**WIND
ENERGY
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DISCUSSIONS**

Interactive comment on "Adjoint-based Calibration of Inlet Boundary Condition for Atmospheric CFD Solvers" *by* Siamak Akbarzadeh et al.

Anonymous Referee #1

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In the manuscript the authors introduce an adjoint based calibration method that can be used to ensure that the inflow boundary conditions represent some predetermined inflow characteristics. For comparison to field measurement data a correct representation of the inflow turbulent boundary layer properties can be very important and the present method can improve this. The presented methods thus seems to be useful for wind turbine or wind farm simulations and will therefore be interesting for readers of the journal.

After reading the manuscript I have various suggestions and comments, which I hope can improve the description of the work

a. Page 2 states "Mainly two different methods are used to set the inflow boundary conditions for ABL flow simulations". There are various other methods that are used within the community such as using white noise, Mann spectrum, (concurrent) precursor methods, etc. For a detailed discussion of turbulence inflow generation methods see Wu, Annu. Rev. Fluid Mech. 2017. 49:23–49 and Stevens and Meneveau, Annu. Rev. Fluid Mech. 2017. 49:311-39 for applications of such methods to wind farm applications.

b. Figure 1: The description of figure 1, and in particular the description of the strangely oriented circle, took me quite some time to understand. The description of this figure should be improved.

c. Can the method only be applied when the actual computational domain is cylindrical?

d. Figure 3: It is unclear what the green grid cell is. Please clarify.

e. Figure 5: The caption states the velocity field at 40 meters is given. What is meant? The velocity field at 40 meters from the ground level indicated in panel 5a?

f. Figure 6: Can it be indicated in the figure which calculations are performed simultaneously (primal and adjoint solver?) or are the different blocks in the figure performed sequently? If so, in what order.

g1. The section starting with "As it was explained in" on page 13 is rather vague. It is unclear to me what the smoothing function does exactly. I think the authors should explain this in more detail, so readers would be able to implement this part of the solution method by themselves. g2. The fitted profile in figure 3b is neither a logarithmic nor a power law. How exactly is the 1D inflow generating domain adjusted to achieve this? How strong can the deviation from the logarithmic/power law be before the code becomes unstable? How would one run the simulation in such a case (one may end up in an infinite loop in the diagram outlined in figure 6).

h. Does the computational time required by the adjoint solved depend on the initial wind direction and speed that is selected?

i1. Figure 8: It is not entirely clear to me what exactly is meant by the reference profile in figure 8a. i2. Page 14 just below figure 8 states: "Indeed, the output of the optimizer could be the exact reference profile if the convergence criterion was stricter." I am not sure what is meant here. When I look at figure 8b it seems that the calibration is performed on the velocity profile over the hill and this seems to match quite closely. When the velocity profile is calibrated at a specific location it could mean that any deviations with respect to measurements, caused by the used simulation method, would accumulate at another location in the domain (for example at the inflow). Is something like this happening? It would be good to discuss how the solution reacts to this.

j. At the end of the manuscript the authors mention various extensions of the method. I am unsure whether various of these effects could be represented using this methods. Due to the use of the 1D domain to generate the vertical profile means that there is no information on the three-dimensional structure of the flow. It is known that for various properties of the atmospheric boundary layer capturing this three dimensional structure is crucial. I do not see who that can easily be incorporated in this method. Can the authors discuss in more detail what the effect of missing some of the three dimensional flow statistics, spatial flow correlations in the inflow are lost, is?

Minor Page 2: page 3 von Karman ==> von Kármán Page 9: clarity, the Eq. 38 ==> remove "the" Page 11: the frozen turbulent ==> frozen turbulence hypothesis Page 13: "In this way the turbulence model parameters are also gradually updated toward the end the of optimization when the inlet boundary velocities have reached their optimum value." ==> sentence does to flow well, please correct.