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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Tempo-spatial distribution of nitrogen dioxide within and around a large-scale wind farm-a numerical case study" *by* Jingyue Mo et al.

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Responses to the Referee #1's comments

This paper investigated the tempo-spatial distribution of NO2 concentrations within and around a large-scale wind farm in Gansu, China using WRF-Chem. Adopting two parameterization schemes, the authors found that the wind farm produces an "edge effect", where NO2 are higher in the upwind and border region but lower within the farm and in the downwind region. This paper is well written and structured, and is valuable for evaluation of the impacts of wind farms on atmospheric transport of pollutants and air quality forecasting. I recommend publication in ACP. I have a few minor comments



on the method and result of this study, and enlist them as the follow:

Response: First of all, we would like thank the Referee #1 for his/her constructive comments on our manuscript which helped us to improve our article. Following the comments from the Referee #1, we have revised the manuscript and address all comments from the Referee #1. Our detailed responses and revisions in accordance with the Referee's comments are presented below and in the revised manuscript.

1. Why do the authors set the distance between two wind turbines to 500m and 1000m in the model scenario S3 and S4? Using the real distance between two wind turbines in the Yumen Wind Farm might be more appropriate in the simulation.

Response: The distances between wind turbines in the YWF and GWF are not uniform but range from 300 to 1000 m. The selection of 500 and 1000 m distances aimed to (1) examine the effects of typical layout of wind turbine across the YWF on spatial distribution of NO2 concentrations; and (2) access the response and sensitivity of air concentration to the density of wind turbines in the YWF via two model scenarios. This point has been added to the revised manuscript (page 8, line 1).

2. Why do the authors choose NO2 as the target air pollutant? NOx might be a better target as no chemical evolution is involved. The distribution of NOx could characterize the impact of wind farm on atmospheric transport without the influence of chemical reactions.

Response: We agree with the Referee #1's comment. Since NOx = NO + NO2 and NO can be quickly oxidized to NO2 in the ambient air, NOx is considered to be approximately equal to NO2. In addition, NO2 is on the list of ambient air quality standards and measured routinely at air quality monitoring stations across China. These data can then be used to verify modeled air concentrations. These have been added to the revised paper (page 7, line 20).

3. In the validation part, only the WRF simulation without wind farm parameterization

was compared with measurements. The simulations under the two wind farm parameterization schemes should also be validated against measurements to demonstrate that the two schemes could well reproduce the impact of wind farm on the wind field and pollutant distribution in the domain studied.

Response: Following the Referee's comment, efforts were made to further compare simulated NO2 concentrations from the model scenarios 2-4 with the measured data collected at the Jiuquan air quality monitoring station (Fig. S1). Results are presented in the revised Fig. S1. Overall the modeled and measured data agreed reasonably well but the modeled concentrations from S3 and S4 scenarios illustrate stronger lag behind the measured data. The winds and temperatures were predicted by WRF model. Since WRF model is an operational forecasting model and has been validated extensively, usually we don't need to verify WRF model. Nevertheless, following the Referee's suggestion we compared WRF predicted winds and temperatures with observed data collected at several met stations within the model domain. Results are presented in the revised Supplementary.

4. The surface roughness length parameterization treats the wind turbines as pure obstacles while the wind turbine drag force scheme considers the turbines as momentum sink of the wind flow. In reality, the wind turbine could both act as an obstacle and a sink of momentum. Therefore, the effect of wind farm on the pollutant distribution might be a combination of the two schemes to some extent.

Response: We agree with the Referee's comment. The wind turbine could both act as an obstacle to enhance the surface roughness and a sink of momentum which results in the momentum loss through both surface friction and spinning wind turbine. The two parameterization schemes used in the present study have, to some extent, similar physical background. This point has been added to the revised paper (page 7, line 2).

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