Assessment of urban cooling strategies using a coupled model for urban microclimate and building energy simulation

Adrien Gros[a,d], Emmanuel Bozonnet[a,d], Christian Inard[a,d] , Marjorie Musy[b,d] , Isabelle Calmet[c,d] ,

[a]*University of La Rochelle, LaSIE* , [b]*ENSA of Nantes, CRENAU*

[c]*Ecole Central of Nantes, LHEEA,* [d]*IRSTV Research Federation*

Summary

- Introduction
- The modeling tool
- The case study
- Results
- Conclusion

Introduction

Buildings context

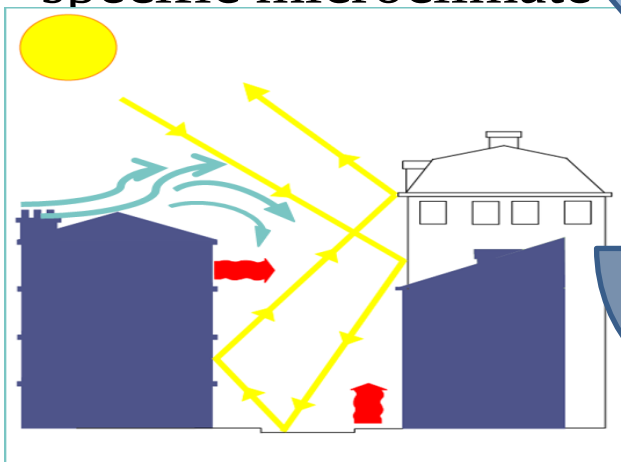
Buildings in Europe :

- 40% of energy consumption
- 36% of CO_2 emission

Building Energy Simulation (BES)

Urban context

specific microclimate



Increase cooling demand

Coupling urban microclimate and BES:

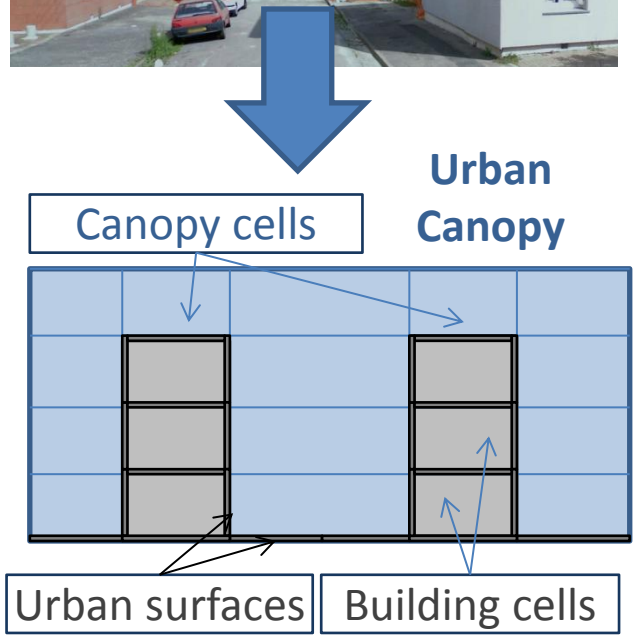
- Improve description of outdoor for BES
- Use landscaping to reduce energy demand
- Impact of building on microclimate

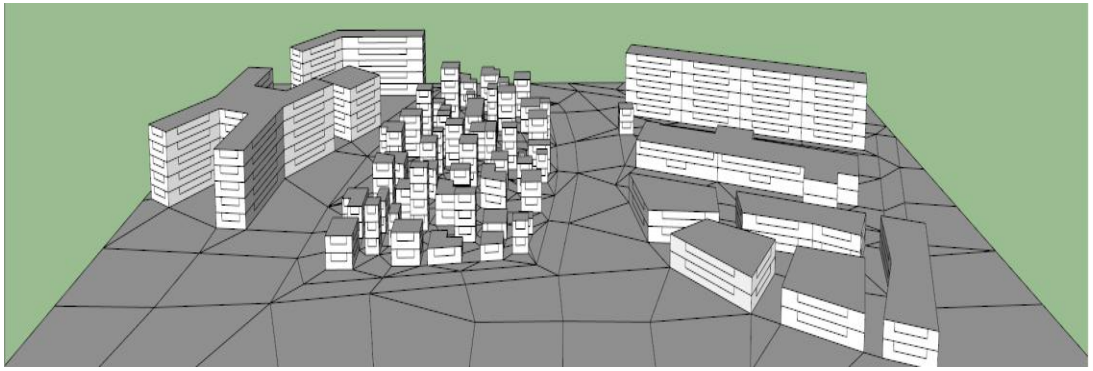
The modeling tool

EnviBatE

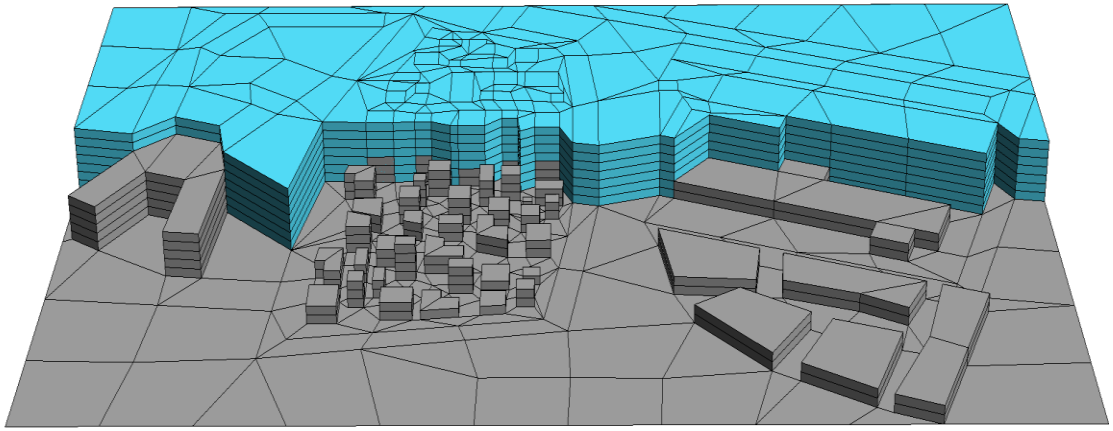
EnviBatE: Numerical mockup

Mesh adapted to BES





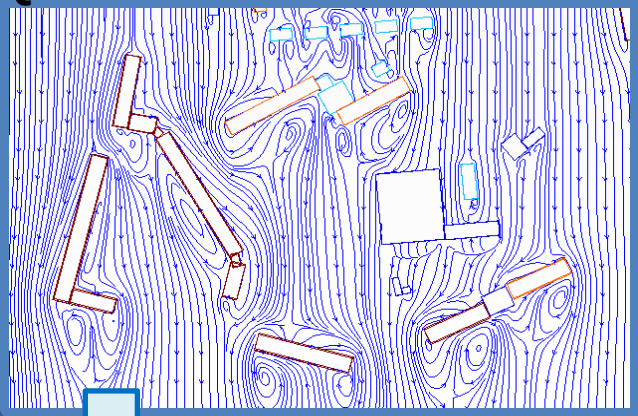
Surfacic mesh



Volumic mesh

EnviBatE: models

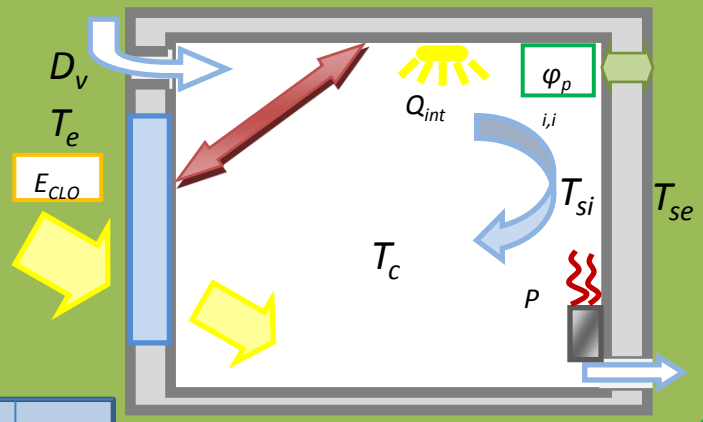
QUICURB



Velocity fields in urban canopy

Reduced building thermal model

weighted factors method



air mass flows between canopy cells

Conductive heat fluxes

SOLENE

- Direct and diffuse solar irradiances
- Form factor

SW and LW irradiance

Outdoor temperature

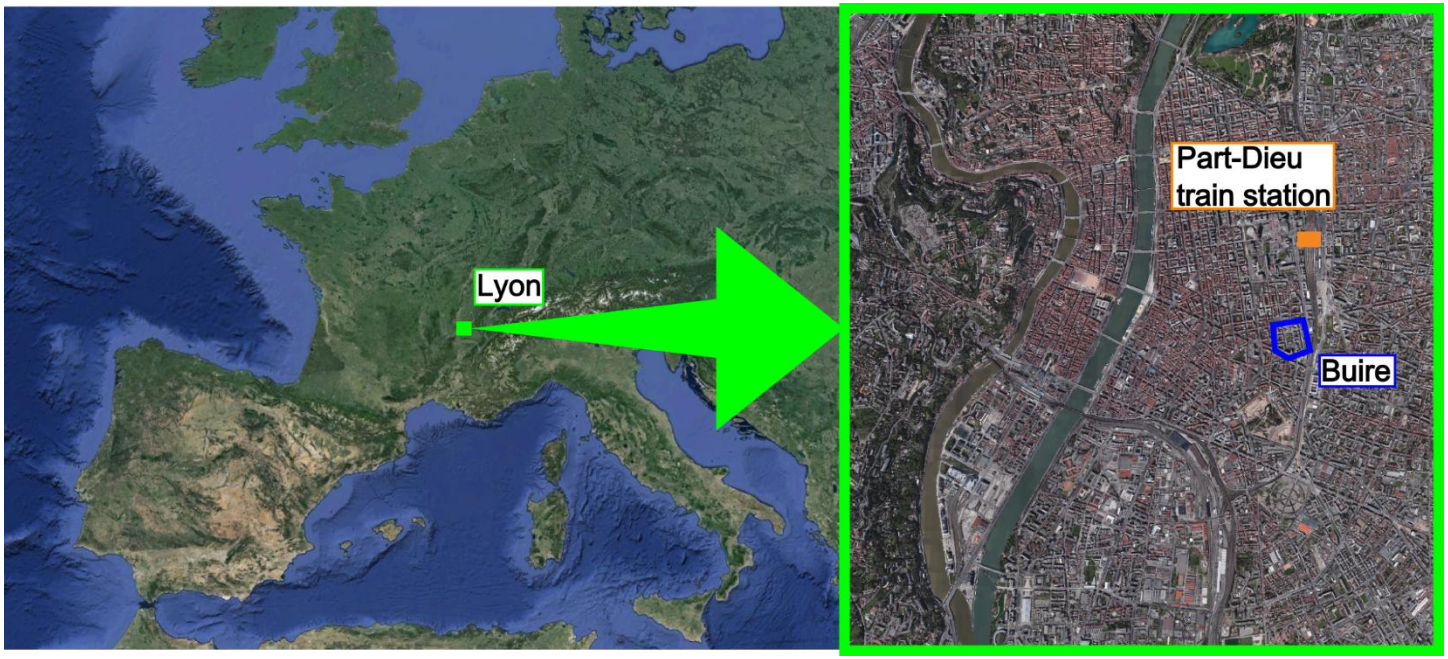
Outside surface temperature

Energy demand/ indoor temperature

The case study

Buire district

The case study – Buire district presentation



Existing district:

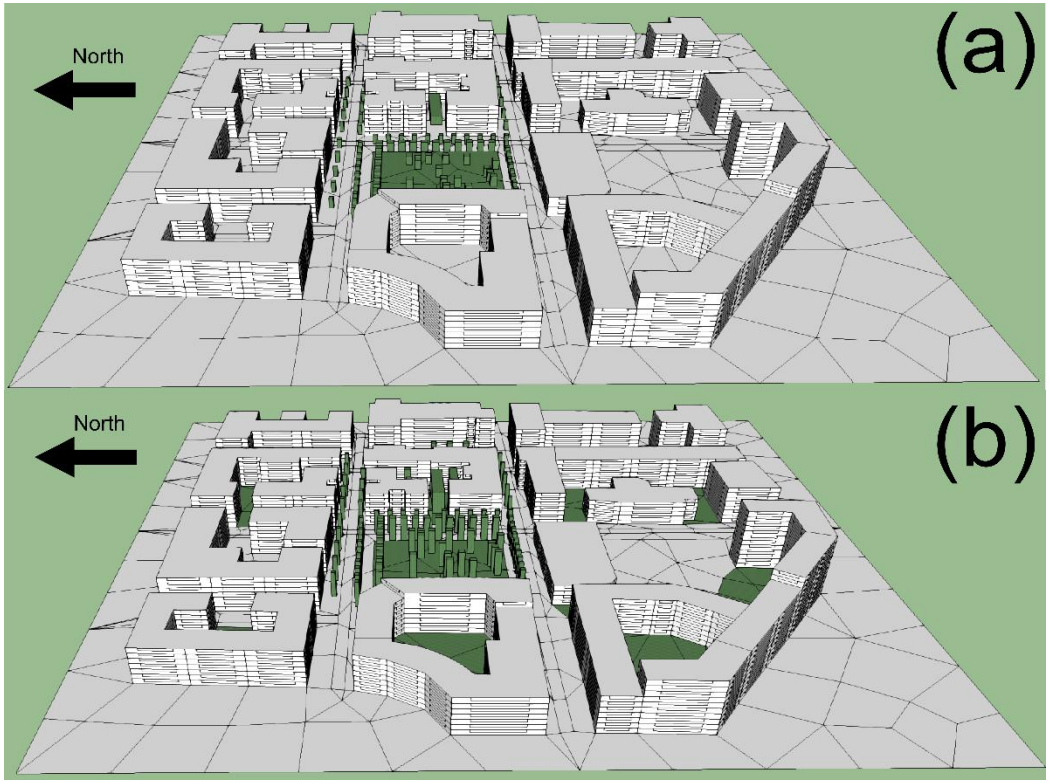
- 70,000 m²
- 10 buildings block
- 8 or10 floors by buildings (24-30 m high)
- Residential buildings

Goal of the study

Two scenario:

- ❑ Actual case

- ❑ Greened case :
  - size of tree is doubled
  - Space between building is greened



Impact of urban landscaping :

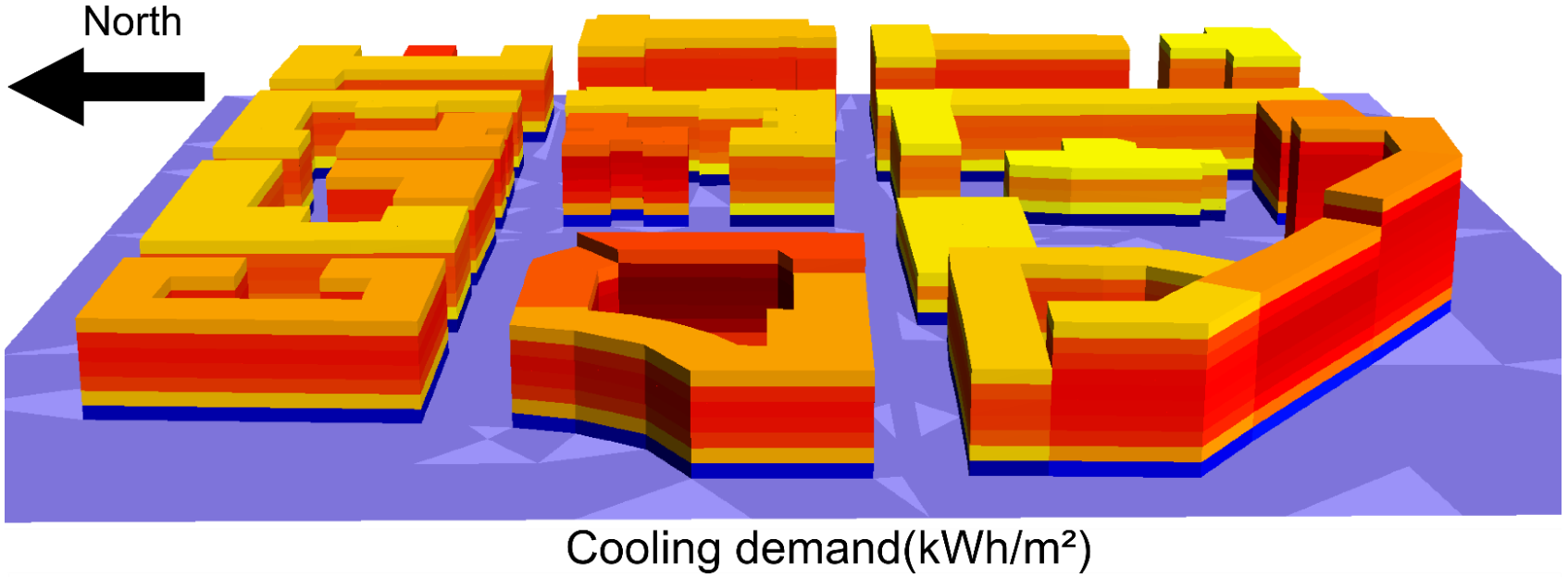
- Microclimate
- Building energy demand

Results

First results with radiative coupling

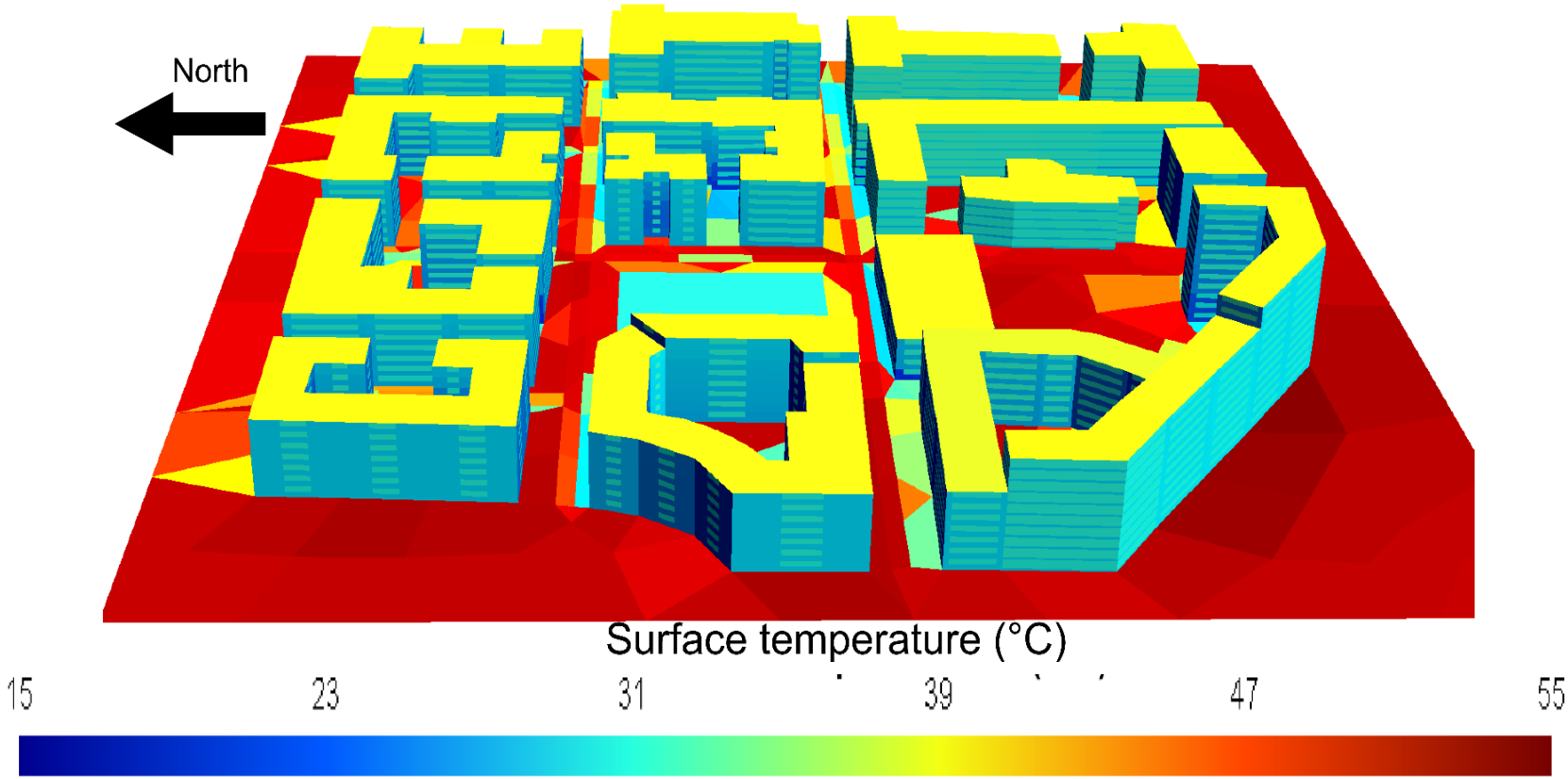
Results for actual case

- From the 1st of May to the 30th of September
- Indoor temperature set point equal to 26°C



- 50% of cooling energy demand < 33 kWh/m²
- Minimum values on ground floor

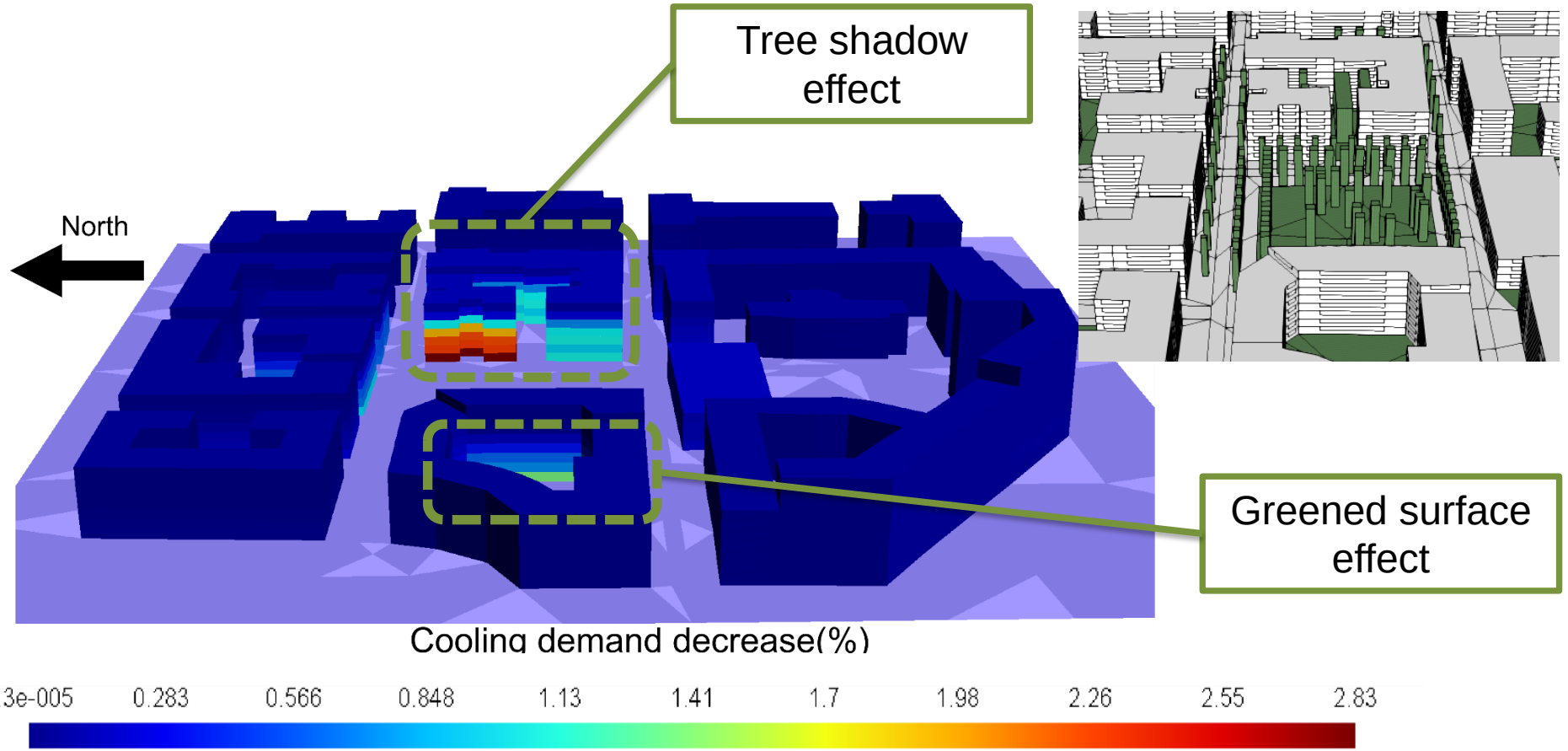
Results for actual case



19th of July at 2 PM (solar time), meteorological ambient temperature equal to 31°C

- Maximum values (55°C) on ground
- Low values (28°C) on windows

Results: impact of green scenario



Maximum decrease ≈ 3%

Relatively low value because tree already exist in reference case

Conclusion

- Developed model:
  - simulation during a seasonal period (hourly time step)
  - BES for each building at district scale
- Study case:
  - Impact of vegetation

Outlooks

- Study of other cooling strategies : cool paint, watering road
- Use experimental data of reduced scale model to validate models

CLIMABAT (1:10 reduced scale model)

Thank you!!

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(QUICURB model)

(Solene model)

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