

*Black: referee's comments green: authors' answers*

*First of all, we want to thank the referee for taking time to review our paper.*

*For the details, please look into the paper with keeping track of changes.*

Referee #2

- This study was based on the FTIR measurement at Xianghe, China. Using the measurement data, the variation and correlation of CO and some hydrocarbons were examined. The methodology was well prepared and also clearly suggested in this manuscript. All results looks moderately fine.

- But this manuscript does not include the new finding and discriminated feature compared to previous works. In other words, the research motivation looks very weak. The only special motivation of this work is that this study is the first FTIR measurement at Xianghe, China. Probably this can be a good motivation, because there were not much FTIR measurements and related analyses in China, I think. However, this 'first measurement' was not resulted in fresh ideas about the hydrocarbon pattern in China. All results and discussions were too plain. What can we learn more for the hydrocarbon pattern in China using this first FTIR measurement at Xianghe, China?

Thanks for the comments. However, we do think this paper has its scientific innovations in addition to the fact that this is the first time we present these measurements at Xianghe.

The FTIR retrievals can provide the column measurements with high precision and accuracy, which are comprehensively discussed in this paper. The motivation of this paper is to better understand the CO, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, HCN and HCHO columns variations and sources in Xianghe, North China. We show the concentration levels of these species, the seasonal variations, and their correlations.

We do not agree with the following comment: "this 'first measurement' was not resulted in fresh ideas about the hydrocarbon pattern in China.". For example, our measurements show that the amplitude of the CO seasonal variation in Xianghe is less than 5%, which is very different from the previous FTIR studies at any other place. The HCN column is a good tracer to identify the boreal forest fire emissions, but not for the other 4 species. The high correlations between CO and C<sub>2</sub>H<sub>2</sub> (C<sub>2</sub>H<sub>6</sub>) are used to estimate their anthropogenic emission ratios. We believe that these results are pretty new findings in North China.

To highlight the scientific findings of this study, we have rewritten many texts in the revised version, including the title, abstract, instruction, and conclusion.

- In detail, the methodology part looks fine, but this is the thing that we already know. This information (retrieval channel, absorption lines, averaging kernels, etc.) has been much discussed in other previous works. Do we have something new in this manuscript, which was not treated in the previous work?

Thanks for the comment. Actually, there are several new retrieval settings as compared to previous NDACC-IRWG retrieval strategies. We have addressed the improvements in

the revised version to emphasize the new retrieval settings used in this study. We did not change the retrieval windows, as they work well at Xianghe, with good fitting residuals (Figure 3). However, we apply the latest SFIT4 retrieval algorithm (v1.0.15) together with the updated WACCM model as the a priori profile, and used the latest ATM20 spectroscopy. All these settings are advanced and innovated, which have not been published in the whole NDACC community yet (tests are ongoing; James Hannigan et al., personal communication). Based on the retrievals at Xianghe, we show that the a priori and spectroscopic settings can be improved compared to the current NDACC-IRWG settings.

- In results, the analyses was composed of simple time-series, monthly mean pattern, correlation between CO and other hydrocarbons, back-trajectory pattern, and emission estimation. The performance is not bad, but again, this is just a 'revival' of previous FTIR works. We already have a number of previous studies showing these information in recent 10-20 years (e.g., Zhao et al., 2002; Vigouroux et al., 2012; Viatte et al., 2013; Viatte et al., 2014; Lutsch et al., 2016, etc.). To have another publication, the new finding should be included in this manuscript, which was not discussed in these previous works. Therefore, the 'unique' pattern of CO and hydrocarbon should be provided with this 'first' FTIR measurement at Xianghe, China. That is the expected point, but it is not included in this manuscript.

Not fully agree! There is no similar study showing these 5 species together in such a polluted site around the world. Our measurements show that apart from HCN, the variations of CO, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, HCHO are dominated by the local anthropogenic emissions in Xianghe, while HCN is still a good tracer to identify the forest fire emission. The unique seasonal variation of CO has been discussed in the paper and is also compared to TROPOMI satellite and ground-based TCCON measurements. The high correlations between CO and C<sub>2</sub>H<sub>2</sub> (C<sub>2</sub>H<sub>6</sub>) are used to estimate their anthropogenic emissions ratios in this study. For the previous studies, CO, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, HCN, and HCHO are strongly related to biomass burning at Reunion Island (Vigouroux et al., 2012), Toronto and Eureka (Viatte et al., 2013; Viatte et al., 2014; Lutsch et al., 2016).

- Nonetheless, I still would like to put the weight on the meaning of 'first' FTIR measurement at Xianghe, China. This may not be the first FTIR measurement in whole China, but based on my knowledge, the 'CO and hydrocarbon' analysis based on Bruker FTIR was very rare in China. It actually relates to the unique meaning of this work. Considering this point, I strongly suggest authors to withdraw this manuscript from ACP, and to submit this manuscript again to AMT (or transfer from ACP to AMT review process, if possible). I think that the AMT looks much better journal to deal with this manuscript.

Seasonal variations and correlations of these species observed by the FTIR measurements in Xianghe reveal the local anthropogenic emissions and the meteorological impact (FLEXPART simulations). This study not only presents the measurement technique, but also shows the scientific innovations about the variations and correlations of these species as well as the reasons behind it.

All co-authors believe this paper fits the scope of ACP, and we kindly ask the referee and the editor to consider it in ACP.

- Before the re-submission or transfer, please improve the quality of discussion. Now, most of statements in the result chapter is just a simple reading of graphs, or too typical not including any meaning (e.g., page 18, line 4-6, "Our results show that ... atmospheric vertical stability" => This kind of statement does not have any real meaning. Anybody can say this with any result),

Thanks for the comments. We changed page 18, line 4-6 to a more specific sentence: "A high CO concentration (categories B and C) is generally with a south-east wind direction, a wind speed below 10 km/h and a more stable atmospheric condition."

or too limited to the small case that is not well generalized (e.g., page 19, line 21-23, "we understand that the drop ... fire emission in the Siberia" => This is just for July and August 2021. Can we generalize this different influence in other years?). Deeper analyses looks very required.

Thanks for the suggestion. HCN enhancements in other years have been investigated and discussed in the revised version. In total, 3 periods related to the boreal forest fire emissions are found.

Apart from our replies, the authors want to address that they are many grammar errors/typos in the referee's comments. (see some examples below; of course, these mistakes are not related to our scientific replies).

'All results **looks** moderately fine' -> 'All results look moderately fine'

'motivation **of** this work' -> 'motivation for this work'

'there were not **much** FTIR measurements' -> 'there were not many FTIR measurements'

'**was** not **resulted in**' -> 'did not result in'

'What can we learn more **for** the' -> 'What can we learn more about/of the'

'**these** information' -> 'this information'

'**in whole** China' -> 'in the whole China'

'**trasfer** from' -> 'transfer from'

'most **of statements** in the result chapter **is** just ... -> 'most of the statements in the result chapter are just ...'

'Deeper analyses **looks** very required' -> 'Deeper analyses are very required'