Implementation of a methodology to assess the effects of cooling strategies on the outdoor and indoor environment

Context of the Proposed PhD

The proposed work is part of a french national collaborative project VF++ ("Cool Cities by and for Users: Integrating Soft, Green, and Grey Solutions to Promote the Health of Inhabitants in a Sustainable Environment"). Its objectives are to develop methodologies to:

- Analyze how architectural and urban structures can create qualitative physical environments and kinesthetic ambiances that reduce individuals' cooling needs;
- Assess indoor/outdoor heat exposure of individuals, as well as the effects of heat adaptation strategies on the quality of the environment;
- Determine how individual and environmental factors affect individuals' thermophysiological and sensory responses, as well as health-related formal parameters, and assess these effects;
- Link socio-spatial inequalities to individuals' experiences and practices in dealing with overheating and their heat tolerance.

In connection with the second objective, urban microclimate tools are effective in testing the impacts of adaptation and cooling strategies on the climate. Building energy tools show the influence of the local climate, among other things, on indoor comfort and the energy demand of buildings. Coupling these two types of tools enables the study of the interdependencies between urban heat mitigation and the cooling potential of buildings[1].
Overheating adaptation solutions are frequently studied in outdoor environments, but their combined impact on both outdoor and indoor spaces, as well as on thermal comfort and human health, remains underexplored. In some cases, outdoor and indoor environments are not entirely distinct and interact, which complicates the development of multi-scale physical models suited to these situations.
Strategies to cool cities are developed considering multiple scales, from the urban scale to the individual scale, while adopting a dynamic approach that integrates daily and seasonal variations. Their implementation and effectiveness depend on the climatic specifics and the characteristics of urban planning. There is no single solution capable of solving the urban overheating problem by itself. Therefore, urban projects typically combine several solutions. However, it is essential to recognize that some of these solutions may be incompatible or cancel each other out, while others may work in synergy and reinforce each other's effects[2].

Scientific locks and Methods

Thus, the various questions that arise are:

- What is the most appropriate modeling approach to assess the effectiveness of different strategies on the indoor and outdoor comfort of residents?
- What level of detail is required to represent these solutions in modeling tools?
- How to assess or validate the modeling tool with experimental measurements?
- Which physical and thermophysiological comfort indicators should be retained and developed to represent the thermal perception of individuals exposed to high heat in the

[1] Lauzet et al., 2019. https://doi.org/10.1016/j.rser.2019.109390
[2] ADEME Guide https://librairie.ademe.fr/changement-climatique-et-energie/4649-rafraichir-les-villes.html

modeling tool?

Missions

The PhD candidate will develop a modeling approach adapted to both outdoor and indoor environments and open spaces where the interior/exterior dichotomy is no longer valid.
They will integrate different solutions, such as:

- Detached facades,
- Thick facades (taking into account renovation strategies),
- Vegetation around buildings or on an envelope element.

Ultimately, the PhD candidate will develop a methodology accompanied by proof of concept and case studies aimed at analyzing the thermal impacts of adaptation strategies in various urban contexts. This evaluation will include the analysis of summer and winter weather conditions, as well as taking into account future climate projections.
The PhD candidate will base their work on a detailed experimental reference campaign in Garibaldi Street (Lyon) and an adjacent building to validate the model, the functioning of various cooling solutions, and the exposure of individuals to heat.

Expected Skills

Education: Master's degree in civil engineering or environmental sciences, with a good knowledge of urban microclimatology or heat transfer.
Knowledge: Engineering sciences, Urban physics, Building physics, Environmental sciences.
Programming, Data processing. Teamwork, listening skills.

Location

Nantes, France
The supervising team is composed of researchers at Cerema, Univ de la Rochelle (LaSIE) and INSA de Lyon/ Université Claude Bernard Lyon1 (CETHIL)

Contacts and Application Submission

Send CV + cover letter + Master's grades (even if incomplete for 2025) + recommendation letters by email to:
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