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Geoscientific Model Development Discussions

Interactive comment on "Application of WRF/Chem version 3.4.1 over North America under the AQMEII Phase 2: evaluation of 2010 application and responses of air quality and meteorology–chemistry interactions to changes in emissions and meteorology from 2006 to 2010" *by* K. Yahya et al.

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Reply to Comments from Reviewer 2

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 Open Access Geoscientific Model Development Discussions

Interactive comment on "Application of WRF/Chem version 3.4.1 over North America under the AQMEII Phase 2: evaluation of 2010 application and responses of air quality and meteorology–chemistry interactions to changes in emissions and meteorology from 2006 to 2010" by K. Yahya et al. Anonymous Referee #2 Received and published: 17 March 2015

This paper evaluates the WRF/Chem model performance and responses of air quality and meteorology-chemical interactions to the meteorological and emission changes in 2006 and 2010. By comparing the model prediction of WRF/Chem and WRF, the chemical feedbacks to meteorology are assessed. And a series of sensitivity simulations are pursued to distinguish the differences driven by emission changes, meteorological variation, and Chemical ICONs and BCONs. This paper is valuable to understand the WRF/Chem model performance in catching the yearly variations, and reveals the necessity of improving the accuracy of emissions and chemical BCONs, the SOA module, and the chemical-meteorology feedbacks in the online-coupled model.

Reply:

We thank the reviewer for careful review of this manuscript and recognition of the values of this work. We have carefully addressed all the comments raised by the reviewer to improve the technical and presentation quality of our manuscript. Please see below our point-by-point replies.

Nevertheless, several important points should be addressed to support the paper conclusions. (1) In section 3.5, "The trends for Precip and CF for simulated variables are not consistent with observed trends from 2006 to 2010. Observed NADP Precip increased slightly from 2006 to 2010 by _7%, however both simulated WRF and WRF/Chem show a small decrease from 2006 to 2010...." . Can the authors explain why the model fail to reproduce the trends of precipitation and CF between 2006 and

2010?

Reply:

Although WRF/Chem is a state-of-science online-coupled meteorology-chemistry model, there still exist large uncertainties in the model treatments of the aerosol-radiation-cloud feedbacks, e.g., in the microphysics and cumulus parameterization schemes which will affect precipitation predictions. In addition, as mentioned in the text, model precipitation has large biases against observations. It is also likely that the decrease in precipitation between 2006 and 2010 by the model is due to the smaller decrease in SWDOWN compared to observations between 2006 and 2010. This would result in less convective precipitation during the summer but increased CF for 2010. In addition, PM2.5 concentrations are more underpredicted in 2010 than 2006 (i.e., simulated PM2.5 is a better agreement with observations in 2006). Underpredicted PM2.5 concentrations will affect the formation of clouds and precipitation via various direct and indirect effects.

In Section 4, additional trend analyses for Jan. and Jul, 2010 based on baseline and sensitivity simulations were added in a new Table (Table 4). The new analyses showed that even though some of the sensitivity simulations performed better for individual chemical and meteorological variables (Table S2), the model's capability in reproducing observed trends analyses is not necessarily improved. The analyses showed that using different emissions, chemical ICONs/BCONs, and meteorology can help to improve individual variable performance; however the base 2006 and 2010 simulations performed best for the trend analyses compared to observations.

The above points have been added in Sections 3.5 and 4.

(2) In the conclusion section, " In general, the model performs well in terms of Corr and NMEs for almost all meteorological and chemical variables in 2006 but not as well in 2010 despite lower NMBs for most variables in 2010, due mainly to inaccuracies in emission estimates and chemical BCONs and ICONs used for 2010 simulations". But

the inaccuracies of emission estimates in 2010, comparing with 2006, have not been in-depth explained in the manuscripts, e.g., section 3.2. Please revise.

Reply:

The above sentence was concluded from the analyses in Section 4.4 where 2006 emissions and chemical ICONs/BCONs were used for the 2010 simulations and the sensitivity simulation showed improved performances for O3 and PM2.5 for 2010. To avoid confusion, we have revised the above sentence in the conclusion to be "due mainly to inconsistencies for emission estimate approaches between 2010 and 2006 and inaccuracies in chemical BCONs and ICONs used for 2010 simulations". We also added the detailed explanation about this point and cited the corresponding reference in Section 2.1 as follows:

"The major sources of uncertainties or errors in the U.S. NEI emissions include: (1) the emissions are calculated using a bottom-up approach based on information provided by individual state, local and tribal air agencies; and (2) improvements in emission-estimation methodology over the years may result in inconsistencies between the NEI data compiled and released by the U.S. EPA (Xing et al., 2013)."

(3) Figure S2, S5, S8-10, S12 are not in good shape. Please revise.

Reply:

Figures S2, S5, S8 – 10, S12 have been revised. There were also problems in the alignment of the figures in the Supplementary material when they were converted to PDF by the journal online software. We will make sure they are in sufficient resolution and quality for the final publication.

(4) Figure 13 and 14, please add the explanation of each column, e.g., the Run 2- Run 3 depicts the differences resulted by the emission changes between 2010 and 2006.

Reply:

The explanations have been added. An additional Table (Table 3) explaining the set-up of the sensitivity simulations has also been included.

The reference cited in this reply:

Xing, J., J. Pleim, R. Mathur, G. Pouliot, C. Hogrefe, C.-M. Gan, and C. Wei, 2013, Historical gaseous and primary aerosol emissions in the United States from 1990 to 2010, Atmos. Chem. Phys., 13, 7531–7549.

Interactive comment on Geosci. Model Dev. Discuss., 8, 1639, 2015.