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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on “The effect of lightning NO_x production on surface ozone in the continental United States” *by* B. Kaynak et al.

Anonymous Referee #2

Received and published: 10 June 2008

This is an interesting model study of the sensitivity of surface ozone to NOx produced by lightning. The conclusion, that on average the contribution is relatively minor, has policy implications because it implies that the background O3 (which cannot be regulated) is not much enhanced by lightning. The paper is suitable for publication, but could benefit by additional discussion of several topics.

1. The uncertainties in lightning NOx emissions are very large, especially for intra-cloud (IC) flashes. The factor of 3 correction for unmeasured number of IC flashes is obviously a rough estimate, as is the new IC/CG ratio of 1 vs. older value of 0.1 for NO production. Figure 2 shows that the new vertical profile of NOx emission is essentially zero in the boundary layer, compared to the older parameterization which maximized at the lowest altitudes. While a very detailed statistical analysis is presented on the

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results with the new parameterization, only one paragraph (bottom of p. 5069, top of p. 5070) is devoted to describing the results from the old parameterization. There, it is argued that allocating more NOx to the boundary layer actually leads to less O3 because the convection occurs in late afternoons and evenings, with lower photolysis and O3 titration by fresh NO. However, this is not obvious, because values of O3 late in the day are usually not the ones that are measured by 1-hr or even 8-hr maxima, and one might expect significant carryover of NOx into the photochemically active hours of the next day. More generally, given the large uncertainties in both the total lightning NOx and its vertical profile, more discussion of the sensitivities might be warranted.

2. While the O3 changes from lightning NOx may be small when averaged over the entire domain, they might be quite important at some specific locations, e.g. from Fig. 10 in Florida, Salt Lake City, or Denver, all of which have significant populations. It might be interesting to explore these exceptional areas in more detail.

3. It is not fully clear how lightning is distributed into CMAQ layers. Looking at Fig. 2, CMAQ has several layers below 1 km, but only one lighting point is shown.

4. It is stated (p. 5070) that O3 production efficiency (OPE) is decreased by lightning NOx, while the actual values reported (OPE = 5.47 for basecase and 5.66 for lightning) indicate the opposite. The reason given, that ozone is decreased by late afternoon NOx injections, has the same problems as mentioned above. However, it is typically true that OPE decreases at higher NOx. Some clarification is needed.

Technical Comments: 5063/18: replace 'to' with 'in'. 5063/19: insert: and 'a' recent. 5064/5,6: not clear 'these cases would not compromise the current 80 ppbv....' 5064/17 and 5065/13: citation (2008b) should be (EPA, 2008b); also need to correct in reference list. Fig.1 suggests more than 2ppb change in MNB lightning is added. 5066/9: replace 'that' with 'those'. 5066/17: replace 'on' with 'in'. 5066/20: replace 'of widely' with 'of a widely'. 5067/1: what is lighting 'mass'? 5067/4: using 'results' from DeCaria.... 5069/5: replace 'narrows' with 'narrow' 5069/8: replace 'is infrequent' with

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'are infrequent'. 5069/19-20: Denver and Salt Lake City don't have high biogenic emissions, yet show large effects.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 5061, 2008.

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