General comments:

“Aerodynamic effects of leading edge erosion in wind farm flow modeling” studies the effect of leading edge erosion (LEE) on wind farm energy production directly through degraded power and thrust curves including the effect on wake losses. It is argued that eroded blades will decrease the energy production of an individual turbine, but at the same time, the wake deficit will also be reduced leading to a wake containing a higher energy for the downstream turbines. To this end an existing damage prediction model is coupled with a proposed aerodynamic loss prediction method to form the combined LEE module. The numerical simulations were performed using a steady wind farm flow model. LEE induced power losses are compared between an individual turbine and an entire wind farm. Finally, a prioritized repair strategy is propose based on Monte Carlo simulations.

The main focus of the study is based on determining the LEE damage of an individual turbine for a given time series of weather inputs (wind speed and rain) and turbine operational data of a site. An existing damage prediction model is combined with a newly proposed aerodynamic damage prediction model to determine the blade-sectional aerodynamic losses. The eroded power and thrust curves are obtained based on these sectional losses are used for a numerical simulation of a wind farm. The input of these numerical simulations are a time series of wind speed, wind direction, and rain to simulate the gradual development of erosion on each individual turbine in a wind farm with a possibility of updating the modeled damage state at a given time step.

The first part of the LEE module is an existing structural erosion damage prediction model that provides estimate of the erosion damage along the blade, based on time series of turbine-local wind speed and rain. In the second part of the LEE module an aerodynamic losses categorization is introduced based on the erosion level and Reynolds number. Finally, these two models are combined to obtain the LEE module.

The aerodynamic loss categorization and combination with the structural damage categorization needs further explanations. Please see below for specific comments.

Specific comments:

1. **pages 5-6, section 2.3:** In this section the aerodynamic loss model is very briefly discussed. There are several unclear points:

   1.1. **lines 133-134:** The manuscript reads: "*Indeed, the maximum loss registered for erosion-type damages never exceeded 64% and once roughness caused the transition to occur at the leading edge, the additional loss from more severe erosion was between 10 − 15%.*"

   It is stated that the maximum loss is 64%, but also argued about additional 10-15% loss. These statements are not clear. Please elaborate what is that additional severe erosion and how can a damage never exceed 64% but can have additional 10-15% losses?

   1.2. **lines 138-142:** The manuscript reads: "*To assess the aerodynamic losses at higher Reynolds numbers 2D CFD computations were performed for four airfoils with relative thickness below 21 % (NACA63-418, FFA-W3-211, DU96-W-180, Risø-B1-18, Risø-C2-18) for a Reynolds number range from 5 − 15 million and different levels of erosion. The latter was generated using the spectral approach detailed in (Meyer Forsting et al., 2022a) and combined with a forward-facing step (height of 1.5 × 10−3 in chord units) on the suction side to represent the worst erosion level. The surface perturbations were directly resolved in those simulations.*”

   The statement suggests that there were more Reynolds numbers considered, but in the results (e.g.: table in figure 3b), only 2 Re numbers are mentioned. Please clearly indicate if more Reynolds numbers are considered or not.

   - What are these various erosion levels and how are they applied in CFD simulations?
   - What is meant by "the latter was generated using a spectral approach"?
   - What is exactly simulated with "spectral approach"?
   - Were there more CFD methods applied? If so, what other methods are used?

   1.3. It seems that the worst erosion level is modeled by a forward-facing step:

   - How does this forward-facing step look like?
   - How was the airfoil geometry modified to obtain this forward-facing step?
   - At which chord location was this step applied?

- What are the mentioned surface perturbations?

Please provide a detailed explanation of the modeling of the erosion in the CFD simulations. Please also provide a brief description of the CFD methods employed and the basic set-up of the cases (e.g. number of grid elements, domain sizes, boundary conditions, etc.) for the sake of the repeatability and comparison for the possible future studies.

1.4. **lines 144-145:** What is meant by "*diminishing drop by about 15 percentage*"? Could you please indicate lift-to-drag ratios for both Re numbers of 5e6 and 15e6 and re-formulate this sentence?

1.5. **lines 145-147:** It is not clear how these 5 categories were defined and what do these categories refer to. Are these categories based on the erosion level/height? Also, what are the values represented in table 3b?

1.6. **lines 147-148:** The manuscript reads: "*The first two categories capture the losses associated with the gradual movement of the transition location towards the leading edge over the entire blade section in question.*"

- Are categories “a” and “b” the first 2 or “b” and “c”?
- It is not clear how these categories capture the losses. Please explain how/why the transition location is moving towards the leading edge.
- Does the category "a" refer to a clean (no erosion) case? Please mention that.

1.7. **line 149**: It is stated that pits and gouges are assumed. Do you mean that one of these categories (is category c meant here) can be related to pits and gouges of the real wind turbine blade situation? If this is the case, how are other categories related to the real erosion cases?

1.8. **lines 149-150:** It is not clear how the additional losses are caused. It is also not clear what is meant by surface roughness and sharp steps. Is the surface roughness mentioned here different than pits and gouges? Are these sharp steps caused by erosion? Do you mean to relate the categories with real cases in these statements?

1.9. **line 152:** Although a reference is given, I suggest to briefly explain how a 60:40 mix of transitional and fully turbulent performance can be obtained/calculated.

1.10. **lines 153-154:** What kind of losses are these? Are these the drop in lift-to-drag ratio (in percent)?

Section 2.3 – general remark: Please explain the CFD simulations set up briefly and explain the procedure of defining the aerodynamic loss categorization in detail. It should be possible to generate this categorization for different Reynolds numbers based on this study.

2. **Section 2.4:** It is not explained how the structural damage prediction model is coupled with the aerodynamic loss categorization to obtain figure 3c. Please provide details of this "summing" procedure.

3. **lines 192-193:** Could you please present the mentioned empirical relation and explain how the losses included into this relation?

4. **Figure 5 caption and line 240:** 2 different values are given for mean annual rainfall. Please check the values.

5. **line 264:** "This corresponds to a 7% reduction..": is this a reduction in losses?

6. **lines 264-269:** Here it is argued that when the single turbine is considered the AEP is higher although the AEP loss is also higher compared to the wind farm case. This discussion needs a further elaboration/clearance.

7. **Figure 8:** It is not clear how exactly this graph is obtained. Maybe if the tables/graph in figure 3 explained in detail then this graph can be understood better. What is the (range of) Reynolds number considered for each blade section? Did you inter/extrapolate the values given in figure 3c for

different Reynolds numbers?

8. **line 323:** Could you please explain what is meant by "... highly wakes instances"?

9. **lines 343-344:** It is stated that: "It is especially visible for the last couple of years." Could you please be more specific?

10. **lines 343-344:** What is an incubation period for this case and how this "feature" is observed?

11. **section 5:** Very detailed and clear discussion on the applicability, shortcomings, and improvement points of the current model. Thanks for including this discussion here.

Technical corrections:
line 165: "between" is repeated twice.
Figures 3 a, b and c: Please enlarge these figures for better readability.
Figure 3b: please indicate the unit of the presented values.
Table 1: Is this table really necessary? Isn't it possible to mention these properties within the text?
line 269: "an 7% reduction" should be "a .."
line 270: ".. is run.." should be ".. are run .."
line 319: ".. gain.Wake .." there should be a space ".. gain. Wake.."
line 378: ".. was found be between .." should be ".. was found to be between .."
line 474: ".. was found to 1.4 % .." should be ".. was found to be 1.4 % .."