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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ozone and NO_x chemistry in the eastern US: evaluation of CMAQ/CB05 with satellite (OMI) data" *by* T. P. Canty et al.

Anonymous Referee #3

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Authors carried out several sensitivity studies to investigate the discrepancy between OMI-derived and CMAQ-simulated NO2 tropospheric columns over the eastern US. Two OMI-derived NO2 products were used in this study, KNMI and GSFC NO2 columns. In general, the manuscript is well-written in a clear manner. However, this reviewer also has several concerns about the works done by authors. Authors should properly address following points for the publication in ACP.

General comments:

1. Authors insisted that CMAQ calculations tend to overestimate NO2 columns over

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urban areas but underestimate over rural regions of the eastern US. Although authors used the OMI NO2 columns and AKs, they never discussed the errors and uncertainty of the OMI NO2 columns and AKs. Both the OMI products are not perfectly "true values", but possibly contain significant errors. Authors almost disregarded these errors and uncertainties in the manuscript. The errors and uncertainties in the tropospheric NO2 retrieval from the OMI sensor vary with analysis regions (urban vs. rural areas) and seasons. The comparison analysis between CMAQ-estimated and OMI-retrieved NO2 columns over the urban and rural areas could be greatly influenced by these errors and uncertainties (e.g., Boersma et al., 2011; Lamsal et al., 2014; Han et al., 2015). For example, Lamsal et al. (2014) reported that the OMI retrievals tend to be lower in urban regions and higher in remote areas, compared with several in-situ measurements.

2. There are numerous issues that can increase or decrease the model-estimated NO2 columns (e.g., Han et al., 2015; Stavrakou et al., 2013). This reviewer wonders why authors chose only three factors of re-activation of organic nitrates and accuracy of the mobile and biogenic emissions in their manuscript. Obviously, there are more issues: (1) reaction rate constant of NO2+OH+M has uncertainty; (2) NO+HO2 reaction is now on hot debate; (3) OH re-activation around the forest areas (like southeastern part of the US region) has been an issue; (4) reaction probability of N2O5 has uncertainty; and (5) daytime HONO chemistry is another one to include. All these issues can affect NOx lifetimes and therefore NOx levels. (1) and (2) affect the rates of HNO3 formation and therefore NOx loss rates. (4) would not be very important in "summer" (July and August), but authors should mention what values (or method) was used for their CMAQ simulations, because this is very important NOx loss pathway (particularly during winter).

3. In connection with 1, the CMAQ simulations over- and under-estimated NO2 columns over the urban and rural regions, respectively, throughout all the cases (Figs. 2–8). This reviewer wonders that the same results can also be found in the comparison

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between two NO2 concentrations from the CMAQ simulations and ground based in-situ AQS measurements.

Minor comments

1. p.4430 L2-5, Again, this is a hasty statement. How about errors and uncertainty of NOx columns and AKs over urban and rural areas?

2. p.4432 L12, CMAQ model does not include stratospheric chemistry. Therefore, vertical domain up to "20 km" is meaningless.

3. p 4439, L 23-25, In the MDL(MGN) simulation (in Fig. 7), authors reported the increase in the CMAQ-estimated NO2 column across the model domain. However, the directly-opposed result was described in Conclusions (p. 4443, L 17-20). Thus, the latter should be properly corrected as shown in Fig. 7.

4. Since the ozone episodes are frequently taking place in summer, the consideration of summer months (July and August) is understandable. However, this reviewer thinks that the conclusion should be more generalized with other season analysis.

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