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WIND ENERGY SCIENCE DISCUSSIONS

WESD

Interactive comment

Interactive comment on “Do Wind Turbines Pose Roll Hazards to Light Aircraft?” *by* Jessica M. Tomaszewski et al.

Anonymous Referee #1

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In the light of close neighbourhood of wind farms and small airport for general aviation in the USA this manuscript examines the question if the wake behind a wind turbine can pose a hazard to light aircraft. The study is based on large-eddy simulations (LES) of neutrally and stably stratified turbulent boundary layers in which the wake flow behind an actuator-line parameterised wind turbine is computed. As a measure of potentially hazardous wake encounters of a light airplane its rolling moment coefficient is computed for many sets of flight tracks in down-wake and cross-wake directions in the LES boundary layer. The aircraft (a/c) solely consists of a wing which is modelled as a line segmented in eight stripes. Both, the wind turbine and the light aircraft are chosen as typical representatives of their kind in the USA.

The paper is well written and good to understand for readers with background in either

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Discussion paper

wind energy or aviation and it should be of high interest for both groups. Since the study adds to the ongoing and contradictory discussion if or if not light a/c are in danger in wind turbine wakes it is of utmost importance that the methodology and assumptions are properly explained and justified.

I recommend publication of the paper after the authors have addressed my comments and questions.

My main concern addresses the simplification of the forces acting on the a/c, p. 7/8: The authors do not account for the a/c motion response (p.7 line 29). However, the swirl in the wake has lateral and vertical flow components. Hence, when the a/c has started to roll not only w changes the angle of attack (eq. 1) but also the lateral (wing-parallel) wind component v, which acts on the wing, yielding a higher roll rate, bank angle and rolling moment coefficient. So, is it justifiable to neglect that response? In the view of my argument (if it is true) the C_roll values obtained and discussed might be an underestimate of the total roll effect and therefore critical.

Classification of the rolling moment coefficient on p. 8, lines 22-23: The classification of an a/c roll as a “low”, “medium”, or ”high” hazard very strongly depends of the flight altitude of the a/c above ground. The same C_roll value being classified as “medium” or “low” when the a/c is flying high above ground might be classified as “high” when the a/c is close to the ground as is the case here. So, I wonder for which flight altitude the thresholds mentioned in the paper are valid. Are these the correct values for a/c flying at wind turbine rotor height ? In the light of that question it is very valuable that the authors present all the C_roll values and state on p.9 lines 2-3: . . .vast majority . . . are contained within |C_roll| < 0.02. . .”. This result together with the ambiguity of the classification should be discussed / interpreted in Chapter 4.

Shear versus wake rotation on p. 9 line 18-19: Since the swirl of the wake (the wake rotation) is strongest where also the shear is large (at the edge of the wake) it is hard to decide if the rolling moment is mainly caused by uncoherent turbulence due to shear or by the more coherent motion of the swirl. The data are available from the LES to do that discrimination, although I would understand that this might be beyond the scope of the paper.

The fleet of a/c encountering the wake in down-wake (cross-wake) trajectories counts 10x10 (44x10), a/c, leaving space between a/c pairs, p. 8, lines 4-8: If my understanding is correct, then not the entire domain is searched for C_roll and there is a chance that maybe the most hazardous parts in the wake are not found because they are just between two a/c. Wouldn't it be better therefore to place (virtual) a/c at _each_ grid-point of the domain (with overlapping wings) to cover the entire wake ? (This would also increase the already impressive sample size drastically.)

Some other points which I came across:

P. 5 line 3: I guess the instantaneous horizontal wind field is plotted.

Fig. 3 on p. 6: The authors mention the numerical noise beyond 8 D downstream which appears as an organised "wavy" structure of the horizontal wind. This structure can also be seen (with a somewhat weaker signal though) at other, more relevant locations in the plotted horizontal cross-sections (e.g. between at 3 and 7D of Fig. 3b and f, close to the lateral boundaries at y=+/- 1.5D. Does this indicate some numerical instability due to the changing grid resolution laterally ? And if so, does it have an impact on the results ?

P. 7 line 1: better: "... across the aircraft's wingspan."

p. 7 line 8: why "linear" velocity ?

p. 9 line 10: "top-left" correct here ?

p.12 lines 13-15: I cannot match the statement (positions) here with the dots in Fig. 4. Please explain or reformulate.

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