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

Adrien Gros\textsuperscript{a,d}, Emmanuel Bozonnet\textsuperscript{a,d}, Christian Inard\textsuperscript{a,d}, Marjorie Musy\textsuperscript{b,d}, Isabelle Calmet\textsuperscript{c,d},

\textsuperscript{a}University of La Rochelle, LaSIE, \textsuperscript{b}ENSA of Nantes, CRENAU
\textsuperscript{c}Ecole Central of Nantes, LHEEA, \textsuperscript{d}IRSTV Research Federation
Summary

• Introduction
• The modeling tool
• The case study
• Results
• Conclusion
Buildings context
Buildings in Europe:
- 40% of energy consumption
- 36% of CO₂ emission

Urban context
Coupling urban microclimate and BES:
- Improve description of outdoor for BES
- Use landscaping to reduce energy demand
- Impact of building on microclimate

Building Energy Simulation (BES)
The modeling tool

EnviBatE
EnviBatE: Numerical mockup

Mesh adapted to BES

Urban Canopy

Surfacic mesh

Volumic mesh
EnviBatE: models

SOLENE
- Direct and diffuse solar irradiances
- Form factor

QUICURB
- Velocity fields in urban canopy
- Air mass flows between canopy cells

Reduced building thermal model
- Weighted factors method

Conductive heat fluxes
- Outdoor temperature
- Outside surface temperature
- Energy demand/indoor temperature

SW and LW irradiance
The case study

Buire district
The case study – Buire district presentation

Existing district:
- 70,000 m²
- 10 buildings block
- 8 or 10 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 1\textsuperscript{st} of May to the 30\textsuperscript{th} of September
- Indoor temperature set point equal to 26\textdegree C

- 50\% of cooling energy demand < 33 kWh/m\textsuperscript{2}
- Minimum values on ground floor
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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