Li et al. shows in their study, that the choice of the spatial model resolution can significantly influence the results of simulations using the GEOS-Chem model. They performed simulations with six different spatial resolutions for December 2014 to January 2015 and for June to July 2015 show the results from NO_x, HO_x, and O_3 for the eastern United States. The influence of the resolutions depends on whether high or low levels of NO_x prevail in an area. For example in the Southern States where usually rather low NO_x concentrations prevail, the simulations with smaller resolutions tends to an increase in NOx, whereby in the area of Great Lakes, where usually rather high NO_x concentrations prevail, the simulations with smaller resolutions simulate smaller values of NO_x. The authors also show the corresponding influence on HO_x and O_3 in these areas.

The NO_x, HO_x and O_3 results are discussed in detail. The authors show that the spatial model resolutions has not only an influence on the surface, but also on higher altitudes. It also has an effect regarding the diurnal and seasonal cycle of the mentioned substances.

General comments:

In my opinion, the scientific relevance of this study is very high, because the authors show the choice of the spatial resolution influence the result of their model significantly. That means that different resolutions leads to different results. If the explanation of the reasons for this model behaviour are true, then this should be the case with every other model. This would have a high impact to every model community.

However, exactly the discussion regarding the reasons, which explain the different results with different resolutions isn´t clearly demonstrated in the paper. How I see this, one reason is only mentioned in the caption of Fig. S1 in the Supplement (!) and sometimes only between the lines. Here the reason is described, that higher resolution modelling tends to concentrate the most NO_x emissions near sources. I think the discussion of this and maybe other reasons should really be more prominent in the main text and the reasons should also be mentioned in the abstract and in the discussion. Because the reasons are really important also for other modellers. If the know them, they can then also try this out with their own model.

I´m also thinking about, whether really only the point sources of the emissions are responsible or are there perhaps also other reasons which are influence the results (e.g. transport processes) or maybe different time steps in the used simulations with different spatial resolutions, which maybe affect the chemistry? It should be clear which possibilities exist and how confident the authors are that this possibilities really lead to the different model behaviour.

Another important point for me are the figures of the supplement, and the supplement itself. In the paper the discussion relating the figures generally jumps between the figures from the main section and the figures of the supplement. In my opinion, this is not convenient in this form. In my eyes, a supplement should only be a supplement. If a figure is important for the explanations in the main text, then it should also be in the main text. The explanation of the not so important figures of the supplement should be written in the supplement. The main text can mention that figures in the supplement exist, but not much more. For example, the figures S1 and S3 are in my eyes really essential to understand the content of the paper. Therefore, these two figures should be in any case in the main text. I would also set figures S2 and S8 to the main text and leave only figures S4 to S7 in the supplement. But of course the authors have to decide this.

What also comes in my mind, I have the feeling that the authors always assume that the highest resolution gives the best results, but is that a sure thing? Maybe the simulation with e.g. 38 km has the best results in comparison to observations. Are there comparisons with measurement data

possible? Can you from the comparisons with TROPOMI conclude which simulation is closest to reality?

Overall, I can absolutely recommend this paper for publication in ACP, in the case that there is a more detailed discussion with regard to the explanation what the reasons are, that the spatial model resolutions has such a high influence to the NO_x (and HO_x and O_3) mixing ratios.

Specific comments:

Throughout the paper:

- You always write of concentrations but I think you are referring most time to mixing ratios, please change this.
- In the case that you use ppt or ppb please use instead pptv or ppbv
- Change “Figure” to “Fig” and “Figures” to “Figs”

Main text:

Page 1, line 1: “The lifetime and concentration of nitrogen oxides (NO_x) are susceptible to non-linear production and loss, and consequently to the resolution of a chemical transport model (CTM).” I am not sure if you can really say here “consequently”.

Page 1, line 2: “Here we use” → “In this study we use”

Page 1, line 3: “resolutions” → “spatial model resolutions” and “(13-181 km)” →”(six different horizontal grids from 13 to 181 km)”

Page 1, line 4 to 5: Please mention that the GL region is a NO_x-saturated area and the SS is a NO_x-limited area. Not every reader know this at this point of the paper.

Page 1, line 5: I would write here “differences to highest resolution of 13 km” instead of “biases” and “-18% to 9%” → “-18% (in GL region) to 9% (in SS region)”

Page 1, line 14 to 15: As I already said, it would be good also to mention the reason for this model behaviour already in the abstract.

Page 1, line 17 and 18: “ ≡ " → “=”

Page 2, line 29: “outstanding” →”unexplained”

Page 2, line 33: “modeled” → “simulated”

Page 2, line 40: I would explain Figure S1 here a little bit more and move the figure from the Supplement to the main text.

Page 2, line 40 and line 50: “resolution” → “spatial resolution”

Page 2, line 50: Do you also use different time steps using the different spatial resolutions? If so, I think that could also have an impact on the chemistry and the NOx results.

Page 2, line 54: Is the “adequate resolution” always the highest resolution?

Page 4, line 104: “from space”. From which satellite instruments?

Page 4, line 108 to 115: You use here the NO2 satellite observations from TROPOMI of the year 2019. Why do you choose the year 2015 for your simulations and not the year 2019?

Page 4, line 120: “concentrations” →”mixing ratios”

Page 4, line 121: “(upper left)” → “(Fig. 1c, upper left)”

Page 5, line 127: Where is “further downwind”?

Page 5, line 129: “observable” → “visible”

Page 6, line 163: Here you write “Another potential cause of the weaker”, but you don’t really explain the first potential cause before (at least in my opinion, except for the caption of Fig. S1).

Page 6, line 184 and line 187: “faster titration” → “faster O3 titration”

Page 7, line 209 and line 216: “diel” → “diurnal”

Page 8, line 250-251 and line 257 and line 262: You compare here one figures from the main part and one figure from the supplement. I would really transfer Fig. S8 to the main part.

Page 9, line 278: Means that you should use the highest possible model resolution?

Page 10, line 300ff: Here I would add a paragraph explaining the reasons for the different results of the simulations with different resolutions.

Figures:

Fig.1:

- Not in every panel of Fig 1c are the green and magenta boxes are drawn. Please change this
- Please use ppbv and pptv instead of ppb and ppt

Fig.2:

- Also here the green and magenta boxes are not drawn in every panel.

Fig. S1:

- “concentrations” → “mixing ratios”
- “ppt” → “pptv”; “ppb” → “ppbv”

Fig. S3:

- “ppt” →”pptv”; “ppb” →”ppbv”