

Dear Anonymous Referee #2,

Thank you for your review and positive recognition of the work. We fully agree that the abstract was too focused on the model and the results and missed the background for the work. A revised abstract is presented below which hopefully has a better balance of the content of the paper. This version will be inserted into the final version of the paper.

Revised abstract for WES paper: WES-2023-099

The continuous upscaling of wind turbines enabled by more lightweight and flexible blades in combination with coning has challenged the assumptions of a plane disc in the commonly used BEM type aerodynamic codes for design and analysis of wind turbines. The objective with the present work is thus to take a step back relative to the integral 1-D momentum theory solution in the BEM model in order to study the AD flow in more details.

We present an analytical, linear solution for a two dimensional (2-D) AD flow with one equation for the axial velocity and for the lateral velocity, respectively. Although it is a 2-D model we show in the paper that there is a good correlation with axis-symmetric and three-dimensional (3-D) CFD simulations on a circular disc. The 2-D model has thus the potential to form the basis for a simple and consistent rotor induction model.

For a constant loading the axial velocity distribution at the disc is uniform as is the case of the classical momentum theory for an AD. However, an important observation of the simulated flow field is that immediately downstream of the disc the axial velocity profiles change rapidly to a shape with increased induction towards the edges of the disc and less induction on the central part. This is typically what is seen at the disc in full non-linear CFD AD simulations as we compare with in the paper.

By a simple coordinate rotation the analytical solution is extended to a yawed disc with constant loading. Again, a comparison with CFD, now with a 3-D simulation on a circular disc in yaw, confirms a good performance of the analytical 2-D model for this more complicated flow

Finally, a further extension of the model to simulate a coned disc is obtained using a simple superposition of the solution of two yawed discs with opposite yaw angles and positioned so the two discs just touch each other. Now the validation of the model is performed with results from axis-symmetric CFD simulations of an AD with a coning of 20 deg and -20 deg, respectively. In particular, for the disc coned in the downwind direction there is a very good correlation between the simulated normal velocity to the disc whereas some deviations are seen for the upwind coning.

The promising correlation of the results for the 2-D model in comparison with 3-D simulations of a circular disc with CFD for complicated inflow like what occurs at yaw and coning indicates that the 2-D model could form the basis for a new, consistent rotor induction model. The model should be applied along diagonal lines on a rotor and coupled to an angular momentum model. This application is sketched in the outlook and is subject for future research.