# Review of *Theory and Verification of a new 3D RANS Wake Model* (revised version R1), by Philip Bradstock and Wolfgang Schlez

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Overall, the authors have responded correctly to most of my suggestions and comments. However, I do have new concerns regarding the grid refinement study that has been added. Since the article is called ...*Verification of a new 3D RANS Wake Model*, then model verification in the form of a grid refinement study should addressed sufficiently in order to accept the article for publication.

**Main comments**

1. It is great that you have added a grid refinement study (Section 3.1), although the results presented in the Figure 2 indicate that either the RANS model does not behave well or something in the grid refinement study is not set up correctly. The numerical discretization error of a well behaving RANS model should decrease monotonically with grid refinement, which is minimal requirement. For example, if the order of the employed numerical scheme(s) is 2, then one would expect to obtain a reduced discretization error by a factor of 4 when the grid is refined by a factor of 2. Figure 2 shows that the absolute value of the chosen error metric increases with grid refinement, which is not acceptable for a RANS model. In other words, if one would choose to apply the RANS model with a finer resolution, then one would end up with a larger discretization error. As a result, a conclusion based on a simulation with the chosen grid size might not be valid for a simulation with a much finer grid. Figure 2 could indicate that the model needs a much finer resolution in order to provide well behaved discretization error.

   Furthermore, it is misleading to normalize the error by the error from your chosen grid size. Instead, it is better to normalize the error by a Richardson extrapolated value, which would represent the solution for a zero discretization error. If you have employed numerical schemes with different discretization orders you could apply a mixed order analysis as suggested by Roy (2003) and applied to a grid refinement study of single wake RANS simulations in Réthoré et al. (2013) and van der Laan et al. (2015). This method also reveals the leading order of the discretization error. However, if the discretization error of the RANS models does not monotonically decrease with grid refinement, then the mixed order analysis cannot be used. In this case, one should normalized by the error/ wind speed of the finest grid and conclude that the model is grid dependent.

   In addition, the information provided in Section 3.1 is not sufficient to understand and redo the grid refinement study: I lack information on:

   (a) How is the error defined? Where is the wind speed extracted in the lateral and vertical (height) dimensions? (You only mention the downstream distance.) Does the error of wind speed represent a point value or is it an integral over a chosen area (e.g. the rotor area representing a virtual downstream wind turbine)? Using an integral value is often a better metric for a grid refinement study.

   (b) What are the values of the thrust coefficients for both wind turbines and what is the wind turbine type that you used?

   (c) What is the distance between the two wind turbines and what is the wind direction relative to the wind farm layout?

2. It is good that you have moved the validation from the conclusion but you also need to remove or rephrase/explain the word accuracy in the conclusion because you have not tested the model accuracy using a validation study.

## References


Réthoré, P.-E., van der Laan, M. P., Troldborg, N., Zahle, F., and Sørensen, N. N.: Verification and validation of an actuator disc model, Wind Energy, pub. online, 2013.

Roy, C. J.: Grid Convergence Error Analysis for Mixed-Order Numerical Schemes, American Institute of Aeronautics and Astronautics Journal, 41, 2003.

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