Manuscript Review: "Modelling Wind Farm Effects in HARMONIE-AROME (Cycle 43.2.2) – Part 1: Implementation and Evaluation"

General

The manuscript addresses the crucial consideration of Wind Farm Parameterization (WFP) in Numerical Weather Prediction (NWP) models, focusing on power production forecasting and the local weather impact of wind farms. The authors integrate Explicit Wake Parameterization (EWP) into the widely used HARMONIE-AROME model, comparing it with the existing FITCH wind farm model. The EWP relies on the actuator disc thrust force and incorporates wake vertical expansion within grid resolution limitations, without additional Turbulent Kinetic Energy (TKE) like the Fitch Scheme. The study rigorously compares these WFPs in HARMONIE-AROME and WRF across different settings and measurements. The paper is well-written, presenting information concisely, offering practical insights for research and application in wind energy.

Main Point:

A notable drawback of EWP, compared to FITCH, is the absence of the TKE source term. The paper argues for this by assuming that the heterogeneous part is a component of the mean flow; thus, an additional TKE source is not necessary. However, I contend that for turbine wakes, especially considering rotational motion and tip vortex variations that are subgrid scale and cannot be resolved by the mean flow in the mesoscale model. Furthermore, the TKE may arise from vertical shear due to the high vertical resolution; however, horizontal shear also cannot be resolved with a resolution of a few kilometers. The lack of TKE consideration affects wind profiles and wake recovery, leading to underestimation of wake effects above hub height. A more in-depth exploration of this limitation in the discussion would enhance guidance for WFP selection.

Other Points:

1. Equations (2-4), the core of EWP, are complex. The derivation process should be either shown or referenced to aid in understanding the underlying physical assumptions. Furthermore, it needs clarification whether these additions are new or identical to the EWP in WRF.

2. Figure 4 raises questions about Ct being larger than 1 at low ambient wind speed. An explanation in the manuscript would enhance understanding.

3. Line 197-197: "the standard deviation of errors (STDE) assesses the non-systematic error". I am not sure how useful of STDE in this paper (mentioned only once later in the paper.) or in general. For example, consider a two cases with equally large bias, where the first one has a correlation of 0 (i.e. random error+systematic error), and the second one has a

correlation of 1 (totally systematic). However, STDE for the two cases can be equal, which limits the intepretation of it.

4. Line 113: The abbreviation "IFS" needs clarification.

5. Figs. 8, 11, 13: I don't understand why the authors show two line for each simulation instead of one time-interpolated line to the measement time. The figures are also quite small to see. Some suggestion: rearrange the right legend to the top or bottom and elimitate the white space in each subplots; change color codes in to a more conistent way (e.g. red for HAR, blue for WRF, solid for FITCH, dashed for EWP, dotted for NWF).