M.Sc. Research Internship Proposal "CORIA-TURN-POPSU"

Subject (Title)

Digital Twin of the Rouen Normandy Metropolis: Physical Models Enrichment

Jumeau Numérique de la Métropole de Rouen Normandie: Enrichissement des modèles physiques

Keywords

Aerodynamics Measurements, Turbulence, Environmental Engineering, Modeling and Simulation, Computational Fluid Dynamics (CFD)

Hosting Entities

The University of Rouen Normandy (https://www.univ-rouen.fr/), with its strong multidisciplinary identity, is a major player in training and research in Normandy region and in France. It pays particular attention to overcome the challenges of higher education and contribute to the overall economic and social development of its territory.
Created in 1967, **CORIA**, "**Co**mplexe de **R**echerche **I**nterprofessionnel en **A**érothermochimie" (https://www.coria.fr/en/the-lab/), is a Joint Research Unit (UMR 6614) CNRS and the University of Rouen Normandy.

Research Context

This internship is in the context of a large project called POPSU: Platform for Observation of Urban Projects and Strategies and in the continuation of internal primary research works made by G. Maroun [1] and F. Catalan [2].
The T.URN Institute (https://www.univ-rouen.fr/actualites/decouvrez-linstitut-t-urn/) integrated recently this project which is financed by the Public Interest Group with Interministerial Vocation, Europe of Architectural and Urban Projects (the GIP EPAU).
In partnership with the University of Paris-1, the Urban Planning Agency of Boucles de Seine et Eure, and the MRN (Métropole de Rouen Normandie), this POPSU project addresses multiple questions related to the socio-ecological transition in the objective of "characterizing the ecological issues at the Rouen Normandy Metropolis".
This internship is also in a global context of developing a multi-risk platform (https://multirisques.univ-rouen.fr/) in Normandy region in France (e.g. for floods, fires and particles dispersion, air pollution dispersion, among others). One of the missions is to predict accurately the local air flow dynamics at the scale of the city in presence of green areas (e.g. trees, forests).

Objective

The main objective is to develop, implement and validate porosity models in CFD to take into account the true resistance of different urban trees to the local wind. This will enrich the physical models in the digital twin and will thus allow to investigate how local trees in the métropole region can affect outdoor air flow dynamics. This is essential for predicting the outdoor local dispersion of different sources of particles (e.g. from industrial and natural fires, airborne pollutants, etc) with an acceptable level of precision at a large scale (scale of the city of Rouen).

The major 3 work packages in this internship are the following:

1- Conduct Aerodynamics Measurements of air flow around trees in a wind tunnel to determine the porosity matrix of different types of representative trees at a laboratory scale.
2- Conduct gaz components emissions from different type of wood/plant fire sources.
3- Conduct 3D CFD simulations to validate the experimental measurements.

Required Profile

Scientific Background*:* Student currently in Master-2 (M.Sc.) in the fields of Aerodynamics, Turbulence, Experimental measurements of fluid flow, computational fluid dynamics. A Beginner experience within OpenFOAM® would be a plus (https://www.openfoam.com/).

Skills: Taste for experiments and modeling and numerical simulation in CFD, in-depth notions in fluid mechanics and turbulence, and aerodynamics in presence of obstacles and immersed objects. Good taste for a teamwork and a good level of Scientific English, speaking, reading and writing.

Internship Details

Starting date : January-February 2025
Period : 6 months
Place : CORIA Lab.

Supervisors team

DBOUK Talib (CORIA), Emilien VAREA (CORIA), Romain CHAMPION (T.URN), Lamiae VERNIERES (INSA-Rouen), GEFFROY Alexandre (T.URN), Béatrice PATTE-ROULAND (CORIA)

Remuneration

≈ 600 € /month

How to Apply

Please send your CV and motivation letter to the following both email addresses:

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References

(1) Georges MAROUN, Modélisation et simulation numérique de la dispersion des polluants dans un milieu urbain, **Rapport de Stage**, CORIA, UROUEN, Août **2023**.

(2) Fermín CATALÁN, Numerical modelling and simulation of the dispersion of pollutants in an urban environment, **Internship Report**, CORIA, UROUEN, Octobre **2023**.

(3) T. DBOUK, N. VISEZ, S. ALI, I. SHAHROUR, D. DRIKAKIS, Risk assessment of pollen allergy in urban environments. Nature, Scientific Reports, **2022**. DOI: https://doi.org/10.1038/s41598-022-24819-w

(4) Viana Parente Lopes JM, Palma JMLM, Silva Lopes A. Modelling the flow within forests: the canopy-related terms in the Reynolds-averaged formulation. **Journal of Fluid Mechanics, 2021**, 910:A7. Doi: https://doi.org/10.1017/jfm.2020.927

(5) C. Chatry, M. Le Quentrec, D. Laurens, J.-Y. Le Gallou, J.J. Lafitte B. Creuchet, J. Grelu, Rapport de la mission interministérielle. Changement climatique et extension des zones sensibles aux feux de forêts. Vie Publique, Rapport, 2010. https://www.vie-publique.fr/rapport/31347-changement-climatique-et-extension-des-zones-sensibles-aux-feux-de-foret

(6) Geon Kang, Jae-Jin Kim, Wonsik Choi, Computational fluid dynamics simulation of tree effects on pedestrian wind comfort in an urban area. **Sustainable Cities and Society**, Volume 56, May **2020**, 102086. DOI: https://doi.org/10.1016/j.scs.2020.102086

(7) Se-Woon Hong, Lingying Zhao, Heping Zhu, CFD simulation of airflow inside tree canopies discharged from air-assisted sprayers. **Computers and Electronics in Agriculture** 149 (**2018**) 121–132. DOI: http://dx.doi.org/10.1016/j.compag.2017.07.011