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Interactive comment on "Comparison of a Coupled Near and Far Wake Model With a Free Wake Vortex Code" *by* G. Pirrung et al.

Anonymous Referee #2

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General comments The paper presents several innovations for the implementation of coupled near-wake/far-wake model. The model is described in details and compared to a free wake vortex code. The method appears to improve the BEM model at a low computational cost.

The new model accounts for the difference in time scales of the far wake model depending on the operating conditions and introduce advanced unsteady aerodynamics corrections. The authors address convergence issues and provide an analytical expression for the determination of the relaxation factor which is essential to reach convergence. Computational time is improved by using this "optimal" relaxation factor and by reducing the number of exponential components of the indicial function. The innovations presented in the paper appear to improve previous implementations. The comparison to a free wake vortex code is relevant and the investigations related to the

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aerodynamic damping is of great importance for turbine fatigue loads.

As a general comment, the inherent differences between the two models should be addressed (either in a discussion paragraph, or by adding extra-investigations), in particular: lifting-line versus lifting-surface approach, rigid curved filaments with no expansion versus free particle, differences in dynamic stall implementations. Each of these "model" differences will have an impact on the results, but the extent of this impact is uncertain. The paper could have even greater value if the impact of this modeling choices were investigated: using a lifting formulation in GENUVP, by deactivating the dynamic stall in both models, etc.

Other comments are listed below.

Specific Comments p2 l8-9 and p2 l22-26: It seems you are giving results in these sentences. If they are results from this paper, you could consider moving them outside of the introduction part, or remove them completely if they are mentioned further in the document.

p4 l18: Could you elaborate more on the correction for the helix angle? The correction is not part of 3a 3b, is it? The sentence seems to say the correction is applied "on" the helix angle. Does the corrected model still assumes that the vorticity lays in the rotor plane? These were questions that came to me when reading this sentence. They are answered in the given reference but some details could help the reader at that point. (In fact you address this later on, in section 3. But the reader can be confused when it is introduced in section 2).

p4 equation (4): This is understood as a sum of vectors. In this paper, a visual distinctions between vectors and scalars could help the reader.

p4 l20 and l24-25: a reference is needed for the BEM model implementation and the a-CT relation used.

p4 l25-28: The description was hard to follow for me. When it is written "to account

for the near wake induction" is it meant in the sense "to compute a 'reduced far-wake' induction which does not include the effect of the near wake induction"? My own reformulation is poor, but could you reformulate the lines 25-28 to guide the reader? Also, could you add a reference or justification to support the removal of the tip-loss factor? Further, though understood, it is probably partially true that a_FW was computed without tip-loss corrections, since the thrust coefficient was probably computed using loads on the blades which in turn were determined included a tip-loss factor. If this is correct, could you comment on that, maybe add an equation to clarify what is meant here?

p9 l9: The author uses a cosine distribution which has indeed some numerical advantages for "elliptic" wings. Number of sections up to 100 were used in this study. Is the model stable above this number of sections? Has the author tried 200 or more sections? Could the elliptic distribution introduce convergence problems or numerical issues due to the small radial elements at the extremities? Have you investigated linear distributions and observed loss of performances (more iterations/computational time, decreased accuracy at the extremities, problems of convergence)? Could the linear distribution then out-perform the elliptic distribution for large number of sections? These questions are slightly rhetorical but your experience on the topic could be beneficial for the community.

p14 l11: It is not obvious what the "hybrid wake" approach is referring to. Does it refer to the way the far wake influence is computed? Or the combination of dipoles and particles?

p15 figure11: The figure demonstrates the effect of the iterative procedure. It could add value to also compare the results with other studies of the acceleration of a flat plate from rest. It can give insights into the validity of the physics and time constants of this model (which was mainly tuned for rotors).

p17+: Oscillations are observed in the results of the GENUVP code. It could add value to the analysis to consider a case where the dynamic stall model was removed

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from both codes in order to compare the build-up of inductions from both codes. The empiricism from the dynamic stall models introduces an extra level of complexity and thus more uncertainty on the source of the observed differences.

p19 l15: How are the vibrations prescribed for the GENUVP code?

Technical corrections p1 l20: I personally had trouble reading the second part of the sentence. Maybe you could replace "far wake computation is using", by "the far wake contribution is computed using"?

p2 l17: Consider splitting the sentence which is a bit long.

p14 l13-14: The sentence "If the relaxation factor..." seems incomplete.

p14 l16: The term "free flow velocity" may be reformulated to "local velocity" to avoid confusion with the free stream velocity.

p15 l1-3: The sentence is difficult to read, could it be reformulated? Also, consider replacing "local flow angle of attack" to "angle of attack" (or "3D angle of attack" or "local angle of attack").

p15 l9-11: Reformulation of these lines could help the reading.

p23 l21: Maybe "and zero drag" is meant. The structure of the sentence is hard to follow.

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