

## Dr Xiaoming Cai PhD

Senior Lecturer

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### About

Dr Xiaoming Cai has over 20 years experience of research in large-eddy simulation (LES) of turbulence in the atmospheric boundary layer and in urban street canyons, dispersion of air pollutants in urban environment, and numerical modelling of meso-scale systems.

### Qualifications

- B.Sc.(Hons), Applied Mathematics, Fudan University, P.R. China
- M.Sc., Computational Fluid Dynamics, Fudan University, P.R. China Ph.D., Institute of Applied Mathematics and Atmospheric Science, UBC, Canada
- Ph.D., Institute of Applied Mathematics and Atmospheric Science, UBC, Canada

### Biography

Dr Xiaoming Cai was born in China and obtained his first degree and masters degree at Fudan University, Shanghai. He completed his PhD in 1993 at the University of British Columbia (UBC), Canada, in large-eddy simulation of atmospheric surface layer. He then did two years postdoctoral research at UBC in numerical modelling of sea breezes and photochemical air pollution. Following that he moved to Birmingham to take the post of Lecturer in 1995 and subsequently the post of Senior Lecturer in 2000.

### Teaching

Dr Xiaoming Cai was the course leader of MSc in Applied Meteorology & Climatology at Birmingham from 1997 to 2010. He was the PI for two successful NERC Master Training Grant applications with awards of NERC studentships from 2001 to 2011.

He has led the following modules: Atmospheric Composition & Physics (master-level), Atmospheric Dynamics (master-level), and Applied Micrometeorology (Year 3 level). He was also involved in delivering the Environmental Modelling module (Year 3 level).

### Postgraduate supervision

Dr Xiaoming Cai currently supervises the following PhD students:

- Fang Zhang, Project: Increasing Frequency and Impacts of Heat Waves in UK Cities caused by Climate Change and the Urban Heat Island Affect
- Jian Zhong, Project: Modelling Air Pollution within a Street Canyon
- James O'Neill, Project: High resolution meteorological modelling of wind field in a coastal, mountainous, and industrial complex
- Richard Bassett, Project: Quantifying the influence of wind advection on urban heat island for an improvement of a climate change adaptation planning tool

He also currently co-supervises the following PhD students:

- (with Rob MacKenzie) Olusegun Fawole, Project: Air Pollutant Dispersion Modeling
- (with Martin Widmann) Anastasios Matsikaris, Project: Assimilation of palaeoclimate proxy data into GCMs using ensemble member selection
- (with Lee Chapman) Juliana Antunes De Azevedo, Project: Urban Climate, Remote Sensing and Energy Demand
- (with Gregor Leckebusch) Mohammad Alharbi, Project: Analysis of the atmospheric boundary layer above the Eastern Red Sea and Saudi Arabia : climatology, synoptic analyses and micro/mesoscale modeling

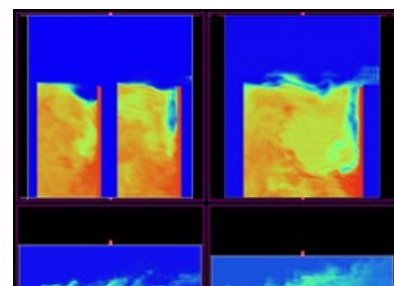
### Research

#### Research group

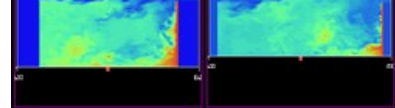
- **[Environmental health sciences \(/research/activity/environmental-health/index.aspx\)](/research/activity/environmental-health/index.aspx)**
- Climate & atmosphere

Dr Xiaoming Cai has research interests in the following areas:

- Boundary-layer meteorology, urban meteorology, and urban climate
- Air pollution meteorology & modelling
- Large-eddy simulation of atmospheric turbulence and dispersion



- Data assimilation for meteorological applications
- Computational Fluid Dynamics



Animated pictures of large-eddy simulation output of a scalar (temperature, water vapour, or pollutant) inside a street canyon for various canyon widths. Background wind above the building roof blows from the left to the right.

His recent research activities are in the following topics:

- Large-eddy simulation of turbulent flows and dispersion of atmospheric pollutants in street canyons
- Coupling chemistry and turbulence in a street-scale large-eddy model
- Large-eddy simulation of atmospheric boundary layer over an inhomogeneous urban surface
- Traffic induced turbulence and its effects on pollutant concentrations in urban street canyons and improvement of operational urban air quality model
- Modelling urban heat island and impact of urbanization on urban climate

He has been involved as a PI or a Co-I in five NERC-funded projects. In particular, he developed a unique LES model based on a meteorological modelling system for turbulence and dispersion in street canyons in an NERC project (Experimental quantification and modelling of dispersion of particles in urban street canyons). He further developed the model in the following aspects:

1. Being capable for various canyon configurations
2. Being equipped with suitable boundary conditions (wall functions) so that the cases with a given temperature and/or a given concentration at walls/roads can be examined
3. Implementing prognostic equations for fast photochemical reactions (NO<sub>x</sub>-O<sub>3</sub> chemistry and, recently, OH chemistry)

He has recently been involved in the following research projects:

- 2009-2011: Modelling turbulent processes near urban surface using large-eddy simulation, The Royal Society, International Joint Project (with Dr Liu, School of Atmospheric Sciences, Nanjing University, China)
- 2010-2012: Birmingham Urban Climate Change Adaptation with Neighbourhood Estimates of Environmental Risk, the Knowledge Transfer Partnerships (KTP) programme, funded by the Technology Strategy Board, NERC, and Birmingham City Council, total value of £127,500
- 2011-2014: High density temperature measurements within the urban environment (HiTemp), NERC Networks of Sensors Programme, funded by NERC (NERC ref. NE/I006915/1; PI: Dr Chapman; CoIs: Prof Grimmond, Dr X Cai), total value of £715,218
- 2012-2017: Fundamental Studies of the Sources, Properties and Environmental Behaviour of Exhaust Nanoparticles from Road Vehicles (FASTER), funded by EU ERC, (PI: Prof. R.M. Harrison; CoIs: Prof A.R. MacKenzie, Dr X Cai et al.), total value of €2,400,000
- 2013-2017: Quantifying the influence of wind advection on urban heat island for an improvement of a climate change adaptation planning tool, NERC CASE studentship (with Dr Chapman at University of Birmingham and Mr Nick Grayson at Birmingham City Council), funded by NERC (NE/K008056/1), total value of £68,671

## Awards

- Lord Stafford Award for Environmental Sustainability, November 2012, Birmingham Urban Climate Change Adaptation with Neighbourhood Estimates of Environmental Risk (BUCCANEER), the Knowledge Transfer Partnerships (KTP) programme with Birmingham City Council.

## Publications

Young, D.T., L. Chapman, Muller, C., C.S.B. Grimmond, and **X.-M. Cai**, 2014: A low-cost wireless temperature sensor: evaluation for use in environmental monitoring applications, *Journal of Atmospheric and Oceanic Technology*, in press.

Zhong, J., **X.-M. Cai** and W. J. Bloss, 2014: Modelling segregation effects of heterogeneous emissions on ozone levels in idealised urban street canyons: Using photochemical box models, *Environmental Pollution*, **188**, 132-143. DOI: 10.1016/j.envpol.2014.02.001

Barnes, M. J., T. K. Brade, A. R. MacKenzie, J. D. Whyatt, D. J. Carruthers, J. Stocker, **X.-M. Cai**, and C. N. Hewitt, 2013: Spatially varying surface roughness and urban breathability in a commercial air quality dispersion model, *Environmental Pollution*, **185**, 44-51. DOI: 10.1016/j.envpol.2013.09.039

Muller, C., L. Chapman, C.S.B. Grimmond, D. Young and **X.-M. Cai**, 2013: Sensors & The City: A Review of Urban Meteorological Networks, *Int. J. Climatology*, online-first: 11 Feb 2013, DOI: 10.1002/joc.3678

Muller, C., L. Chapman, D. Young, C.S.B. Grimmond and **X.-M. Cai**, 2013: Towards a standardised protocol for urban meteorological networks, *Bull. Amer. Meteor. Soc.*, DOI: 10.1175/BAMS-D-12-00096

Bright, V., W.J. Bloss and **X.-M. Cai**, 2013: Urban street canyons: coupling dynamics, chemistry and atmospheric pre-processing, *Atmospheric Environment*, **68**, 127-142. DOI:10.1016/j.atmosenv.2012.10.056

Grawe, D., H.L. Thompson, J. Salmond, **X.-M. Cai**, K.H. Schluenzen, 2013: Modelling the impact of urbanisation on regional climate in the Greater London Area, *Int. J. Climatology*, **33**, 2388-2401. DOI: 10.1002/joc.3589

Tomlinson, C.J., T. Prieto-Lopez, R. Bassett, L. Chapman, **X.-M. Cai**, J.E. Thornes, and C.J. Baker, 2013: Showcasing urban heat island work in Birmingham - measuring, monitoring, modelling and more, *Weather*, **68**, 44-49

**Cai, X.-M.**, 2012: Effects of wall heating on flow characteristics in a street canyon, *Boundary-Layer Meteorology*, **142**, 443-467. DOI 10.1007/s10546-011-9681-6.

**Cai, X.-M.**, 2012: Effects of differential wall heating in street canyons on dispersion and ventilation characteristics of a passive scalar, *Atmospheric Environment*, **51**, 268-277. DOI 10.1016/j.atmosenv.2012.01.010.

Solazzo, E., S. Vardoulakis and **X.-M. Cai**, 2011: A novel methodology for interpreting air quality measurements from urban streets using CFD modelling, *Atmospheric Environment*, **45**, 5230-5239. DOI: 10.1016/j.atmosenv.2011.05.022

Bright, V., W.J. Bloss and **X.-M. Cai**, 2011: Modelling atmospheric composition in urban street canyons, *Weather*, **66**, 106-110

Thornes, J., W. Bloss, S. Bouzarovski, **X.-M. Cai**, L. Chapman, J. Clark, S. Dessai, S. Du, D. van der Horst, M. Kendall, C. Kidd, and S. Randalls, 2010: Communicating the value of atmospheric services. *Meteorological Applications*, **17**, 243-250.

Solazzo, E., **X.Cai**, S.Vardoulakis, 2009: Improved parameterisation for the numerical modelling of air pollution within an urban street canyon, *Environmental Modelling & Software*, **24**, 381-388.

**Cai, X.-M.**, J.F. Barlow and S.E. Belcher, 2008: Dispersion and transfer of passive pollutants in and above street canyons – Large-eddy simulations, *Atmospheric*

Solazzo, E., **X. Cai** and S. Vardoulakis, 2008: Modelling wind flow and vehicle-induced turbulence in urban streets, *Atmospheric Environment*, 42, 4918-4931.

Chapman, L., Thornes, J.E., Huang, Y., **Cai, X.-M.**, Sanderson, V.L., & White, S.P., 2008: Modelling of rail surface temperatures: a preliminary study, *Theoretical and Applied Climatology*, 92, 121-131.

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Grawe, D., **X.-M. Cai** and R.M. Harrison, 2007: Large eddy simulation of shading effects on NO<sub>2</sub> and O<sub>3</sub> concentrations within an idealised street canyon, *Atmospheric Environment*, 41, 7304-7314.

Solazzo, E., S. Vardoulakis and **X.-M. Cai**, 2007: Evaluation of traffic producing turbulence schemes within operational street pollution models using roadside measurements, *Atmospheric Environment*, 41, 5357-5370.

Yu, Y., **X.-M. Cai**, and X.S. Qie, 2007: Influence of topography and large-scale forcing on the occurrence of katabatic flow jumps in Antarctica: Idealized simulations, *Advances in Atmospheric Science*, 24, 819-832.

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Yu, Y., **Cai, X.-M.**, King, J.C. and Renfrew, I.A., 2005: Numerical simulations of katabatic jumps in Coats Land, Antarctica, *Boundary-Layer Meteorol.*, 114, 413-437.

Baker, J., Walker, H.L. and **Cai, X.-M.** 2004, A study of the dispersion and transport of reactive pollutants in and above street canyons - A Large Eddy Simulation, *Atmospheric Environment*, 38, 6883-6892.

**Cai, X.-M.**, Nasrullah, M. and Huang, Y. 2004: Fumigation of pollutants into a growing convective boundary layer over an inhomogeneous surface: a large eddy simulation, *Atmospheric Environment*, 38, 3605-3616.

Cui, Z.-Q., **Cai, X.-M.** Baker, C. 2004: Large eddy simulation of turbulent flow inside a street canyon, *Quart. J. Royal Meteorol. Soc.*, 130, 1373-1394

**Cai, X.-M.**, Zheng Y. and McGregor, G.R. 2002, Modelling of meteorological conditions at an urban scale for the PUMA winter campaign, *Physics and Chemistry of the Earth*, 27, 1479-1485.

**Cai, X.-M.**, Luhar, A.K. 2002: Fumigation of pollutants in and above the entrainment zone into a growing convective boundary layer: a large eddy simulation, *Atmospheric Environment*, 36, 2997-3008.

**Cai, X.-M.** and D.G. Steyn, 2000: Modelling study of sea breezes in a complex coastal environment, *Atmospheric Environment*, 34, 2873-2885.

**Cai, X.-M.**, R.A.S. Hourston and D.G. Steyn, 2000: A Numerical Study of Meteorological Conditions during PACIFIC '93, *Atmosphere and Ocean*, 38, 457-479.

**Cai, X.-M.**, 2000: Dispersion of a passive plume in an idealised urban convective boundary layer: a large-eddy simulation, *Atmospheric Environment*, 34, 61-72.

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Uno, I., **X.-M. Cai**, D.G. Steyn and S. Emori, 1995: A simple extension of the Louis method for rough surface layer modelling, *Boundary-Layer Meteorology*, Vol.76, 395-409.

**Cai, X.-M.**, D.G. Steyn and I.S. Gartshore, 1995: Resolved scale turbulence in the atmospheric surface layer from a large eddy simulation, *Boundary-Layer Meteorology*, Vol.75, 301-314