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Interactive comment on "Is the Blade Element Momentum Theory overestimating Wind Turbine Loads? – A Comparison with a Lifting Line Free Vortex Wake Method" *by* Sebastian Perez-Becker et al.

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Dear authors,

I think this is a very good and important article! It is great that things are really investigated in detail to explain the phenomena that you observe. Also the idealized aerodynamics only comparison is a good idea to access basic model behavior before going ahead with the turbulent simulations. In my opinion the article could be a bit more nuanced about what a BEM model is. For example the title seems a bit exaggerating

to me - in principle you are only investigating if a particular BEM code is overpredicting loads, not the BEM code family as a whole. Also, as you state in the article, it is not a really fair comparison for the loads if the dynamic inflow model is deactivated.

Very recently we did a study of a grid based BEM model against an azimuthally averaged BEM model, both with dynamic inflow (see 'Implementation of the Blade Element Momentum Model on a Polar Grid and its Aeroelastic Load Impact' on wind energy science discussions, currently in proofreading). The outcome of that work is that the difference between a polar grid and an azimuthally averaged BEM model on DLC1.2 blade root flapwise fatigue loads is in the order of 8-10%. This is a similar order of magnitude as the difference between lifting line code and the BEM code you show in your article. The main reasons for these differences are a local dynamic inflow (vs an annular averaged) and better reaction of the induced velocity to shear and sampled turbulence, which is also very well in line with your conclusions.

Based on this difference we observed between different BEM implementations it might be too general to state that 'BEM overestimates loads'. Maybe you could mention our findings in your article or state that different BEM implementations car give different results and 'the BEM model' doesn't exist.

But again, I really like the very thorough approach and the detailed descriptions and analysis of the observed phenomena and I think your article is a very good contribution to the field of wind turbine aerodynamics.

Please find more detailed comments below.

Best regards,

Georg

- page 2 line 3: change the sentence to 'In the case of turbulent wind simulations, several repetitions of individual DLCs with different turbulent wind realizations are required...'. Without that it seems strange that simulations have to be repeated.

- page 3 line 33: The near wake model is not really a lifting line free vortex wake model. It is a simplified lifting line model where the vortices follow helical paths. The helix angles can vary in time, but the vorticity is definitely not as free to move around as in a true free wake model.
- page 4 line 1: than instead of that
- page 5 line 16: This explanation of a dynamic stall model is maybe a bit misleading, because it seems like it is applied on the static airfoil data in a preprocessing step. Can you rephrase this to explain better what the model does (for example applying time filters on the dynamic angle of attack and the separation point on the airfoil).
- page 8 line 2: You mention that tilt angle violates assumptions in BEM theory. But in practice tilt angle is no different from a yaw so as such it should be handled by the yaw correction model. Also, cone and radial induction can be taken into account in a BEM model, see our recent paper.
- Figure 3: Maybe I missed it but did you use fully turbulent or transition polars?
- page 12: You mention that the pitch angles agree in all computations, and they don't change when going from aerodynamic to aeroelastic simulations. It might be worth mentioning that that is probably only true because blade torsion is not included.
- page 16, line 7: Do you have an idea why the generator speed drops below the minimum generator speed in the BEM simulations? I think that the controller should prevent that.
- page 19: I am not quite sure if it is correct to say that the influence of different aerodynamic models is decreasing with higher wind speed. At high wind speeds, the load distribution changes when going to a higher fidelity model because the

strongest vortices are no longer necessarily trailed from the tip. Thus the common tip loss corrections for BEM models are not doing their job anymore and BEM load distributions differ more from high fidelity results than at low wind speeds. See the attached Figure from 'A coupled near and far wake model for wind turbine aerodynamics' (Wind Energy). Moreover, we found a large difference in fatigue loads for polar grid BEM vs annular average BEM at high wind speed in 'Implementation of the Blade Element Momentum Model on a Polar Grid and its Aeroelastic Load Impact'.

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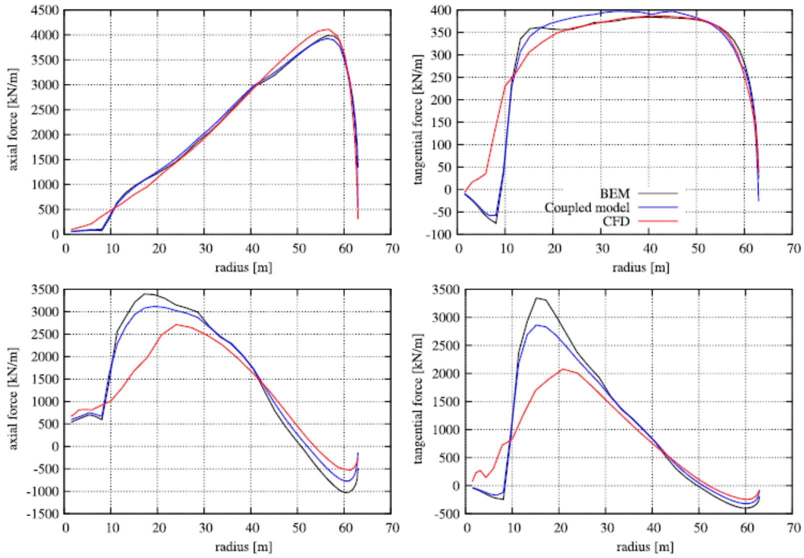

Figure 12. Comparison of axial and tangential forces in normal operation at 8 (top) and 25 m s^{-1} (bottom) of a blade element momentum (BEM) model, the coupled near and far wake model and full rotor CFD.

Fig. 1.