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, 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.

We thank the reviewer for the overall positive assessment of the manuscript.

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.

Both reviewers have suggested including additional details on the LNO schemes. In the revised manuscript, we have now added this information to the Methodology Section as "2.1 The LNO schemes" on Page 4 of the revised manuscript.

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?

In this study, three lightning NO schemes are involved. It is correct, all the schemes are related to the observed lightning flashes from NLDN network, but the formulations are different. The hourly (hNLDN) or monthly (mNLDN) schemes do depend on the availability of the observed NLDN data for their applications, but the third one, the parameterized scheme (pNLDN), was derived using historical data from the observed NLDN data and model predicated convective precipitation, and its application doesn't require the actual observed data. Instead, the lightning flashes are derived from the linear and log-linear relationship that is parameterized in the scheme. And it is specifically tailored for applications such as air quality forecast when the observed lightning flashes are not available. We have now incorporated this point in Conclusions on Page 15 of this revised manuscript.

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!

Though the difference between correlation coefficients are small, but the increase is persistent through the domain and all subregions that indicates the general trend. Therefore, we describe it as slightly higher.

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

T**he question of why NOx is over/under-estimated during night/day-time is rather a complicated issue that is currently under active investigation in many research groups with coordinated efforts. There are several hypotheses including (1) issues related to representation of vertical mixing, (2) issues related to magnitude of anthropogenic emissions, especially from the mobile sector, and (3) spatial and temporal allocation of emissions.**

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

We thank the reviewer for catching this error. It has now been corrected.

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?

We thank the reviewer for the suggestion. The impact of lightning NO_x on O_3 production generally occurs downwind of the location of lightning flashes as revealed in our later analysis related to Figures 7-10. Often it is the case that when the ozonesonde measurements indicated difference on O_3 mixing ratios, the difference of NO_x mixing ratios from the different model cases is insignificant at the same location. We however examine the issue raised by the reviewer using the aircraft measurements in detail in later section in the manuscript.

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..."

Thanks. It was a typo. It has now been revised to “an improved estimate of nitrate wet deposition”

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..."

Thanks. The sentence has been modified as suggested by the reviewer.

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

Thanks, the change has been made.

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.

Thanks, we have revised the manuscript as suggested.