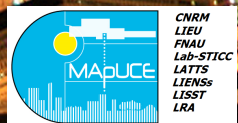


New fine-scale Urban Data & their application

From urban and social data to energy consumption simulations.

Valéry MASSON, R. Schoetter, E. Bocher, J. Hidalgo, A. Amosse, M. Bonhomme, A. Bourgeois, S. Faraut, J. P. Levy, G. Petit, C. Plumejeaud, N. Tornay, G. Bretagne, S. Haoues-Jouve, R. Jougla, M.-L. Lambert, A. Lemonsu, N. Long, and D. Vye

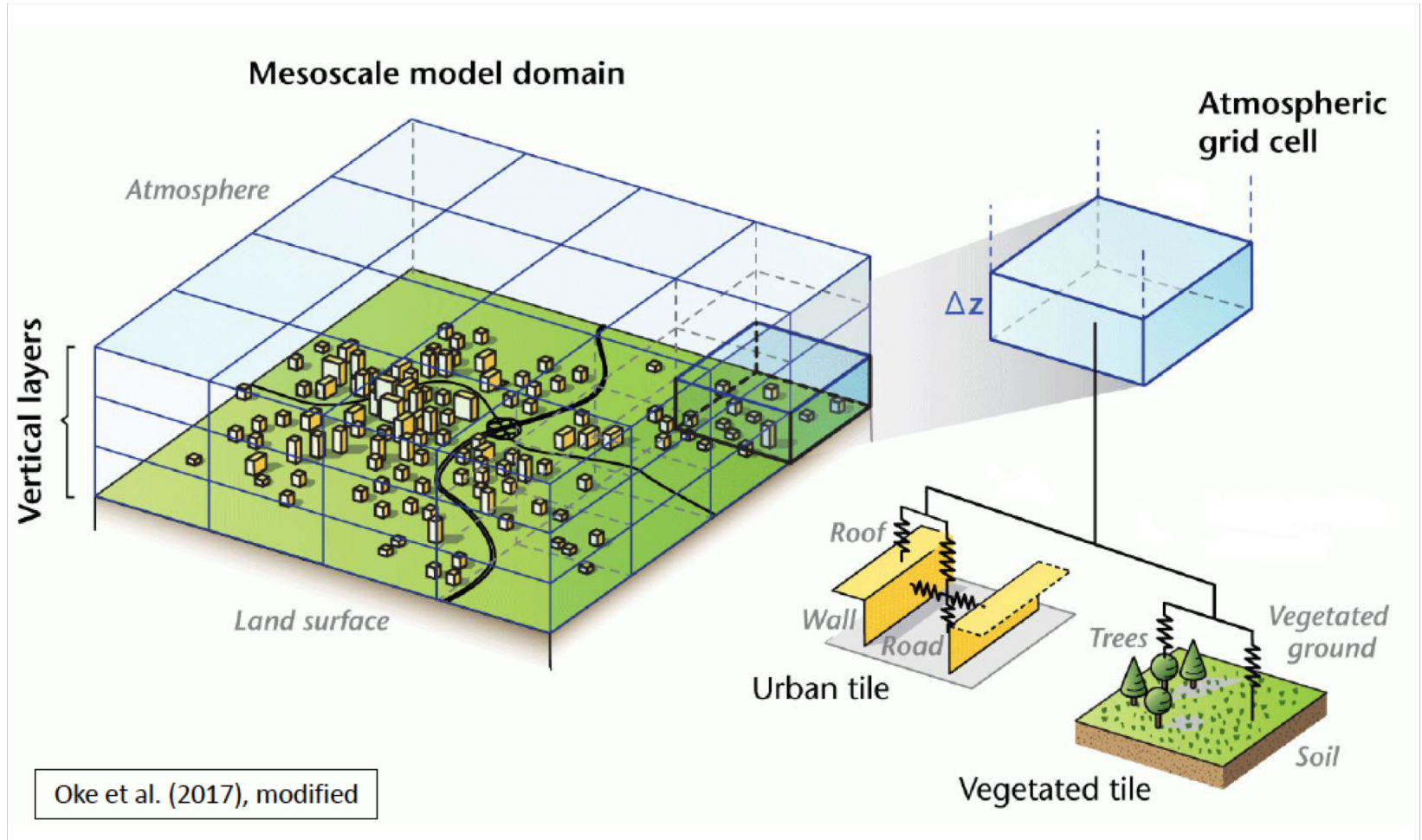


MAPUCE project results

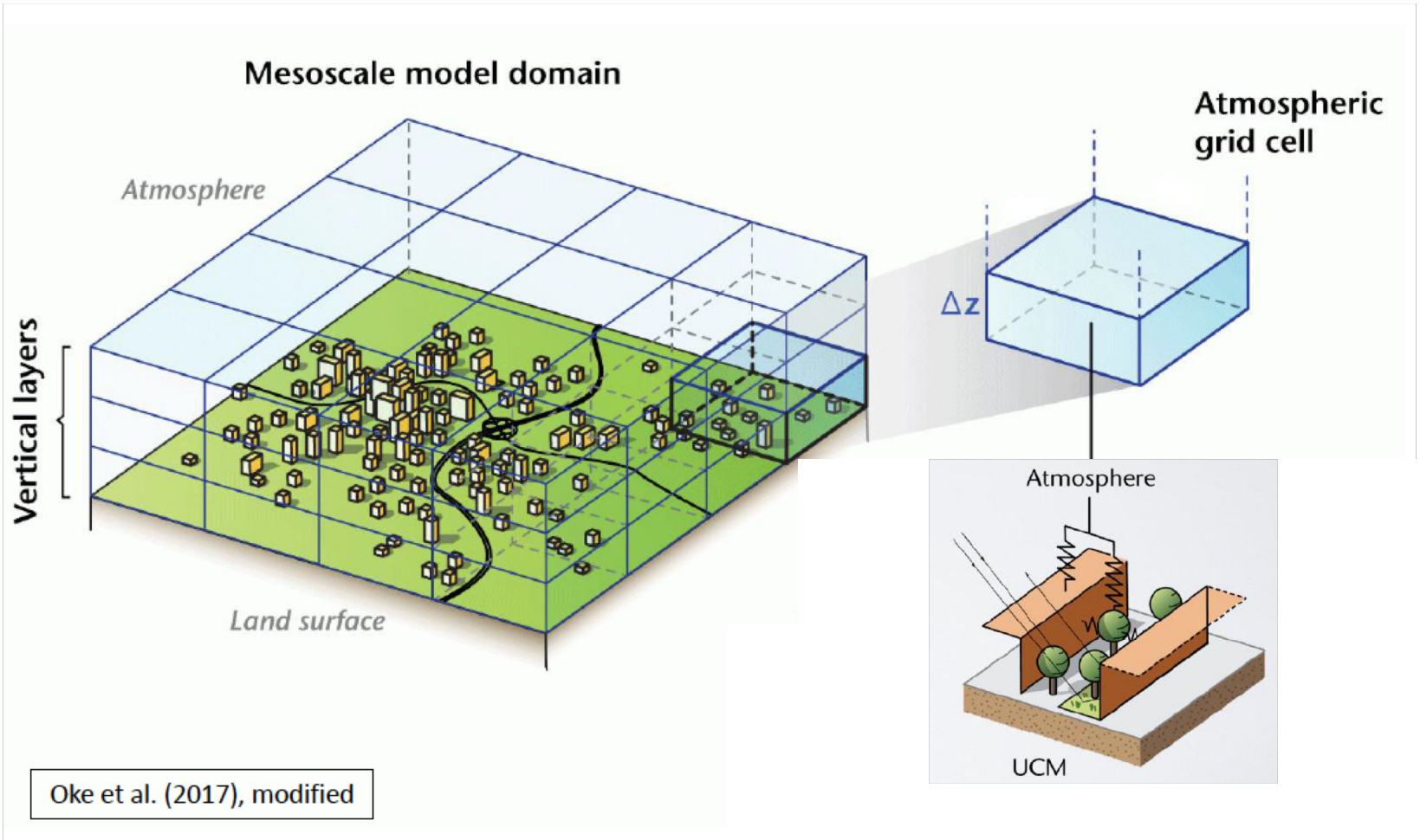
© Copyright Météo-France



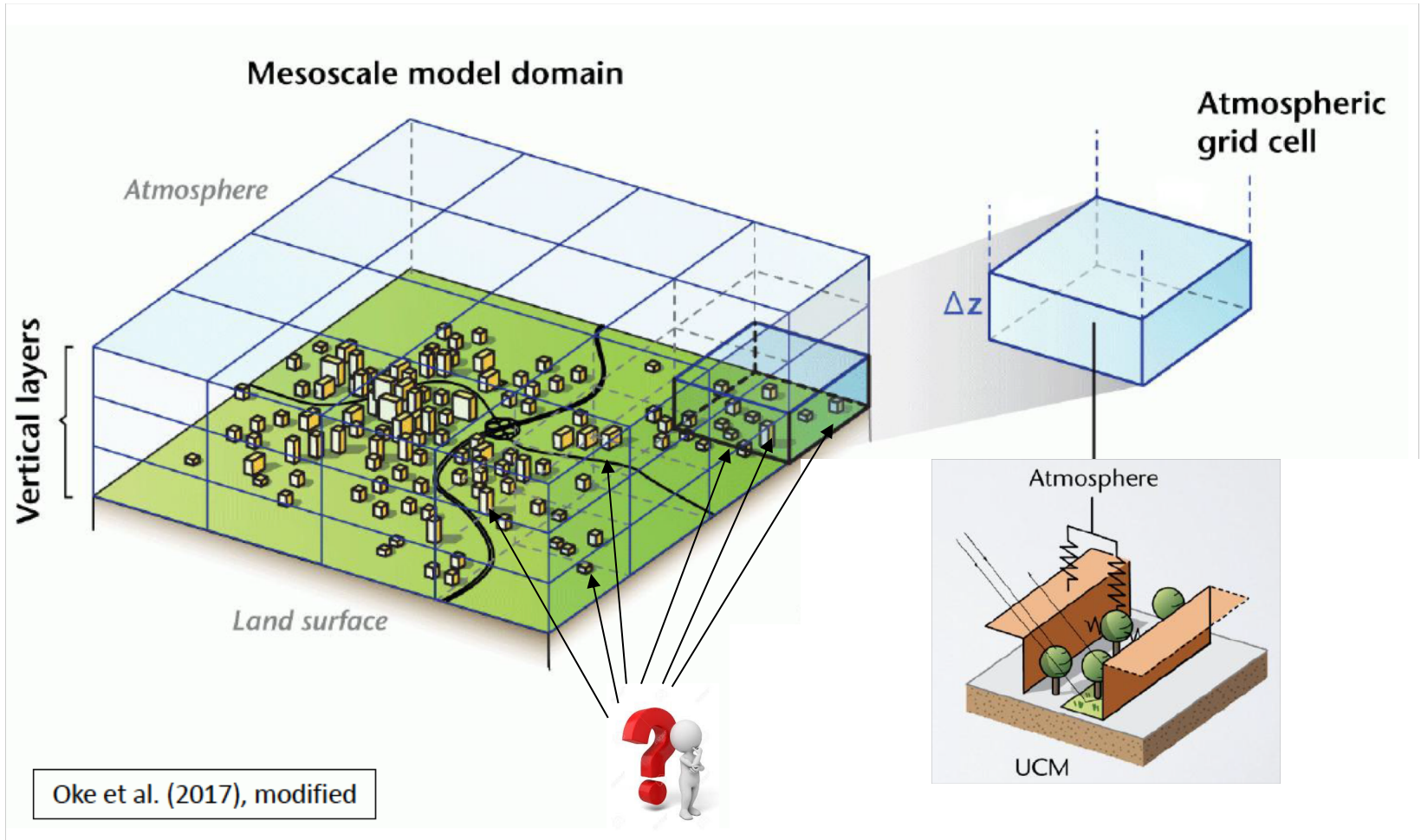
Urbanized atmospheric models



Urbanized atmospheric models



Urbanized atmospheric models



Modelling of behavior influenced energy fluxes

1. Morphological & typological urban data

Bocher et al, 2018, Urban Climate

Bernard et al 2018, Climate

Dumas et al 2018, Urban Climate, submitted.

2. Architectural information

Tornay et al 2017, Urban Climate

3. Modelling of behaviors effects

Bourgeois et al 2017, Energy Res. & Social Science

4. Modelling of many building's use in the grid mesh

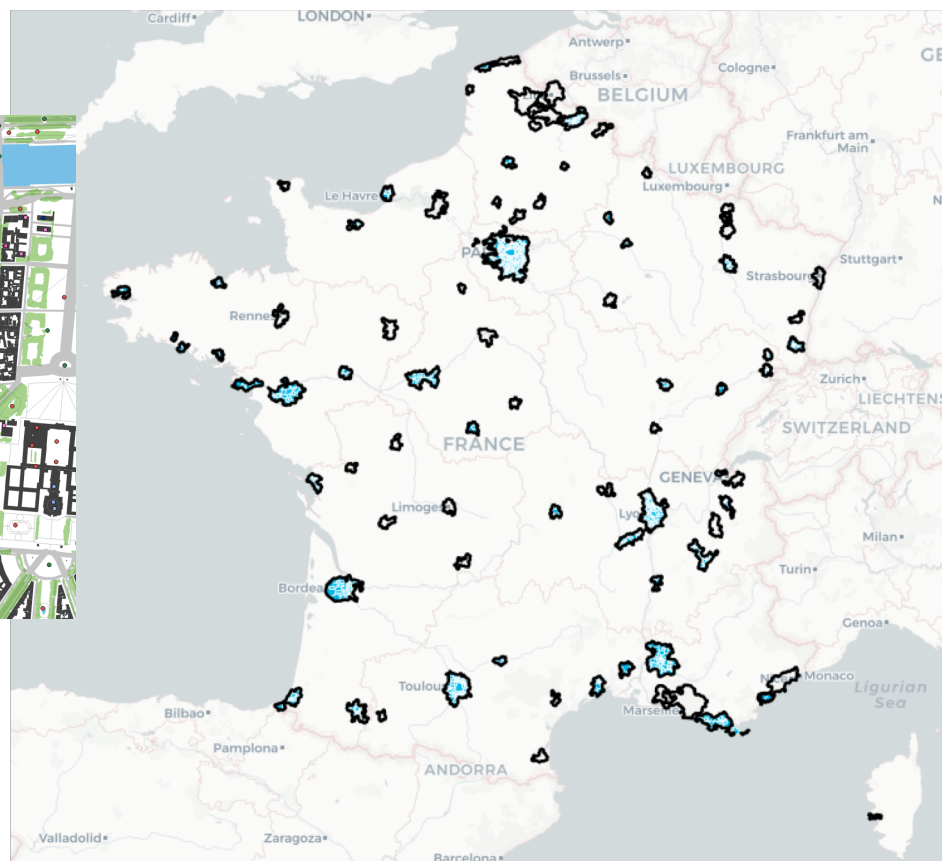
Schoetter et al 2017, Geosci. Model Dev.

1.

Urban database

Urban block scale data on 43 cities in France

- Morphological indicators
- From building's info

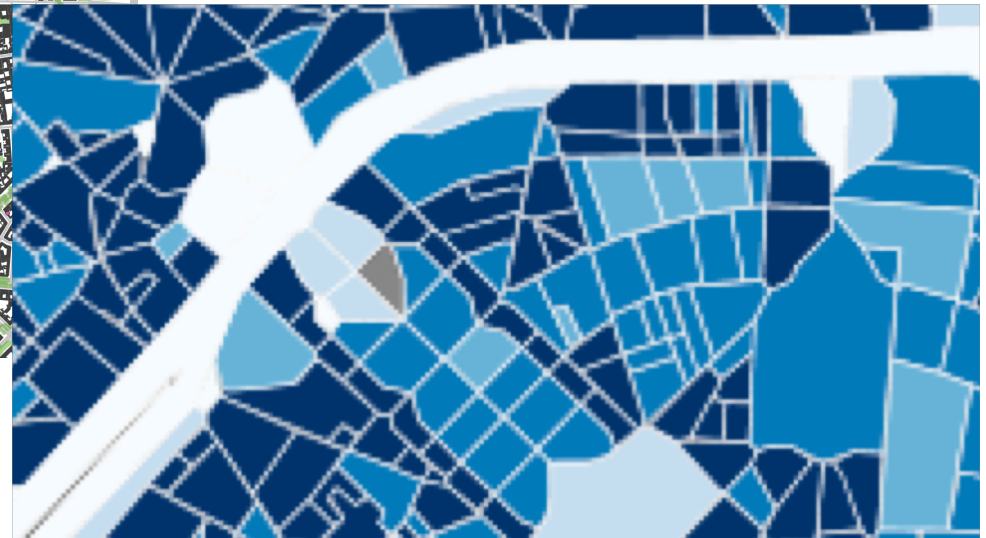


Urban block scale data on 43 cities in France

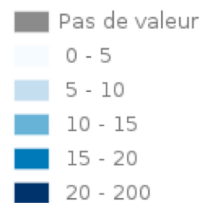
- Morphological indicators
- From building's info



Mean building height in block



+ Hauteur moyenne des bâtiments

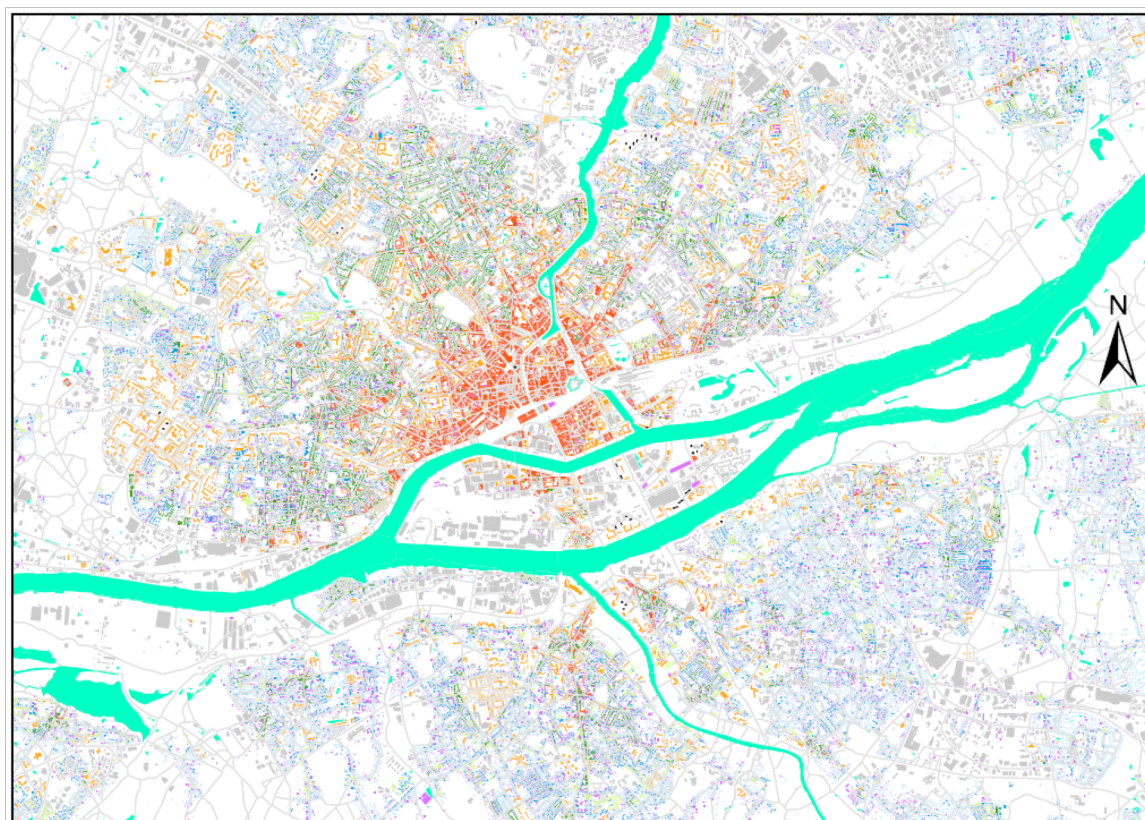


1.

Urban database

Building typologies

- At the building scale
- Done using random forest using many morphological indicators



0 1 000 2 000 Meters

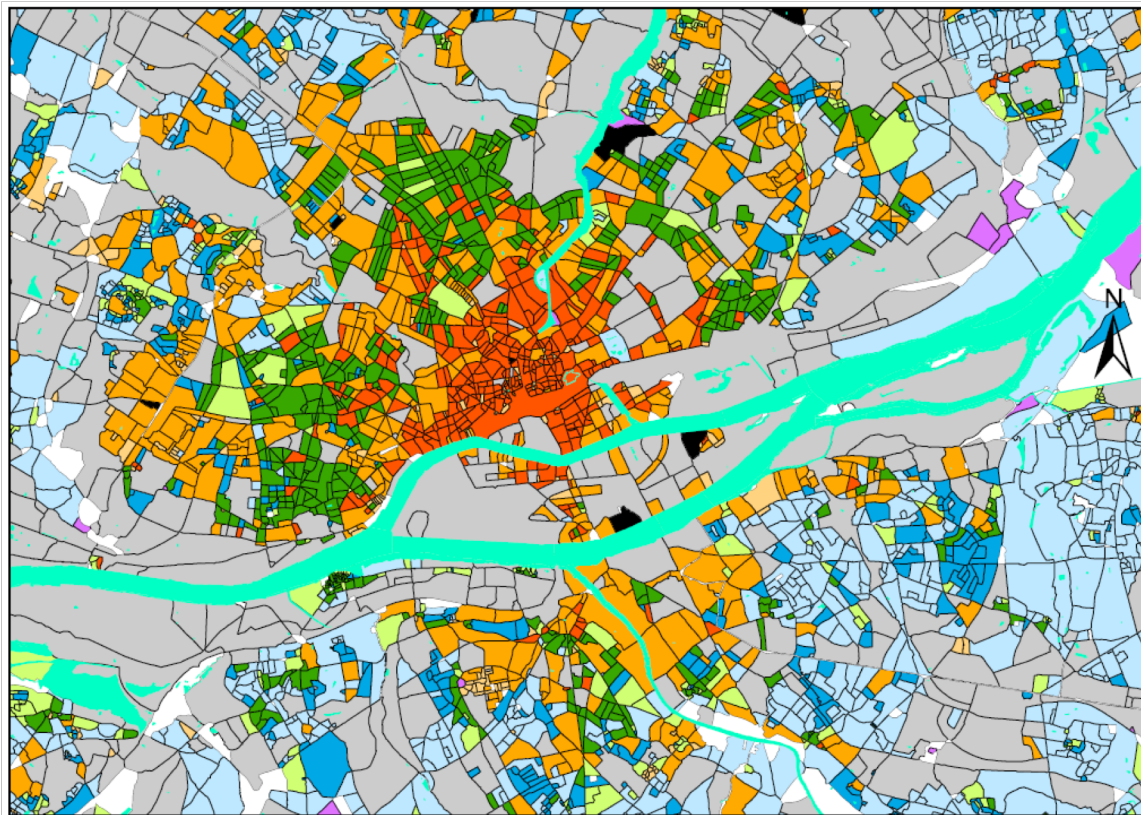
mapuce.orbisgis.org

1.

Urban database

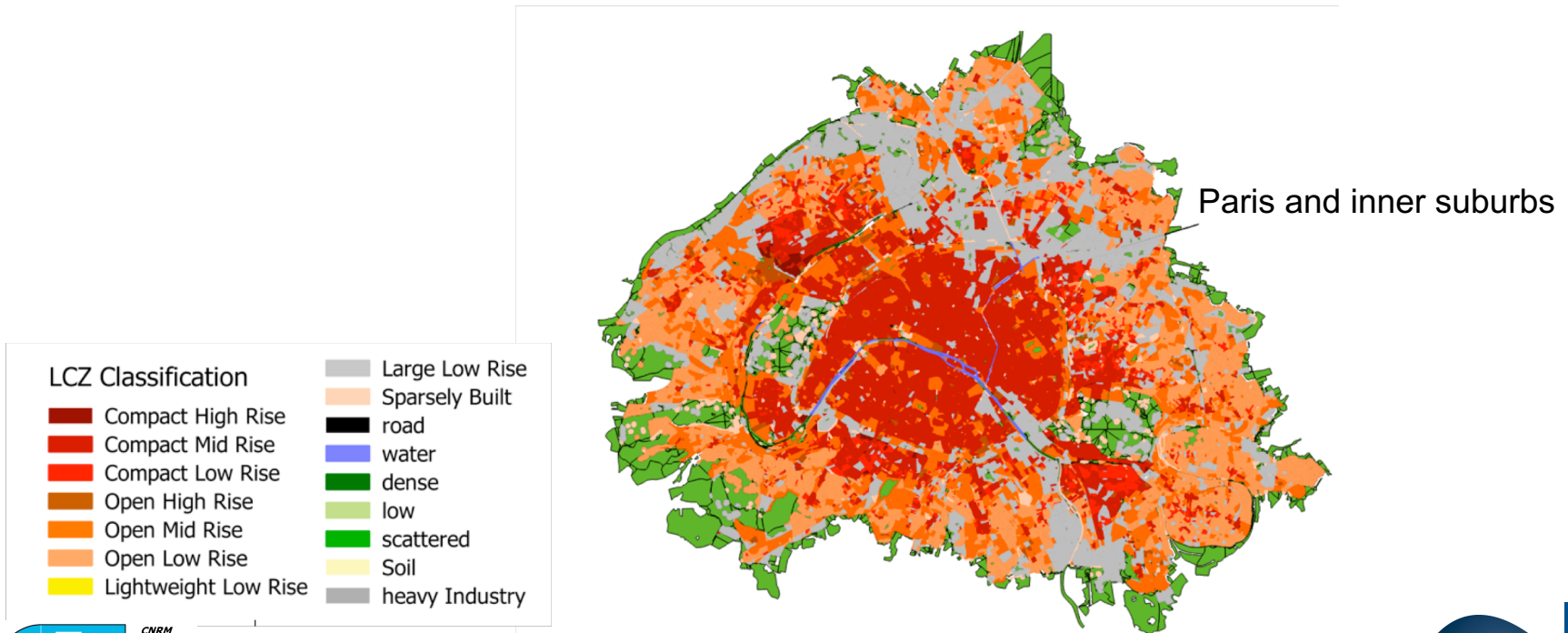
Building typologies

- At the building scale
- Aggregated at block scale



Local Climate zones

- At the neighborhood scale,
- From urban blocks in vector shape !!
- Using classification rules using building height and building density
 - (see presentation of Guillaume Dumas)



2. Architectural information

Why is it important ?

- Construction Materials & practice → heat conduction
- Building technological equipments → anthropogenic heat
- Windows → how much solar heat goes into the buildings



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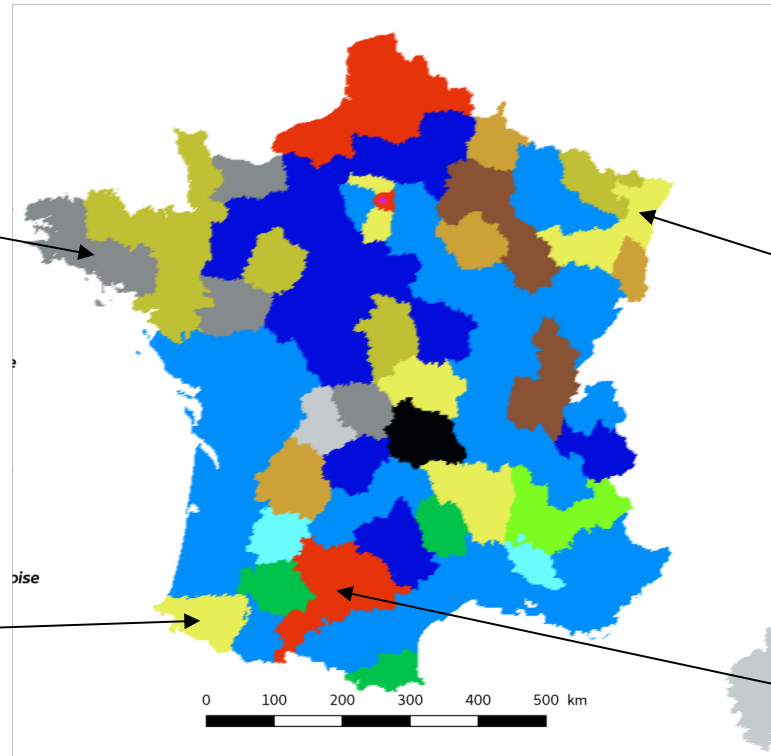
Inferred Model parameters:

- Depth, thermal conductivity, heat capacity, of each layer of roof, wall, inner floors.
- albedo and emissivity of roofs and walls
- Windows & shelters
- etc...

2. Architecture varies from one location to another

Problem:

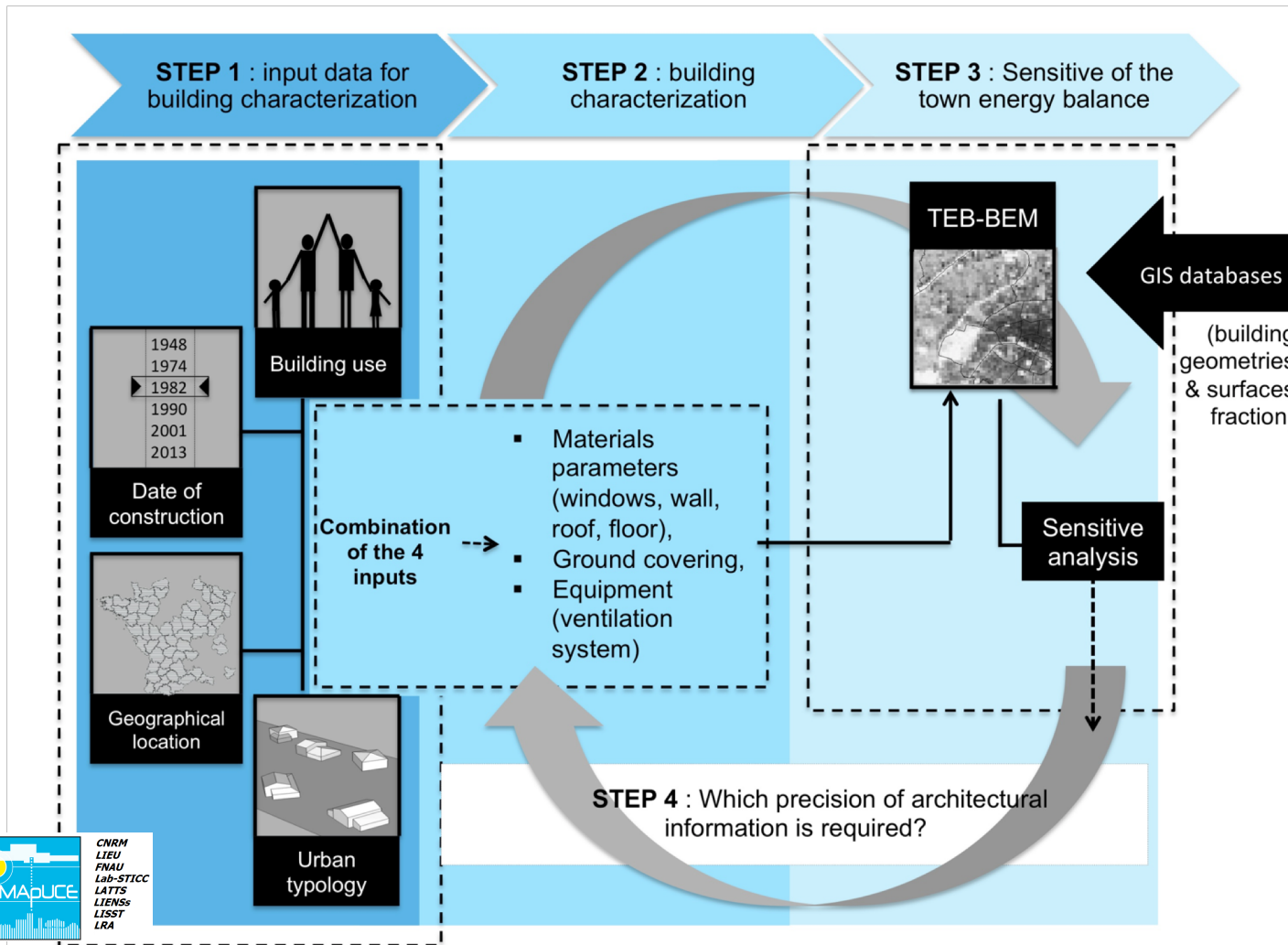
These parameters vary a lot, and are mostly unknown (no database exist).



*Architectural territories
Before 1948 (a lot of variety)*

2. Solution : from architects' expertise

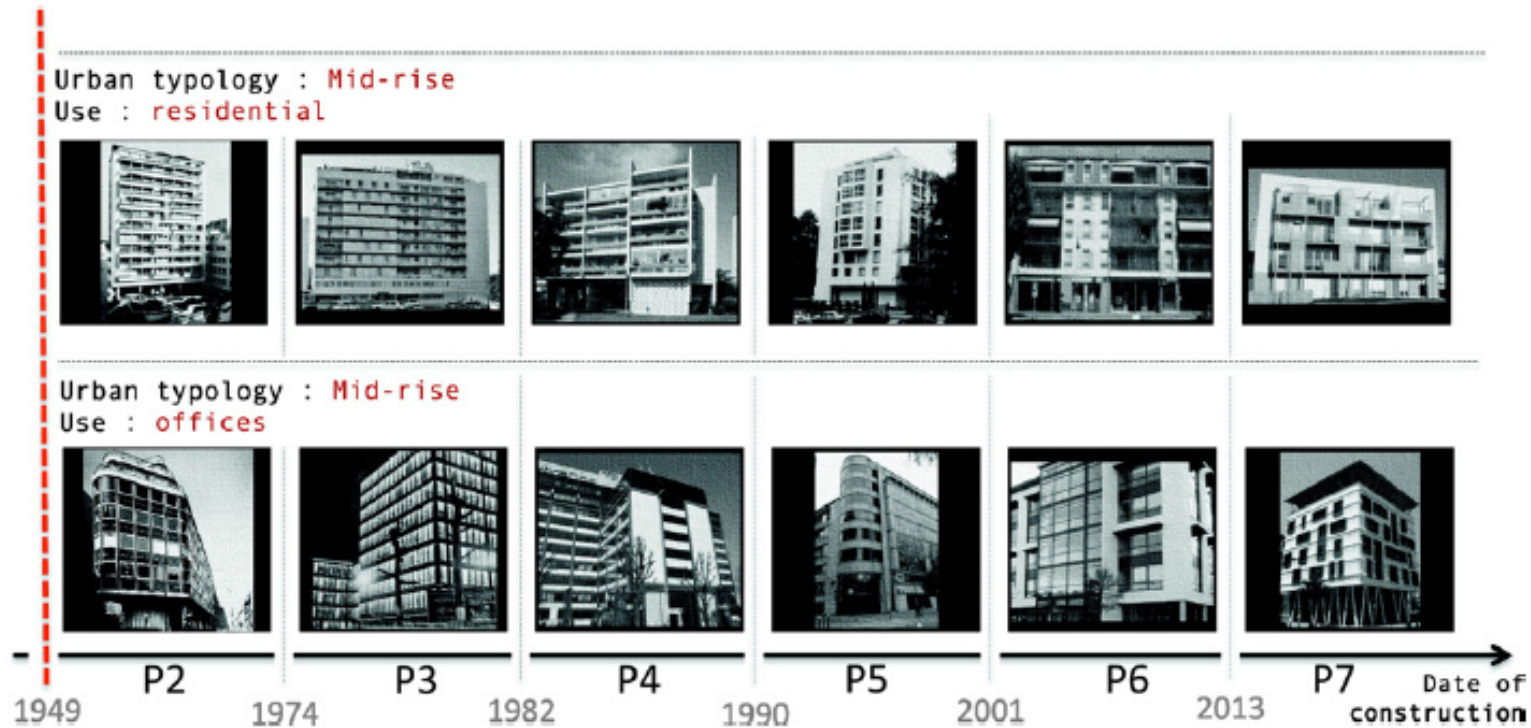
Architectural characteristics evaluated from 4 inputs:
location and building's age, use & typology



2. Solution : from architects' expertise

This has been done in France, by a team of architects:

Temporal evolution of construction practices

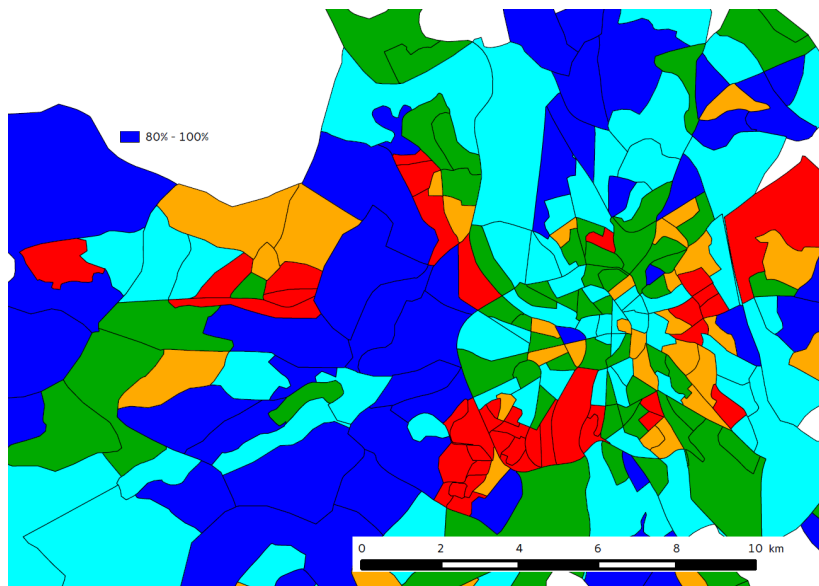


3. Modelling inhabitants behaviours

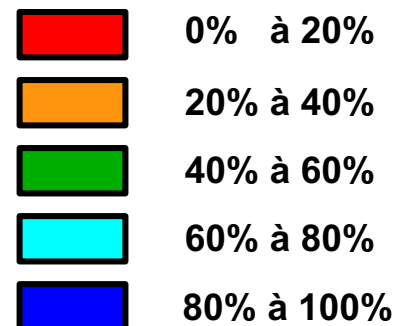
- Methodology (Bourgeois et al. 2017; Energy Res. & Soc. Science)
 - Input data: Surveys on energetic behaviors, Population Census
 - Statistical models between behaviors and census data
- Results: 2 indicators on energetic inhabitants' behaviour
 - Energy Control behavior → f (heating type & fuel, age of people)
 - Changes heating target temperature (18.4°C to 22.3°C)

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% of households with **High Energy Control behavior**, Toulouse



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 - in offices and commercial areas (10 and 7 W/m² of floor)

4. Modelling MANY building's uses

Why is it important ?

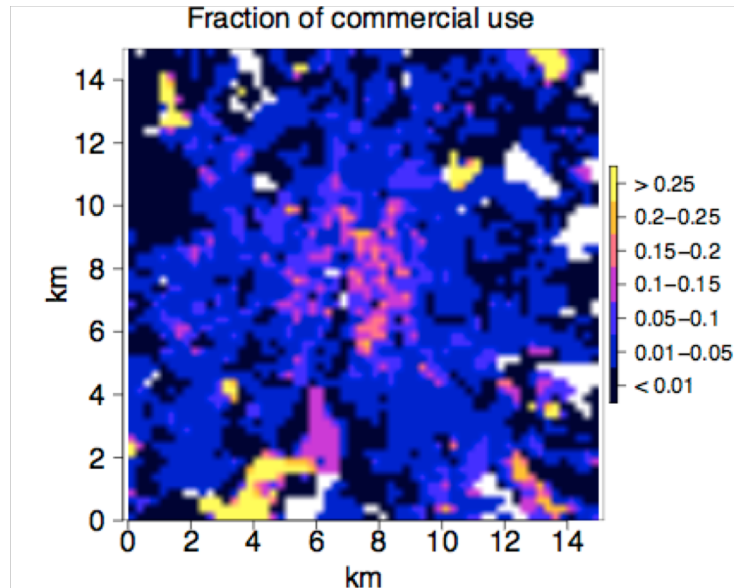
- Because *Anthropogenic Fluxes* are very much dependant on uses
- Some neighborhoods are homogeneous, others not at all.



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4. Modelling MANY building's uses

Why is it important ?

- Because *Anthropogenic Fluxes* are very much dependant on uses
- Some neighborhoods are homogeneous, others not at all.
- Behaviors may strongly vary within one or similar residential building(s)



4. Modelling MANY building's uses in TEB

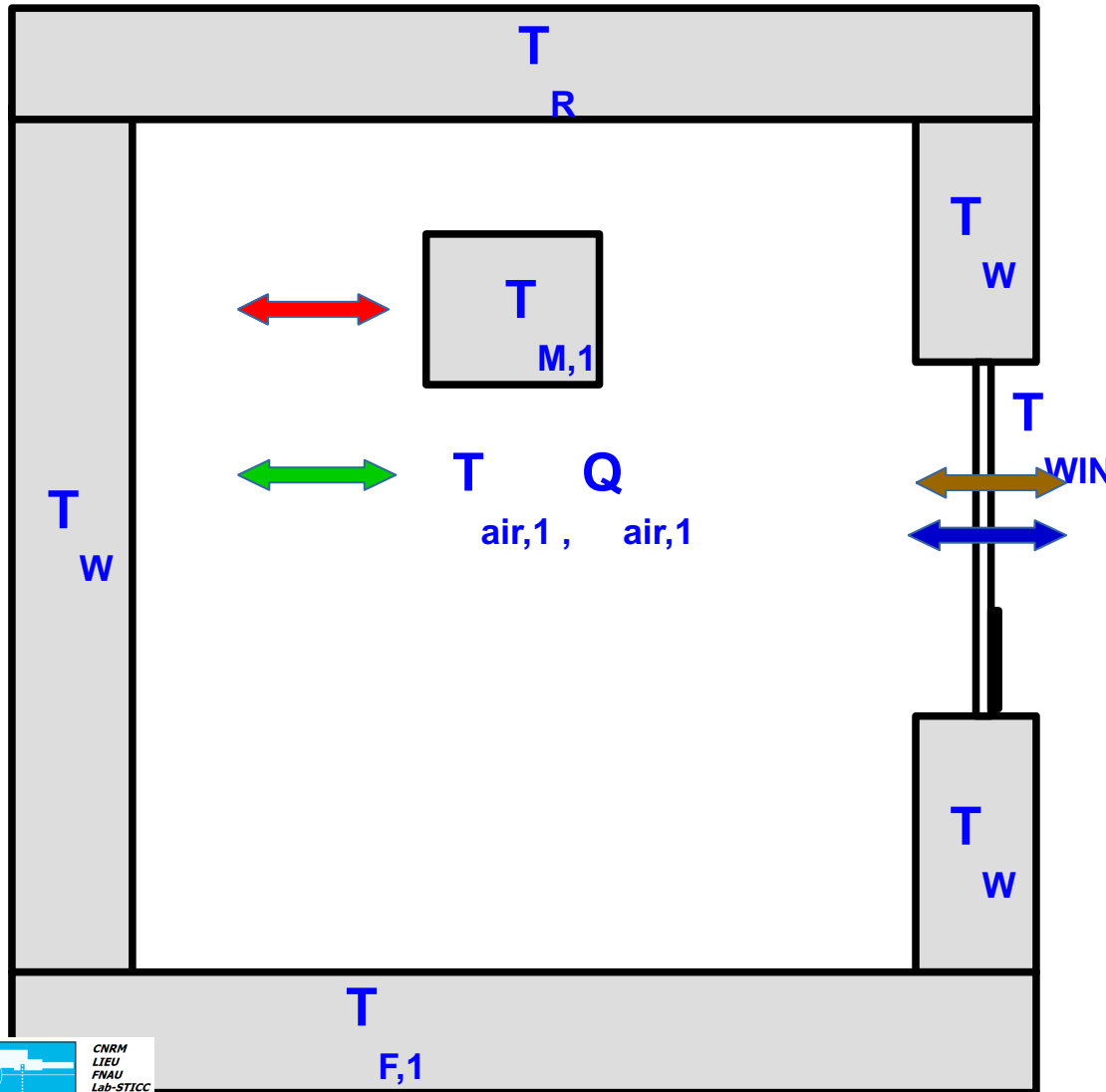
- Methodology
 - To avoid multiple calls of TEB
 - In the unique building of the grid-mesh:
 - Multiple calls of BEM for different uses and behaviours





- Assumption:

The differences in use and behaviour have a much higher influence on the indoor conditions than the external envelope of the building.

4.

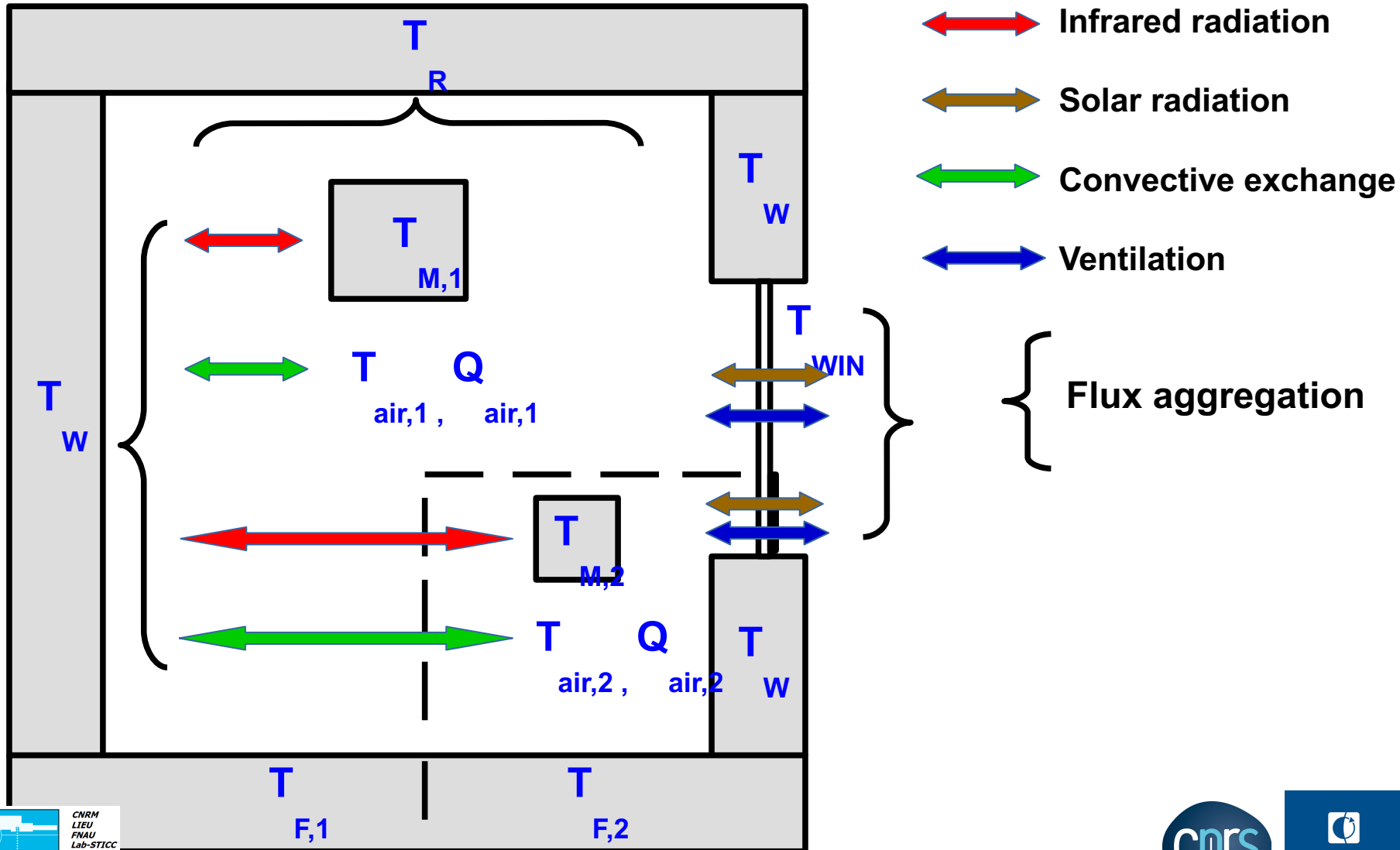
Modelling MANY building's uses in TEB



-  Infrared radiation
-  Solar radiation
-  Convective exchange
-  Ventilation

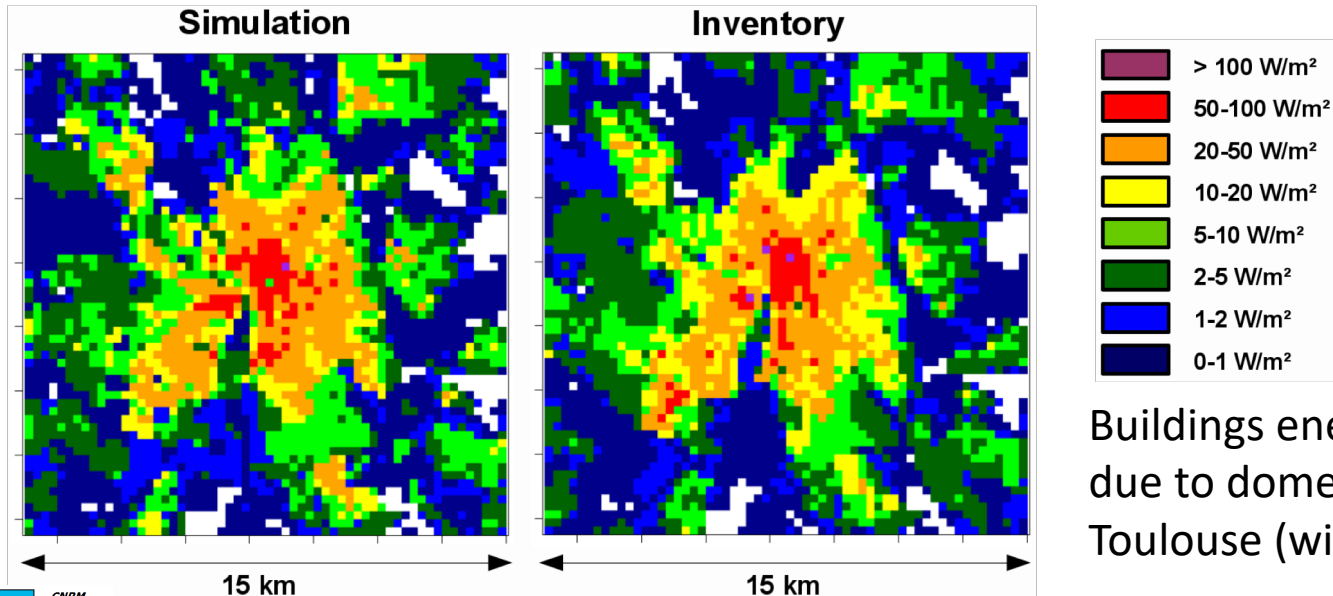
4.

Modelling MANY building's uses in TEB



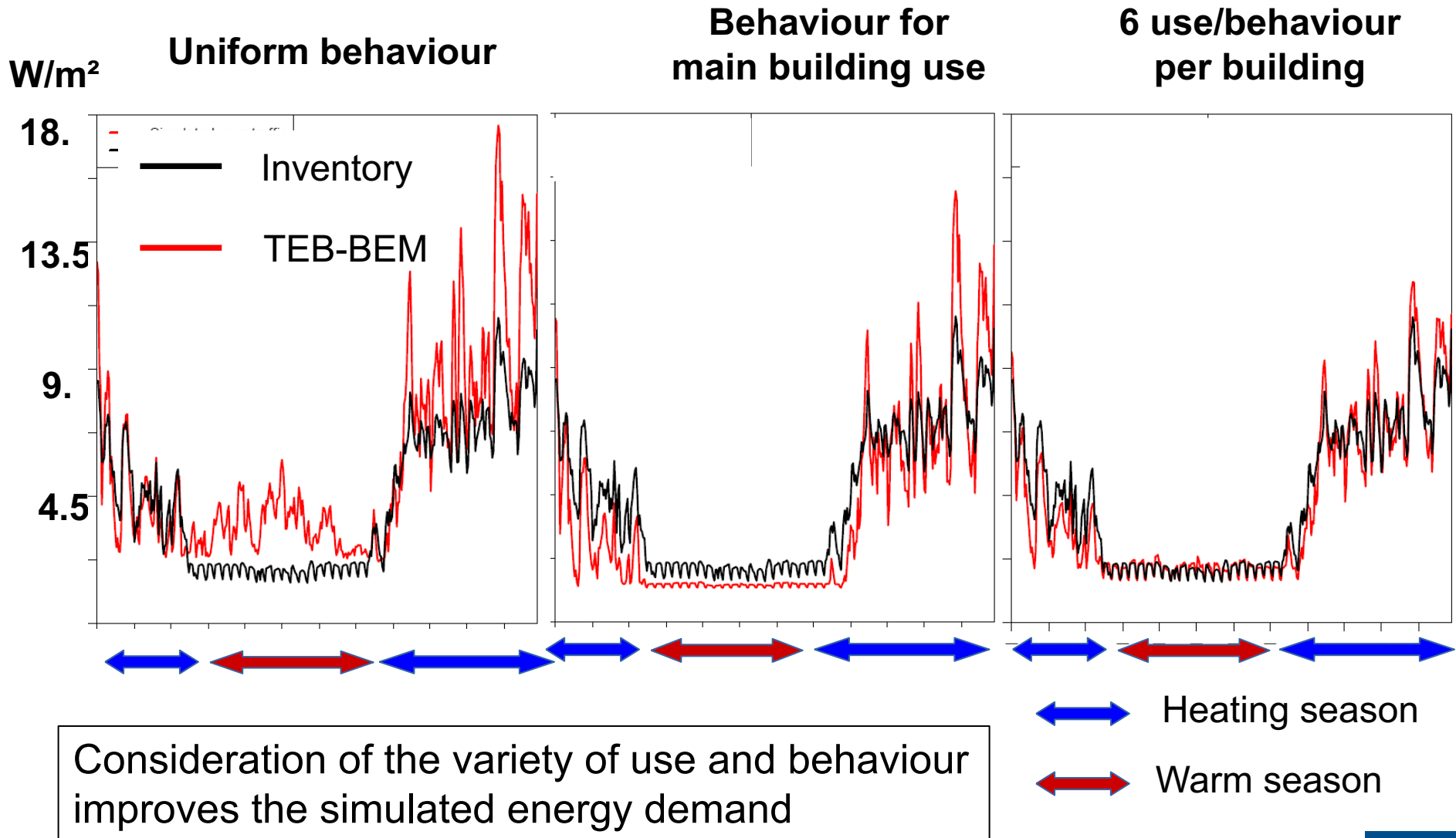
4. Results on Energy consumption

- 1 year-long simulation with MesoNH model at 250m of resolution
- Validation with CAPITOUL campaign data (see R. Schoetter presentation).
- TEB-BEM with 6 different uses/behaviors in buildings.
(offices, commercial, non-heated, 3 different behaviors in residential)



Buildings energy consumption
due to domestic heating,
Toulouse (winter 2004-2005)

4. Influence of behavior model complexity



4. Issue: How to gather building's uses data ?

- Extended databases barely exist

- Possible solution:

OSM



Conclusions

To model inhabitants behaviors improves BEM simulations

To use several uses inside keeping only one building is a good approximation

Need for input data on urban morphology, architecture & people

Perspectives

Work focused on domestic heating.

What about air conditioning ? Or other behaviors ?

How to generalize this approach worldwide ?

A low-angle, upward-looking photograph of several modern skyscrapers. The buildings are made of glass and steel, with a grid-like pattern of windows. They converge towards the top of the frame, creating a strong sense of height and scale. The sky is a vibrant blue, filled with numerous small, white, fluffy clouds. The overall composition is dynamic and emphasizes the verticality of the architecture.

Thanks!

Any Question?