Proposal for a PhD thesis:

Global warming, cities and inhabitants: Contribution to the study of the efficiency of passive cooling strategies for urban housing during heatwaves

Keywords : Passive cooling, natural ventilation, summer comfort, energy in buildings, numerical modeling

***Supervising team** :*

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Localisation :
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Subject :

Context: Considering

- global warming, resulting in an increase in heat waves in many European regions,
- the densification of urban centers, contributing to the intensification of the urban heat island effect,
- the modification of the housing structures, in terms of composition and energy performance,
- and the evolution of the composition of the households and the corresponding modes of living,

summer comfort is today a key issue of contemporary urban development, with major health, economic and social, but also environmental and energy consequences. One of the main challenges is not only to limit urban overheating during days, but also to allow residents to recover at night. For the building sector, the objective is more precisely to obtain comfortable indoor temperatures during hot periods, while avoiding the use of active air conditioning to limit energy consumption and reduce peaks of power demands.

Problem: However, during these particularly hot periods, the ambient conditions in dwellings depend on the regional meteorological conditions, as well as on the local urban environment/morphology, the composition of housings and the behavior of inhabitants. The problem of maintaining thermal comfort in summer using solutions that favor the energy conservation in buildings is thus more complex than addressing the problem of reducing their annual heating consumption, which has mainly guided building energy studies up to now. Indeed, the development of passive cooling strategies involves phenomena and transfers that develop at multiple but intricate time and spatial scales (from small scales of aerodynamic turbulence to the larger scales of more or less inert buildings and heat waves), which often cannot be simply decoupled by thermal insulation. The scientific objective of this thesis is thus to highlight the characteristics of the different modes of passive cooling in housings, and more particularly those related to natural ventilation, as well as the levers and practical brakes contributing to the development of such strategies.

Methodology: This work aims at developing a building thermal model coupled with an existing advanced fluid dynamics numerical model[1]. The objective is to evaluate to what extent different passive cooling strategies influence the thermal and aeraulic conditions in dwellings and the energy demand for air-conditioning, according to the characteristics of the housing and the strategies generally implemented by the inhabitants (collaboration with a master's degree student in human and social sciences). Therefore, this model will notably make it possible to characterize different types of airflow within different types of buildings and neighborhoods in order to evaluate the natural ventilation potential of dwellings and the associated cooling of indoor ambiances.

The originality of the approach twofold. First, it is the internal / external coupling and the consideration of fast dynamics, which are generally simplified in studies despite their immediate influence on comfort. Second, it is the strong link between this work and the work of a master student in a human and social sciences (definition of use cases, free cooling strategies and performance indicators, and implication of citizens and local urban stakeholders), which would allow to develop a pluridisciplinary approach of the problem.

Collaborations: V. Chasles (EVS UMR 5600 - human and social sciences laboratory based in Lyon - http://umr5600.cnrs.fr/fr/accueil/) to study the link between the thermal behavior of buildings and the behavior and heath of inhabitants, and P. Sagaut (M2P2 UMR 7340 - laboratory of computational fluid mechanics, based in Marseille - http://www.m2p2.fr/) for the advanced fluid mechanics modeling.

Prerequisites:

Good knowledge of heat transfer and building physics, bases of fluid mechanics, modeling skills. Good level of English and good communication skills.

Skills or interest in architecture, urban planning or the humanities and social sciences will be valued.

Required background: engineer's or master's degree in civil engineering or energetics

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Funding: Thesis that can be funded by a doctoral contract

Duration of the work: 3 years, beginning on 01/10/2019

Application procedure: Send by e-mail, your curriculum, your cover letter, as well as references to contact to frederic.kuznik@insa-lyon.fr and lucie.merlier@insa-lyon.fr **before the 20/04/2019**

[1] Lattice Boltzmann-Large Eddy Simulation (LBM LES)