we'll be consulting our partners for ideas. Any suggestions for a suitable space would be warmly welcomed.
- We're ready to start work integrating the exterior and interior flow models we have developed. This will provide new information on indoor-outdoor exchange in natural ventilation.
- We'll be further developing our reduced order models for rapid – almost real time – calculations. This is just one of the practical applications we're hoping to develop as part of MAGIC, to support town planners and developers. If you have ideas on how MAGIC's research findings could be used to support industry and would like to collaborate with us, then please get in touch.
- We're holding our next partners meeting on **March 21st at Imperial College London, please save the date.** This will include a presentation by the GLA's Stephen Inch, looking at the Mayor's London Plan and how it supports improved Air Quality including natural ventilation.

OTHER NEWS

New Team Member: We are welcoming a new member to the MAGIC team in 2018 with Sophy Bristow joining us as the new Project Coordinator.

Partnerships: Collaboration is important to us, and we've been busy spreading the word about MAGIC at a range of talks and events in 2017, including the APRIL meeting at City Hall, the International Refurbishment Symposium and the Low Energy Ventilation network meeting. If you're working in an area that you think would be interesting to us, or if you have a potential partnership opportunity, then please **get in touch**.

MAGIC in the news: In November, MAGIC featured in the New Statesman's Clean Cities Supplement. You can read the full supplement **here**.

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