Response to Referee #1:

Thanks very much for your comments, suggestions and recommendation with respect to improve this paper. The response to all your comments are listed below.

This paper presents a study to quantify the variability, source and transport of Ethane (C_2H_6) using solar absorption measurements from a ground-based high resolution Fourier transform infrared spectrometer performed over Hefei, eastern China. The measurements of five years (2015 - 2020) have been used to evaluate the GEOS-Chem model simulations, as well as to analyze dependencies on meteorological and emission factors using generalized additive models. Finally, the authors highlighted the sensitivities of model results to quantify relative contributions of various source categories and regions to the observed C_2H_6 abundances.

I have some concerns, which are mentioned below in the major and minor comments section. I recommend the publication of the manuscript after these points are addressed.

Response: All your comments listed below have been addressed. Please check the point by point response as follows.

Major Comments

1. P7 L23: It is hard to see the difference in the C_2H_6 emission distribution from the plots of Fig. A1. Perhaps, showing the relative difference w.r.t. the annual mean would be a good way to highlight the seasonal change.

Response: In the revised version, we have plotted both the absolute C_2H_6 emission distribution and the relative difference with respect to the annual mean value. Please check Fig. S1 for details.

2. P10 L4: the overestimation of 17.4% in December is not so evident from the figure. Please give more information on how this is calculated?

Response: This is a typing mistake. It is actually underestimation rather than overestimation. We have change it to adapt Figure 3. This information is calculated by (monthly mean of GEOS minus monthly mean of FTIR)/monthly mean of FTIR). We have inserted this equation in the revised version. By extending the time series of GEOS-Chem to match the FTIR observations, i.e., we run one year more for GEOS-Chem, now 17.4% becomes 14.6%. Please check section 3 for details.

3. P11 L40: the values do not match the figure, e.g., biogenic, please verify the absolute and relative contribution for other components as well.

Response: We have verified the absolute and relative contributions for all components in the revised version. Please check abstract, section 5.1, and conclusion for details.

4. P11 L41: these numbers should change based on the corrections done for the above comment.

Response: Done. Please check abstract, section 5.1, and conclusion for details.

5. Figure 3: Please provide some explanation on why the measurement uncertainties are lower during the summer time and vice-a-versa.

Response: It's a visual illusion but not real. In order to save time (for the huge computation task in this study), we did not run error analysis for all retrievals but only for a randomly selected C_2H_6 retrieval. This approximation did not affect any points of this study.

The retrieval errors added to all individual measurements in Fig.3 are 6.21% which is deduced from the error budget of randomly selected C_2H_6 retrieval at Hefei in Table 1. High levels of C_2H_6 troDMF occur in winter and low levels of C_2H_6 troDMF occur in summer. As a result, for a constant retrieval error (6.21%), the absolute uncertainties in summer are lower than those in winter. The observed C_2H_6 troDMF reached a minimum monthly mean value of (0.36 ± 0.26) ppbv in July and a maximum monthly mean value of (1.76 ± 0.35) ppbv in December. In this case, the monthly mean absolute uncertainties of C_2H_6 in summer and winter are 0.022 (0.36*6.21%) and 0.11 ppbv (1.76*6.21%), respectively. The former value is lower than the later one.

We have included a clarification to avoid this misleading, i.e., "A retrieval error of 6.21% in Table 1 was used to estimate the retrieval uncertainties of all observations. As a result, the uncertainties in winter are larger than those in summer due to a higher C_2H_6 level in the season". Please check the caption of Figure 3 for details.

Minor Comments:

1. P1 L32: together with atmospheric modelling

Response: Done.

2. P1 L36: no brackets needed

Response: Done.

3. P3 L4: ... namely the infrared working group (IRWG) of the Network for the Detection of ...

Response: Done.

4. P4 L19: please provide the spectral range of the NIR and MIR observations.

Response: Done. "This FTIR observatory alternately saved near infrared (NIR) and middle infrared (MIR) solar spectra in routine observations, with spectral ranges of 4,000 to 11,000 cm^{-1} and 500 to 8,500 cm^{-1}, respectively."

5. P5 L30: shouldn't this be table 1?

Response: It is table 3 indeed but to avoid misleading, we have removed the words "and Table 3" since Fig.2 already conveys this message.

6. P6 L7: zero level uncertainty reported is different from the value in table 1

Response: It should be 1.45% and we have modified it to be consistent with Table1.

7. P14 L36: and -3.93%, respectively

Response: Done.