MAGIC CIRCULAR

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Envisaging a world with zero carbon cities

With summer well and truly underway, the high temperatures have got everyone reaching for their fans and thinking about air conditioning. So how realistic is natural ventilation in these kinds of conditions? This is a question we've been looking at in relation to the test room at Elephant and Castle, and you can find out more about our findings overleaf. One thing is for sure, as heatwaves become more common, we will need a better understanding of building and city design in relation to natural ventilation if we're going to optimise both energy efficiency and productivity in cities around the world. This summer's weather has put these questions front and centre—and we're glad to be helping address the challenge.

To take our research forward, we've recently been setting up our second test site in Cambridge. It's next to a busy road, but also both green and blue space, so we hope it will expand our understanding of the different factors which can impact pollution flows and the potential for naturally ventilating buildings.

Finally, please make a note in your diary, our next partners meeting will be on Thursday September 20th at Downing College Cambridge. We're looking forward to continuing the discussion around how end-users will benefit from the final MAGIC tools, and what they need to support decisions around natural ventilation. We look forward to seeing you there.

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

NATURAL VENTILATION ON HOT DAYS

Jiyun's recent efforts have been focused on looking at whether our test-room at London South Bank University in Elephant and Castle could be thermally comfortable during working hours in summer, with zero cooling energy.

To answer this question, the indoor thermal conditions of the test room were evaluated via the EnergyPlus model for all the weekdays from July 01 to August 31, 2017 under different window opening scenarios during working hours (8:00-18:00). The simulation results showed that the best scenario with the largest air change rate occurs when opening the lower sash of the courtyard-side window and upper sashes of two London-Road-side windows to take advantages of both cross ventilation and stack ventilation effects. The office room can be thermally comfortable for 92% of working hours under the best window control scenario based on the European thermal comfort standard BS EN 15251. This implies that for the remaining 8% of working hours during hot days the room cannot be cooled to comfortable range with daytime ventilation only. To find the right cooling strategy for hot days, the hottest day (July 06, 2017) was selected as the summer design day. A combination of precedent night-time cooling, daytime natural ventilation and blinds shading were found to be effective to make the office room thermally comfortable during nearly 100% working hours at the summer design day (see Figure 1).

The results have significant implications for occupant behaviour as we expect increasingly hot periods in summer. For example, it could be used to help develop guidance where occupants are recommended, for example, to check the weather forecast for the next day and if the maximum temperature is expected to be higher than 28 °C, to leave the office windows open during the night; and otherwise, keep the windows closed.

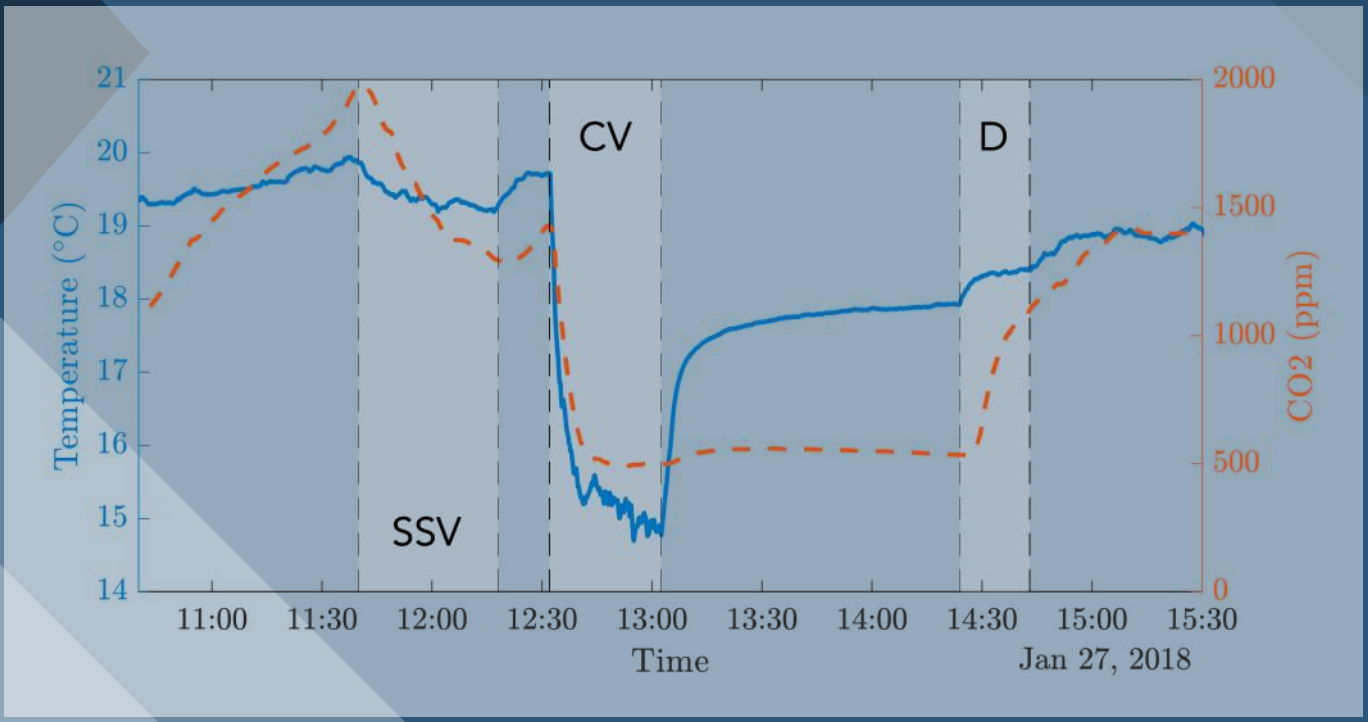


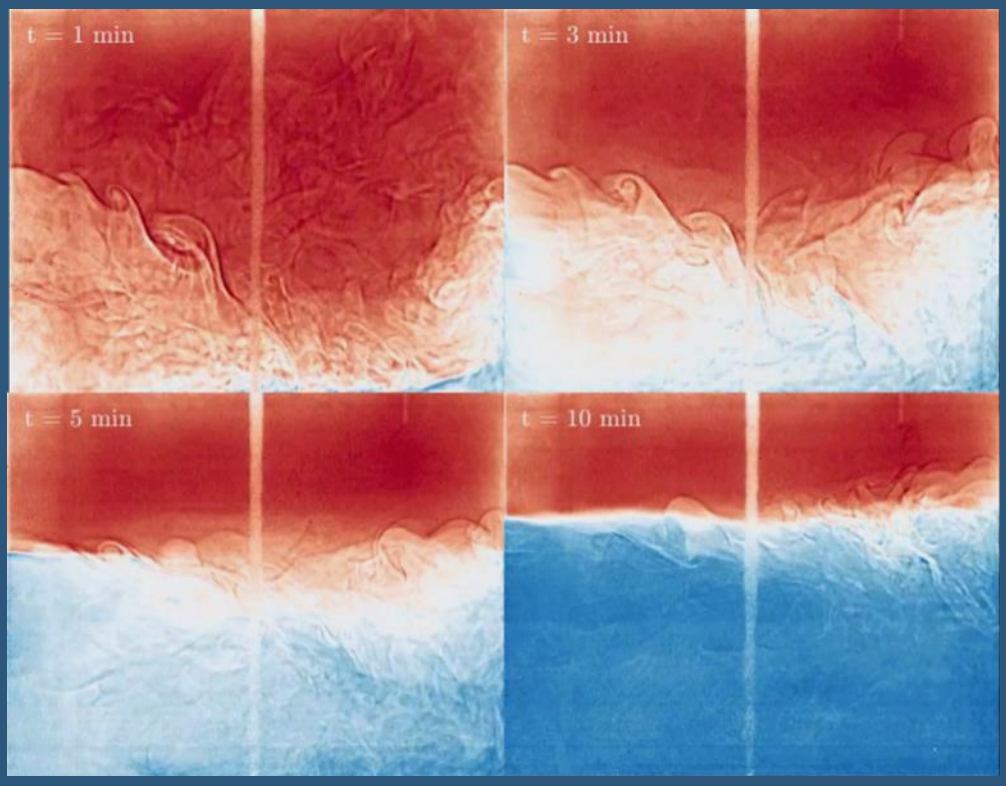
Figure 1. The indoor thermal condition of the summer design day (July 06, 2017) with night-time cooling at July 05, daytime natural ventilation and usage of blinds at July 06.

INVESTIGATING VENTILATION FLOWS WITH WATER

Megan and her team have begun experiments investigating the effect of temperature differences on cross-ventilation. The experiments are performed in a large water flume, with a cross-sectional area of 2 m x 1 m. Into the flume is placed a model room, which is a 0.5 m cube. Before the start of an experiment, the water inside the model room is heated and dyed. The flume is switched on, to provide a flow past the model room, modelling the effect of wind. Two windows are opened on opposite walls of the model room, one at the front, facing the wind, and one at the back. For this experiment, the flow velocity was 2.5 cm/s and the temperature difference was 1 degree C. The dyed, warm fluid inside the room (red) is flushed out by the wind, cooling the lower layer of the room, up to the top of the windows. At late times, there is a two-layer stratification in the room - a warm upper layer and a cool lower layer. You can see the video here.

Experiments performed by Megan Davies Wykes and Elkhansaa Chahour.

Figure 2: Showing the water flume experiment as viewed from the side



Other news:

- Read a full update on our research in the paper *Natural ventilation in cities: the implications of fluid mechanics* published online in Building Research and Information on June 29 2018
- If you'd like to attend our partners meeting on September 20th, please email sb2257@cam.ac.uk
- Check out the latest videos of our modelling on the MAGIC YouTube channel
- Follow us on Twitter @MAGICities

CAMBRIDGE TEST SITE

Following the analysis of results from our Elephant and Castle test site, Shiwei and the team spent some time thinking about where our next site should be. We had learnt a lot about pollution flows in the inner city, and the impact of different roof shapes and building heights, for example. But what about parks, what about rivers and other water sources, what impact do those have on pollution flows and the potential to naturally ventilate buildings?

Cambridge is fortunate enough to be full of green and blue space, so we settled on a University of Cambridge site at the junction of Trumpington Road and the Fen Causeway, both busy roads but also backing onto a large park and the Cam river.

Shiwei and the team have been busy setting up the new room and the external monitoring system. Working with Cambridge City Council we've set up MAGIC monitors and temperature loggers around the city and we've also put MAGIC monitors, wall temperature monitors, two ultrasonic anenometers and a temperature array in the room itself. As well as ongoing monitoring we are also conducting short-term, controlled experiments to explore the impact of different window opening set-ups on natural ventilation and comfort in the room. The photo below shows the room with our monitoring equipment carefully positioned. Watch this space for the results.

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