Energie-Innovationszentrum Cottbus

Brandenburgische Technische Universität Cottbus - Senftenberg

MASTER / BACHELOR THESIS or STUDY PROJECT

Chair of Numerical Fluid and Gas Dynamics · Scientific Computing Lab, Energy Innovation Center (EIZ)
Brandenburg University of Technology (BTU), Cottbus, Germany

Numerical simulation and modeling of fluctuating wind fields for renewable energy applications

Synopsis – Fluctuating wind fields govern the momentarily available power of wind turbines at a given site. In order to accurately estimate the volatility of wind energy production, current efforts aim at downscaling numerical weather predictions in order to provide detailed and site-specific predictions of the near-surface winds. These winds exhibit strong daily variations and non-Gaussian fluctuations due to the presence of turbulence that is influenced by local stratification effects and Earth's rotation. Turbulence denotes a chaotic flow that encompasses an enormous range of scales due to which it is computationally not feasible to resolve relevant small-scale processes within state-of-the-art numerical tools. The aim of this thesis, therefore, is to contribute by utilizing novel modeling approaches for downscaling. The overall research has various facets. Possible topics for a thesis range, for example, from further development and application of standalone single-column stochastic modeling tools [1,2], or advanced closure modeling within large-eddy simulation [3,4], to application of community and open-source models, like WRF (among others) [5] or OpenFOAM [6].

[1] Klein & Schmidt (2022), accepted for publication in *Adv. Sci. Res., EMS'21 Special Issue* — [2] Kerstein & Wunsch (2006) *Boundary-Layer Meteorol.* **118**:325 — [3] Glawe *et al. Z. Angew. Math. Mech.* **98**:1907 — [4] Freire (2022) *Boundary-Layer Meteorol.* **184**:25 — [5] Fischereit *et al.* (2022) *Boundary-Layer Meteorol.* **182**:175 — [6] *flapFoam* (`https://gitlab.cc-asp.fraunhofer.de/iwes-cfsd-public/flapfoam`, last accessed 2022-10-17)

Modes

- **a) Master / Bachelor Thesis (1 semester):** Extension of data analysis; own stochastic simulations
- **b) Study Project (2 semesters):** Numerical simulations with a community model
- **c) Study Project and Master Thesis (3 semesters):** Tasks of a) and b), aiming at model coupling

Tasks

- Review of relevant literature
- Visualization, post-processing, and analysis of numerical simulation data
- Comparison with relevant reference data
- Own numerical simulations with in-house stochastic or community models

Desired skills

- Solid knowledge of fluid mechanics, atmospheric dynamics, boundary layers, or related topics
- Affinity to programming (preferably Python, Matlab, C/C++, or Fortran)
- Scientific attitude (curiosity, self-motivation, and critical reasoning)
- Experience with data analysis, numerical simulation, multiphysics modeling, or CFD is an asset

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