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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of open crop residual burning on air quality over Central Eastern China during the Mount Tai Experiment 2006 (MTX2006)" *by* K. Yamaji et al.

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The authors are deeply grateful to the referee for his/her review providing excellent suggestions for improvements of this manuscript.

General comments:

Although the general research framework looks plausible, the details of the methodology employed are questionable. In this study, authors used an Eulerian modeling setting over East Asian domain (without nested-griddng over CEC) to prove their presumption. But, the modeling setting is too crude to prove their presumption. In case that this set of Eulerian modeling is used to evaluate/analyze the observational data from the point-measurement "networks", I think it would be a working idea in some sense. But, when a rather coarse-grid Eulerian modeling is carried out for evaluating the limited number of observational data from only a "single measurement location" like Mt. Tai, it could inherently contain large uncertainty. This uncertainty is even more enhanced by the fact that the open residue burning would be "spotted" spatially, not massive like Siberian or tropical forest fires. Also, the emissions from the open yard burning could be highly time-resolved, since they are rather controlled burning by peasants, unlike the massive, uncontrollable forest fires. But, authors carried out the CMAQ model simulations with a coarse-grid horizontal resolution, 80 km x 80 km. Vertical resolution would also be several hundred meters (because only 7 layers below 2 km were employed; I guess that many layers of the 7 layers are located even near the surface, probably below _1km, but Mt. Tai is _1500 m high). In addition, the open residual burning emissions are just "daily-resolved" in this modeling setting. Overall, with these modeling settings, I do not think that the accuracy of the "single point-location" measurement data can be evaluated successfully. In other words, for this study purpose the modeling settings should be much more sophisticated. Otherwise, it is likely that the CMAQ modeling could mislead to erroneous quantification and/or conclusions.

Reply to General comments:

We understand that the major concern is in the modeling frame. We will re-submit the revised manuscript including the discussion about uncertainties pointed out by the referee.

We thought that the model resolution, 80km was coarse generically for regional model in particular to compare with only a "single measurement location", but we used this model frame by following reasons: Firstly, as mentioned by other paper published in this special issue (e.g. Kanaya et al., 2008), since the site is free from local sources as it is located at 1534 m high, we believe the summit of Mt. Tai had a representativeness for the Central Eastern China, with much reduced spatial inhomogeneity compared to a urban site. Meanwhile, we think that urban sites at the Central Eastern China

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with outstandingly high emission rates of atmospheric pollutants are not befitting for locations with regional representativeness there. This location seemed to be suitable for evaluation of this regional model frame. Additionally, this model system has been validated well using rural/remote site observation (Uno et al., 2005 and 2007; Tanimoto et al., 2005; Yamaji et al., 2006 and 2008; He et al., 2009). For model resolutions, we tried to use more fine resolution (80km-14layers, 80km-19layers, 23km-19layers) for the other study as shown in supplemental figure (see Fig.1). However we could not obtain large difference and enough merits at the top of Mount Tai. From point of view of emission inventories for Asian scale, their current resolutions with 0.5 degree, (about 60×30 km in mid-latitudes) and their original mapping information were not enough to input in the model frame using fine resolution. Note that the original inventory (0.5 degree and based on 2006) in this study was already the finest one that we can find in CEC. While publicly available ground-based observation data in this region are very limited, we will show comparisons between model and a few observation in the revised manuscript using ground-based observation data at other sites, e.g., Mondy (51.40 N, 101.00E, 2000m asl) , Mt. Hua (110.09E, 34.49N, 2064ma.s.l.), Mt. Huang (118.15E, 30.14N, 1836ma.s.l.)., Xinglong (40.42N, 117.4E, 940m asl) and satellite data (OMI NO2, (Irie et al., 2008)) to evaluate more the model's reliability. This manuscript is the first modeling paper using a new emission inventory (0.5 degree) for the intensive observation campaign at the Mount Tai, and then this study used a simple regional model, which was validated well using rural/remote site observation. The additional model experiments (e.g. with changing the model resolution, using new chemical and aerosol scheme, and changing natural emissions) are our important issue in the future.

Comment 1:

Although the MODIS fire data-base can provide daily hotspot map, it cannot catch all the fire events occurred during the study period. Particularly, fires under the clouds cannot be detected. Therefore, in the meteorological field analysis, the cloud distributions should be considered and discussed in detail for this type of study.

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Reply to Comment 1:

Agreeing with this referee's comment, we will show cloud information in the revised manuscript.

Comment 2:

Current NMVOCs, POA (primary organic aerosols), and BC emissions in East Asia are highly uncetain. The uncertainties in these emissions frequently exceed even more than _100%. Also, biogenic emissions are very poorly established in East Asia. In this study, 1ox1o GEIA emission for isoprene and terpene (1995) appeared to be used, but this emission is old, and has been reported to be overestimated greatly. Also, soil NOx emissions were neglected in this study, but the soil NOx emission is usually important in the areas, where the "agricultural residue burning" is active (because the main source of soil NOx is fertilizer).

Reply to Comment 2:

We agree with this referee's comments. These uncertainties are high, so that will discuss more in the revised manuscript.

Comment 3:

The SOA formation of CMAQ model or current knowledge of the SOA formation, is not very accurate. Therefore, the uncertainty in the SOA formation scheme of the CMAQ model could introduce a large uncertainty in Fig. 2 and Table 3 & 4.

Reply to Comment 3:

As mentioned by the referee, CMAQ-MADRID elicits high performance with accurate model inputs comparing with CMAQ-AERO3or4 (Zhan, 2004). We will mention the uncertainty in the SOA formation scheme in the revised manuscript.

Relatively minor point 1:

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Some awkward English expressions throughout the manuscript frequently hamper reading the manuscript.

Reply to 1:

We will re-submit the revised manuscript after English proofing by native speaker.

Relatively minor point 2:

In Table 1, since the CEC is such a polluted area and is located almost in the center of modeling domain, the influence of the boundary conditions would be of limited importance.

Reply to 2:

As mentioned by referee, the influence on BC and OC from the boundary conditions is very low. However, CO and O3 concentrations are affected by the boundary conditions even at CEC.

Relatively minor point 3:

In the text and Table 3, only "correlation (r)" is analyzed, but in addition to correlation, "error" and "bias" are also important, and should also be analyzed.

Reply to 3:

The "error" and "bias" analysis will be added.

Relatively minor point 4:

In Fig. 2, why were not temperature and NOx, and SO2 concentrations included? Temperature is more important than, for example, relative humidity.

Reply to 4:

This paper focuses on emission from biomass burning, and thus we think that NOx and SO2 are less impact from biomass burning comparing with BC and OC. On the

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other hand, relative humidity is an important factor to evaluate that the area is under either oceanic or continental air-masses. However, we understand that the other comparisons between model and observations are needed. So, we will add some of them in the revised manuscript.

Relatively minor point 5 (IMPORTANT):

Also, in Fig. 2, there are differences between model-predicted and measured wind directions. In this type of study, even 1o difference in the wind direction at the receptor area (Mt. Tai) can result in huge differences in the source region (burning sites), as the difference in the angle tends to get larger along the backward trajectories.

Reply to 5:

As mentioned as the referee, this problem is important. We will discuss this in the revised manuscript.

Relatively minor point 6:

Fig. 3, I think that if backward trajectory analysis (like HYSPLIT) from the Mt. Tai site is superimposed with the MODIS fire map, it would be much more appealing.

Reply to 6:

Following the referee's suggestion, the results of backward trajectory analysis will be illustrated with MODIS maps.

Relatively minor point 7:

I also recommend authors to re-construct the manuscript. For example, I do not think that the detailed discussion from p. 22107:18 to p.22108: 28 is suitable for "Introduction".

Reply to 7:

Following the referee's suggestion, we will re-construct. For example this part will be

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moved to results.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/9/C10366/2010/acpd-9-C10366-2010-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 9, 22103, 2009.

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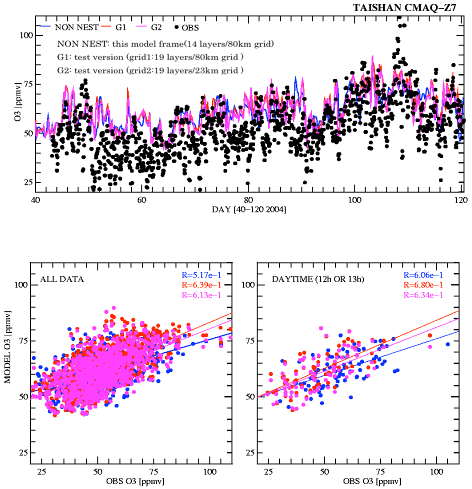

Fig.1 Comparison between observed O3 and simulated O3 at the top of Mount Tai in 2004 (40-120 as Julian date). An upper panel illustrates temporal variations for observation (black dots), simulated O3: non nest with 14 layers and 80 km spatial resolution (blue line); nested grid 1 with 19 layers and 80 km spatial resolution (red line); nested grid 2 with 19 layers and 23 km spatial resolution (pink line). Bottom two panels (right: all data and left: noon time only) show correlations between model and simulations: non nest with 14 layers and 80 km spatial resolution (blue); nested grid 1 with 19 layers and 80 km spatial resolution (red); nested grid 2 with 19 layers and 23 km spatial resolution (pink).

Fig. 1.

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