MAGIC - Partner Meeting

An update on numerical modelling using Fluidity

Rossella Arcucci, Megan Davies Wykes, Michela Garau, William Lin, Laetitia Mottet, Jiyun Song, Huw Woodward, Dunhui Xiao.
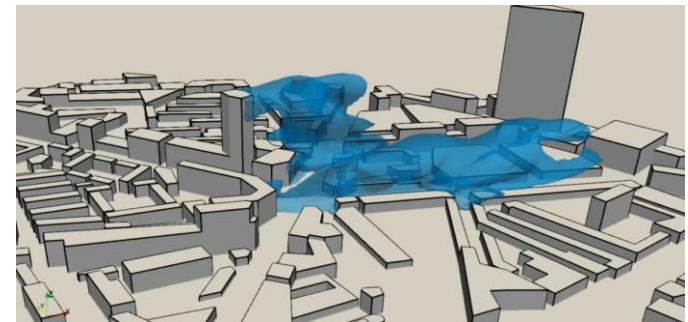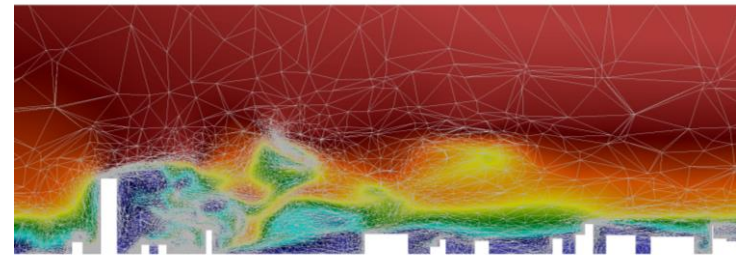
21st March 2018

Numerical Modelling

Fluidity

- Open-source CFD software developed at Imperial College London

- Finite-element method

- Unstructured and adaptive mesh

- Model for turbulence: Large Eddy Simulation (LES) approach
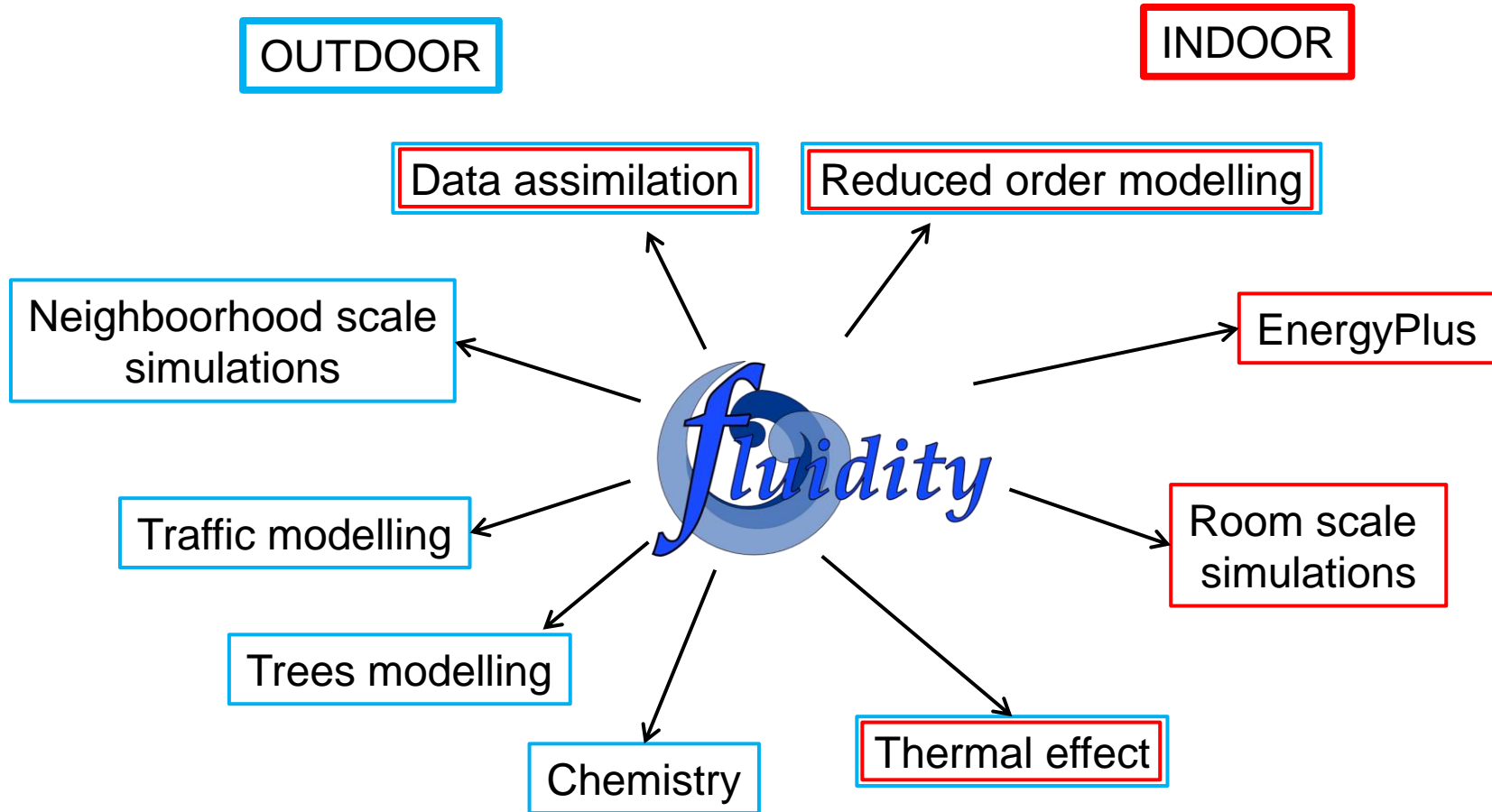
- Inlet velocity: synthetic eddy method

Numerical Modelling

Fluidity

Neighboorhood scale simulations

Comparison with wind tunnel experiment

Laetitia Mottet   William Lin
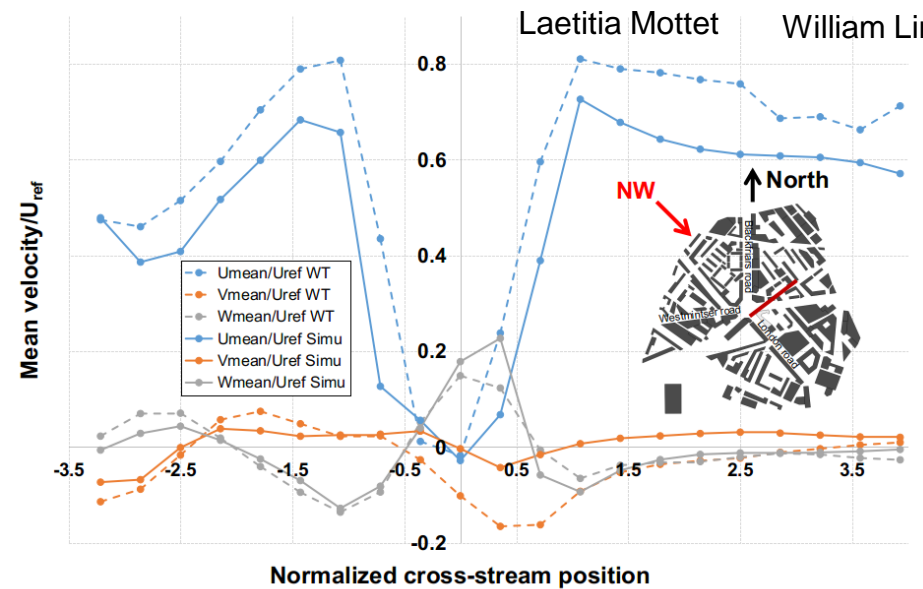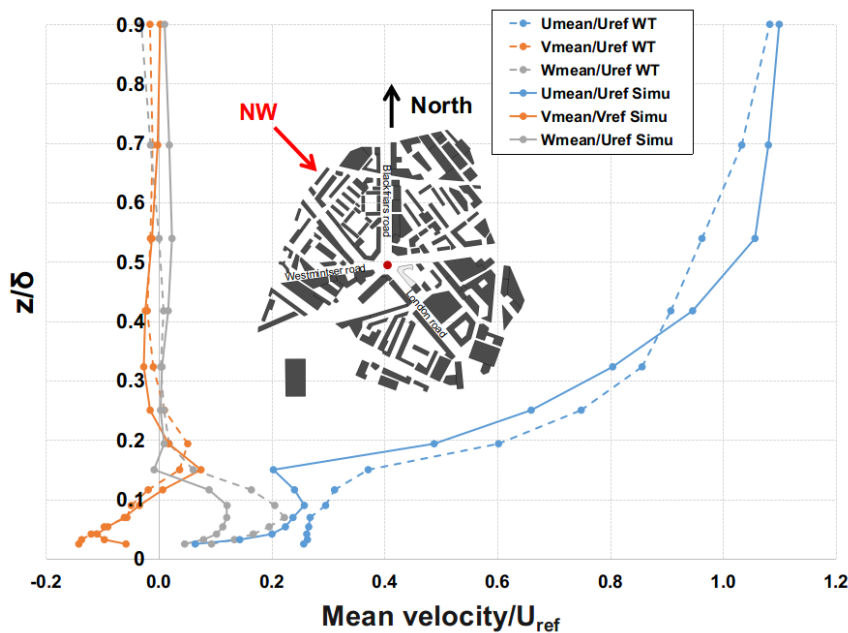
Neighboorhood scale simulations

Pollutant transport
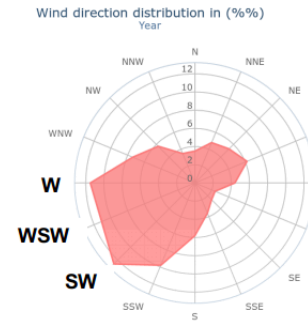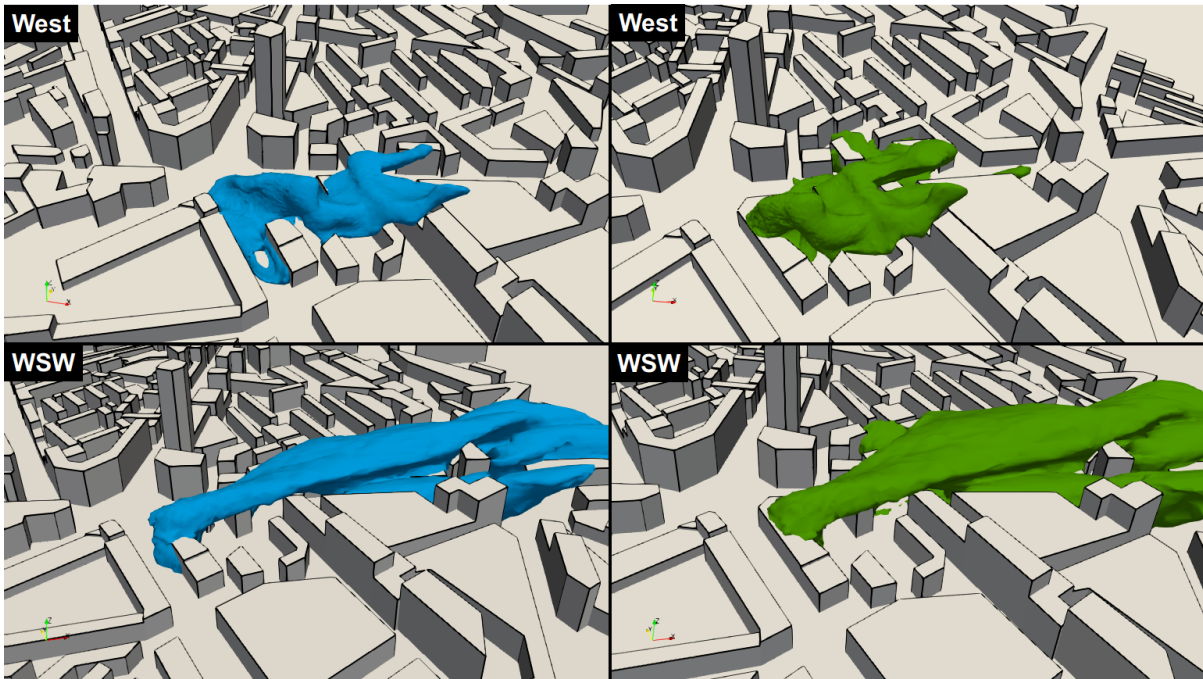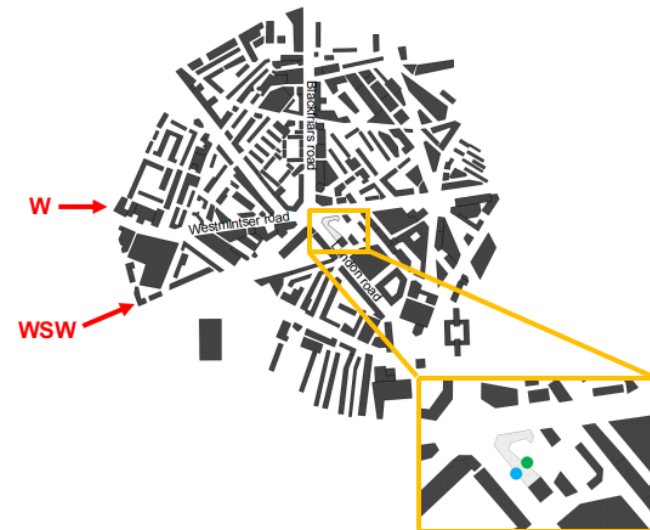
Towards more realistic models

Traffic modelling
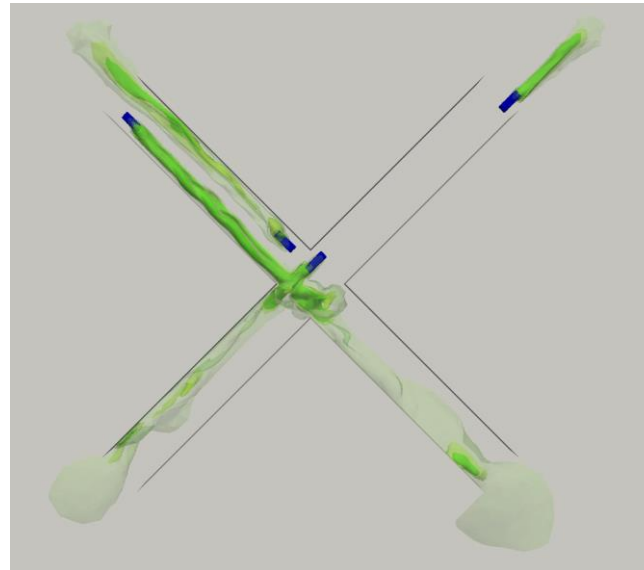
Huw Woodward

PTV
Vissim

Towards more realistic models

Roof shape effects

Huw Woodward

Wind direction

Flat roofs

Wind direction

Pitched roofs

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Imperial College London

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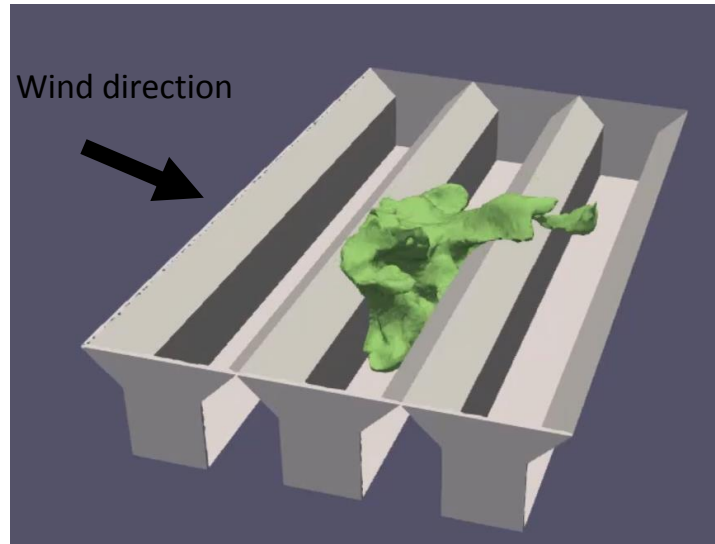
Towards more realistic models

Roof shape effects

Michela Garau

Legend: All Roofs (red), No Roofs (blue)

Diffuse Source Waterloo Rd

Wind

SW

Wind Direction   230°

● **Measuring Point**

★ **Source**

Diffuse Source St George's Circus

Wind
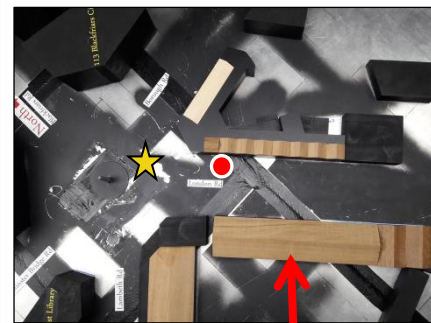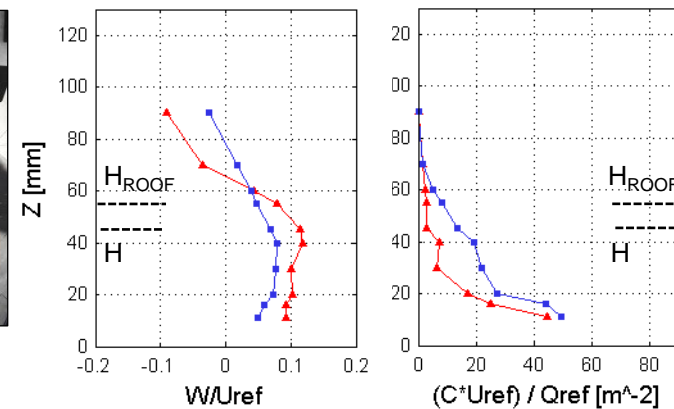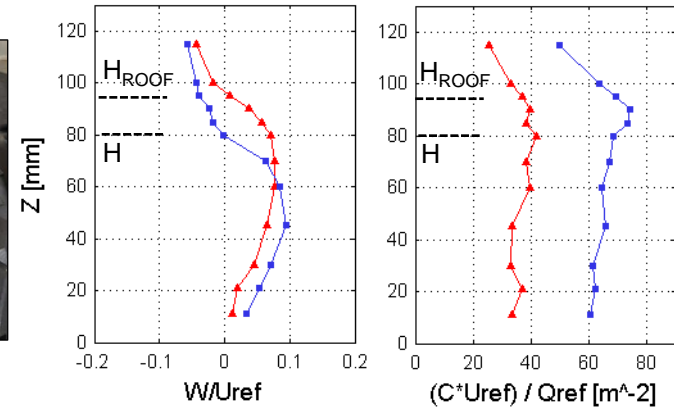
Towards more realistic models

Tree modelling

Huw Woodward

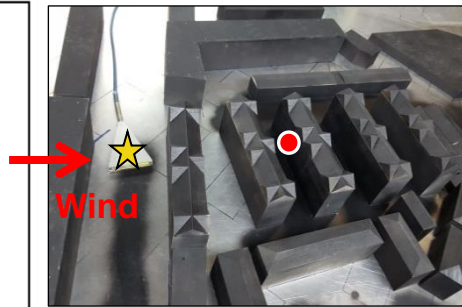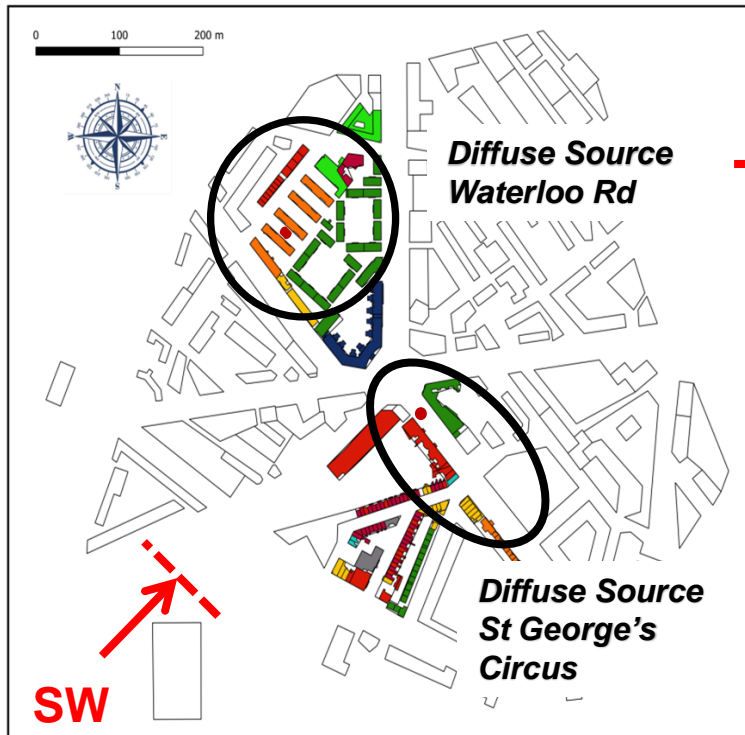- Trees are modelled as porous objects which absorb pollutants.

Sink added to momentum equation:

$$S = C_d A \left(\frac{1}{2} \rho v |v| \right)$$

Sink added to the diffusion equation:

Tree

$$\Delta C = C \, A \, V_d$$

Tracer1
1.000e+00
0.75
0.5
0.25
0.000e+00

Towards more realistic models

Elevation of the terrain

Laetitia Mottet

Yuzhong district, Chongqing, China. LoHCool project.
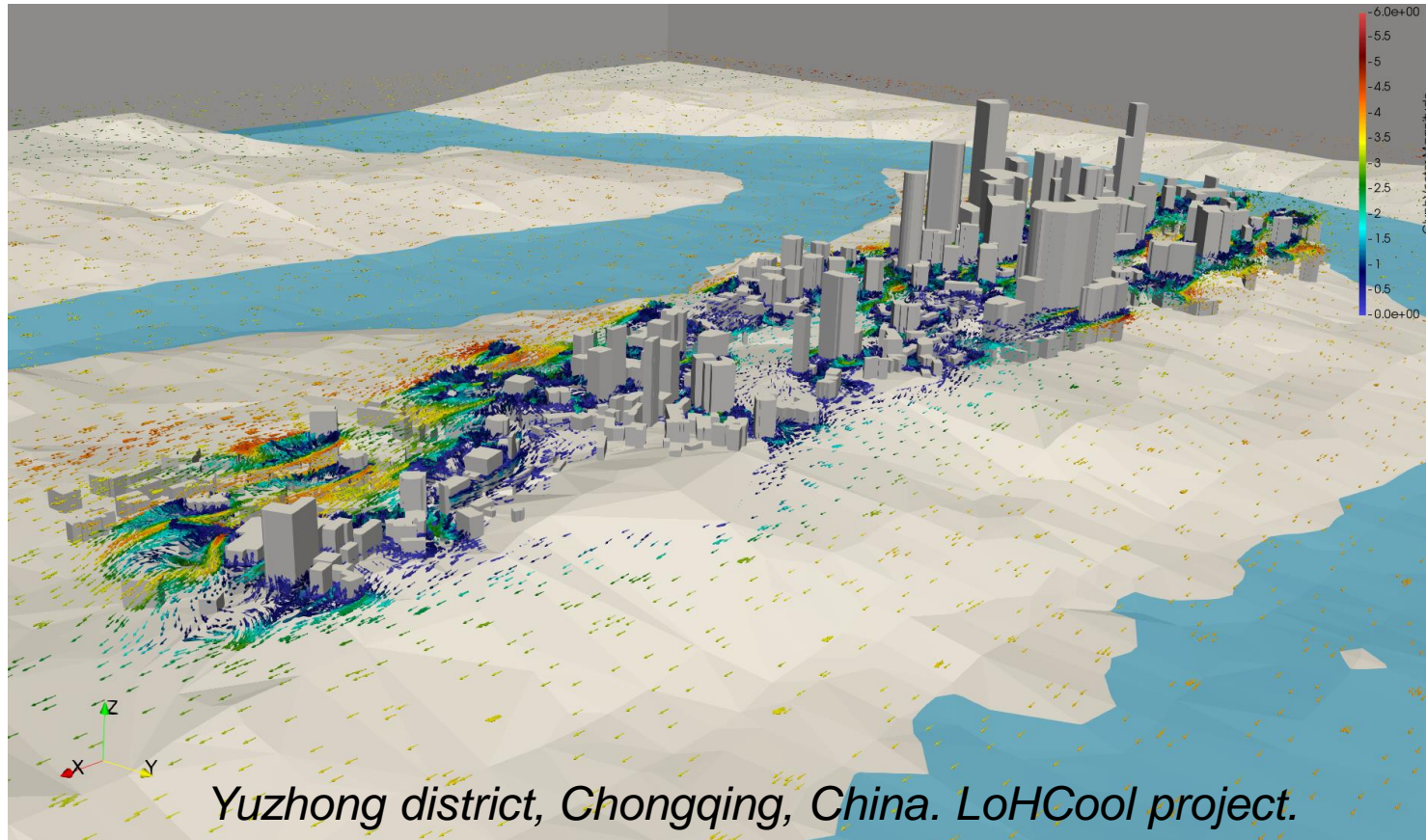
Towards more realistic models

Data assimilation (DA)

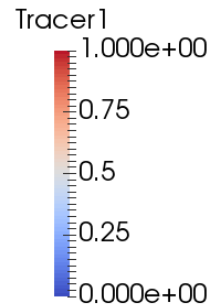DA is an uncertainty quantification technique used to incorporate observational data into a prediction model in order to improve numerical forecasted results.

Rossella Arcucci
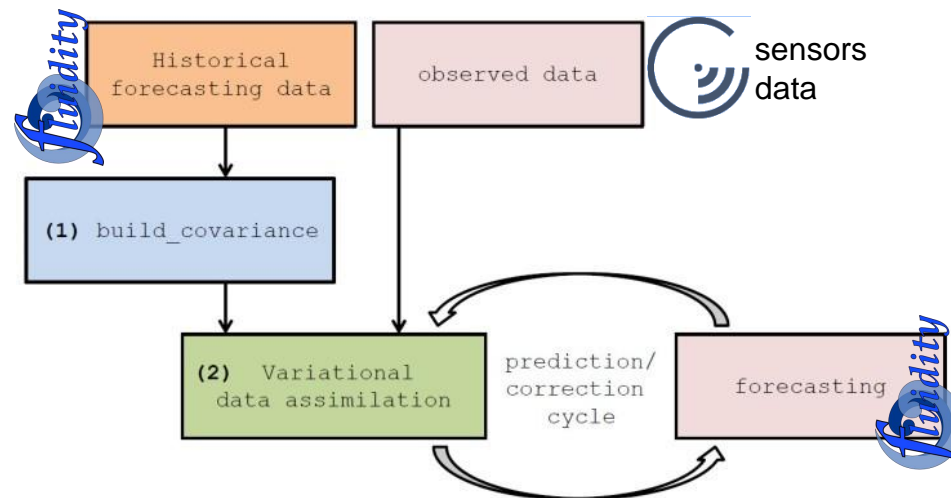
State of the art of DA in MAGIC: FluidityVAR

Towards more realistic models

Data assimilation (DA)

- 3D case study: error for Velocity

Blackfriars rd

Westmintser rd

London road

Rossella Arcucci
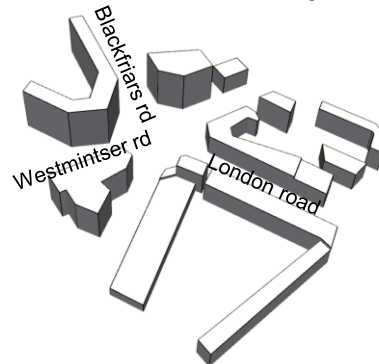
Error before DA
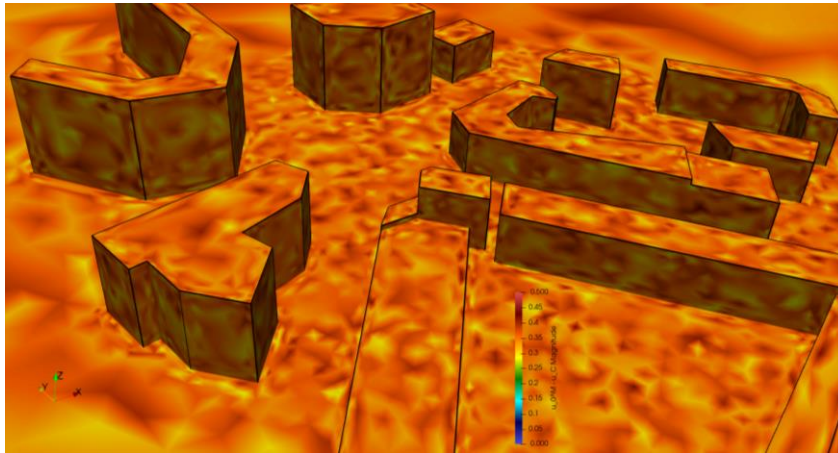
Error after DA
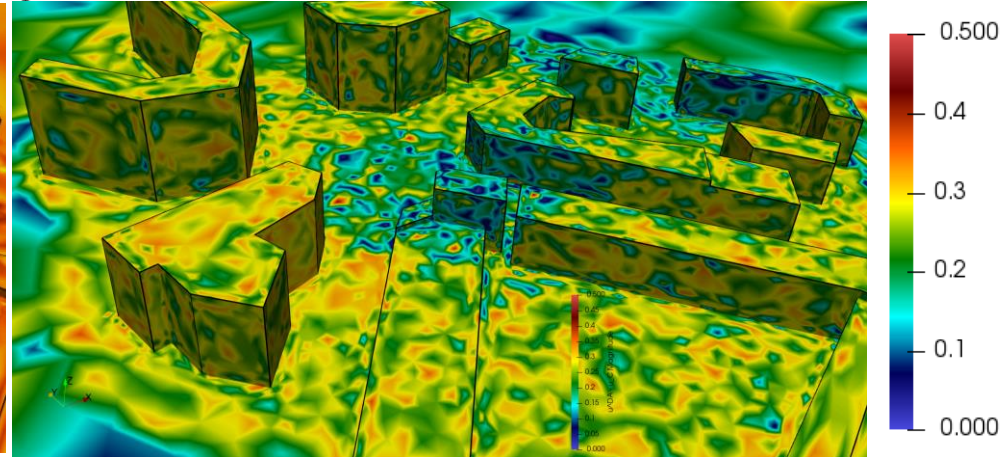
Towards more physics

Thermal effect - Microclimate

- Main factor influencing the urban microclimate

Laetitia Mottet
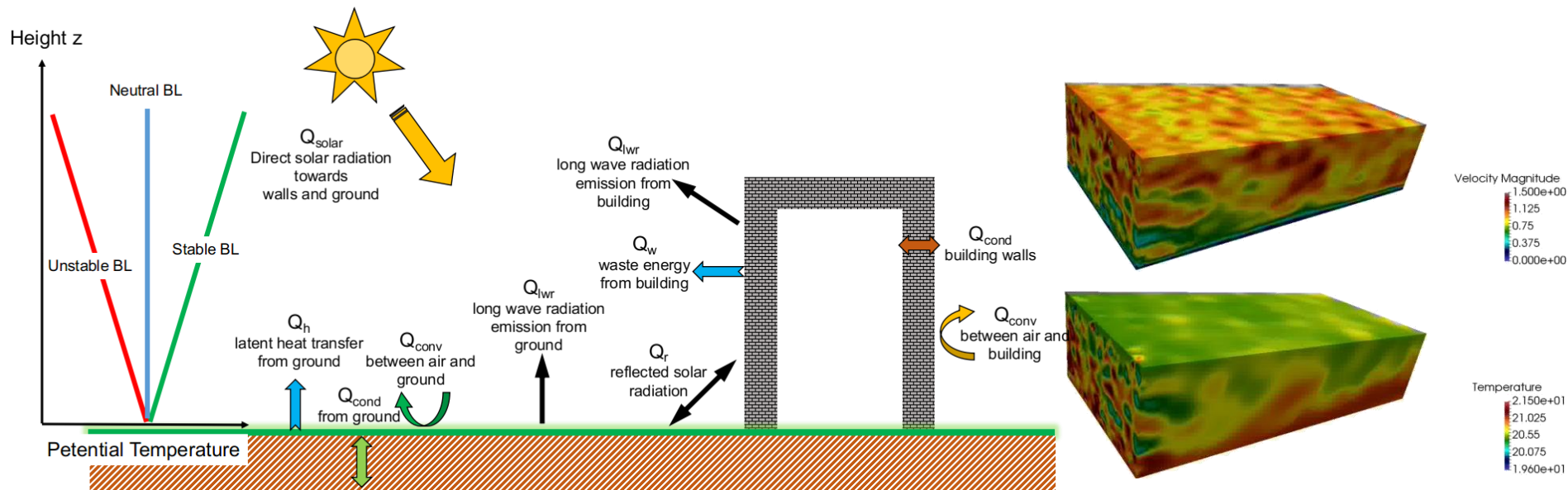
Towards more physics

Chemistry

$$NO_2 + h\nu \rightarrow NO + O \qquad (1)$$
$$O + O_2 + M \rightarrow O_3 + M \qquad (2)$$
$$NO + O_3 \rightarrow NO_2 + O_2 \qquad (3)$$
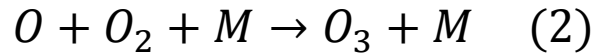
Huw Woodward
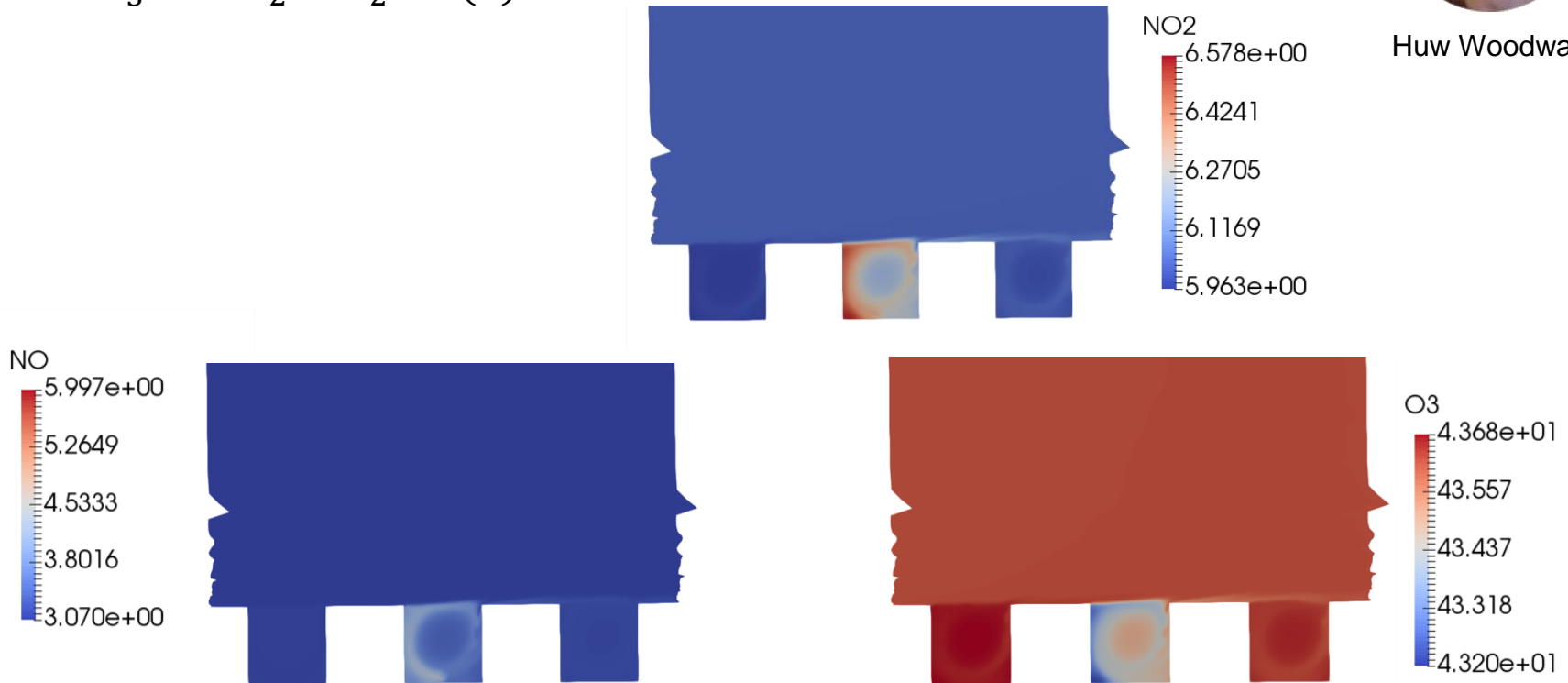
Indoor modelling

EnergyPlus

- Wind pressure coefficient

London Road Side

Courtyard Side

Laetitia Mottet   William Lin   Jiyun Song
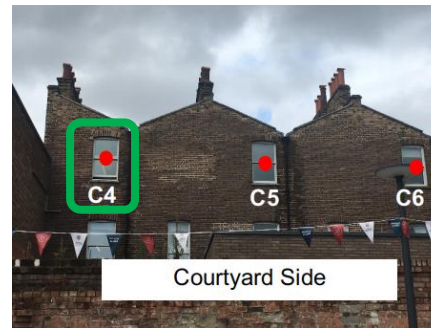
- Use outdoor sensor data, building material data, wind tunnel experiments and Fluidity simulations to model indoor thermal conditions.

PRESSURE COEFFICIENT L37

PRESSURE COEFFICIENT L38

PRESSURE COEFFICIENT C4

Simulation

Wind Tunnel

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Summary
Fluidity: a complete tool

- Neighboorhood scale simulations
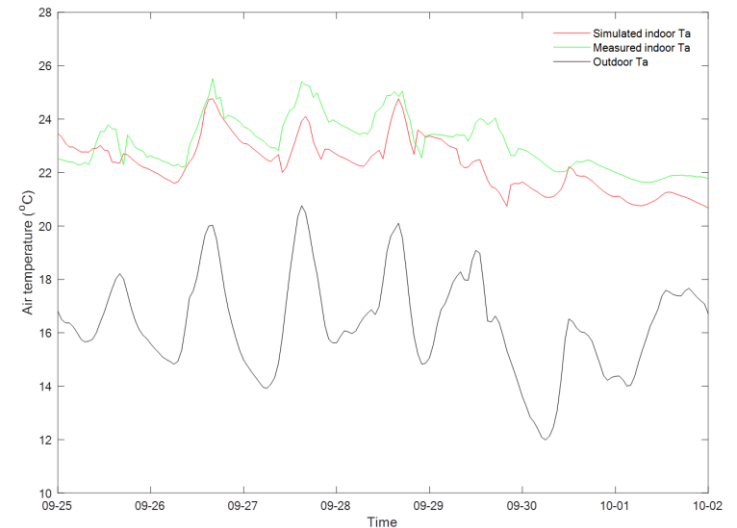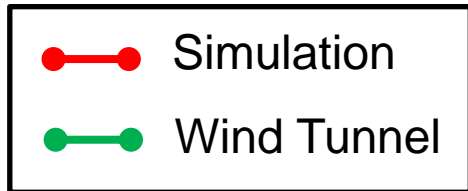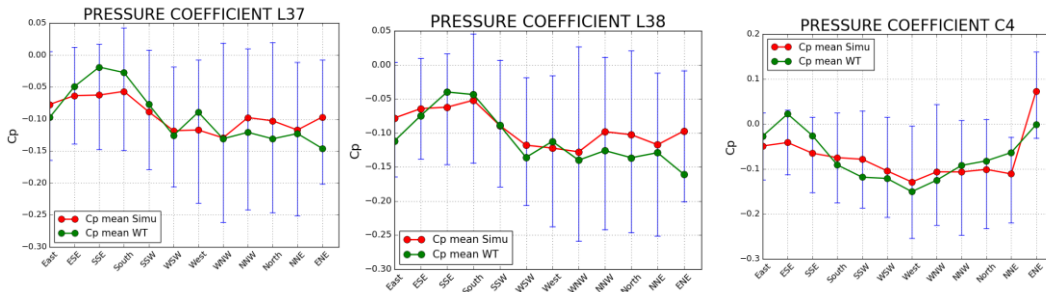 - Study of flow patterns
  - Study of the pollutant transport

- Towards more realistic models
  - Traffic modelling
  - Roof shape effects
  - Tree modelling
  - Elevation of the terrain
  - Data assimilation

- Towards more physics
  - Urban microclimate
  - Chemistry

- Towards fast numerical tool
  - Non-intrusive reduce order model

- Indoor modelling

Coupling all these models

Testing more physics with NIROM

Predict potential of NV based on external conditions

Coupling of DA/NIROM

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