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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mapping Asian anthropogenic emissions of non-methane volatile organic compounds to multiple chemical mechanisms" *by* M. Li et al.

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NMVOC mapping is very important procedure to support atmospheric chemistry modeling of ozone and aerosol. This paper by Li et al. integrates many existing chemical speciation information and presents an undated method to convert total NMVOC emissions into model-ready emissions for regional and global chemical transport model (CTM) simulations.

The authors suggest an improved speciation framework of NMVOC in INTEX 2006 Asian inventory adopting an explicit assignment (mechanism-dependent species map-

ping) and applying updated profiles (composite profiles by median average of local, U.S. SPECIATE and literature profiles). The new mapping methodology is explicitly described and includes some benefits. They added more local source profiles than Zhang et al. (2009) to segregate INTEX 2006 NMVOC into the CTM chemical mechanism species. Using the averaged source profiles seems to be more reasonable approach than single profiles for chemical mapping in the subjected geographical region (Asia). Overall, their subject regarding an improved mapping method and comprehensive source profiles for the anthropogenic NMVOC emissions are relevant to the scope of ACP. However, there are several thins need to be added or improved as in the following specific comment section, to make this manuscript to be publishable.

Response: We thank Referee #3 for the valuable comments on how to improve the article. We addressed the comments as below.

(1) The speciation profiles, in their present format, are hard to be used by other researchers since they are too summarized or just presented as OFPs. The final speciation profiles developed in this work would better be explicitly presented using comprehensive tabulations, as in Andreae and Merlet (2001), because one of the major virtue of this work is to provide improved speciation information to the related science community.

Response: The tabulated composite profiles used in this work are available from the following website: http://mic.greenresource.cn/intex-b2006.

(2) A comprehensive table which explains mapping between author's chemical species and other major speciation schemes (e.g. SAPRC, GEOS-Chem, MOZART, CB05) would better be developed and presented, instead of individual tables such as Tables 2 and 3.

Response: The mapping tables between individual species and the six major mechanisms (SAPRC-99, SAPRC-07, CBIV, CB05, RADM2, and RACM) are available from Dr. Carter's website: http://www.engr.ucr.edu/ carter/emitdb/. Those tables are too

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large to be included in the manuscript (including thousands of species). In the Sect. 2.4 of the revised manuscript, we added a sentence to indicate the availability of those mapping tables.

(3) Even though the profile development procedures are described in the chapter 2.2, the reasons of selecting speciation profiles are still unclear. Since large volume local and international speciation profiles should be reviewed during composite profiles development, comprehensive evaluation of existing speciation profiles should be very beneficial to the readers.

Response: We further clarified the profile selection process in the revised manuscript. The profiles are selected with the following steps. We first searched candidate profiles from SPECIATE database and a variety of literatures for each source category. As the numbers of local-measured profiles are still very limited, we include all available "local" profiles from literatures as candidate profiles. For those sources which local profiles are available and we believe that there are significant differences between Asian and western countries due to different technologies and/or legislations, only local profiles are used (e.g., solvent use). For sources which similar technologies are used in Asian and western countries (e.g., boilers, vehicles), profiles from SPECIATE database are also included. We then identified the OVOC rich sources and corrected the incomplete profiles which missed OVOC fraction. The "composite" profile for each source was finally developed with the same weighting factor for each individual candidate profile.

We agree that a comprehensive evaluation of existing profiles would be very useful for understanding the uncertainties. However, it is very difficult to conduct such an evaluation because profiles in literatures are always measured in inconsistent and incomplete ways and many profiles in SPECIATE database are provided without detailed information. In this work, we conducted a sensitivity analysis for a few important source categories, i.e., residential biofuel combustion and on-road vehicles, to evaluate the impact of profile selection to emissions. It is shown that the composite profiles represent the average level of ozone formation for these sources. We expect this sensitivity

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analysis results can relief the concern on the issue of profile selection to some degree.

(4) As the author have described (Page 32666: 23-24) one of the main objective of their study is to develop model-ready anthropogenic NMVOC emission datasets for CTMs. They applied a new mapping method and developed model-ready emissions for 8 chemical mechanisms, such as CB-IV, CB05, SAPRC-99, SAPRC-07, RADM2, RACM2, GEOS-Chem, and MOZART-4. In the context of the aim of their study, I think that the results and discussions about the consistency of the new mapping method for these chemical mechanism species are important and should be included. I guess that many of the atmospheric chemistry modeling community members also want to see the new NMVOC mapping method can generate a certain level of consistent results for multiple chemical mechanisms.

Response: The mapping tables we used in this work are developed by Dr. Carter (Carter 2013, http://www.engr.ucr.edu/ carter/emitdb/), who is the developer of SAPRC mechanisms and the leading scientist in this field. In these mapping tables, each individual organic compound is assigned with conversion factors to mechanism species according to its carbon bond (for CBIV and CB05) and chemical group (for (SAPRC-99, SAPRC-07, RADM2, and RACM2), hence it provides a consistent way of species mapping for different chemical mechanisms. To our knowledge, this is the most accurate chemical mapping approach in the community, which has been used in processing U.S. emission inventories. However, in previous Asian emission inventory studies, the interfaces between NMVOC emissions and CTMs are underdeveloped. In this work, we improved the species mapping framework for Asia by using the accurate mapping table from Carter (2013).

(5) To present the effect of the new mapping methodology for Asian anthropogenic NMVOC emissions, the author compared the OFP that calculated with the newly mapped INTEX 2006 NMVOC emissions by applying MIR scale values and the OFP with the previous emissions. The MIR approach assumes high NOx (or highly VOC sensitive) condition for ozone formation (Carter 1994). If some countries or regions in

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Asia are highly VOC-sensitive, for which the MIR based OFP may be somewhat useful to investigate the effect of the newly derived emissions of mechanism species on ozone formation. If some countries or regions in Asia are highly NOx-sensitive, for which the MIR-based OFP is not appropriate. The availabilities of VOC and NOx can be affected by meteorological factors. Therefore, the MIR based OFP calculation without any consideration of the geographical distribution of NOx and meteorology in the subjected geographical region cannot reasonably present the effect of the new NMVOC mapping methodology. My suggestion is that a comparison with at least a CTM (e.g., GEOScheme, CMAQ, etc.) simulation results (New – versus Previous- mapping) should be included in this paper to investigate the valid effect of the new NMVOC mapping method on ozone (or aerosol) prediction in Asia.

Response: We agree that comparing emissions in CTMs is a good way of evaluating emission inventories. However, we feel that it is beyond the scope of this manuscript for the following two reasons. First, the main objective of this paper is to provide an improved NMVOC speciation framework for Asian regions. As pointed by another referee, the methodology presented in this work can be used as guidelines in developing speciated emissions. We used the same mapping method for both datasets (defined as "INTEX-B" and "this work" in the manuscript), with the differences in profile development and selection. In this respect, we think that evaluating the impact of profile selection by using CTM is not important for this paper, given the fact that we have demonstrated the impact by comparing OFPs. Second, most emission inventory papers do not include such evaluation. The community usually rolls in the following way: emission inventory groups developed bottom-up inventories and published their data; modeling groups evaluated the inventory and provided feedback; then emission inventory developers improved their work based on the evaluation. Compiling emission inventory is a very time consuming work, and many emission inventory groups do not have the capacity to run models. Setting a bar of including CTM evaluation in emission inventory papers would be unfair to emission inventory developers.

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(6) Since isoprene and terpenes are also very important precursor species of ozone and aerosol formation, these are considered as primary explicit organic or lumped organic species in most of chemical mechanism such as SAPRC 99/07, CB05, and so forth. I cannot find any presentation for these species in this paper. Are their emissions negligible because this paper only covers anthropogenic emissions?

Response: Yes, this work only addressed anthropogenic emissions in which isoprene and terpenes are negligible.

(7) Although authors clearly outlined their methods, some parts of their assumption have weaknesses (e.g., ozone forming potential (OFP) calculation). In addition, the results are somewhat insufficient to support their objective and derive coherent discussions. In the context of their subject, this paper should contain some results and discussions whether the new method can yield consistent emission mapping results for different chemical mechanisms. In addition, it is needed to add reasonable investigations and discussions about how much are the new mapping method and data effective for the CTM ozone and aerosol prediction.

Response: See responses above.

Minor Comments

(1) The authors need to clarify the versions of SPECIATE.

Response: The version of SPECIATE database used in this work is 4.2, which is added in the main text and Table S1 of the revised paper.

(2) Figure 10: need separate labels for figures (a) and (b).

Response: Corrected.

References: Carter, W. P. L.: Development of an improved chemical speciation database for processing emissions of volatile organic compounds for air quality models, report available at: http://www.engr.ucr.edu/ carter/emitdb/, 2013.

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