TWO-YEAR POST-DOCTORAL POSITION
for the ANR project

Analysis of the dynamical coupling between the URBAN canopy and the TURBulent atmospheric surface layer

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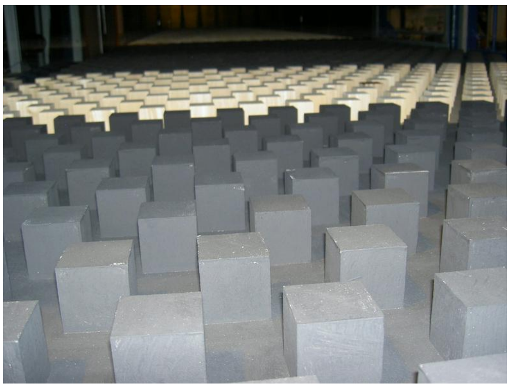
JOB PROFILE :

This vacancy is for a 2-year post-doctoral position in the Dynamics of the Urban and Coastal Atmosphere (DAUC) group headed by Dr. Isabelle Calmet to work within the framework of the URBANTURB project described below (PI: Dr. Laurent Perret). The DAUC group is part of the Laboratory for Hydrodynamics, Energetics and Atmospheric Environment (LHEEA) of Ecole Centrale de Nantes (ECN), whose research activities are focused on the study of (i) the micro-climatology and meteorology from the neighborhood- to the city-scale, (ii) the micro-meteorology in coastal environments or complex topography, (iii) air quality and pedestrian comfort (focusing on pollution dispersion and street ventilation) and (iv) turbulent transfer mechanisms between the lower-atmosphere and the urban and vegetation canopies.

The selected candidate is expected to actively participate in the first and second steps of the project which consist in investigating the characteristics of the turbulent flow developing over urban terrain of idealized geometry. This work will be based on wind-tunnel experiments conducted in the large atmospheric boundary-layer wind-tunnel of the LHEEA lab (25m x 2m x 2m) using combined Laser Doppler Velocimetry, Thermal anemometry and Stereoscopic Particle Image Velocimetry. The goal is first to obtain a detailed database of the velocity field of the flow in and above the urban canopy to allow, in a second step, the study of the coherent structures present in the flow and their dynamical interaction. The selected candidate will therefore have to design and conduct high-quality experiments, post-process the data and perform analysis with advanced signal processing methods for coherent structures extraction and characterization.
We are therefore seeking a highly motivated independent candidate, holding a PhD degree in turbulence or related fields with a strong experience in experimental fluid mechanics, mastering optical velocity measurement methods as well as advanced signal processing techniques.



Atmospheric boundary-layer wind tunnel at LHEEA lab.

SUMMARY OF THE PROJECT URBANTURB :

Understanding and modelling the dynamics of the atmospheric flow over urban terrains still represent an important scientific challenge with high stakes for our ability to handle the ever growing population in urban areas and the associated issues of air quality and urban management. The encountered difficulties arise from the high geometrical complexity of built areas, the existence of numerous interacting thermodynamics processes of both natural and anthropogenic origin that take place in the urban-canopy, and the mutual influence of the atmospheric processes. In particular, the wind field and turbulence play a crucial role in driving the instantaneous exchanges of various quantities such as momentum and heat or particles. From a purely aerodynamic point of view, the atmospheric flow over the urban-canopy can be considered as a high Reynolds number boundary layer flow developing over a heterogeneous and multi-scale surface. This flow has therefore an important multi-scale character in both the spatial and temporal domain with strong and complex inter-scale interactions. The resulting high complexity still limits our ability to understand the dynamics of urban flows but also to model them due to the prohibitive computational cost of performing obstacle resolving simulations at the district- or city-scale that would be necessary to take into account the whole range of phenomena at play.

The research project URBANTURB aims at elucidating the interaction mechanisms between the lower-atmosphere and the urban-canopy flow and developing new modelling strategies to account for the interactions between these two regions of the flow. The focus will be on neutrally-stratified configurations. Recent results obtained for high-Reynolds number boundary-layer flows over smooth-walls have shed light on the nature of the coupling between the near-wall turbulence and the large-scales of the flow developing above and enabled the development of simple predictive models. Building upon these findings, the project will consist in three main phases. The goal of the first one is to identify and characterize, both in the canopy region and in the boundary-layer developing above, the turbulent coherent structures that play a major role in the interaction between theses flow regions and in the transfer processes in order to extract scaling laws. This analysis will be based on the realisation of well-controlled wind-tunnel simulations of high-Reynolds number flow over rough wall or dense urban-like canopies but also on large-eddy simulation of similar configurations. The second main step will concern the investigation and the modelling of the interaction mechanisms between the large-scales present in the boundary-layer and the canopy turbulence. The aim here is to develop predictive models that accurately account for the identified interactions. The last phase will be devoted to the performance assessment of the modelling strategies in numerical codes.

CONDITIONS OF EMPLOYMENT:

- Estimated maximum net salary per year: 25 000€;
- Duration of the contract: Temporary for the renewable duration of 1 year;
- Expected starting date: 1st of September 2015.

KEYWORDS: atmospheric flows, urban canopy, turbulence, wind tunnel, PIV, LDA, hot wire, coherent structures.

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