Comparison of four large-eddy simulation research codes and effects of model coefficient and inflow turbulence in actuator-line-based wind turbine modeling

Large-eddy simulation (LES) of a wind turbine under uniform inflow is performed using an actuator line model (ALM). Predictions from four LES research codes from the wind energy community are compared. The implementation of the ALM in all codes is similar and quantities along the blades are shown to match closely for all codes. The value of the Smagorinsky coefficient in the subgrid-scale turbulence model is shown to have a negligible effect on the time-averaged loads along the blades. Conversely, the breakdown location of the wake is strongly dependent on the Smagorinsky coefficient in uniform laminar inflow. Simulations are also performed using uniform mean velocity inflow with added homogeneous isotropic turbulence from a public database. The time-averaged loads along the blade do not depend on the inflow turbulence. Moreover, and in contrast to the uniform inflow cases, the Smagorinsky coefficient has a negligible effect on the wake profiles. It is concluded that for LES of wind turbines and wind farms using ALM, careful implementation and extensive cross-verification among codes can result in highly reproducible predictions. Moreover, the characteristics of the inflow turbulence appear to be more important than the details of the subgrid-scale modeling employed in the wake, at least for LES of wind energy applications at the resolutions tested in this work.