

Interactive comment on “Tempo-spatial variation of emission inventories of speciated volatile organic compounds from on-road vehicles in China” by H. Cai and S. D. Xie

Anonymous Referee #1

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General comments:

This paper estimates emissions of 69 NMVOC species from on-road vehicles in China from 1980 to 2005, by applying literature-based VOC profiles to the total NMVOC emissions published by the same group (Cai and Xie, 2007; Bo et al., 2008). This methodology is very similar to previous works for China (Klimont et al., 2002; Streets et al., 2003; Wei et al., 2008) and has few improvements. In the meanwhile, the method of simply averaging various VOC profiles is quite questionable (see specific comments below). Compared with their previous paper (Bo et al., 2008), the only new work involved in this paper is using VOC profiles to calculate the long term trend of speciated VOC

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emissions from China's vehicle fleet, but the quality of their results was downgraded by the rough method and bold assumptions.

Besides, this paper is weak in the following aspects. First, I am particularly troubled by the lack of detailed information on how some important parameters were generated (see specific comments below). This leaves the reader uncertain about the validity of the data used in this estimation. Second, there is another concern that without in depth discussions in the paper the conclusions drawn by the authors cannot be substantiated. As a specific study focused on vehicle emissions, the discussion part should include the follows: (1) Comparison with other studies. This is not the first work addressing speciated VOC emissions in China. The authors should compare their estimates with previous studies (Klimont et al., 2002, Streets et al., 2003, Wei et al., 2008) as well as tunnel/road side based VOC profiles (Tsai et al., 2006, Tang et al., 2008); (2) how the emission trends were driven by the recent regulations; and (3) how the emissions impact temporal and spatial patterns of the ozone formation potentials.

Having said all that, I think that this paper contributes little to current science and is unable to meet the strict quality standards consistent with publication in ACP. Therefore, I do not believe that this paper should be published on ACP.

Specific comments:

Page 11055, Line 15, the authors need to explain how the cold start emissions were calculated, especially how they obtained the data of soak time distributions for different vehicle types in China. The authors refer readers to Reference Cai and Xie (2007), but this information is not given in this reference.

Page 11055, Line 15-16, “which includes six situations corresponding to specific vehicle category”, the six situations were unclear, and need to be clarified.

Page 11055, Line 16, “a normal (20 km/h) and (40 km/h) mode or a freeway (80 km/h) normal” need to be explained more. Also, I think these three speeds are too far from

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being representative of vehicle speeds in China during the past 25 years. The average speed has changed a lot from 1980 to 2005. Moreover, the average speeds differ significantly among different city sizes in China, 20 km/h is common only in large cities such as Beijing and Shanghai. For most cities in China, the average speed is over 30 km/h or even higher. As speed is a very important parameter in estimating vehicle emissions, if the average speed is not considered carefully, the accuracy of the inventory presented in this paper will be highly questioned. Since the 1990s, numerous studies have been conducted to understand the driving patterns in China, and the authors should look into these studies to improve their estimations.

Page 11056, Line 4-23. This method is quite questionable. The different profiles should not be simply averaged since they differed in the number of samples, the types and technologies of tested vehicles, and the measurement methods. A simple example is, a study with ~100 vehicles were usually more reliable than a study with a few vehicles. We can find that the profiles varied significantly for several important species. The authors should carefully compare the different profiles and give appropriate weights for the profiles if an average profile is used. Also, the SPECIATE database by USEPA should be included in the comparison as it contains a huge database and has been extensively used in VOC speciation studies.

Page 11056, Line 11, how is the profile normalized?

Page 11057, Line 9-10, the authors said "Table 3 summarizes the utilization rate of TWC among gasoline vehicles based on the governmental statistical data (NBS, 2006)." As far as I know, Chinese statistics did not release the utilization rates of TWC. Utilization rates of TWC are very important in the entire estimation as TWC affects VOC emissions significantly, so the authors need to present clearly how the utilization rates of TWC among gasoline vehicles were generated based on the government statistical data.

Page 11057, Line 11, it is more reasonable to allocate vehicle emissions by road net-

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works than total GDP (Zheng et al., 2009).

Page 11058, Line 6-7, "197 million vehicles in 2005" seems not correct, please check

Page 11058, Line 11, "increase of the VMT", there is no evidence to say VMT in China is increasing these years. Actually, VMT usually drops when total vehicle stock increases. To be precise, it would be better to remove this. Or, it will be beneficial if the authors can give the references that prove VMT in China is increasing.

Page 11058, Line 20, please explain why the proportion of evaporation emissions would grow.

Page 11059, Line 7-12, "Although light duty vehicles (LDV) and heavy duty vehicles (HDV), and motorcycles were recognized the primary contributors to total NMVOC emissions in the 1980s and for the period of 1990–2005, respectively, contributions of vehicle categories to the emissions of speciated NMVOC groups varied. . .", I am not sure the meaning of this sentence.

Page 11059, Line 17-28 and its following paragraphs. For these paragraphs, the analysis is difficult to understand because the terms of "passenger cars (PCs)", "light-duty vehicles (LDVs)", "heavy-duty vehicles (HDVs)" and "buses" are confusing. In this area, it is a common sense that PCs are a part of LDVs, and large buses are a part of HDVs. If the authors have different definitions for these terms, they may need to specify their vehicle categories somewhere at the front of the paper, so the readers could understand these paragraphs.

Page 11062, Line 6-7, "revealed that the NMVOC emission per unit of output was much higher in China, mostly due to higher emission factors of vehicles and higher VMT in China". This is not true. US VMT is not lower than China VMT. I suggest the authors to look into the Highway Statistics Series released by US Department of Transportation to make a careful comparison of VMT between the U.S. and China, and then make a precise statement here.

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Page 11068, Uncertainty analysis, the authors “ignored the uncertainty of the gross NMVOC emissions since they were estimated by a reliable methodology using best available raw data of emission factors and activity data (Cai and Xie, 2007).” The uncertainties of total NMVOC emissions can not be ignored as it could be significant (Streets et al., 2003; Bo et al., 2008). The authors need to present the total uncertainties of speciated VOC emissions caused by the uncertainties in total VOC emissions and VOC profiles. No matter how reliable the methodology and data are, an emission inventory always has uncertainties, especially for an inventory for China. For example, people always estimate Chinese VMT values based on very limited surveys and make a bunch of assumptions because Chinese government doesn't release VMT data, and I am sure that (Cai and Xie, 2007) used the same way to obtain VMT, this method definitely will involve uncertainties. Also, as mentioned above, the authors used very limited speed ranges to represent vehicle speeds in all Chinese cities during 25 years, this can not be called “best available raw data”, since many studies are already available to provide more reliable speed data than what were used in this paper.

References

- Bo, Y., Cai, H., and Xie, S. D.: Spatial and temporal variation of historical anthropogenic NMVOCs emission inventories in China, *Atmos. Chem. Phys.*, 8, 7297–7316, 2008,
- Cai, H. and Xie, S. D.: Estimation of vehicular emission inventories in china from 1980 to 2005, *Atmos. Environ.*, 41, 8963–8979, 2007.
- Klimont, Z., Streets, D. G., Gupta, S., Cofala, J., Fu, L. X., and Ichikawa, Y.: Anthropogenic emissions of non-methane volatile organic compounds in china, *Atmos. Environ.*, 36, 1309– 1322, 2002.
- Streets, D. G., et al.: An inventory of gaseous and primary aerosol emissions in Asia in the year 2000, *J. Geophys. Res.*, 108 (D21), 8809, doi:10.1029/2002JD003093, 2003.
- Tang, J.H., et al.: Implications of changing urban and rural emissions on non-methane

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hydrocarbons in the Pearl River Delta region of China, *Atmos. Environ.*, 42, 3780-3794, 2008.

Tsai, W. Y., et al.: Vehicular fuel composition and atmospheric emissions in South China: Hong Kong, Macau, Guangzhou, and Zhuhai, *Atmos. Chem. Phys.*, 6, 3281-3288, 2006.

Wei, W., Wang, S. X., Chatani, S., Klimont, Z., Cofala, J., and Hao, J. M.: Emission and speciation of non-methane volatile organic compounds from anthropogenic sources in china, *Atmos. Environ.*, 42, 4976–4988, 2008.

Zheng, J.Y., et al.: Traffic flow and road network-based spatial allocation of regional mobile source emission inventories, *ACTA SCIENTIAE CIRCUMSTANTIAE*, 29, 815-821, 2009 (in Chinese)

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 9, 11051, 2009.

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