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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Will the role of intercontinental transport change in a changing climate?" *by* T. Glotfelty et al.

Anonymous Referee #1

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General comments

The authors present an interesting study on the evolution of intercontinental transport of air pollution due to climate change. To that end, they use a comprehensive modeling system that consists of a global integrated online meteorological/air quality model. This model treats all major air pollutants (including ozone and particulate matter (PM)) as well as deposition of nitrogen, black carbon, and mercury. The modeling results are analyzed in detail and changes in pollutant concentrations and deposition fluxes are clearly explained in terms of changes in meteorology. Comparisons with previous studies appear to be very thorough and provide useful information to understand the results of this study within a broader context. The paper is very well written. The introduction provides a comprehensive review of previous work on the intercontinental

transport of air pollution, which sets the stage nicely for this study. Model performance is critically evaluated for meteorology against that of another model. The only missing aspect is a discussion of the limitation of this modeling study (and most other air quality studies concerning the effect of climate change on air quality), which should be added in the conclusion. Future work to address some of those limitations could also be proposed.

In summary, this work provides valuable information concerning the effect of climate change on long-range transport of air pollutants including ozone, PM, and atmospheric deposition of pollutants. Therefore, this work deserves publication after minor revisions to address the comments indicated below.

Detailed comments

Section 1: Introduction

P. 2692, lines 11-13: This sentence is succinct and more detail could be provided. For example, the increase in OH is presented as leading to ozone removal (I suppose via the reaction cycle of ozone reacting with OH to produce HO2 and ozone reacting with HO2 to produce OH), which implies that VOC chemistry is not important since VOC oxidation by OH would lead to more ozone production. Please clarify.

Section 2: Experimental design

The model description and set-up are well presented and the reasons for selecting the years (2001 and 2050) and season (March-April-May) used in this study are clearly described. The comparison of model performance between the simulations used in this study and on one hand those based on more years and on the other hand those obtained with a different model is sufficiently detailed and the conclusions are useful to understand the potential limitations associated with this type of study.

P. 26498, line 8: "signal" instead if "singal".

Section 4: Changes in future emissions

This section provides a clear description of the changes in emissions between 2050 and 2001. How the emission scenario used here relates to the latest RCP emission scenarios is well described and places this specific study within the current context of RCP emission scenarios.

P. 26500, line 28: space between “species” and “except”

Section 5: Impact of EAAEs on current and future air quality

This section presents the results of the model simulations in terms of the impact of climate change on air quality, with a focus on intercontinental transport of air pollutants. The discussion of the results is well done as the authors provide convincing explanations for the changes in air pollutant concentrations and deposition fluxes.

P. 26501, lines 10-11: The use of “northerly” and “westerly” is confusing here. If one assumes that they mean the direction from which the pollution is coming, then shouldn’t the transport of pollution from Asia to the Arctic be “southerly”? If it is the direction toward which the pollution is being transported, then, the transport from Asia toward the North American continent should be “easterly”. Please clarify.

P. 26504, line 4: The range 0.9-0.3 ppb is given for PAN. Should it be written as 0.3-0.9 ppb or, as currently written, does it reflect a decrease from 0.9 ppb at the surface to 0.3 ppb at 450 mb? If so, did the range of 0.3-0.5 ppb in 2001 represent 0.3 ppb at the surface and 0.5 ppb at 750 mb? Please clarify.

P. 26505, lines 17-18: It would be useful to be very clear that what is meant by controllable over the U.S. refers also to the control of anthropogenic emissions to reduce oxidant levels. For example: “. . .over 50% of the BSOA is controllable over the Southeastern U.S. by reduction of anthropogenic emissions”.

Section 6: The impact of EAAEs on the climate system

This section presents results that can only be obtained with an integrated meteorological/air quality model, i.e., the effect of changes in atmospheric chemical composition on

meteorology, mostly cloud formation and induced effects on atmospheric radiation. The discussion of the interactions between meteorology, radiation and chemical composition is clear and sufficiently detailed to offer convincing explanations of the processes at play.

Section 7: Concluding remarks

One of the major contributions of this study is that it provides quantitative information on the effect of long-range transport of air pollutants as a function of a changing climate.

A discussion of the limitations of this study would be useful. Such a discussion could also form the basis for suggesting future work to address some of those limitations. Most modeling studies (including this one) addressing the impact of climate change on air quality use a single meteorological model and a single air quality model. The use of model ensembles would bring some robustness to the modeling results, but it is of course limited by the associated computational cost. Also, the number of years being simulated is a limitation in most studies linking climate change and air quality. The greater the number of years being simulated, the more robust the modeling results (but the greater the computational cost). This point is discussed in part in Section 2 (Experimental design), where the climate change obtained from 1 year simulations is compared to those obtained from the AOC (2 years) and AOF (4 years), but it could be discussed in more general terms here. Clearly, such additional modeling (multi-models and multi-years) is beyond the scope of this work and may not in any case be feasible at this point; nevertheless, it would be useful to point out directions for future work in this area.

Another potential limitation of this kind of study is the lack of testing of the ability of air quality models to simulate changes in air pollution due to changes in emissions and/or meteorology. It is likely that air quality models can simulate satisfactorily the changes in ozone concentrations and mercury deposition rates due to changes in emissions of precursors; however, we probably cannot be as confident about changes in secondary

PM due to changes in their precursors. Furthermore, the effect of meteorology on PM may be complex and this may be a source of uncertainty for all studies of the effect of climate change on PM concentrations. Some discussion of these points and suggestions on how to test air quality models for future studies would be useful.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 26489, 2013.