RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

ONERA
THE FRENCH AEROSPACE LAB

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PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DAAA-2025-11**
(à rappeler dans toute correspondance)

Lieu : ONERA Lille

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DESCRIPTION DU STAGE

Thématique(s) : Ecoulements libres, écoulement pariétaux

Type de stage : ☒ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

Intitulé : Experimental characterization of the turbulent wakes of « spires » for the generation of atmospheric boundary layer in wind tunnel – Caractérisation expérimentale du sillage turbulent de « spires » pour la génération de couche limite atmosphérique en soufflerie

Sujet:

The Atmospheric Boundary Layer (ABL) is a region of the atmosphere characterized by transports of momentum, heat and humidity, interacting with the Earth surface through its high turbulence intensity. This complex environment is studied by the discipline of "Wind engineering" through the complementary efforts of experimental and numerical research, with applications to civil engineering, pollutant dispersal or wind turbines studies. The experimental approach consists in generating artificially a flow representative of an ABL downstream of the desired scaled models in wind tunnel. The current state-of-the-art makes use of a combination of "wall-mounted spires array" with an artificial roughness fetch, as described in Irwin (1981) and visible in wind tunnel in Figure 2. However, no model currently exists to predict the turbulence characteristics generated by a given "spires-roughness" device, thus preventing any "a priori" design process. Therefore, time-consuming trial-and-error steps are still required to generate turbulence intensity and integral length scale profiles representative of the atmosphere. Overcoming this design difficulty would greatly improve the range of turbulent wind conditions achievable in wind tunnel and the adaptability of these devices from one wind tunnel to the other.

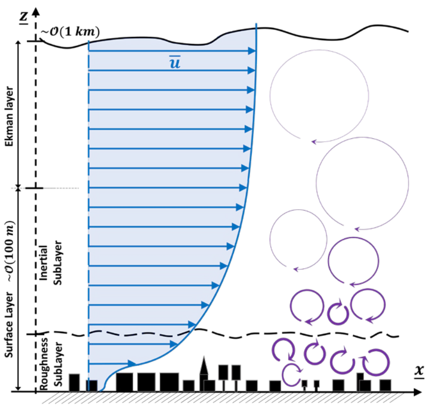

Figure 1 - The structure of the ABL without thermal forcing

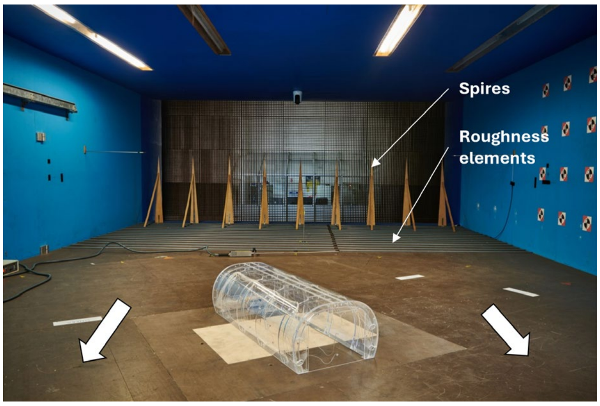

Figure 2 - ABL generation devices installed in the wind tunnel L2 (ONERA Lille) for the study of the flow around an airship hangar

Recent experimental studies undertaken at ONERA Lille indicate that a better understanding of the complexity of the near-wake flow development downstream of "spires" is required to suggest improved spires-generated turbulence models (T. Huret, PhD thesis). An example of the observed flow characteristics within a transverse plan relatively close to a spires array is highlighted in Figure 3, highlighting the coexistence of well-separated turbulence production regions (Figure 5) linked to longitudinal vortex structures (Figure 4).

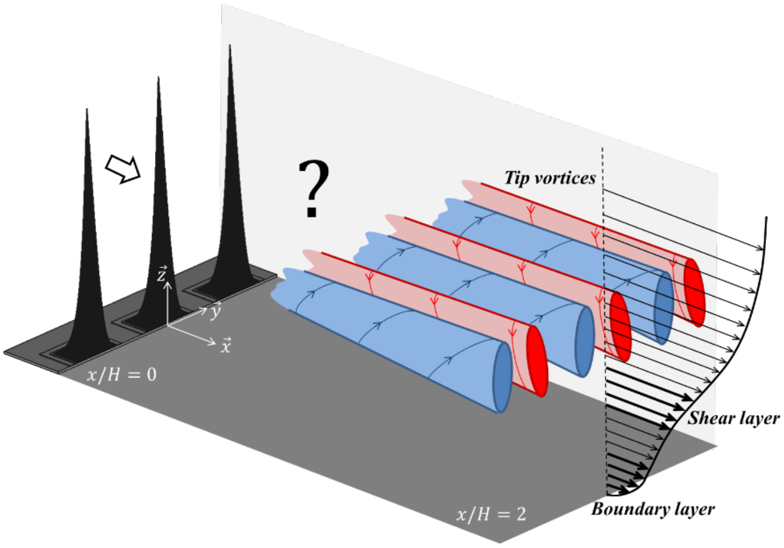

Figure 3 - Schematic visualization of the flow development downstream of a configuration of "spires", as observed in Figure 4 and Figure 5

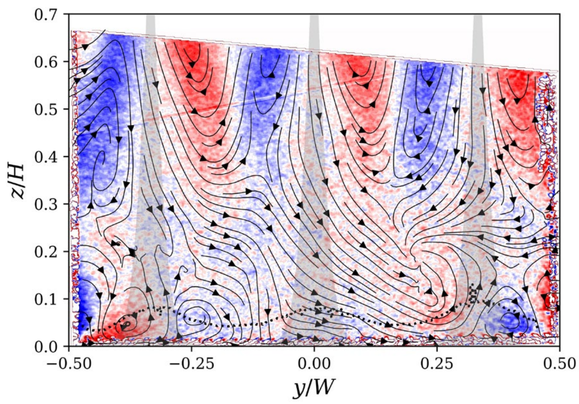

Figure 4 - Longitudinal vorticity measured by S-PIV over a transverse plan downstream of a configuration of "spires"

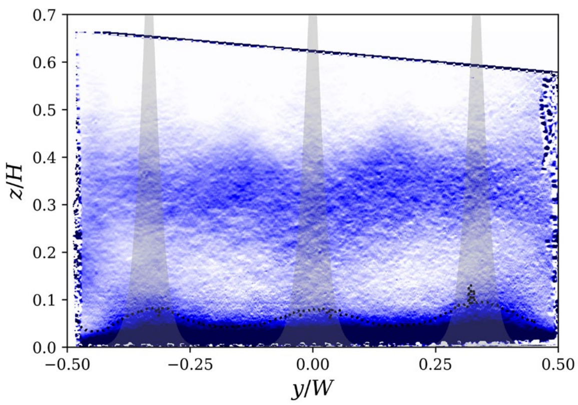

Figure 5 - Production of Turbulent Kinetic Energy (TKE) measured by S-PIV over a transverse plan downstream of a configuration of "spires"

Using Stereo-Particle Image Velocimetry, this internship project aims at initiating a parametric study relating the “spires-roughness” geometry with their near-wake flow development. A specific focus will be given to the interaction between spires wakes with the near-wall turbulent boundary layer. This work may be complemented using oil-film visualization (to help the analysis) and Hot-Wire Anemometry (for the study of possible dynamic characteristics of the flow such as vortex shedding). The final understanding of the flow development is expected to be used to improve and correct the current modelling efforts of turbulence downstream of ABL generators.

References:

Irwin, H.P.A.H., 1981. *The design of spires for wind simulation*. Journal of Wind Engineering and Industrial Aerodynamics 7, 361–366.

Huret, T.,2024. *Wind tunnel simulations of turbulent shear flows representative of atmospheric boundary layer by the use of upstream passive device*, PhD thesis

Est-il possible d'envisager un travail en binôme ? Non

Méthodes à mettre en œuvre :

☒ Recherche théorique	☐ Travail de synthèse
☒ Recherche appliquée	☐ Travail de documentation
☒ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : Oui		
Durée du stage :	Minimum : 5 mois	Maximum : 6 mois (sur dérogation)
Période souhaitée : à partir de Mars 2025		

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	**Ecoles ou établissements souhaités :**
Fluid mechanics and turbulence A deep interest in undertaking experimental campaign and physical modelling Python	« Ecole d'ingénieur » or master 2