Atmos. Chem. Phys. Discuss., 4, S538–S543, 2004
www.atmos-chem-phys.org/acpd/4/S538/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of different emission inventories on simulated tropospheric ozone over China: a regional chemical transport model evaluation" *by* J. Ma and J. A. van Aardenne

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Received and published: 16 April 2004

We thank the reviewer for his fair comments on our manuscript. We have addressed the issues point-wise and made modifications to the text for those issues in which we want to meet his/her comments.

(i) A more detailed description of the methodologies used to compile the inventories should be included.

A general overview of the inventories as presented in this paper allows the reader to understand the main differences between the inventories. Providing more detail on the calculation of Chinese emissions within the EDGAR and TRACE-P emission inventories would require us to provide details that go beyond what the publications of these emission inventories provide on China. We feel that unless the reviewer provides

a good motivation for his request more detail on the emission inventories is not needed.

(i-a) TRACE-P, What model was used to forecast values for the year 2000?

(i-b) What does the sentence Şactivity data have been taken for the Chinese situationŤ mean?

These two questions can be clarified by adding the following text to the manuscript: The data used consists of actual statistical data for the year 2000, model forecasts values based on 1995 values in the RAINS-Asia model and trend extrapolations from emission estimates for the late 1990s. For China activity data have been taken on country specific studies. For example, fuel use by sector and province were taken from work by Sinton and Fridley (2000).

(i-c) How are NMVOC added to the CORP inventory?

NMVOC emissions were not included in the CORP emission inventory. In an earlier model study Ma et al. (2002a) added NMVOC emissions using a NOx/NMVOC factor based on Berntsen et al. (1996). These NMVOC emissions have been used in our study. The text in section 2.3 has been adjusted to highlight this.

(ii) There is not an adequate description of the model transport and chemistry included.

In section 3 more detail on the model transport and chemistry has been included: The chemical mechanism used in the model was initially developed by Stockwell (Atmos. Environ., 20, 1615-1632, 1986) and modified by Ma et al. (J. Environ. Sci. Health, A35, 1931-1939, 2000) by updating the rate constants, incorporating the permutation reactions of organic peroxy radicals, and etc. The revised chemical mechanism was compared well with the explicit NCARŠs Master Mechanism using the trace gas concentrations observed at the China regional background atmospheric observatory as model initial conditions. The mechanism was further improved by adding acetone as a tracer into the model and including parameterization of heterogeneous reactions of N2O5 and NO3 on sulfate aerosols (Ma et al., 2002a). The model implemented with

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such mechanism was used for the study of tropospheric ozone over China by Ma et al. (2002a; 2002b).

(ii-a) What aspects of the model may have led to relatively small ozone concentration differences the large differences in emission inventories?

The reasons for the smaller difference in simulated ozone concentration than in its precursors, for instance, NOx, are complicated. In unpolluted areas (e.g., western China), anthropogenic NOx emissions as well as its concentrations are low, and ozone is controlled mainly by the transport (Ma et al., 2002b). The differences in NOx emissions as well as its concentrations may be rather larger in relative sense. However, the differences in simulated ozone concentrations are smaller due to rather small fraction of ozone attributed to in situ photochemistry. In polluted areas (e.g., most parts of eastern China), anthropogenic NOx emissions as well as its concentrations are high, and ozone is controlled mainly by photochemistry (Ma et al., 2002b). Ozone concentrations should be sensitive to the variations in NOx concentrations and thus its emissions. However, the amount of ozone produced per NOx emitted is not linear (Liu et al., J. Geophys. Res., 92, 4191-4207, 1987; Lin et al, J. Geophys. Res., 93, 15879-15888, 1988; Trainer et al., J. Geophys. Res., 98, 2917-2925, 1993). With NOx ozone production increases at high NOx levels and decreases at high NOx levels, and the NOx threshold is around 1-10 ppbv, depending on NMVOC conditions and so on (Poppe et al., Geophys. Res. Lett., 25, 3823-3826, 1998). Generally, surface NOx levels in polluted areas of eastern China fall in this range (Figure 2a1). Therefore, the differences in simulated ozone vary and can be opposite in sign with the differences in simulated NOx (Figure 2b1, Figure 3b1 and Figure 4b1). Kasibhatla et al. (J. Geophys. Res., 103, 22663-22669, 1998) estimated that the net ozone production efficiency (OPE) ranges from 2 to 3 ppbv O3 ppbv-1 NOx in the eastern United States during summer. Assuming a 100% NOx increase at 3 ppbv NOx and 30 ppbv O3, the O3 increase is estimated to be 6 to 9 ppbv, i.e., 20-30% increase in relative sense. Our results are in agreement with this estimate, indicating that the model chemical mechanism we used

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is reliable.

(ii-b) How did the sensitivity studies address these aspects of the chemical mechanism?

We did not address how well the chemical mechanism behaved. We just looked at the model results using various emission inventories with the same mechanism.

(ii-c) Where there deficiencies in the chemical mechanism?

As stated above, we do not think that there are any deficiencies in the chemical mechanism leading to doubtful results.

(iii) The motivation for performing the sensitivity analysis should be better described.

If we understand the reviewer correctly he agrees with us that uncertainty in emission inventories is an important issue. Maybe we have not been clear enough about the intention of this paper. If the reviewer feels that the following text clarifies our intention we will include this in our revision.

The motivation to perform this sensitivity study is to deal with the following dilemma that often arises in discussion between modelers and the emission inventory community: In order to pinpoint the emission inventory as cause for the difference between model calculation and observations, quantitative information is needed on how much the emission inventory is an inaccurate calculation of the -real emission-. Although most of the processes leading to emissions are understood, data on these processes (activity data or emission factors) are often not available in the amount of detail required for accurate emission inventory construction. This gathering of data is a time consuming task and in order to decide how much effort should be spent on constructing the inventory, insight in the extent to which an inventory should be accurate is needed.

(iii-a) What aspects of the chemical transport mechanism are targeted by these sensitivity tests?

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As in our answers to Question (ii-b) above, we did not address how well the chemical transport mechanism behaved. We just looked at the model results using various emission inventories with the same model.

(iv) Technical comments

(iv-a) Figure 1 and 2 need more descriptive figure captions

Figure 1. Anthropogenic surface emissions of NOx, CO, NMVOC over China according to the EDGAR, TRACE-P and CORP estimates. Both EDGAR and CORP estimates are for the year of 1995, and TRACE-P is for the year of 2000. While EDGAR and TRACE-P NMVOC emissions are independent on NOx emissions, CORP NMVOC emissions are scaled to NOx emissions. Units are Gg yr-1 per 1 degree grid.

Figure 2. Difference in surface NOx, CO and CH2O due to the use of different emission inventories EDGAR, TRACE-P and CORP (denoted as cases B, C1 and C2, respectively). Simulated results with EDGAR are given as reference and the differences are shown with the relative deviations of TRACE-P and CORP to EDGAR. Note that the relative differences are large for NOx in western China due to low emissions and concentrations of NOx in unpolluted areas.

(iv-b) The third sentence in the second paragraph of section 2.2 has no verb

This section has been changed (see issue 1a and 1b).

(iv-c) The 5th sentence in the first paragraph is section 2.3 is not sufficiently descriptive

By adding: These NMVOC emissions of Ma et al. (2002a) are used for the CORP inventory.

(iv-d) The scenario labels in section 3.3 are confusing and should be changed.

The text has been modified to clarify this. The model sensitivity runs were performed with the scenarios below, where EDGAR emissions were replaced with TRACE-P or CORP for one species. S1: TRACE-P NOx with EDGAR CO and NMVOC; S2: CORP

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NOx with EDGAR CO and NMVOC; S3: TRACE-P CO with EDGAR NOx and NMVOC; S4: CORP CO with EDGAR NOx and NMVOC; S5: TRACE-P NMVOC with EDGAR NOx and CO; S6: CORP NMVOC with EDGAR NOx and CO.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 507, 2004.