*** Blue color indicates the change being made in response to the comments in the text.**
*** Red color indicates question or comment.**
*** Black color texts show the responses to the reviewer.**
*** Yellow highlight show action header**

1) response
2) before – text before correction
3) after – text after correction
4) added – text is added to the original article

Interactive comment on "Impacts of future climate change and effects of biogenic emissions on surface ozone and particulate matter concentrations in US"
by Y. F. Lam et al.

Anonymous Referee #2

Received and published: 29 January 2011

Response:
To anonymous Referee#2:

Thank you for the valuable comments. We are very happy that you enjoyed reading the publication. All of your comments have been incorporated into the original text.

Regards,
Yun Lam/Joshua Fu

Introduction: - p. 2185/l. 11: no comma in sentence; "The issue has been reported in the regional model as well as..."

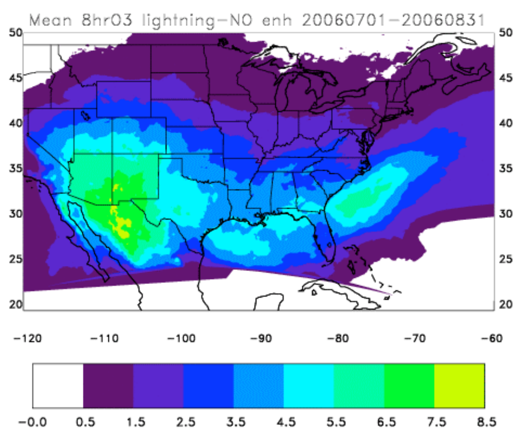
Response: Fixed. We have decided to remove this sentence since it did not fit well in the content.

Methodolgy: On p. 2209 it is mentioned that CMAQ does not account for lightning emissions. This important fact needs to be mentioned in the methodology and an attempt should be made to quantify the potential impact on the results (at least it should be stated whether this lack of lightning NOx emissions could have a significant impact or not).

Response:

In GEOS-Chem, the additional NOx produced at the upper layer from lightning has increased the average concentration of NOx in the upper layer, which eventually affects the NOx concentration at the surface. Research has been showed that with or without the effects of lightning NOx from CMAQ can be up to 8.5 ppbv for MDA8. (Allen et al., 2010)

Allen, D., Pickering, K., Pinder, R., Henderson, B., Koshak, W., and Pierce, T.: Impact of Lightning-NO Emissions on Eastern United States Photochemistry During the Summer of 2006 as Determined Using the CMAQ Model, The 9th Annual CMAS Conference, Chapel Hill, NC, 11-13 October, 2010.



Added:

(pg 14 ln 24-29)

These discrepancies is partially contributed by the lack of lightning emissions in CMAQ since we did not implement lightning as a source of NOx in the upper troposphere for either the present or future climate condition. Allen et al. (2010) suggested that the enhancement of MDA8 from lightning NOx could be up to 2.5 ppbv in the Northeast and 5.0 ppbv in the Southeast domain.

- p. 2191/l. 15-19: I would like a brief discussion of the treatment of SOA and their precursor-chemistry in CMAQ added to this paragraph to help the reader since several comments are made about this issue later on in the paper. One or two sentences should be sufficient.

Added:

(pg 5-6 ln 45, 1-2)

Please noted that the AERO4 does not include aerosol pathway from isoprene to secondary organic aerosol (SOA), which may lead to underestimation of PM2.5 in CMAQ

- p. 2192/l. 9-11: sentence is a stub; rephrase

Before:

We have estimated the differences in total anthropogenic NOx and VOC emissions between those two models at the present-year (2000) were at the levels of 10% or less for the Continental U.S.

After:

(pg 6 ln19-21)

The overall NOx and VOC differences between those two models were estimated to be less than 10%.

- p. 2192/l. 19-23: sentence needs to be untangled; possibly split into two sentences

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Before:

The Southeast domain includes the majority of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) states and, with half of Kentucky and West Virginia (97.6–73.3W, 29.8–37.2N) and the Midwest domain, contains all the mid-northern states and up to the middle of Wyoming. (107.4–87.5W, 38.6–49.8N).

After:

(pg 6 ln 24-32)

The Southeast domain includes the majority of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) states, with half of Kentucky and West Virginia (97.6–73.3°W, 29.8–37.2°N); The Midwest domain contains all the mid-northern states, up to the middle of Wyoming. (107.4–87.5°W, 38.6–49.8°N).

- p. 2193/l. 5-9: I assume that MEGAN is used here without its facility of emission factor distributions (as far as I know these exist only for present-day conditions). I would like to have a remark included here to clarify this aspect.

Response:

Added:

(pg 7 ln 13-15)

We assumed the same land use and vegetation patterns as 2000 on all years and all scenarios. These include the same leaf area index (LAI) and plant functional type (PFT) as well.

- p. 2195/l. 15-23: The description of the simulation scenarios has obviously copied and pasted since it doesn't correspond to the table it references to. Also, reading the paragraph I get the impression we are dealing with 12 scenarios (4 + 8). Edit this entire paragraph to fit it into the manuscript.

Response: Fixed. We have simulated total of 8 simulations. We have modified the text to remove confusion.

Scenario			Model			Scenario index
Meteorology	Anthrop. emission	Bio. emission	GEOS-Chem	CMAQ	CMAQ	
1999-2001	2000	MEGAN2 (1999-2001)	4° x 5°	36km x 36km	12km x 12km*	2000M_2000E_M
1999-2001	2050	MEGAN2 (1999-2001)	4° x 5°	36km x 36km	12km x 12km*	2000M_2050E_M
2049-2051	2000	MEGAN2 (2049-2051)	4° x 5°	36km x 36km	12km x 12km*	2050M_2000E_M
2049-2051	2050	MEGAN2 (2049-2051)	4° x 5°	36km x 36km	12km x 12km*	2050M_2050E_M
2000	2000	BEIS3 (2000)	-	36km x 36km	-	2000M_2000E_B
2000	2050	BEIS3 (2000)	-	36km x 36km	-	2000M_2050E_B
2050	2000	BEIS3 (2050)	-	36km x 36km	-	2050M_2000E_B
2050	2050	BEIS3 (2050)	-	36km x 36km	-	2050M_2050E_B

* Only 2000 and 2050 cases were simulated.

Before:

Overall, eight simulation scenarios were selected and summarized in Table 4. The first four scenarios, marked with the dash line, were intended to investigate the effects of downscaling and the future air quality in the United States. These scenarios are (1) present meteorology with present emissions, (2) present meteorology with future emissions, (3) future meteorology with present emissions and (4) future meteorology with future emissions, which are identical to the scenarios used in (Wu et al., 2008b), for GEOS-Chem. While the eight scenarios, filled with grey color, were used to study the impacts of change of biogenic emissions (MEGAN Vs. BEIS) in the future climate scenarios (2000 and 2050).

After:

Overall, eight simulation scenarios were selected and summarized in Table 4. The first four scenarios, marked with the dash line, were intended to investigate the effects of downscaling and the future air quality in the United States. These scenarios are (1) present meteorology with present emissions, (2) present meteorology with future emissions, (3) future meteorology with present emissions and (4) future meteorology with future emissions, which are identical to the scenarios used in Wu et al. (2008b), for GEOS-Chem. While the other four scenarios were combined with the previous four scenarios to study the impacts of change of biogenic emissions (MEGAN2 vs. BEIS3) in the future climate scenarios (2000 and 2050), as shown in grey color.

Discussions: - p. 2197/l. 8-9: sentence makes not much sense; rephrase sentence

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Response: Fixed. We have removed this sentence since it does not fit the discussion.

- p. 2198/l. 15-18: sentence is a stub; revise

Before:

For the downscaling perspective, a large difference (i.e., 0.6 m/s) was found between the GISS and MM5-36km outputs in the Midwest. The difference was caused by the manner in which topographical variables are implemented by the GISS GCM and MM5 models in the Rocky Mountain area where significant elevation changes within the modeling grids.

After:

(pg 10 ln 14-17)

For the downscaling perspective, a large difference (i.e., 0.6 m/s) was found between the GISS and MM5-36km outputs in the Midwest. The difference was caused by the inconsistencies of terrain elevation and grid resolution between GISS GCM and MM5 in the Rocky Mountain area where significant change in elevation was observed.

- p. 2200/l. 22: replace "prediction" by "predicted"

Response: Fixed

- p. 2200/l. 25-29: this section needs some revision and clarification

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Response: Fixed

- p. 2201/l. 12: replace "second" by "secondary"; also, clarify: CMAQ does not treat SOA formation from isoprene which accounts for 0.01 to 1.52 _g/m3 in OTHER models

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Response: Fixed

- p. 2204/l. 6: replace "consistently" by "consistent"

Response: Fixed

- p. 2204/l. 17-20: second half of sentence a stub; revise

Before:

As reported by (Wu et al., 2008b), the GEOS-Chem predicted a 2.0-5.0 ppbv increase of domain-averaged MDA8 ozone over the Midwest and Northeast domains, while little change over the Southeast domain from climate change.

After:

(pg 14 ln 5-8)

As reported by Wu et al. (2008b), the GEOS-Chem projected a 2.0-5.0 ppbv increase of domain-averaged MDA8 ozone over the Midwest and Northeast domains, and a little change over the Southeast domain due to climate change.

- p. 2205/l. 23: replace "inconsistence" by "inconsistent"

Response: Fixed

Before:

Inconsistencies in the GEOS-Chem and CMAQ MDA8 ozone results in the southeast domain were observed.

After:

(pg 14 ln 39-40)

In the southeast domain, inconsistent MDA8 ozone between GEOS-Chem and CMAQ was observed.

- p. 2205/l. 24: remove "results"

Response: Fixed

- p. 2205/l. 27: insert "a" between "not" and "major": "...not a major contributor..."

Response: Fixed

- p. 2205/l. 27-28: should read: "...both models did not implement recycling of OH

from..."; also OH is a radical, not an ion, so OH is enough

Response: Fixed

Before:

since both models did not implemented recycling OH^- from photo-decomposition of isoprene nitrate. Instead, the differences in implemented chemical mechanisms and grid resolution between the models caused the actual different.

After:

(pg 14 ln 44-46)

since both models did not implement recycling of OH from photo-decomposition of isoprene nitrate. Instead, the differences in implemented chemical mechanisms and grid resolution between the models caused the actual different.

- p. 2207/l. 9: reverse order of sentence to increase readability

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Response: Fixed

Before:

For $PM_{2.5}$, since the GEOS-Chem v7.03.06 did not incorporate sufficient $PM_{2.5}$ species at the moment, no $PM_{2.5}$ comparison between GEOS-Chem and CMAQ will be presented.

After:

For $PM_{2.5}$, no comparison between GEOS-Chem and CMAQ will be presented since parts of the secondary organic species and the breakdown of $PM_{2.5}$ and $PM_{2.5}$ to 10 were missing from GEOS-Chem v7.03.06.

- p. 2207/l. 28: replace "were" by "was" Conclusions:

Response: Fixed

- p. 2208/l. 10-11: sentence is hard to follow; rephrase

Before:

The CMAQ simulation comparisons of using MEGAN and BEIS biogenic emissions on the climate change scenarios were performed in this study.

After:

(pg 16 ln 23 – 24)

The CMAQ simulations on the climate change scenarios were performed using MEGAN2 and BEIS3 biogenic emissions.

- p. 2208/l. 21: replace "had" by "have"

Response: Fixed

References: - p. 2185/l. 24: "Xiaoyan et al." appears to be missing in the list of references

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Response: The order of the author's name "Jiang, Xiaoyan" was misplaced in EndNote. The last name should be "Jiang". It is fixed now. It should be appeared as:

Jiang, X., Wiedinmyer, C., Chen, F., Yang, Z.-L., and Lo, J. C. F.: Predicted impacts of climate and land use change on surface ozone in the Houston, Texas, area, J. Geophys. Res.-Atoms., 113, D20312, doi:10.1029/2008JD009820, 2008.

- p. 2198/l. 28: "Mickley wt al." appears to be missing in the list of references

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Response: Fixed

Mickley, L. J., Jacob, D. J., Rind, D., and Streets, D.: Effects of 2000-2050 global change on U.S. ozone air quality, AGU Fall meeting, San Francisco, CA, 11-15 December, 2006.

- p. 2211/l. 18-24: the two references "Hogrefe et al., 2007a/b" appear to lack a citation counterpart in the text.

Response: Fixed

Hogrefe, C., Hao, W., Civerolo, K., Ku, J. Y., Sistla, G., Gaza, R. S., Sedefian, L., Schere, K., Gilliland, A., and Mathur, R.: Daily simulation of ozone and fine

particulates over New York State: findings and challenges, J. Appl. Meteorol. Clim., 46, 961-979, 2007a.
Hogrefe, C., Lynn, B., Solecki, B., Cox, J., Small, C., Knowlton, K., Rosenthal, J., Goldberg, R., Rosenzweig, C., Civerolo, K., Ku, J. Y., Gaffin, S., and Kinney, P. L.: Air Quality in Future Decades – Determining the Relative Impacts of Changes in Climate, Emissions, Global Atmospheric Composition, and Regional Land Use, in: Air Pollution Modeling and Its Application XVII, 217-226, 2007b.

- p. 2212/l. 6-8: reference "Jiang et al." not cited in text

Response: Fixed

Various air quality studies have implemented the downscaling methodology for evaluating the influence of climate change, land-use modification, and different emissions projection scenarios on both anthropogenic and biogenic emissions on the regional scale in the United States (Civerolo et al., 2007;Jiang et al., 2008;Jacobson and Streets, 2009;Zhang et al., 2008).