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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Development of a high temporal–spatial resolution vehicle emission inventory based on NRT traffic data and its impact on air pollution in Beijing – Part 2: Impact of vehicle emission on urban air quality" *by* J. J. He et al.

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1. At present, the contribution of vehicle emission to PM2.5 is a hot topic. The research result of contribution in this paper is relatively small. The generation of PM2.5 is a complex chemical process, in addition to the primary emission source, the contribution of the second transformation cannot be ignored. The switch on and off test of emission in model simulation may not be suitable for evaluating the chemical conversion. How

do the authors consider it? More explanations need to be illustrated.

Response: Source apportionment based on air quality numerical model includes source sensitivity simulations using the brute force method (also referred as zero-out method) or the decoupled direct method (DDM), air pollution tagged method, and the adjoint method (Burr and Zhang, 2011a; Burr and Zhang, 2011b; An et al., 2015; Zhang et al., 2015). With comprehensible physical and chemical process, adjoint method has a significant advantage in source apportionment compared to sensitivity simulations or tagged method. However, the development of adjoint model is facing a challenge due to complicated mathematics and a large amount of data processing and programming, which results in less available regional scale air quality ajoint model. The tagged method tracks contribution of pollutant from specific source and undergo the explicit atmospheric processes, but it is not able to simulate indirect effects and oxidant-limiting effects. The contribution of vehicle emission is acquired via numerical sensitivity test of switching on/off vehicle emission in Beijing in this study. The switch on/off emission was widely used to investigate the contribution of single source or local emission in previous studies (An et al., 2007; Cheng et al., 2007; Lang et al., 2013; Wu et al., 2011). However, a widely range of emission variation may result in significant variation of background pollution level. In this study, the simulation of switching off vehicle emission in Beijing keeps atmospheric background pollution level basically which has a significant effect on the chemical conversion because of relative limited change of emission. Meanwhile it considers the effect of vehicle emission on secondary pollution, e.g. secondary aerosol which becomes the important components of PM in Beijing. So the uncertainties of this method is relative small.

Reference: An, X., Zhu, T., Wang, Z., Li, C., and Wang, Y.: A modeling analysis of a heavy air pollution episode occurred in Beijing, Atmos. Chem. Phys., 7, 3103-3114, doi:10.5194/acp-7-3103-2007, 2007. An, X. Q., Zhai, X. S., Jin, M., Gong, S. L., Wang, Y.: Tracking influential haze source areas in North China using an adjoint model, GRAPES-CUACE, Geosci. Model Dev. Discuss., 8, 7313-7345, doi:10.5194/gmdd-8-

7313-2015, 2015. Burr, M., and Zhang, Y.: Source apportionment of fine particulate matter over the Eastern U.S. Part I: source sensitivity simulations using CMAQ with the brute force method. Atmospheric Pollution Research, 2, 299-316, 2011a. Burr, M., and Zhang, Y.: Source apportionment of fine particulate matter over the Eastern U.S. Part II: source apportionment simulations using CAMx/PSAT and comparisons with CMAQ source sensitivity simulations. Atmospheric Pollution Research, 2, 318-336, 2011b. Cheng, S. Y., Chen, D. S., Li, J. B., Wang, H. Y., and Guo, X. R.: The assessment of emission-source contributions to air quality by using a coupled MM5-ARPS-CMAQ modeling system: A case study in the Beijing metropolitan region, China, Environ. Modell. Softw., 22, 1601-1616, doi:10.1016/j.envsoft.2006.11.003, 2007. Lang, J., Cheng, S., Li, J., Chen, D., Zhou, Y., Wei, X., Han, L., and Wang, H.: A monitoring and modeling study to investigate regional transport and characteristics of PM2.5 pollution, Aerosol Air Qual. Res., 13, 943-956, doi:10.4209/aaqr.2012.09.0242, 2013. Wu, Q., Wang, Z., Gbaguidi, A., Tang, X., and Zhou, W: Numerical study of the effect of traffic restriction on air quality in Beijing, Sola, 6a, 17-20, doi:10.2151/sola.6a-005, 2010. Zhang, L., Liu, L.C., Zhao, Y.H., Gong, S.L., Zhang, X.Y., Henze, D., Capps, S., Fu, T., Zhang, Q., Wang, Y.X.: Source attribution of particulate matter pollution over North China with the adjoint method. Environ. Res. Lett., 10, 084011, doi:10.1088/1748-9326/10/8/084011, 2015.

Changes in manuscript: More details were supplied in section 2.2.

2. The spatial distribution of the VEC to NO2 and PM2.5 is different. It needs to be discussed in detail combined with the emission distribution characteristics of high resolution and the wind field.

Response: The spatial distribution of VEC or RVEC are tremendously affected by vehicle emissions, as they are mostly consistent with the rate of vehicle emission in total emission (Fig. 4). As pointed by Jing et al., (2015), the uncertainty of HTSVE is very small through multiple comparison with statistical data and real time observation. But the uncertainty of other sector emissions has a negative influence on the precision of

RVEC, which need more improvement for accurate environmental management. Local circulation also determines the spatial distribution of RVEC. High PM2.5 emission from vehicle is found between north Fourth Ring Road and north Five Ring Road (See Part. 1, Fig. 9). Controlled by southwest wind, PM2.5 from vehicle is easily transferred out of the main urban areas, which results in low RVEC in July. However, the most of PM2.5 from vehicle stay in east main city controlled by northwest wind, which results in high RVEC in December.

Changes in manuscript: Annual mean emissions and the rate of vehicle emission in total emission for NO2 and PM2.5 were added in Fig.4 (Revised manuscript). More details and modifications were supplied in section 3.1.

3. The vehicle emissions have obvious peak characteristics in morning and evening. How the authors consider this in your simulation test? Does the simulated diurnal variation have some characteristics influenced from the peak characteristics?

Response: Based on NRT traffic data, vehicle emissions of each road are derived from vehicle emission inventory model (see Part 1). Significant diurnal variation of vehicle emissions is observed with two peaks during 7:00-10:00 and 16:00-18:00 BT (Fig. 1). With the assistance of ArcGIS, hourly gridded vehicle emissions were estimated at the resolution as same as CUACE (HTSVE). Hourly emissions of CUACE including industry, power plant, vehicle etc., were calculated by daily mean emissions and activity level of different sources. To analyze the effect of high resolution vehicle emissions on air pollution, the vehicle emissions of CUACE were replaced by HTSVE in air quality numerical simulation. Fig. 2 shows the diurnal variation of NO2 concentration from CUACE. NO2 concentrations were affected by emissions, meteorological conditions, and physical and chemical processes. It seems that meteorological conditions may be the primary reason responsible for the diurnal variation of NO2 as low concentration vs high emissions appears in daytime. The weak peak of NO2 appears because of high emissions in the morning. The strong peak in p.m. is determined by a combined effect of high emissions and unfavorable diffusion of meteorological conditions. The reason for diurnal variation of pollutant concentrations is not deeply discussed as it is not the major concern in this paper.

4. Provide significant test of the VEC and RVEC in summer and winter.

Response: The significant test of the difference of VEC and RVEC in different seasons were carried out using one-way analysis of variance, and is listed in revised version.

Changes in manuscript: It was modified in section 3.2 and 3.3.

5. INTEX-B inventory is usually INTEXB 2006.

Response: Anthropogenic emissions of CUACE were developed by CMA based on INTEX-B inventory, emissions database for global atmospheric research (EDGAR) and environmental statistics database. Some old data was corrected and updated according to the variation rate of anthropogenic emissions from environmental statistics database.

Changes in manuscript: The detailed description was added in section 2.3.

6. In Fig. 3, provide the mean concentration of sites observation.

Response: Fig.3 has been modified according to referee's suggestion.

7. In Fig. 6, adds fluctuation range of the mean VEC.

Response: The figure has been modified according to referee's suggestion.

8. In Fig. 7, adds fitting line and fitting degree.

Response: The figure has been modified according to referee's suggestion.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 19239, 2015.

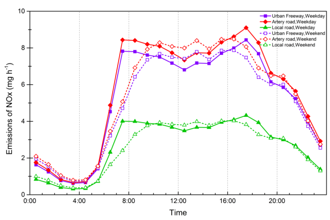

Fig. 1. Hourly variation of vehicle emission by road type on weekdays and weekends.

Fig. 1.

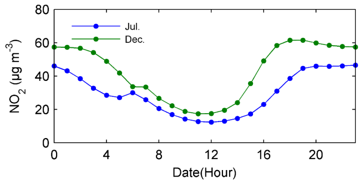

Fig. 2. The diurnal variation of NO_2 concentration from CUACE.

Fig. 2.