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Simulating wind and marine hydrokinetic turbines with actuator lines in RANS and LES[1] PETER BACHANT, MARTIN WOSNIK, Center for Ocean Renewable Energy, University of New Hampshire — As wind and marine hydrokinetic (MHK) turbine designs mature, focus is shifting towards improving turbine array layouts for maximizing overall power output, i.e., minimizing wake interference for axial-flow or horizontal-axis turbines, or taking advantage of constructive wake interaction for cross-flow or vertical-axis turbines. Towards this goal, an actuator line model (ALM) was developed to provide a computationally feasible method for simulating full turbine arrays inside Navier–Stokes models. The ALM predicts turbine loading with the blade element method combined with sub-models for dynamic stall and flow curvature. The open-source software is written as an extension library for the OpenFOAM CFD package, which allows the ALM body force to be applied to their standard RANS and LES solvers. Turbine forcing is also applied to volume of fluid (VOF) models, e.g., for predicting free surface effects on submerged MHK devices. An additional sub-model is considered for injecting turbulence model scalar quantities based on actuator line element loading. Results are presented for the simulation of performance and wake dynamics of axial- and cross-flow turbines and compared with moderate Reynolds number experiments and body-fitted mesh, blade-resolving CFD.

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