The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Multilevel Monte Carlo derivative-free optimization under uncertainty of wind power plants

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Keywords: *Optimization, Uncertainty Quantification, Derivative-free optimization*

In this work we investigate the performance of a novel derivative-free optimization under uncertainty (OUU) algorithm based on Multilevel Monte Carlo (MLMC) for wind power plants. Our optimization algorithm combines the flexibility of derivative-free algorithms, which can be easily applied to black-box codes, and the efficiency of MLMC estimators, which can lower the cost of performing UQ by fusing information obtained from sources with varying accuracy and cost. The main component of this algorithm, which is implemented in Dakota [1], is the possibility to target a reliability formulation, *i.e.* a linear combination of mean and standard deviation for the quantities of interest, within a MLMC estimator in order to achieve an accuracy comparable to a reference Monte Carlo estimator, at a reduced cost.

We will target optimization of wind power plants by considering the optimal wake steering strategy based on yaw alignment for each individual turbine in order to maximize the power output. We will include several uncertainty sources, like environmental conditions, *e.g.* wind inflow velocity angle and magnitude, and controller errors, *e.g.* turbine sensors for the inflow wind angle measurement and we will rely on levels (for the MLMC construction) built from varying spatial discretizations. Results will be presented on both a benchmark problem for illustrative purposes and the wake steering scenario simulated by using Reynolds-Averaged Navier-Stokes simulations.

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REFERENCES

[1] Dakota, A Multilevel Parallel Object-Oriented Framework for Design Optimization, Parameter Estimation, Uncertainty Quantification, and Sensitivity Analysis: Version 6.15 User's Manual, Sandia Technical Report SAND2020-12495, (2021).