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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Simulation of Mexico City plumes during the MIRAGE-Mex field campaign using the WRF-Chem model" *by* X. Tie et al.

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Responses to Reviewers:

Reviewer 1:

We thank the reviewer for the careful reading of the manuscript and helpful comments. We have revised the manuscript following their suggestions as is described below.

General comments

This manuscript investigates the evolution of ozone and its precursors in the Mexico City urban plume during the 2006 MILAGRO campaign using the WRF-Chem model, examines the roles of CO, NMHCs and OVOCs in O3 production in the plume outflow,

and assesses the contribution of HO2 and RO2 to O3 production in the aged plume. It is well organized and well presented. I recommend publication after minor revisions.

Specific comments

1 p9228 L2-3, on emissions used in the model. This seems to be the major weakness in this paper if the emissions shown in Table 1 in Tie et al. (2007a) were not mistyped. According to the table, the VOC emissions are very high (similar to those used in West et al. (2004)), about three times of those in the official emission inventory (EI) for the year 2006 in the MCMA, while the NOx emissions are unusually low, less than half of those in the MCMA EI 2006. The emissions appear to be constructed based on the EI before 2002 (based on the references cited). Over the years the emissions in the MCMA have reduced significantly, in particular for VOCs. It would be ideal to construct the emissions based on the EI 2006 in conjunction to more VOC measurements during the MILAGRO campaign. Given the emissions used, the model under predicts NOy but over predicts VOCs (see Tab 1 and Fig 6, when the transport is corrected). In addition, it seems that the anthropogenic emissions outside the MCMA area are set to zero, which likely leads to the model's underestimation of background concentrations of all species in Tab 1. Considering the rather large model domain and significant contributions from the regional anthropogenic emissions, the influence of the regional emissions on the regional backgrounds can be important. Although, probably, the emission issue may not change the conclusion on the plume evolution, it will affect the model evaluation. It would be helpful to address the effect of the emissions inaccuracy on the model observation comparison and possible impacts on the conclusion.

We check the emissions in the model, and find the emissions are somewhat different compared to the emissions used in Table 1 of Tie et al. [2007]. In this calculation, the SO2, CO, NO, and VOC emissions in this are 2.55E4, 2.39E6, 1.69E5, and 1.28E6 (ton/year), respectively. The NO emission is close to Molina and Molina [2002] and West et al [2002], and higher than Tie et al. The VOC emission is close to West et al, but is lower than Tie et al. We think that there are large uncertainties related to all cur-

rent emission inventories, and it is important to clearly state what are emissions used in this calculation. With clearly understanding the emissions used in the model, the comparison between the calculated and measured CO, NO, NOx, VOC, etc can give some insights regarding the uncertainties of the emissions. In the revised manuscript, we add more details in emissions, including a new table (Table 2) to describe the emissions. We also add some texts in different place to address the uncertainties of the emissions. The uncertainties due to the uncertainties of background emissions are also addressed in the revised manuscript.

2. p9225 L11-22, flight 4 is missing, and flight 11 does not meet the selection criterion of long flight hours.

There are some mistakes regarding the descriptions of the flight information. Corrections for the flight information are included in the revised manuscript. In addition, we describe that flight-11 is special flight, and is used for having background information.

3. P9230 L 2-4, March 18 was Saturday when emissions are up to 30% than on the weekdays. The emission reduction on Saturday can be seen from the measurement in Fig 3. Taking this into account, the PBL on this day is presented even much better.

This is a good point, and we address this issue in the revised manuscript.

4. P9231 L17 and P9232 L 7-8. If the difference of the calculated and measured [CO] is b (b=model/obs -1), where b = -27, 2, -9, -24, and -25% on the 5 flights, then the adjustment factor A should be 1/(1+b)-1 (i.e., obs/model -1), or /(1-0.27)-1,1/(1+0.02)-1, 1/(1-0.09)-1,: : :etc.) on the 5 flights, not 27, -2, 9, 24, and 25%.

Thanks for the suggestion. There is a typo in Eq. 2, and it should be [1+A(i)/100]-1 instead of [1+A(i)/100]. Now it is corrected.

5. Fig 6 and relevant text in Section 3.2, is a uniform adjustment factor (18n%) applied to all data points, or are different adjustment factors applied to the data of different lights? And, since the transport correction is applied to CO, NOy, NOz, and O3, why it

is not applied to VOCs?

We have clarified that the adjustment factor is uniformly applied for all flights for some chemical long-lived species, such as CO, NOy, NOz, and O3.

6. p9233 L 18-19 and p9234 L 15-16, underestimation of background concentrations, see Comment #1.

Adding the uncertainties related to emissions from outside of the cities.

7. p9235 L6-9, the large variation of calculated NOx errors in different flights may also reflect the temporal and spatial bias of simulated plumes traversed by some flights.

We add text to describe that the modeling the timing and locations of the city plumes are difficult, and the uncertainty of transport could introduce errors in simulating the city plumes.

8. p 9249 L1-2 and Fig 9, I think the simulation compares well with the observation based on the data points (the 2nd order polynomial fitting is applied to the whole data of young and aged plumes, which does not necessarily reflect the model-measurement difference of the young plume).

We add text in the manuscript to state that the comparison between model and measurement in the young plume may have more uncertainties.

9. p 9239 L17-20 and p 9240 L15-16, since the relationship (of CO-O3 and O3-NOz) is non-linear, why there are slopes?

The slop is not a linear line, which shows the non-linear relationship of CO-O3.

10. Section 4.5, the analysis on the plume evolution and the roles of OVOCs, HO2 and RO2 in O3 production is based on one day simulation. The conclusion would be strengthened if results from other flight days when the flight traverses a city plume are also discussed and have similar findings.

As suggested by the reviewer, we analyze the ozone production in another flight (March/18, flight-6). The results (not shown) are similar to Figures 11 and 12, which are consistent to our current conclusions.

11. p9243, L15, k9[NO2][OH] may significantly underestimate L(NOx) in the young plume, because in the MC PANs and organic nitrates are the major components of NOz.

According to the original definition suggested by Liu et al. [1987], the definition of ozone production efficiency is the number of O3 produced by a loss of NOx molecular. The reaction of OH + NO2 is the ultimate loss of NOx. However, the PAN formation is not the net loss of NOx, because of NOx can re-produced by PAN.

Technical

P9222 L19, change aging to aged. P9225 L12-13, “18(flight March 6)” should be “18 March (flight 6)”? P9234 L23, delete 2nd and. p9236 L17 and p9237 L13, reverse the order of 15 and 24 ppbv, and 3.1 and 4.1 ppbv. P9242 L12, delete The. p9244 L14, should Eq. (3) be Eq. (4)? P9245 L8, change insider to inside

All these typos are corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 9221, 2009.