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Interactive comment on "Simulating Lightning NO_X Production in CMAQv5.2 Using mNLDN, hNLDN, and pNLDN Schemes: Performance Evaluation" *by* Daiwen Kang et al.

Anonymous Referee #2

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General Comments

The scope of this paper is to evaluate the impact of three Lightning NOx parameterisation schemes in WRF-CMAQ on ozone, NOx and nitrate deposition compared with a base case without such parameterisation. The use of a variety of observations at different heights is commendable and it is clearly presented. The paper is well written and easy to follow. Although differences between the three parameterisation schemes and the base case are generally large, the three schemes perform fairly similarly to each other in a number of cases presented. This is not surprising, given that the three parameterisation schemes used are different versions of the same scheme. However,

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the authors use all the observations in their toolbox to provide a clear explanation of where the schemes show the largest difference and try to identify the best performing scheme.

Specific Comments

There is not enough information about the three parameterisation schemes. It would be useful to add at least a very short description here (including the vertical distribution algorithm) and then refer the reader to the relevant paper for further details.

Given that the model uses hourly or monthly observed lightning flashes information from the NLDN network, I expect this parameterisation schemes are only available for simulations of the past, e.g. hindcasts and case studies, but not for air quality forecasts (for which the observed lightning flashes are not available). Can the authors add a comments in the text to address the relevance of this work for air quality forecast or specify its intended areas of application?

l.184-185 "...all model cases with LNOx exhibit slightly higher correlation coefficients than the base simulation, suggesting the importance..." Looking at table 1 and 2 I see identical values for most locations and tiny differences (0.69 vs 0.70; 0.73 vs 0.74; 0.52 vs 0.53) for other cases. I would rather say that the correlation coefficients between simulations with and without LNOx are not significantly different!

l.257-259 can the authors comment on why NOx is over/under-estimated during night/day-time?

In Figure 4, the legend for AQS is wrong (no star symbol used in the plots)

Figure 6. It would be interesting to add 2 further panels to show equivalent results for NOx profiles in the different model simulations. Can this help explain the lower surface ozone in hNLDN? If not, can the author suggest what processes are responsible for it?

Technical Comments

l.53 "pNLDN, provides an improved estimate for LNOx compared to the base simulation that does not include LNOx." LNOx is of course improved if it is included in the simulation! I think this should be: "...provides an improvement for ozone and NOx compared to the base simulation..."

l.65-66 "The significant impact of LNOx on surface air quality was earlier..." Given the explanation given by the authors I think this should be: "The significant impact of LNOx on process-based understanding of surface air quality was earlier..."

l.66 replace "in that" with "which found"

l.288-289 "the vertical profile lines can be separated" this is confusing, replace with same text used later (l.308) which is much clearer.

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