Position at CEREA

«Modeling of offshore wind energy resource and wake effect»

Context

CEREA (Atmospheric Environment Centre) is a joint Laboratory between the École des Ponts/Paris-Tech and the Research and Development division of Électricité de France (EDF). Its main activity is the modeling of the impacts of electricity production and traffic on the atmospheric environment, from local to continental scales. To that end, CEREA develops and/or uses different models of atmospheric flows (Code_Saturne for the local scale, MM5 and WRF for mesoscale) and pollutant dispersion (Polyphemus/Polair3D). It also makes use of meteorological instruments in order to provide input and validation data to these models and to study atmospheric processes. During the past few years, these tools were also used for wind energy applications, the goal being to improve the methodology required for wind resource assessment and wake effect calculations. As part of a Ph.D. thesis, a methodology based on the use of Code_Saturne has been developed for onshore complex terrain. This work is currently carried on in the framework of the European project WAUDIT.

The strong development of offshore wind energy capacity, which is expected for the next 10 years especially in Europe, leads to the need of methodologies and tools suited to the specificities of the marine Atmospheric Boundary Layer (ABL) and to the turbine layout used over the sea. A new project started in January 2011 at EDF-R&D (managed by the EDF-R&D UK Centre in London) to support the development of EDF Group offshore wind capabilities. The development of tools and methodologies for offshore wind conditions assessment will be one component of this project, and the topic of the work proposed for this position.

Work program

A position is open at CEREA for 24 months with the development and the validation of a methodology for the modeling of offshore annual energy production as main objective. The main steps are:

Bibliographic survey

A bibliographic survey will be performed in order to:

- Define the state-of-the-art in: marine atmospheric boundary layer modelling (especially the air-sea momentum transfer), models used for offshore wind resource assessment, wake modelling (inside a farm and between farms).
- Identify the instrumentation, which is currently the most commonly used for offshore wind resource assessment, the existing public data sets, and to select the best documented ones.
- Identify the software packages used for offshore wind resource estimation and wake modelling.

The deliverable (expected for the end of 2011) will be a report, which will summarize the content of the most important papers, conference proceedings, reports or other information about current works and will list the available data sets.

The next steps of the work will be more precisely defined following the conclusions of this bibliographic survey.

Developments in Code_Saturne

Some developments will be introduced in Code_Saturne in order to take into account the specificities of the marine ABL. They will include a surface layer parametrization, which will have to take into account the coupling between the momentum flux and the waves, and to use universal functions, which are well suited to stable stratification. The wind and turbulence profiles will then be compared to an offshore data set using a coupling with a mesoscale model to define the boundary conditions.

Offshore wind potential computation

The wind resource will be calculated with Code_Saturne for a site chosen on the basis of the bibliographic

study. A data set including several years of wind and turbulence measurements at several vertical levels is required for this step. A clustering method will be used in order to insure the long-term representativeness with a reasonable computation time.

Computation of the Annual Energy Production (AEP)
A wind farm will be selected for which a data set including both wind and electric power data is available. The grid for Code_Saturne will be built including the rotor of the wind turbines in order to take into account the wake effects (wind speed decrease and turbulence increase). A comparison will be performed with the data in order to check the ability of Code_Saturne to calculate the losses of production due to the wakes.

Report writing
A report will be written describing the methodology and the results.

Profile of candidates

- Ph.D. or Engineer degree in Atmospheric Sciences or Fluid Mechanics
- Strong experience in computer use (Linux, Fortran, C, Python)

Location
The place of residence will be based in the EDF R&D Office in Chatou, just several kilometers to the west of Paris.

Application
The interested candidate should send a CV with motivation letter to :
Luc Musson-Genon, deputy-director of CEREA: luc.musson-genon@edf.fr
Eric Dupont, researcher at CEREA: eric.dupont@edf.fr