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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Actuator Line Simulations of Wind Turbine Wakes Using the Lattice Boltzmann Method" *by* Henrik Asmuth et al.

Anonymous Referee #2

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The manuscript describes usage of the cumulant lattice Boltzmann method (CLBM) for simulating the wake structures behind a 5MW turbine when being modeled with an actuator line method. Comparisons with the ELLIPSYS3D code are presented. It is found that for a laminar inflow very comparable wake behavior can be obtained at reduced computational costs. This is expected for LBMs, as demonstrated by other authors in a variety of contexts.

The manuscript is generally well prepared and quite readable. It is strongest when applying the LBM to wind turbine flows and comparing the results to the Navier-Stokes code; it is weakest when trying to establish the CLBM as a reliable scheme for high

quality LES. Before publication, the manuscript requires some major alterations.

Some detailed technical comments:

- Page 5, line 6. ν is the kinematic viscosity
- Section 2.2: The CLBM is described in Section 1 in physical quantities. The reader unfamiliar with LBM might wonder why in addition a rescaling / normalization would be necessary as sketched in Section 2.2. The answer to this question is that LBMs are generally always implemented in non-dimensional units, meaning $\Delta x^{LB} = \Delta t^{LB} = 1$. This is also the case here as $c_s^{LB} = 1/\sqrt{3}$, which is the non-dimensional lattice speed of sound in LBM. This section should be re-written, the normalization and it purpose expressed more clearly.
- Section 4.2, Table 1: A proper convergence analysis would not evaluate the error norm versus the next finer resolution (which will invariably lead to superconvergence), but employ a reference computation at least 4x finer than the highest resolved computation in order to obtain accurate order of accuracy estimates. However, attempting a convergence analysis for a test case in transition is a somewhat futile effort, as evidenced by Table 1. The CLBM as well as the QUICK scheme should lead to 2nd order accurate results and not 1st order as shown in Table 1. My suggestion is to remove in particular this table.
- Section 5 is investigating the influence of a higher-order limiter on the CLBM. The authors apply this parameter instead of the Smagorinsky model for scheme stabilization and imply that this would be implicit large eddy simulation (ILES). It is not. The idea of ILES is to use a tunable parameter such that inherent scheme dissipation plus tuned dissipation agree with the required subgrid scale dissipation of a particular LES model. The approach obviously requires an exact understanding of dissipation behavior of the numerical scheme in the first place plus

an exact understanding of the tunable contribution towards the physical meaningful model limit. Just experimenting with a higher-order limiter only demonstrates the availability of such a tunable parameter, but none of the former. I suggest reducing this section considerably and to eliminate the notion of ILES in most places. This section ultimately only underscores that even in the previous section no fully turbulent wake is developed and even the Smagorinsky model is usually only activated to stabilize the computation. As can be inferred from Fig. 8, no fully turbulent spectrum could be establised. In that sence, not even the Smagorinsky model in combination with CLBM is verified at all by the presented computations.

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