Taking into account building environment in the energy consumption evaluation

Benjamin Morille [1] Nicolas Lauzet[2] Marjorie Musy[1,2]

[1]Institut de Recherche en Sciences et Technique de la Ville, FR CNRS 2488, Nantes, France

[2]Centre de Recherche Nantais Architectures Urbanités, AAU UMR CNRS 1562, Nantes, France

AAU crenau ambiances architectures urbanités

iRSTV FR CNRS 2488 Institut de Recherche en Sciences et Techniques de la Ville

Context

Reduction of building energy consumption

- 44% of the energy consumption in France
- Thermal regulation more and more exigent

Tools to evaluate energy consumption in a accurate way

- Improvements to take into account building environment
- Keep operational tools with acceptable time computation

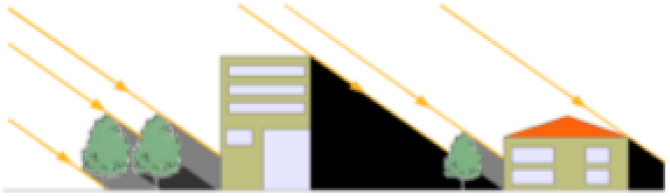
Objectives of the study

- Evaluation of the influence of the building environment on the energy consumption.
- Variation of this influence with the urban density.

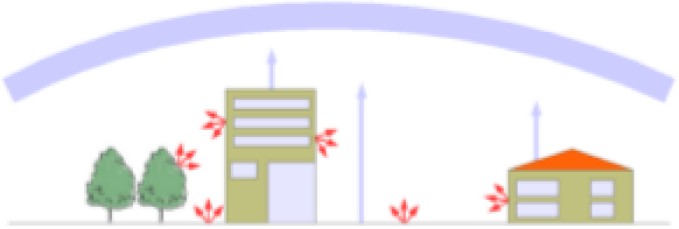
Preliminary findings...

- When is it (or not) necessary to take into account the influence of the urban environment in dynamic thermal simulation models?
- How to efficiently take urban environment into account?

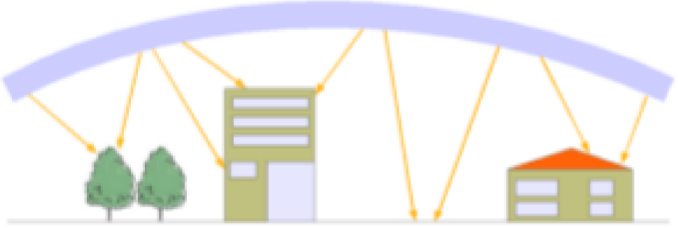
The building environment : physical phenomenon



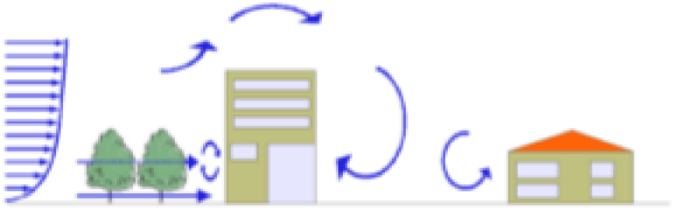
Direct solar radiation, solar masks



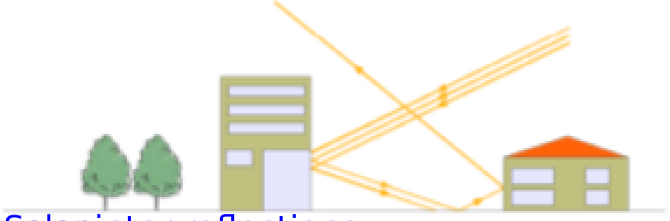
Surface temperatures, infrared radiation



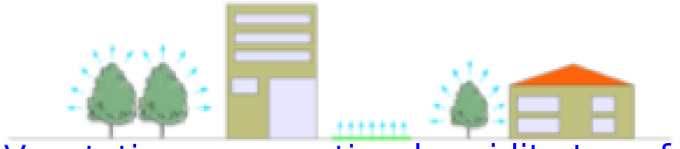
Diffuse solar radiation



Aeraulic phenomena, convective transferts, air temperatures



Solar inter-reflections

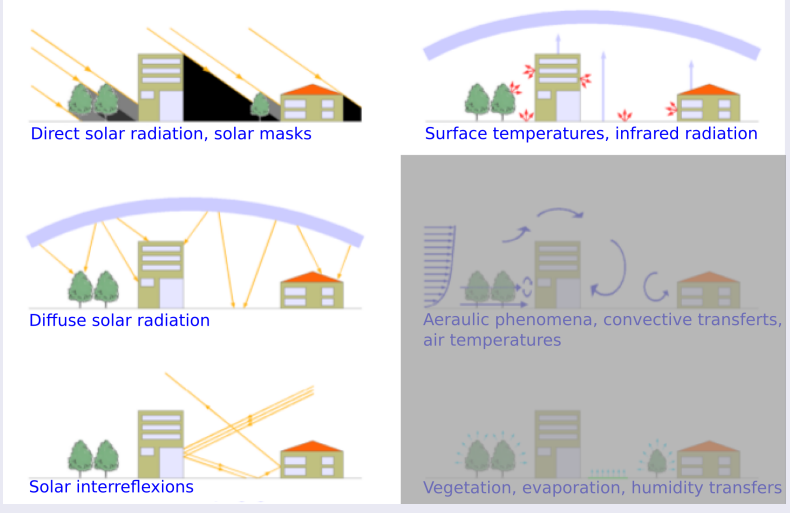


Vegetation, evaporation, humidity transferts

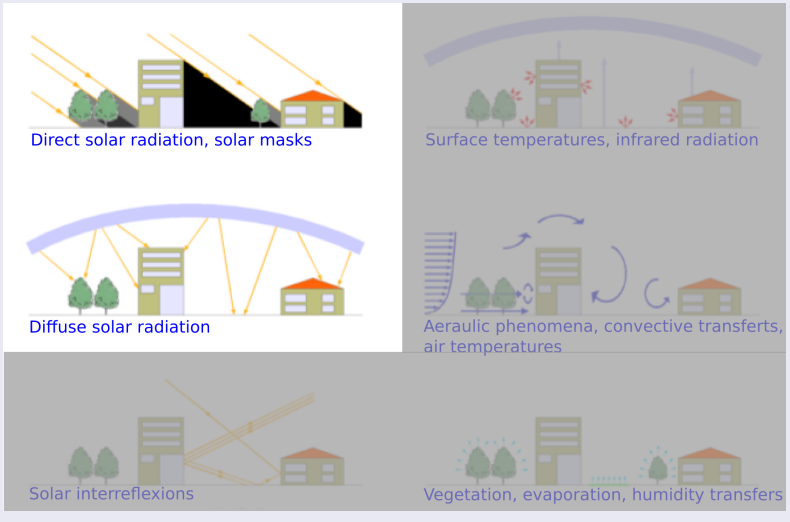
Thermal building environment

- Focus on the radiative exchanges
- Comparison with building energy consumption computed by commercial tools

In this study



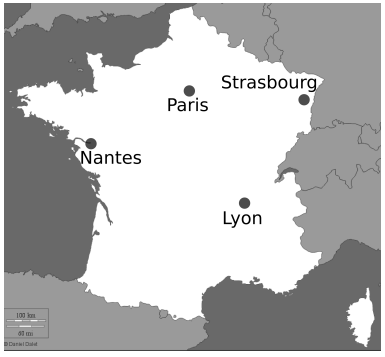
Commercial tools

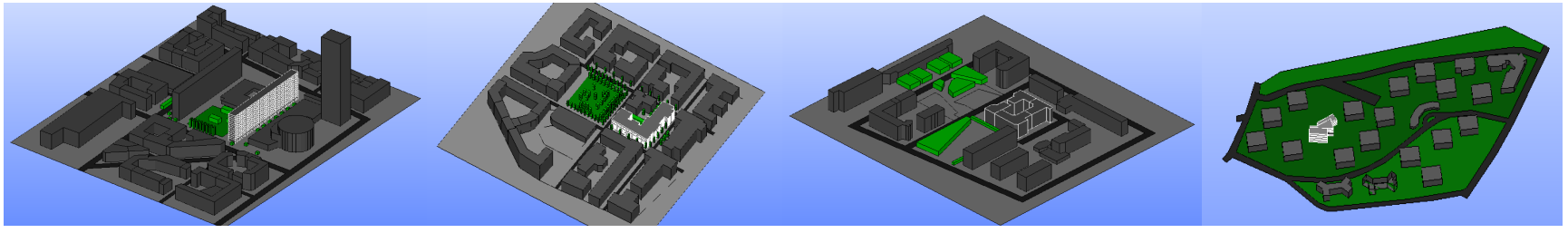


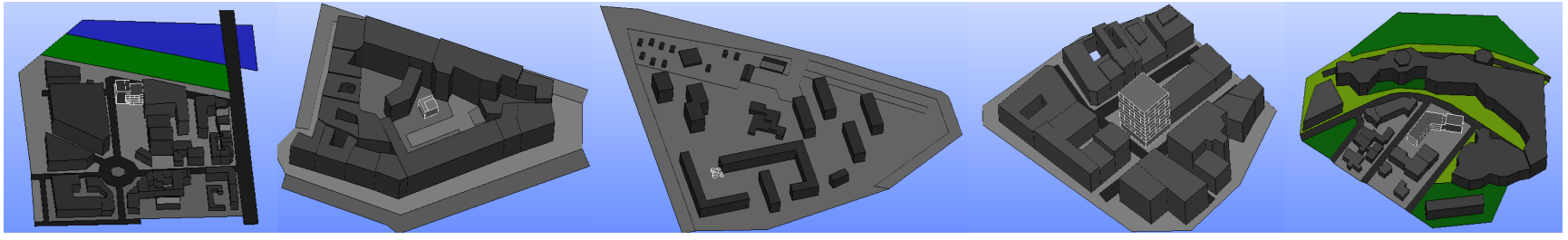
Methodology

9 districts with various densities

- Lyon (3)
- Nantes (2)
- Strasbourg (2)
- Paris (2)

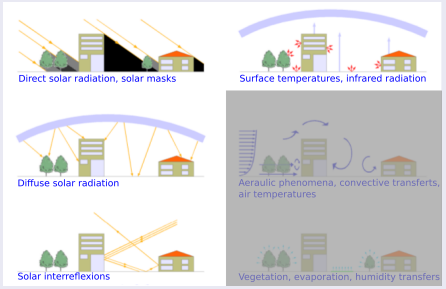


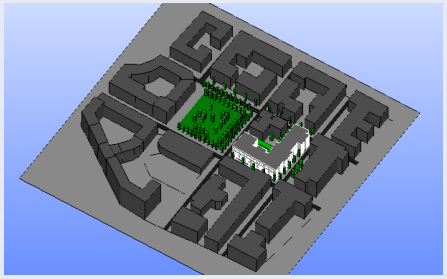




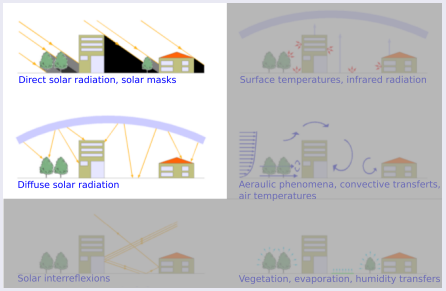
Methodology

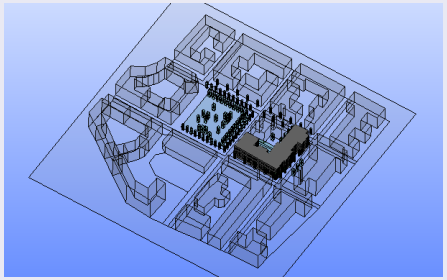
With environment





Without environment

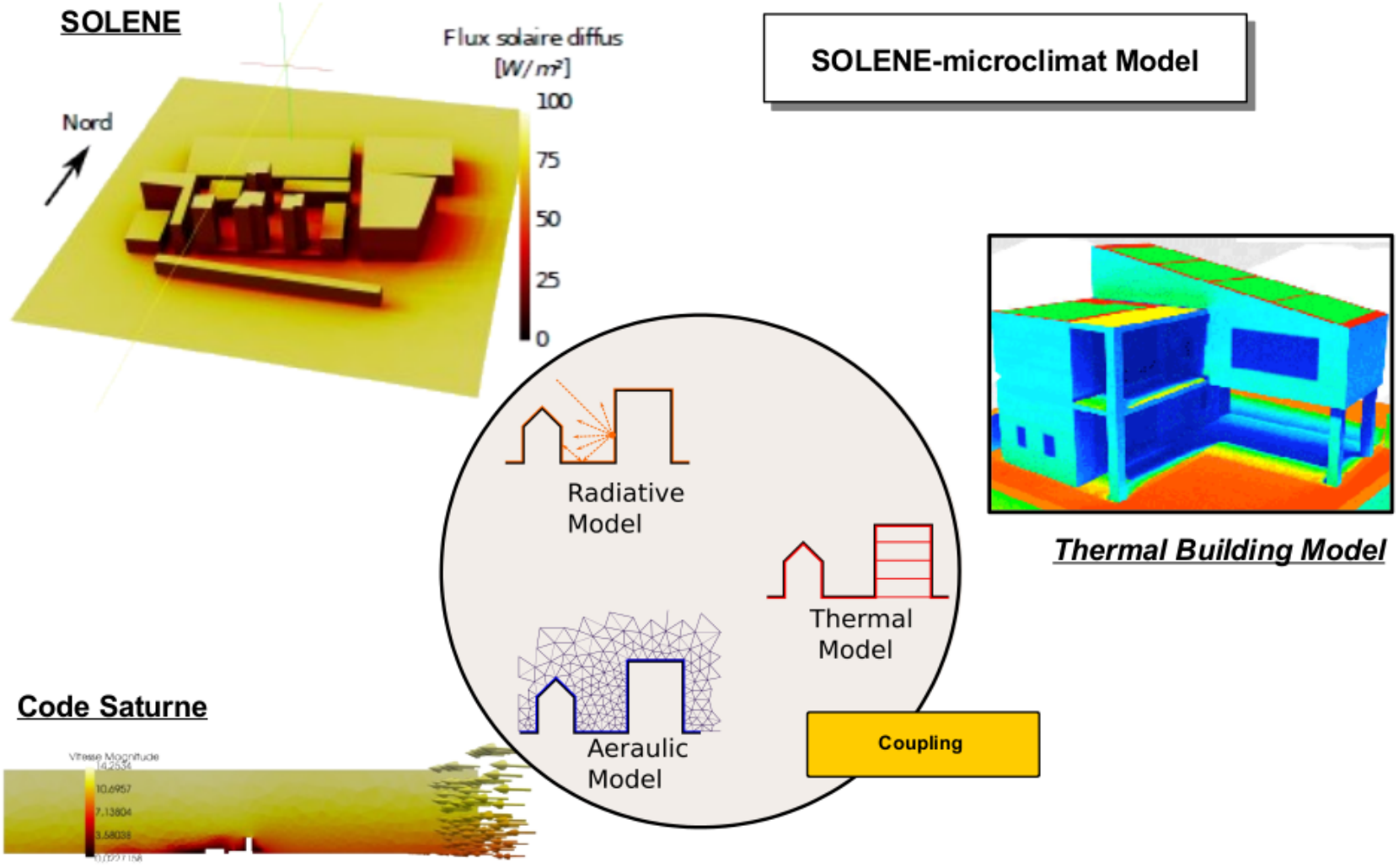




Simulation period

- Winter season : December 21th
- Summer season : June 21th
- Initialisation : 14 days

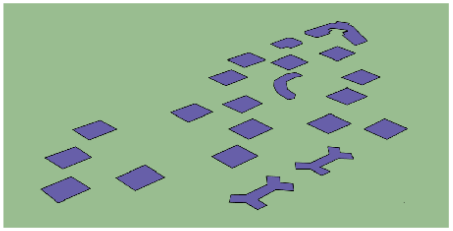
SOLENE-microclimat

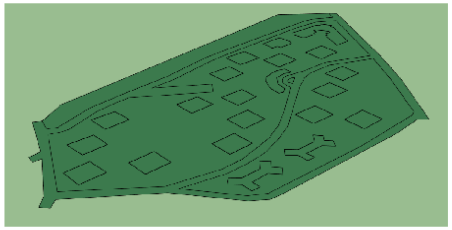


Density indicators

Building density

(1) $Footprint\ building_{\ surface}$ (2) $Total\ ground_{\ surface}$





$$Footprint\ building_{\ density} = \frac{Footprint\ building_{\ surface}}{Total\ ground_{\ surface}} \quad \frac{(1)}{(2)}$$

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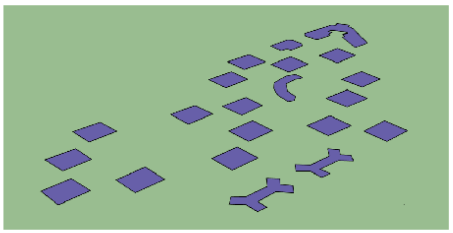
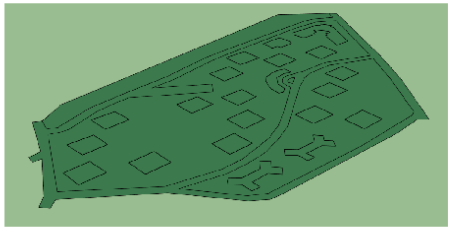
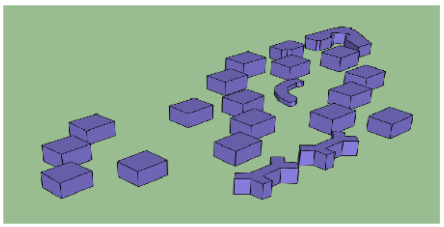


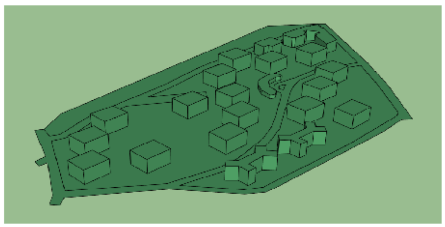


$$Footprint\ building_{density} = \frac{Footprint\ building_{surface}}{Total\ ground_{surface}} \quad \frac{(1)}{(2)}$$

Facade density

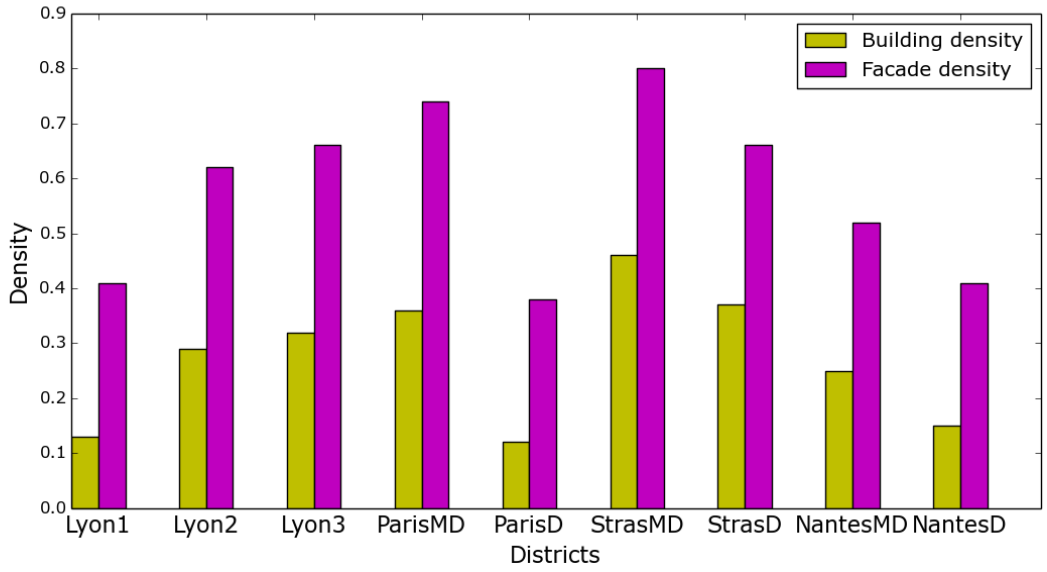
(1) $Facade\ building_{surface}$ (2) $Total\ ground\ and\ facade\ building_{surface}$





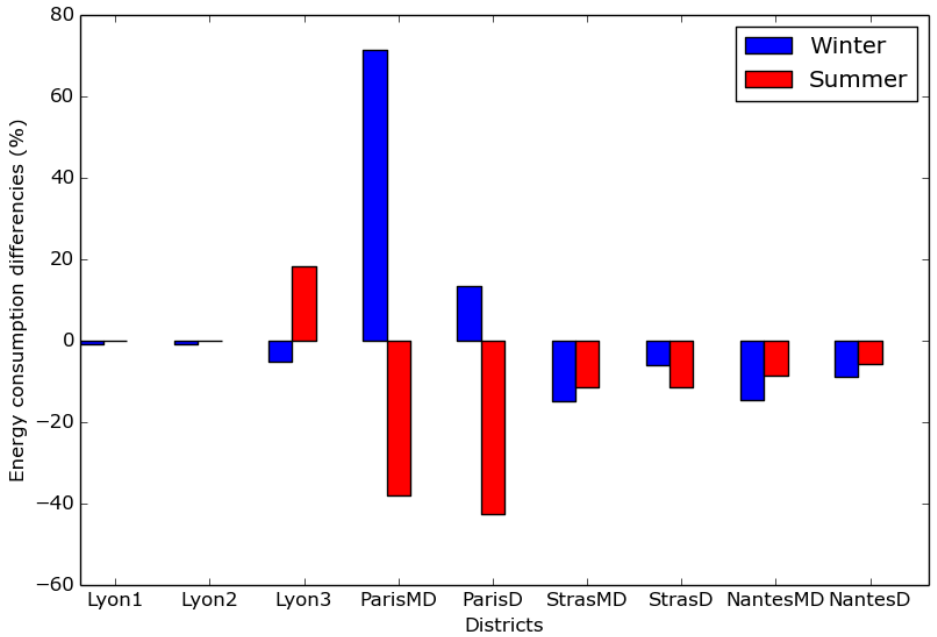
$$Facade\ building_{density} = \frac{Facade\ building_{surface}}{Total\ ground\ and\ facade\ building_{surface}} \quad \frac{(1)}{(2)}$$

Densities of the selected districts



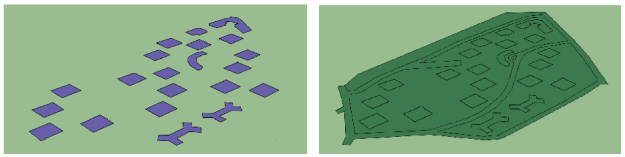
- Good heterogeneity of the district densities
- The higher the building density, the higher the facade density

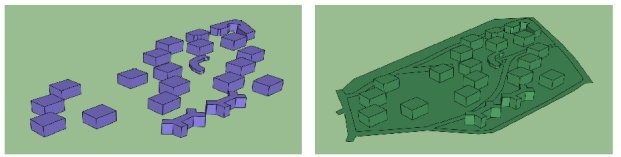
Energy consumption differencies

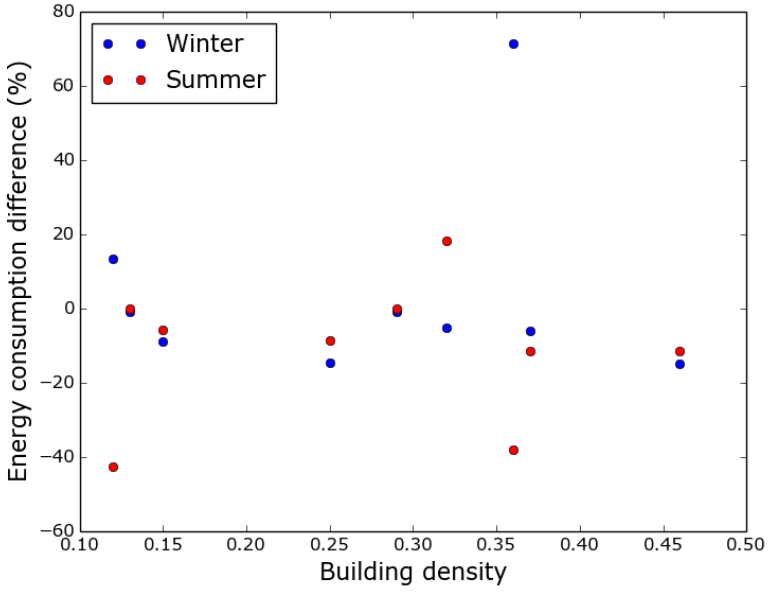


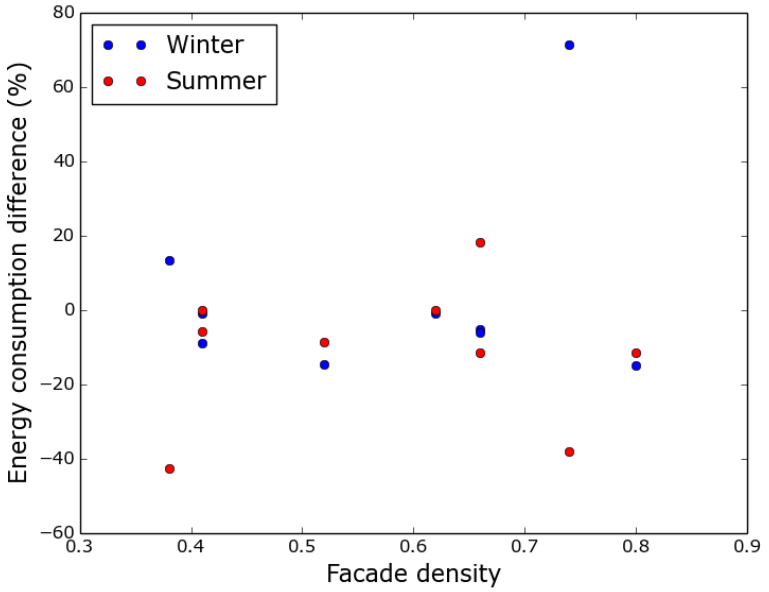
- Buildings slightly impacted in winter are also slightly impacted in summer
- Surprising results for some cases.

Energy consumption linked with the density



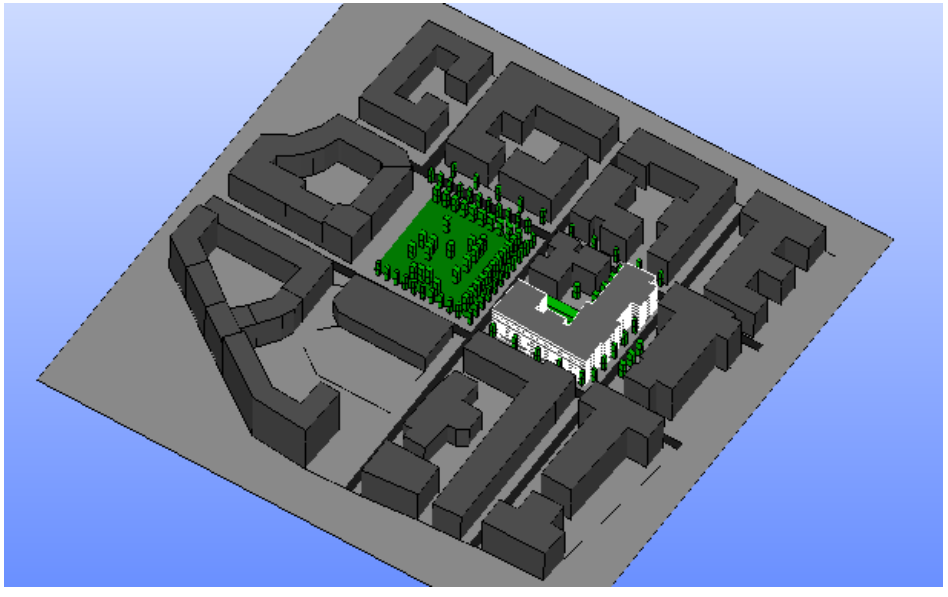






- No obvious dependency with building density
- No obvious dependency with facade density

Urban surfaces view factor



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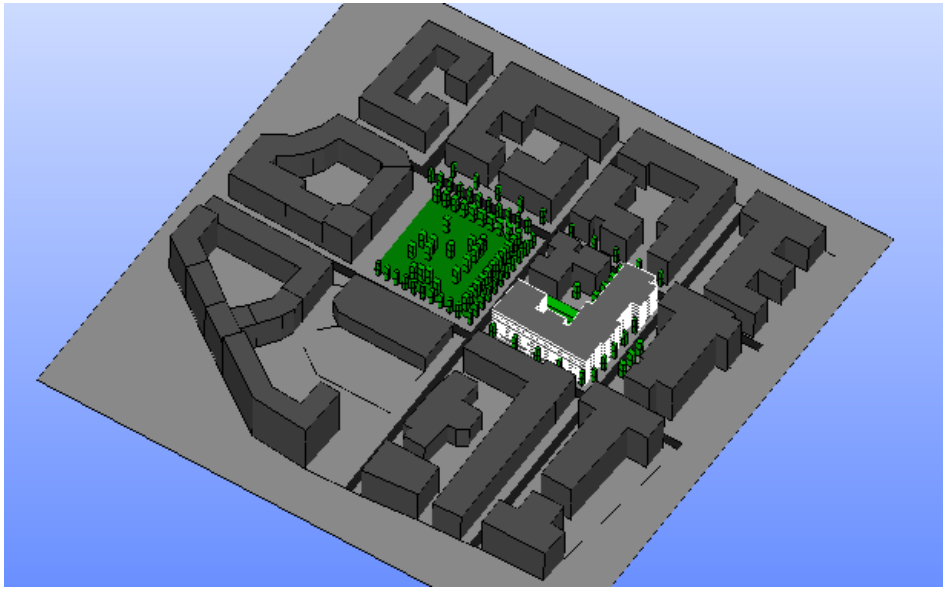

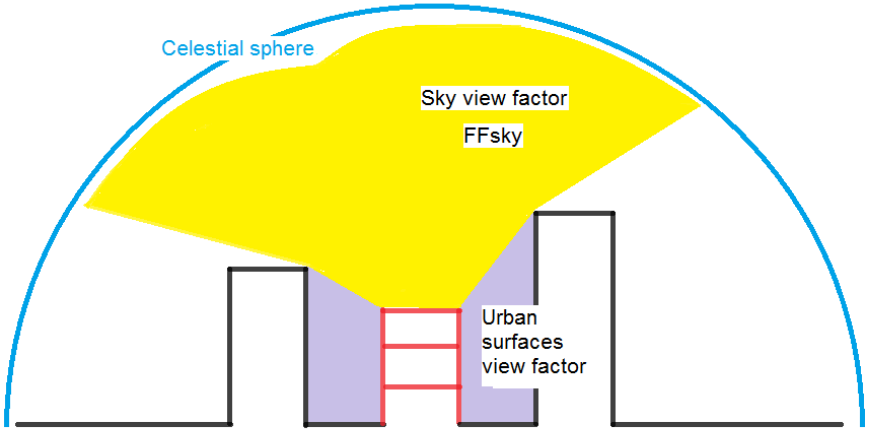

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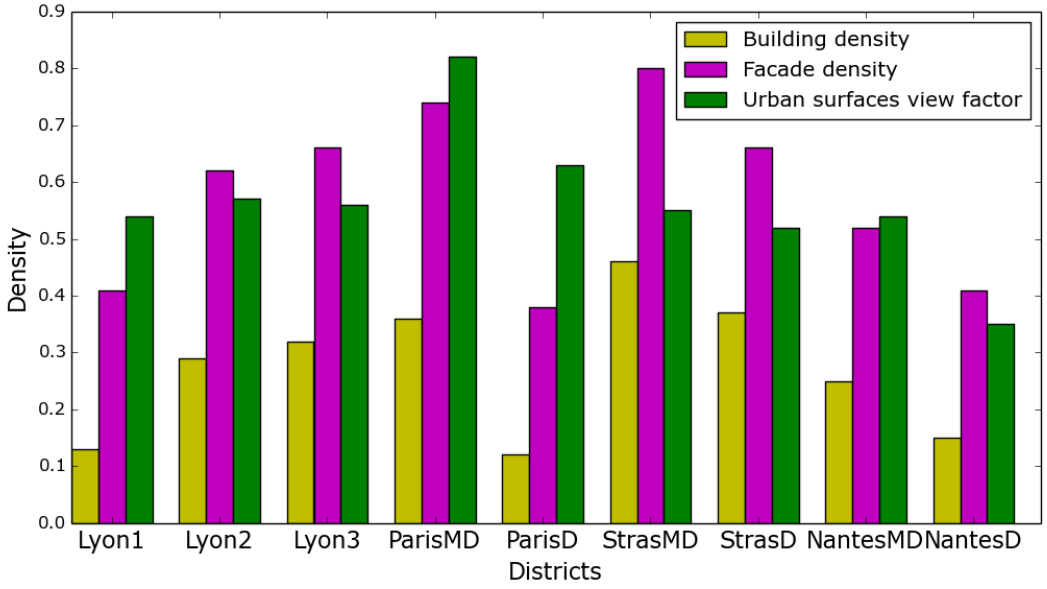
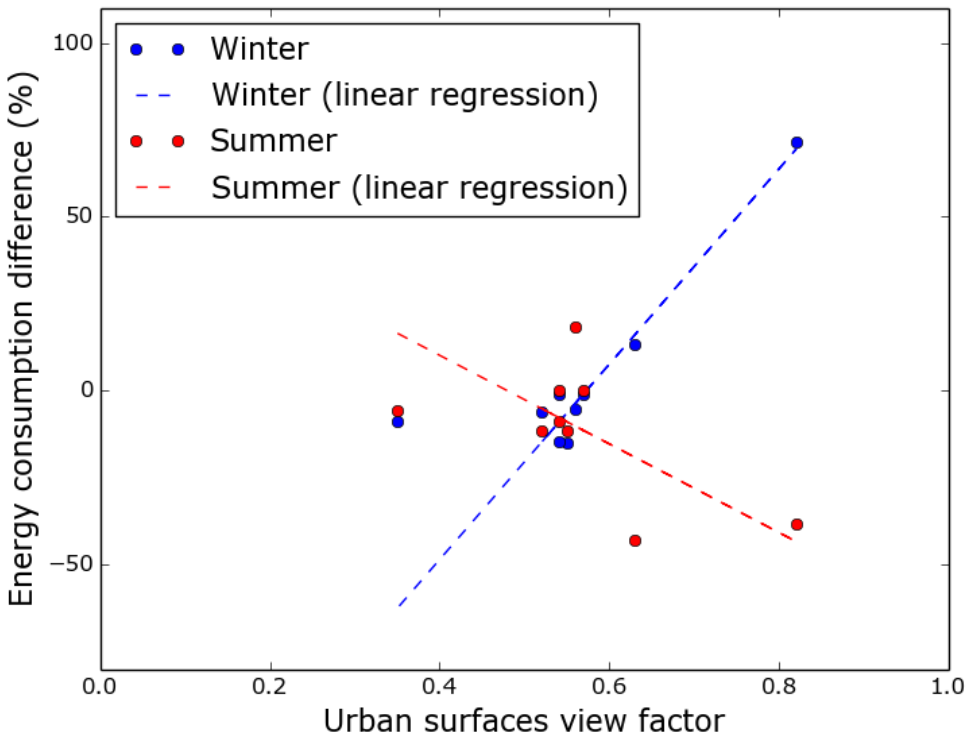


- New density indicator without correlation with the two first ones.

Energy consumption Vs urban surfaces view factor



- Uncertainity on the correlation
- The study require buildings presenting heterogeneity in their urban surface view factor

Conclusion

- Taking into account buinlding environment : more then 50% differencies
- No correlation with building density and facade density
- Urban surface view factor presents better correlations
- Urban surface view factor values have to be with a better heterogeneity
- Investigate more in detail the influence of radiation transferts :
  - study the infuence of solar and infrared radiation independantly
  - use less integrated density indicator. Do investigation floor by floor
  - study the influence of the albedo values.

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Thank you for your attention!!!