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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Evaluation of NU-WRF Performance on Air Quality Simulation under Various Model Resolutions – An Investigation within Framework of MICS-Asia Phase III" *by* Zhining Tao et al.

Anonymous Referee #2

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Review

The manuscript presents a detailed investigation of NU-WRF at three different resolutions (45 km, 15 km, and 5 km) in simulating meteorology and air pollution over the North China Plain. Comparing model performance at different resolutions provides insights into model processes that are resolution dependent. The manuscript concludes that the 15-km resolution model has the overall best performance among the three. This is somewhat surprising as the finest resolution model is often assumed to be better, but the discussion provided in the manuscript is not sufficient to provide a

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process-level understanding of why a particular resolution of the model outperforms, which is one major concern for the manuscript. Overall, the manuscript is well-written and will be suitable for ACP after the following comments are addressed.

Major comments: 1. For the most part, the manuscript provides only domain-mean comparison between the three resolutions against observations. Although site-level model evaluation is shown in the figures, they are mere statistics and lack follow-up investigations or discussions that can be linked to certain model processes or input data that can provide insights for model improvement or can be generalized for other regions and time periods. For example, more analysis should be conducted to examine where/when the variations in meteorology and air quality are the largest within the domain that are most challenging for the 5-km model to capture.

2. It is not clear whether the model input data are resolution aware. Are the underlying emissions inventory data and land surface data (topography, LAI, etc) at a fine resolution of 5 km and then aggregated to the coarser resolutions? If the model is not driven by inputs that can resolve 5-km surface conditions, the 5-km model will not be able to correctly simulate air pollution variations at the 5-km scale.

3. Figure 7, top panel: Ozone simulated by the 45-km model is almost 20 ppbv higher than the other two resolutions for July throughout the whole domain, while emissions of ozone precursors and meteorology are not so different. Why? Is this some kind of model error? If the model's oxidant budget is strongly resolution-dependent, one will question whether the model processes are parameterized correctly. A stable model should produce regional-mean concentrations of key species that are more or less consistent between different resolutions; it is the sub-regional variability and extreme concentrations that will differ as the resolution changes. This is reflected in ozone simulated by the 15-km and 5-km grids, but the 45-km model is an outlier.

4. Table 3: Natural emissions (isoprene, dust, and sea salt) are very different between the three resolutions, varying by almost a factor of two. While these emissions are de-

pendent on meteorology and thus on the model resolution, the standard practice is to implement a scaling factor so that the domain-wide emissions are consistent between different resolutions. Otherwise, it will not be a fair comparison as the emissions are not constant across the three resolutions. As this manuscript is part of a model intercomparison study, these emissions should be consistent with other models participating in the study.

Minor comments: Line 215-210: the different conclusion from Gao et al. was due to the difference in observations or in the model setting?

Table 2: I don't understand this table. What are the numbers in each cell and why they are so different?

Line 32: add "the" before 21st century

Line 68: remove "however"

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