Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "An Evaluation of the Efficacy of Very High Resolution Air-Quality Modelling over the Athabasca Oil Sands Region, Alberta, Canada" *by* Matthew Russell et al.

Anonymous Referee #2

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The authors present an interesting and well-planned study to evaluate the impacts of high-resolution modeling on air quality model performance. As growing computational resources facilitate model runs at higher grid resolutions, it is important to understand the extent of the improvements that can be expected from increased resolution and limitations that will continue to constrain model performance, especially if tied to traditional assessment metrics. For this reason, the study conveys a valuable message that should be shared with the modeling community. The study is carefully structured and the manuscript is well-written. However, several modifications can be made to strengthen the manuscript. Some comments are included below:

1. While the manuscript compares model performances under 2.5 and 1 km grid resolutions, the authors should also discuss model performance relative to acceptable performance benchmarks for air quality modeling. Do the simulations, with either grid resolution, meet recommended performance benchmarks, for example those reported in Emery, et al., 2017 (doi:10.1080/10962247.2016.1265027)? Showing that the modeling was able to meet standard performance expectations would add confidence to the conclusions drawn about the effect of increasing resolution by indicating that the case is an adequate one to draw conclusions from.

2. The manuscript describes 1km grid simulation as "very high resolution". However, recent work with regional-scale models such as CMAQ or WRF-Chem has been carried out at horizontal grid resolutions of 1 to 3 km. Many of the modeling studies referenced in the manuscript are several years old. A deeper discussion of the progression and current state of grid resolution in Eulerian air quality modeling would strengthen the paper. The paper should discuss what constitutes "very high resolution" at present and, more importantly, what maximum level of resolution can be expected from existing modeling frameworks given the dependence of existing subgrid-scale parameterizations on grid resolution.

3. Although the manuscript's analysis is well structured, some additional discussion of how the findings can be expected to be representative of air quality modeling beyond this specific simulation would be beneficial. Do the authors expect the findings to remain consistent across often applied increasing resolution levels in regional-scale air quality modeling, for example 36km to 12km to 4 km? Should similar conclusions be expected over more urban domains?

4. The manuscript states that the study results are "strongly suggestive of the presence of issues such as illustrated in Figure 3", that is plume structures that are better represented by the higher resolution but more affected by errors in wind fields. An illustrative example of this taken from the simulated results would strengthen this conclusion. A comparison of simulated plumes that mirrors the schematic included in figure 3 would

be beneficial.

5. The authors briefly mention the connection between grid resolution in air quality modeling and associated health impacts projections (line 67-70). Previous work has looked at the impact of increasing grid resolution and improved model performance on health effects estimates, and how these sources of uncertainty compare (e.g., Thompson, et al., 2012, doi:10.5194/acp-12-9753-2012). Some additional discussion of the role of uncertainty due to grid resolution in the larger context of air quality impact assessments, including exposure and health impacts, would be beneficial.

Smaller comments:

- Lines 64-65: This sentence is unclear.

- Lines 97-99: Expand on this statement. What specifically makes the VHR representations more realistic?

- Line 231: Remove "for areas"

- Line 462: Changing "first three columns" to "third column", might be clearer

- Tables 2-5: Including the definition of each acronym used for the metrics somewhere on the chart or at the beginning of the charts would improve readability.

- Line 567-569: The issue of air quality models excessively mixing pollutants along the vertical dimension within the boundary layer has been previously acknowledged by several studies (e.g. Garcia-Menendez, et al., 2014, doi:10.1016/j.scitotenv.2014.05.108).

- Figure 8 needs to be improved. The x-axis of the left panels is illegible. Lines and colors on the right plots are a bit hard to observe as well; a higher resolution/quality plot would help.