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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Attribution of future US ozone pollution to regional emissions, climate change, long-range transport, and model deficiency" *by* H. He et al.

Anonymous Referee #2

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Overview

This study uses a regional chemical transport model driven by chemical boundary conditions from a global model to examine changes in U.S. surface ozone between present-day and two future emission/climate scenarios (A1B and A1Fi). High-resolution modeling is valuable as it might provide more detailed spatial and temporal information on the response of surface ozone to changes in emissions versus climate. However, as I will discuss in detail below, this manuscript does not represent a substantial contribution to process-level understanding of present-day to future changes in U.S. ozone pollution. The discussions presented are often incomplete or scientifically inaccurate. In my view, the paper cannot be published in ACP in its present form.

Specific Comments:

1. Changes in emissions versus climate?

It is not clear how the role of changes in emission versus climate on the ozone inflow to US is separated in the experiment sets. In Table 1, Figures 4, 6, and 7, the authors stated that the CMAQ experiments Cases 1-5 are driven by dynamic boundary conditions from the CAM-Chem global model, but it is not clear which CAM-Chem experiment among Cases 11-15 is used. If the same CAM-Chem experiment has been used in the CMAQ simulations, the extent to which changes in the ozone inflow to the US are driven by the impact of changes in non-US anthropogenic emissions versus climate change in A1B and A1Fi scenarios? This question cannot be answered by the comparisons between CASES 1-5 and 6-10 experiments! In addition to changes in hemispheric emissions, shifts in atmospheric circulation patterns can also impact decadal variability in the strength of Asian pollution inflow to the U.S., as demonstrated by Lin et al (2014, Nature Geosci). Global and regional circulation patterns are likely to change under future climate scenarios. Thus, it is important to design the model experiments to be able to separate the role of emission vs. climate on global to regional scales.

Related to this comment on atmospheric circulation variability, it seems odd to me that the authors define present-day climate as conditions during the five-year period of 1995-1999 but provide no discussion on the extent to which this short, five-year period can represent present-day climate. The frequency of mid-latitude cyclones [e.g. Leibensperger et al., 2008; Turner, et al., 2013] as well as hemispheric pollution transport patterns (Lin et al., 2014) can change significantly from year to year and even from decade to decade: their variability clearly affects ozone in the US. How does their variability during the 1995-1999 period compares with the past 20-30 years?

2. Changes in methane?

The methane level might play an important role in changes in background ozone in the US (e.g. Wild et al., 2012; Clifton et al, 2014). How does the methane level change in the A1B and A1Fi scenarios? How their changes are represented in the global CAM-Chem simulations? How do they affect the ozone inflow to the US in the CMAQ simulations?

3. Changes in stratosphere-to-troposphere ozone transport?

Recent work has shown that deep stratosphere-to-troposphere transport (STT) of ozone contributes substantially to high-ozone events observed at Western U.S. high-elevation sites (e.g. Langford et al., 2009; Lin et al,2012). Studies have also shown that the STT ozone flux is likely to increase under a warming climate (e.g. Collin et al., 2003; Hegglin et al., 2009). How does STT change from present-day to future climate in your model simulations?

Why not also include the analysis of ozone changes in the intermountain west region (Figure 1)?

4. Changes in lateral boundary conditions of long-lived chemical species? (Figure 2)

In Figure 2, it is awkward that the authors examined changes in lateral boundary conditions of short-lived species: NOx and VOCs. These short-lived species are not expected to make a substantial contribution to long-range of ozone. Why not examine changes in relatively long-lived species like ozone, CO, and PAN? It would be even better if the authors can look at how the two models compare to the ozonesonde data at Trinidad Head, California and discuss how the inflow changes.

Please change the y axis in all vertical profiling plots (Figs. 2, 3…) to pressure in hPa or altitude in km. A sigma value has no meaning as it depends on the model top!

5. Model evaluation.

Table 2: It is not clear in the caption whether this is for annual mean or for a specific season.

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Figure 5: Why not show the maps for each season and for the entire US?

Recommendations:

Revision of the paper will greatly benefit from a thorough literature review on the various drivers of long-term changes in tropospheric ozone and explicitly discuss how their model experiments are designed to address these issues. It would be also useful to do the analysis for each season, at least separating ozone changes during spring vs summer, as the specific drivers in different seasons can be very different.

References:

Lin, M.Y., L.W. Horowitz, S. J. Oltmans, A. M. Fiore, Songmiao Fan (2014): Tropospheric ozone trends at Manna Loa Observatory tied to decadal climate variability, Nature Geoscience, 7, 136-143, doi:10.1038/NGEO2066.

Leibensperger, E. M., Mickley, L. J., and Jacob, D. J.: Sensitivity of US air quality to mid-latitude cyclone frequency and impli-cations of 1980–2006 climate change, Atmos. Chem. Phys., 8, 7075–7086, doi:10.5194/acp-8-7075-2008, 2008.

Turner, A. J., A.M. Fiore, L.W. Horowitz, and M. Bauer (2013), Summertime cyclones over the Great Lakes Storm Track from 1860–2100: variability, trends, and association with ozone pollution, Atmospheric Chemistry and Physics, 13, 565–578, doi:10.5194/acp-13-565-2013.

Wild, O., A.M. Fiore, D.T. Shindell, R.M. Doherty, W.J. Collins, F.J. Dentener, M.G. Schultz, S. Gong, I.A. MacKenzie, G. Zeng, P. Hess, B.N. Duncan, D.J. Bergmann, S. Szopa, J.E. Jonson, T.J. Keating, A. Zuber (2012), Modelling future changes in surface ozone: a parameterized approach, At, 12, 2037-2054, doi:10.5194/acp-12-2037-2012.

Clifton, O.E., A.M. Fiore, G. Correa, L.W. Horowitz, and V. Naik (2014), 21st Century Reversal of the Surface Ozone Seasonal Cycle over the Northeastern United States, Geophysical Research Letters.

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Langford, A. O., K. C. Aikin, C. S. Eubank, and E. J. Williams (2009), Stratospheric contribution to high surface ozone in Colorado during springtime„ Geophys. Res. Lett., doi:10.1029/2009GL038367.

Lin M.Y., A. M. Fiore , O. R. Cooper , L. W. Horowitz , A. O. Langford , Hiram Levy II , B. J. Johnson , V. Naik , S. J. Oltmans , C. Senff (2012): Springtime high surface ozone events over the western United States: Quantifying the role of stratospheric intrusions, Journal of Geophysical Research, 117, D00V22, doi:10.1029/2012JD018151.

Collins, W. J., R. G. Derwent, B. Garnier, C. E. Johnson, M. G. Sanderson, and D. S. Stevenson (2003), Effect of stratosphere-troposphere exchange on the future tropospheric ozone trend, J. Geophys. Res., 108(D12), 8528, doi:10.1029/2002JD002617.

Hegglin, M. I., and T. G. Shepherd (2009), Large climate-induced changes in ultraviolet index and stratosphere-to-troposphere ozone flux, Nat. Geosci., 2, 687–691, doi:10.1038/ngeo604.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 26231, 2014.