

1 **Response to reviewer #1**

2 In urban areas IVOCs are among the most important and yet least understood precursors to
3 secondary organic aerosols. Tunnel test is a widely adopted approach to characterize vehicle
4 emissions of air pollutants as it can obtain results representing real-world emissions with a large
5 number of driving vehicles involved. This study is the first tunnel test conducted to characterize
6 vehicular emission of IVOCs. As the field campaign was carried out in a very busy urban tunnel
7 with traffic flows of over 30,000 vehicles per day, the results from this study are valuable and
8 implicative for the emission reduction of IVOCs, which is of great importance for SOA to
9 further alleviate air pollution due to fine particles in urban areas. The data quality is good with
10 available QA/QC procedures, and the manuscript is well written and organized. I recommend
11 its publication in the form of “measurement report” in ACP after addressing the following
12 comments.

13 Specific comments:

14 Lines 75-79: the sentences are a little confusing, rewrite it.

15 **Response:** We have rewritten the sentences as:

16 “However, driving conditions significantly influence vehicular IVOCs emissions (Drozd et al.,
17 2018; Tang et al., 2021), therefore emissions of IVOCs under real-world driving conditions
18 may be quite different from that measured with chassis dynamometers.” (*Line 75-78*)

19 Lines 88-91: “For this reason, IVOC emission factors derived from vehicle tests in the US have
20 been used to update China’s emission inventories with the inclusion of IVOCs (Liu et al., 2017).
21 It is unknown whether the borrowed emission factors could well reflect the vehicular emissions
22 of IVOCs in China.”, consider to change as “As IVOC emission factors derived(Liu et al.,
23 2017), it is unknown.....”.

24 **Response:** Thanks. Revised as suggested. (*Line 87-89*)

25 Lines 125-126: “classify the vehicle types”, change to “classify vehicles into different fuel
26 types”.

27 **Response:** Revised as suggested. (*Line 124-125*)

28 Lines 129-131: “...a gas chromatography / mass selective detector (GC/MSD; Agilent, 7890

29 GC/5975 MSD, USA) with a capillary column (Agilent, HP-5MS, 30 m × 0.25 mm × 0.25 μm).”

30 Should be “...a gas chromatography / mass selective detector (GC/MSD; 7890 GC/5975 MSD,

31 Agilent Technologies, USA) with a capillary column (HP-5MS, 30 m × 0.25 mm × 0.25 μm,

32 Agilent Technologies, USA).”

33 **Response:** Revised as suggested. (*Line 128-130*)

34 Line 143: the retention time: the retention times; of n-alkane: of a n-alkane

35 **Response:** Revised as suggested. (*Line 142*)

36 Line 148: in the 11 bins.

37 **Response:** Revised as suggested. (*Line 147-148*)

38 Line 169: “occurs” à “occurred”.

39 **Response:** Revised as suggested. (*Line 168*)

40 Lines 171-172: “IVOCs detected in the second tube only accounted for 2.6 ± 1.4% of the total

41 in the two tubes, indicating no breakthrough during the sampling”: as 2.6% detected in the

42 second tube, why no breakthrough?

43 **Response:** We have revised “no breakthrough” as “negligible breakthrough”. (*Line 171*)

44 Line 181: of a given species.

45 **Response:** Revised as suggested. (*Line 180*)

46 Line 192: 76.3% on average.

47 **Response:** Revised as suggested. (*Line 191*)

48 Line 193: a percentage of: an average percentage of.

49 **Response:** Revised as suggested. (*Line 192-193*)

50 Line 204: change “diesel” to “DVs”.

51 **Response:** Revised as suggested. (*Line 203*)

52 Line 217 “<http://www.mee.gov.cn/>”: it just directs to the web site of MEE, but not to the specific

53 documents with the relevant information. Try to be more specific or you need cite other

54 appropriate references.

55 **Response:** Revised as suggested. The following link directly provides proportion of China III
56 or lower emission standard diesel vehicles in 2019.

57 (http://www.mee.gov.cn/xxgk2018/xxgk/xxgk13/202012/t20201201_810776.html) (*Line 216*)

58 Lines 225-226: “GVs still share a much larger portion than the China V and VI ones in the on-
59 road fleets (<http://www.mee.gov.cn/>).” Change to “.....ones in China’s on-road fleets
60 (<http://www.mee.gov.cn/>....)”, as mentioned above, the website address should be more specific
61 so that the readers can easily find information about fleet compositions in China.

62 **Response:** Revised as suggested. (*Line 225-226*)

63 Lines 231-233: “The speciated IVOCs consist of n-alkanes, b-alkanes and PAHs. Naphthalene
64 dominated the quantified PAHs, accounting for $56.82 \pm 1.21\%$ of total PAHs emissions.”
65 change to “Among the speciated IVOCs (Table S1), naphthalene dominated the quantified
66 PAHs, accounting for $56.82 \pm 1.21\%$ of total PAHs emissions.”

67 **Response:** Revised as suggested. (*Line 231-232*)

68 Line 243: bins.

69 **Response:** Revised as suggested. (*Line 243*)

70 Lines 244-245: “The mass ratios of IVOCs in each bin to the n-alkane in the same bin ranges
71 9.0-15.8 (Table S2). As n-alkanes are more easily and routinely quantified, the relationships
72 of...” rewrite to “The mass ratios of IVOCs to the n-alkane in the bins ranged 9.0-15.8 (Table
73 S2). As n-alkanes can be more easily and routinely quantified, the relationships of...”.

74 **Response:** Revised as suggested. (*Line 243-245*)

75 Line 248: consider changing to “as the results here were obtained for a fleet dominated by GVs”

76 **Response:** Revised as suggested. (*Line 247*)

77 Line 274: “totalled”: “totaled”

78 **Response:** Revised as suggested. (*Line 274*)

79 Line 291: “ontained in a tunnel”: “obtained from this study in a tunnel”

80 **Response:** Revised as suggested. (*Line 294-295*)

81 4. Conclusions and implications: in this part the authors present many emission estimates and
82 percentages, some of which cannot be directly figured out by the readers. Better added some
83 explanations in the supporting information about these.

84 **Response:** Thank you for the suggestions. As suggested, to make it more informative to readers,
85 we have added explanations in the Supporting Information as below:

86 **Text S4**

87 **Estimations of IVOCs emission**

88 Firstly, we used the mileage-based EF_{IVOCs} and the average vehicle fleet composition observed
89 in tunnel to calculate IVOCs emissions percentage of DVs and GVs (Table S4). Then, as
90 showed in Table S4, the fuel-based EF_{IVOCs} and fuel consumptions in China in 2019
91 (<http://www.mee.gov.cn/hjzl/sthjzk/ydyhjgl/>) were used to estimate IVOCs emissions from
92 diesel- and gasoline-fueled engines.

93 Table S4. Estimations of IVOCs emission from on-road DVs and GVs and from diesel- and
94 gasoline-fueled engines.

	Diesel vehicles	Gasoline vehicles
Mileage-based EF ($mg\ km^{-1}$)	62.79±18.37	13.95±1.13
Fleet composition	5%	95%
IVOCs emission percentages	19.1%	80.9%
	Diesel-fueled engines	Gasoline-fueled engines
Fuel-based EFs ($mg\ kg^{-1}$)	984.9±288.2	239.5±19.5
Fuel consumptions (Tg)	150	120
IVOCs emissions (Gg)	147.7	28.74

95

96 Line 306: “revealed complex and different results”, it should be more specific.

97 **Response:** Thank you for the suggestions. As suggested, we added some sentences in revised
98 manuscript:

99 “our tunnel tests for on-road fleet revealed that although the ratios of IVOCs-to-POA and
100 IVOCs-to-NMHCs were comparable to that from previous chassis dynamometer tests, no
101 significant positive correlations were found between IVOCs and POA or NMHCs in our tunnel
102 measurements.” (*Line 308-311*)

103 Line 339: “on-road diesels are comparable to the non-road diesel engines” change to “on-road
104 diesel vehicles are comparable to that for non-road diesel engines”.

105 **Response:** Revised as suggested. (*Line 344-345*).

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