

## ***Interactive comment on “Summertime weekly cycles of observed and modeled NO<sub>x</sub> and O<sub>3</sub> concentrations as a function of land use type and ozone production sensitivity over the Continental United States” by Y. Choi et al.***

**Anonymous Referee #2**

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General Comments:

This manuscript describes weekly cycles in both ground-based and modeled NO<sub>x</sub> and O<sub>3</sub> concentrations in the United States for several defined land use and chemical regimes. Previously described GOME-2 chemical regimes based on HCHO/NO<sub>2</sub> are used, as well as HCHO/NO<sub>2</sub> from CMAQ, and land use from AVHRR. The study finds that GOME-2 designations do a better job of defining chemical regimes than the CMAQ simulation and that generally all three designations (GOME-2, CMAQ, AVHRR) capture previously observed weekly cycles in O<sub>3</sub> and NO<sub>x</sub>.

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The combined use of satellite observations, surface measurements, and model output to examine high-, moderate-, and low-NO<sub>x</sub> conditions is an interesting approach to improving our understanding of regional NO<sub>x</sub> chemistry. There are several issues that I feel need to be addressed, however, prior to publication in ACP.

1) The language in the manuscript does not make it clear what is being tested here. I'm not sure if the point is to test the land and chemical designations or to test the ability of the model to capture the weekly cycle in these different regimes. The main point of the paper needs to be made clear at the start. Additionally, the novelty of the results is not clear and more analysis of the observations is needed throughout the paper. What does this work contribute to our knowledge about AVHRR, about CMAQ, etc.?

2) Conclusions are drawn from a single month of observations such that there are only 3 or 4 days of data are available for each day of week anomaly reported. I worry that the statistics are insufficient to be confident in the day-to-day comparisons reported. Is there a reason that the analysis is limited to Aug 2009? We agree with the authors that the analysis should be extended to a longer time frame if possible. That said the statistics would be improved if the authors grouped the weekdays and weekends in their analysis, rather than comparing, for example, Tuesdays to Saturdays.

3) It is unclear whether AVHRR geographical regions are being suggested as a proxy for the spatial patterns of the different chemical regimes. AVHRR data are grouped into “urban”, “forest”, and “other” regions, but the different classifications are not explained. Comparisons are made throughout the work between the land types and chemical regimes but it is unclear whether the expectation is that the sets are connected in some way. Do land types tell you about low/high VOC? Are the authors testing how the higher isoprene/monoterpene emissions from forests affect the chemistry? The use of AVHRR land types is interesting, especially if somehow used as a proxy for the VOC reactivity, but needs to be clarified and justified.

4) GOME-2 observations occur at 9:30am while model and surface observations are

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taken from 1-5pm. What impact does this time difference have on the reported cycles? OMI continues to provide useful data and because it overpasses at 1:30pm within the window of the authors analysis it seems to be a better choice for this investigation. Alternatively, could this analysis be performed prior to the OMI anomaly problems? Also, a 40% cloud fraction filter is high and, if the analysis is expanded beyond one month, a lower cloud fraction should be used.

5) Emissions in the model are from NEI 2005. Emissions from point sources are scaled, however, mobile source emissions are not. Previous work indicates that there have been substantial reductions in mobile NO<sub>x</sub> emissions from 2005 to 2009 (e.g. Kim et al., 2009; Russell et al., 2010), and subsequently NEI 2005 emissions are likely too high for this analysis. I suspect that this would have a significant impact on the land and chemical regimes used to describe day of week cycles and suggest scaling emissions using observations available in the literature.

6) I wonder if discarding low NO<sub>2</sub> column observations ( $<1 \times 10^{15}$  molec cm<sup>-2</sup>) is effectively throwing out all of the low-NO<sub>x</sub> observations. This seems to be the case since a weekly cycle is observed for the forested regions and these observed weekly cycles in the forested and other regions are the same size those observed in the urban region.

Specific Comments:

- 1) Introduction: Consider referencing Kim et al. (2009) and Russell et al. (2010).
- 2) Section 2.1: The number of grid cells for each regime would be easier to examine if it were summarized in a table instead of listed in this paragraph.
- 3) Section 2.2: The number of observations from GOME-2 for each day of week should be included.
- 4) Day-to-day comparisons are described in detail in sections 3.2 and 3.3, however, no interpretation of the results is provided. Why are these results interesting? What do

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they teach us?

- 5) Figure 1, right panel: The canopy density plot is not necessary.
- 6) Figure 2: Would more averaging improve the figure? It is hard to see the important points of the figure in the scatter.
- 7) Figure 7: This figure could be incorporated into figures 5 and 6 (e.g. Figure 5 showing AVHRR NO<sub>x</sub>, GOME-2 NO<sub>x</sub>, and CMAQ NO<sub>x</sub>). You might also consider combining the data into fewer bar graphs, using different colors to distinguish the data so that it is easier for the reader to make the comparisons. Axes should be set so that data is within the chart (e.g. Fig.7, O<sub>3</sub> plots).

Technical Corrections:

The manuscript would benefit from additional copyediting. Some examples follow:

- 1) Page 1588, Line 5: Delete "those of the amount of NO<sub>x</sub>"
- 2) Page 1591, Line 28: "As much as one-to-one correspondence" is not clear. Please rephrase.
- 3) Page 1591, Line 6: Move "TM4NO2A version 2.1 is used for GOME-2 NO<sub>2</sub> column density and TEMIS version 2.3 is used for GOME-2 HCHO column density" to the end of the paragraph.
- 4) Page 1592, Line 1: Replace "planet" with "planetary".
- 5) Figure 2 Caption: Replace "Surface" with "surface". Replace "30% NO<sub>x</sub>" with "30% NO<sub>x</sub> reduction".

References

Kim, S.-W., Heckel, A., Frost, G. J., Richter, A., Gleason, J., Burrows, J. P., McKeen, S., Hsie, E. Y., Granier, C., and Trainer, M.: NO<sub>2</sub> columns in the western United States observed from space and simulated by a regional chemistry model and their implica-

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tions for NO<sub>x</sub> emissions, *J. Geophys. Res.*, 114, D11301, doi:10.1029/2008JD011343, 2009.

Russell, A. R., Valin, L. C., Bucsela, E. J., Wenig, M. O., and Cohen, R. C.: Space-based constraints on spatial and temporal patterns of NO<sub>x</sub> emissions in California, 2005–2008, *Environ. Sci. Technol.*, 44, 3608–3615, doi:10.1021/es903451j, 2010.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, 12, 1585, 2012.