

***Interactive comment on “Regional-scale modeling of near-ground ozone in the Central East China, source attributions and an assessment of outflow to East Asia – The role of regional-scale transport during MTX2006” by J. Li et al.***

**J. Li et al.**

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We thank Reviewer#2 for his/her constructive comments. Response to the Specific comments by Reviewer #2

General comment: This is an interesting paper which attempts to identify the origin of O<sub>3</sub> in East Asia using a technique in which O<sub>3</sub> in various provinces in eastern China and East Asia are tagged. The results do lend insight into the relative contributions of different regions to observed O<sub>3</sub> concentrations. Some of the observations that are presented to evaluate the model calculations have not been published previously and give valuable insight into the concentrations of O<sub>3</sub>, CO, NO<sub>x</sub> and BC at mountain sites

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in eastern China.

Response: We greatly thank the Reviewer#2 for his/her encouragement and insightful comments concerning the manuscript. The manuscript has been greatly reworded to provide more insightful results about summer high ozone in central eastern China. Particular attention was given to identify possible ozone production regions of high ozone levels in CEC and the role of regional transport.

Comment 1: The paper uses the O<sub>3</sub> tagging technique (described in Wang et al., JGR, 1998 and Sudo and Akimoto, JGR, 2007) in which the intercontinental transport of O<sub>3</sub> produced in the boundary layer and free troposphere over continental regions is individually tracked. This technique counts O<sub>3</sub> that is produced in the boundary layer of country A from emissions from country A as O<sub>3</sub>A. However, it also counts O<sub>3</sub> that is produced in the boundary layer of country A from emissions transported across the border from country B (ex. PAN and CO with lifetimes sufficient to be transported long distances) as O<sub>3</sub>A. It does not count O<sub>3</sub> produced from emissions from country A after they leave country A as O<sub>3</sub>A but rather assigns the O<sub>3</sub> produced in the other region to the other region. In the earlier applications of the technique, the errors introduced by this approach are smaller than they are here because the distance between regions is larger. For example the distance between East Asia and North America is thousands of miles. However, the distance between the various regions here within eastern China can be tiny as many regions border each other directly. Eastern China itself is divided into nine regions with the rest of China divided into six regions and Korea, Japan each being separate regions. I am concerned that as a result the O<sub>3</sub> that is represented here as SSD (southern Shandong province), for example, actually includes O<sub>3</sub> formed from emissions from the surrounding regions and does not fully include the O<sub>3</sub> formed from the emissions from SSD itself. At present there is no discussion of the shortcomings of the tagging approach in the paper although the authors do mention the shortcomings of the sensitivity approach. At minimum, the implications and uncertainties associated with the tagging technique should be discussed in the paper. It would be helpful as

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well, space permitting, to compare the results of a single regions tagged O3 values with those of a sensitivity run (say 20% reduction of O3 precursors from SSD then multiplied by 5 to estimate the total contribution of SSD emissions to O3 in the region and compare with the tagged SSD values).

Response: The referee is totally right. In present modeling studies, there are two methods to indentify the origins of tropospheric ozone: sensitivity approach and tagging technique. What sensitivity approach reveals is the total impacts of emissions themselves from any targeted region on ozone levels at any given site. What the tagging technique reveals is to separate the contributions of regional-scale transport to local ozone concentration for distinct regions, that is, to take the ozone at any given grid in which regions has this ozone been produced. For any ozone production region, the tagging technique may count the contributions of O3 that was chemically produced over this region from precursors transported across the border from its surrounding regions, and exclude the contributions of its ozone precursors' emissions that have been transported out of this region. So the tagging technique is widely used to identify the possible important ozone production regions of ozone at any given site, whereas sensitivity approach is used to analyze whose emissions have important impacts on ozone at any given site. I agree that none of both is superior. Besides the non-linearities of photochemistry in sensitivity approach, this difference between both approaches will bring a discrepancy when we compare their results. As pointed out by the referee, the discrepancy in intercontinental transport is small. In this study, due to shorter distance between various regions, this discrepancy of both approaches is likely larger than that in intercontinental transport. Although there is no perfect test method to estimate the error of the diagnostic results of this study (since the exact ozone contributions are unknown), we employed an error analysis method developed by Grewe (2004) to estimate the error of this study in the revised version. In the error analysis, our results were compared with sensitivity approach that is modified to reduce the impacts of non-linearities. This is done in section 4.3 in the revised version. The analysis showed that errors associated with the contributions from SSD, AH and JS in this study to total

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ozone at Mt. Tai mostly were within 7 ppbv (13-30%) and 8.5 ppbv (20-30%), respectively. This suggests that our results in this study are reasonable. To be more exact, we changed "source regions" to "ozone production regions&" in the revised version. In section 1, last paragraph, our objective has been changed to "to identify the regions in which high ozone levels are produced over CEC". We also softened the wording on the shortcoming of sensitivity approach in section 4.1 last paragraph.

Comment 2: The paper would benefit from careful editing by someone experienced with English grammar as in many places the intended meaning is difficult to surmise.

Response: We have improved the English wording by a native English speaker.

Comment 3: The legends and labels for the contours in the figures need to be larger to be legible.

Response: We have improved the quality of figures and enlarged the labels.

References:

Grewe, V.: Technical Note: A diagnostic for ozone contributions of various NO<sub>x</sub> emissions in multi-decadal chemistry-climate model simulations, *Atmos. Chem. Phys.*, 4, 729-736, 2004.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, 8, 13159, 2008.

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