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Interactive comment on “VOC species and emission inventory from vehicles and their SOA formation potentials estimation in Shanghai, China” by C. Huang et al.

Anonymous Referee #1

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This manuscript describes the development of an emissions inventory for mobile sources in Shanghai that includes SOA production from vehicle exhaust. Constructing the inventory involved a combination of new emissions measurements from a small fleet of vehicles, characterization of traffic in Shanghai, and inclusion of SOA yield data from previous studies. This manuscript clearly represents a large effort on the part of the authors. It is topically relevant to ACP. I believe it should eventually be published, but first requires substantial revisions.

While this paper represents a potentially important contribution, I found it very difficult to understand. The main points of the manuscript seem to be buried. Some of this

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is a matter of writing style and structure, but in many ways the key points are not articulated well. My take away after multiple readings is that: (1) Vehicle emissions, even after accounting for SOA production, are an important but not dominant source of OA in Shanghai, and (2) Even after accounting for SOA production, diesel vehicles, which account for less than 20% of VKT, contribute more than 50% of mobile source OA in Shanghai.

Part of my trouble in understanding this manuscript is the lack of discussion of the key points. The paper needs some discussion to help readers synthesize all of the results. Right now it reads as a long list of results with limited interpretation. There are many paragraphs where a new observation is followed by 3-4 sentences enumerating results (usually a string of numbers) from previous studies. This is very difficult to follow and takes away from the big picture.

In addition to the confusion structure, there are several places (outlined below in more detail), where different figures contradict each other. The worst offense seems to be Figure 8, which I cannot reconcile with previous tables and figures, notably Figure 5.

The authors may want to consider splitting this work into two manuscripts: one describing the vehicle measurements and another describing the inventory building and ambient data. This might help focus the discussion and reduce reader confusion.

Specific comments: Abstract Line 13: The OA emission rate of 15.6 ug/m³/ppm-CO is for primary emissions. I think readers would understand this sentence better if the term “primary emissions” was used instead of “initial emissions.” Line 13: It is not clear if the secondary OA production rates are maximum production or SOA production after a set amount of oxidation time. Line 24: “a large number of OA mass” is grammatically incorrect.

Page 7979, Line 14: Semi-volatile, not semi-volatility. Also, while IVOCs seem to be good SOA precursors, SVOCs do not necessarily generate much new OA mass upon oxidation. Under most atmospheric conditions at least some SVOCs will be in the

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particle phase. Thus oxidizing the SVOC vapors causes SVOC POA to evaporate, creating a “pumping” mechanism that leads to relatively little mass generation but overall oxidation of the OA.

Page 7980 Line 13: “The number of vehicles in Shanghai increased to 1.9 times of the number in the last decade” Does this mean that the number of vehicles doubled in the last decade?

Page 7982 Line 1: What is the ECE urban cycle? Is the ECE urban cycle a 1-bag test, or were VOC samples only collected from 1 bag of a multi-bag test?

Page 7982, Line 21: What is the IVE model? The acronym needs to be defined.

General comment on Methods section: This section needs more detail. There were many occasions while reading the manuscript when I was not sure what methods the authors used and felt like the methods were not adequately explained.

Section 2.1: What range of VOCs were analyzed in the GC system? My general experience with GCs equipped with cryotrap pre-concentrators and sampling from SUMMA canisters is that species in the C2-C12 range can be quantified. However the figures later in the manuscript (Figs 3 and 4) seem to indicate that this method was used to identify species up to C20. More detail on the pre-concentrator and GC method is required to convince me that C20 species were quantitatively measured with this method.

Section 2.2.1: It is not clear how the data from the video camera surveys was merged with the GPS data collected for individual vehicles. Also, Table 1 shows aggregated VKT data for the full Shanghai fleet. Was this determined from the camera survey, the GPS data, or a combination of both?

Section 2.2.2: How were the fleet composition data from the vehicle database used in the inventory? E.g., are they combined with the data from Section 2.2.2?

Bottom of page 7983 and Fig 1: What are the meanings of the “static” and “adjusted” fleet? How were these determined?

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Page 7984, Lines 1-2: “Vehicle emission factors were calculated with the IVE model and adjusted by the results of real-world emission measurements in major cities of China.” What emissions measurements, and in what cities, are the authors referring to? I thought the purpose of testing the vehicles in Table 1 was to build the emissions inventory.

Figure 2: Were the same vehicles tested in this study and the previous studies? The organization of the bars (current study) and data points from previous studies give the impression that the same vehicles were tested multiple times.

Page 7984, Lines 12-13: “Limited number of measurements made it difficult to verify the accuracies of the emission factors.” Which accuracies are the authors referring to? The previous data or their own? They should have a good idea of the accuracy of the measurements and methods used in each test. Perhaps if every vehicle was tested only once there would be uncertainty about test-to-test variability (precision), but this is a separate issue than accuracy.

Figure 3: Why do so many bars go above 100%?

Page 7986, Lines 5-10: Make sure this is an apples-to-apples comparison for the diesel vehicles. Were the same methods used? In both May and Schauer there was a significant amount of unidentified VOC mass - e.g., the sum of spectated VOCs did not match the total carbon from an FID. How was that handled here?

Page 7987, comparison to Gordon et al - the best comparison would be to map the Euro standards to the closest LEV standard, since SOA yields were higher for newer vehicles in Gordon et al.

Line 1 page 7988 - Gordon's off-road engines had no catalytic converter. Do the motorcycles tested here have one or similar pollution control?

Section 3.3: The emissions inventory is developed from which data, specifically? Emission rates presented in this manuscript and the vehicle survey? Or were previous ve-

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hicle measurements also included?

Section 3.3: How were evaporative emissions calculated? And how are the evaporative emissions assigned to specific vehicle classes?

I do not understand what the audience is supposed to learn from Fig 6. First, the red line is undefined (I assume it is the mean diurnal profile). Second, what is the difference between “Initial” and “Vehicular” X/E? It seems that the “Initial” X/E is supposed to account for all sources, and therefore varies seasonally. It is not clear whether initial or vehicular X/E is used to determine the photochemical clock from equation 1.

Figure 7: (1) The color bar should have units on it. (2) The text states that the inventory POA/CO line is pink. It is orange.

Page 7991, Lines 8-9: What is meant by the “initial” POA/CO ratio (4.84 ug/m³/ppm-CO)? How is this determined? In Figure 7 this seems to be labeled as Vehicular POA, but it is not clear that this is Vehicular POA. Also the slope in Fig 7 is 4.3, not 4.84.

Page 7991, Line 10: Vehicles only account for 25% of CO emissions? This seems very low. What are the other sources?

Fig 8: Why are OA/CO from vehicles so low? Other tables/figs (e.g., Figure 5) show that SOA/CO is between 15.6 and 42.7 ug/m³/ppm-CO, but in this figure it is below 10. I don't understand how this figure relates to previous figures.

Figure 9: Does this figure only include tailpipe emissions or are evaporative emissions also included?

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 7977, 2015.

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