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Interactive comment on “Quantifying pollution inflow and outflow over East Asia through coupling regional and global models” *by* M. Lin et al.

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Authors Response to Short Comments

We thank Wing Lin for the thoughtful comments that we believe have helped us to strengthen the manuscript.

*Below we include the original comments (shown in black), and we respond to each comment line-by-line. **Our responses are shown in bold.***

The overall contents are well presented. The author has demonstrated the advantages of using finer resolution models (i.e., WRF-CMAQ) on the issue of long-range transport

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studies. However, a few places may need some touch ups and improvements.

1) The title of the paper “ Quantifying pollution inflow and outflow over East Asia through coupling regional and global models” may not represent well the contents of the paper. I realized that the author has coupled MOZART with CMAQ (using MOZART as the boundary conditions for CMAQ) to study the inflow and outflow over East Asia. However, the major focus of the paper have been on the advantages of WRF-CMAQ over MOZART for the March episode along with the Asia outflow results from those simulations. Very little or near nothing on the discussion of the coupled model. The “coupling term” has seems mislead to the audience.

» **Agreed. We changed the title to: “Quantifying pollution inflow and outflow over East Asia in spring with regional and global models”**

2) Pg. 129, line 15. The argument of “O₃ production tends to be in the NO_x-limited regime in MOZART” is wrong. The author has used the reason “Total emissions of NO_x are 15% lower in MOZART, which leads to a relatively higher VOC/NO_x ratio in the global model.” Although NO_x is 15% lower, however, that does not translated to “NO_x limited regime in MOZART”. According to the Table 1, the calculated VOC/NO_x ratios in both MOZART and CMAQ are similar. It should be noted that most of East Asia studies have shown the East Asia is more VOC limited. Therefore, such writing is confusing. Unless, the author has more data or analyzes to support such argument. Otherwise, this writing is not justified.

» **We agreed that most studies for East Asia have suggested that ozone formation over this part of the world is likely in the VOC-limited (NO_x-saturated regime). The sentence of “O₃ production tends to be in the NO_x-limited regime in MOZART” has been cut. But we do think the ozone formation chemical formation regimes associated with the VOC-to-NO_x ratio in MOZART will affect the ozone response to foreign emissions. For example, MOZART emits much lower NO_x emissions in the urban areas of Tokyo, Seoul and Beijing than CMAQ (Figure**

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S1), and it gives lower ozone response at these megacities than CMAQ. To further support our discussion on the influence of chemical regimes on the ozone response, we have conducted a new sensitivity test using the CMAQ model to access the relative role of direct long-range transport of O₃ vs. local production driven by PAN decomposition on the total response of EA O₃ to EU emissions reductions. Our results show that NO_x released from EU PAN decomposition contributes up to approximately 50% of total O₃ responses in subsiding plumes at mountain observatories, and the chemical regime where the subsiding PAN decomposes determines the O₃ production efficiency.

» We added a new subsection (section 4.2) presenting the findings described above.

3) Figure 7 at Pg. 150. It is unreasonable to use 20% perturbation with a factor of 5 to represent a full impact from Europe to East Asia since the nature of non-linearity in O₃ chemistry. Some researchers (Wu et al. and Akimoto et al.: : Can't remember which year) have shown the O₃ remained in linear relationship when 20% to 35% foreign reduction (i.e., NO_x) is imposed. I believed that the linear relationship between O₃ and NO_x will not maintain when 100% of European emissions reduction is used. If the author want to continue to use the factor of 5 as the 100% of EU enhancement to East Asia, he/she should first demonstrate such technique is a good approximation or able to find some papers to support his/her argument. If the author can not prove that, this approximation should not be accepted since it is not scientifically sound. Therefore, this result could most likely be a wrong representation of the output result and may lead to over exaggerate the contribution of European enhancement to East Asia.

» We agreed that the response of ozone to emission reductions is not linear. Thus, we re-made relevant figures for the discussion of EU enhancement (Figure 7, 8 and 9), and restricted our discussion in the text to the response to a 20% decrease in European emissions.

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