Thesis topic :
Analysis of the marine atmospheric boundary layer in the coastal zone from field observations and mesoscale modeling for wind resource assessment.

Scientific objectives:
The detailed understanding of the dynamic mechanisms at work in the atmospheric boundary layer in a marine environment is identified by the scientific community as a major obstacle for the development of wind turbines at sea. These coupled mechanisms generate complex flows: low level jets, extreme shear, local thermal breezes, which can deviate significantly from the standard conditions of the atmosphere conventionally described and used in the field of offshore wind power for the evaluation of the producible and the sizing of the machines. The lack of field observations and the limitations of weather forecasting models (low resolution) are two major obstacles. The thesis proposes to contribute to filling these gaps by the combined analysis of field observations and numerical mesoscale simulations with fine mesh (tens of meters) with the objective of better documenting the characteristics of the low layers of the atmosphere of interest in offshore wind (10–200 m).
This project is made possible thanks to the accumulation in recent years by the LHEEA of long-term observations from a network of sensors and ad hoc campaigns using a fixed LiDAR from the ground (LHEEA) and access to data bases from floating LiDARs (data provision) [1, 2]. The LHEEA's numerical modeling means [3] will make it possible to understand the spatial dimension of these particular phenomena and to understand the establishment of complex situations. One or more specific developments will be made to the numerical model in order to improve the existing modeling tool (better consideration of stable thermal conditions, wind-wave interactions, tides or currents).

Expected results: constitution and analysis of a field database and increase in representativeness of numerical models for the description of the lower layers of the marine atmosphere in order to characterize the specificities of the offshore wind resource and assess their impact on the resource wind turbine.

The main stages foreseen for the thesis work are as follows:
- Getting started with numerical modeling tools,
- Identification and development of judicious complementary functionalities
- Getting started with field databases
- Choice and implementation of pre- and post-processing strategies,
- Coupled analysis of field data and model results

Skills and knowledge required:
• solid knowledge of fluid mechanics
• basic knowledge of atmospheric flows
• experience in numerical modeling
• experience or interest in field measurement techniques
• good analytical and synthesis skills

• good level of English, written and oral

Practical conditions:

- Laboratory: LHEEA (Laboratoire de recherche en Hydrodynamique, Énergétique et Environnement Atmosphérique) UMR 6598 CNRS – École Centrale Nantes, École Centrale de Nantes, 1, rue de la Noë. 44321 Nantes cedex 3
- Start: November 1, 2021
- Contacts: Boris CONAN (boris.conan@ec-nantes.fr), Isabelle CALMET (isabelle.calmet@ec-nantes.fr)
- Funding: Pays de la Loire region and Ecole Centrale Nantes
- Duration: 3 years
- The possibility of teaching may be considered
- Application deadline: 18th February 2022

References :

[1] Conan, B., Kéravec, P., Perignon. Y., Lighthouse and buoys to measure the offshore wind resource. *Wind Energy Science Conference*, Jun 2017, Copenhague, Denmark

[2] Conan, B. Scanning LiDAR field observation of near-offshore wind resource and extremes in the Northeast Atlantic coastal region of France, Preliminary results. *Wind Energy Science Conference*, 2021

[3] Calmet, I., Mestayer, P. G., van Eijk, A. M., & Herlédant, O. (2018). A coastal bay summer breeze study, part 2: high-resolution numerical simulation of sea-breeze local influences. *Boundary-layer meteorology*, *167*(1), 27-51.