Response to Referee #2

We thank the referee for helpful comments to improve this paper. Our responses are detailed below. Please note that ***referee's comments*** and our responses are in different styles.

General comments:

This paper addresses the long-term tropospheric distributions of CO2 over the Asia-Pacific region obtained from the commercial airliner measurements under CONTRAIL project. High quality tropospheric CO2 data in general are sparse and such data specially the rapid developing Asian regions are specially limited. These long-term observations can contribute to constrain the emission patterns for the rapid developing Asian region that is critically important to the global carbon budget. The text provides a good summary of upper tropospheric CO2 distributions and role of the responsible factors for the seasonal distribution over Asia-Pacific region. I acknowledge the large amount of work provided by the authors and interesting information issued from this study. This work is interesting to be published and is fully within scope of ACP.

We thank the referee for recognizing the value of this work and helpful comments.

Technical Comments:

Abstract: Please include 2-3 sentences for highlighting the importance of the study.

We have added the following sentences at the beginning of the abstract:

"Measurement of atmospheric carbon dioxide (CO_2) is indispensable for top-down estimation of surface CO_2 sources/sinks by an atmospheric transport model. Despite the growing importance of Asia in the global carbon budget, the region has been monitored for atmospheric CO_2 only sparsely and our understanding of atmospheric CO_2 variations in the region (and thereby that of the regional carbon budget) is still limited. In this study, we present…"

Abstract: Line 18: "It is found. . .. season" – The sentence is long and not clear to me. Please reformulate it.

The sentence has been reformulated as follows:
"It is inferred that a substantial contribution to the UT CO_2 over the northwestern Pacific comes from the continental East Asian emissions in the spring, but in the summer monsoon season, the prominent air mass origin switches to South Asia and/or Southeast Asia with distinct imprint of the biospheric CO_2 uptake."

Introduction: Line 27: "China is now . . ..nations" – The sentence is not clear. Please reformulate it.

The sentence has been changed to:
"China is now the world's largest CO_2 emitter, and India, Japan, and the Republic of Korea are all in the world's top 10 emitting nations (Boden et al., 2016)."

Figure1: Please tag the climatological mean CO2 concentrations along with the flight tracks in "a" panel if possible.

According to the suggestion, we have added the annual average ΔCO_2 field to panel a. The caption text has been changed accordingly.

Figure 3. Please mentioned the source of wind vector data in the caption.

We have added the following description (underlined):
"… Also shown are monthly averaged wind vectors at 250 hPa <u>from the JCDAS/JRA-55 reanalysis data (averaged for the observation years)</u>."

Figure 3 and 4. Please remove the wind vectors at the boundaries of each boxes. Also reduce the wind vector density. The anticyclonic feature from the wind vectors is not very clearly. The author could try to plot the wind vectors at 215 hPa or 200 hPa for better visualization of anticyclone if possible. The following study can be refer for example

Park, M., W. J. Randel, L. K. Emmons, and N. J. Livesey (2009), Transport pathways of carbon monoxide in the Asian summer monsoon diagnosed from Model of Ozone and Related Tracers (MOZART), J. Geophys. Res., 114, D08303, doi:10.1029/2008JD010

Chandra, N., Hayashida, S., Saeki, T., and Patra, P. K.: What controls the seasonal cycle of columnar methane observed by GOSAT over different regions

in India?, Atmos. Chem. Phys., 17, 12633-12643, https://doi.org/10.5194/acp-17-12633-2017, 2017.

We thank the referee for the suggestion. The wind vectors at the boundary have been removed and the number of wind vectors has been now reduced. As in previous studies, including the studies suggested by the referee, the altitudinal center of the anticyclone is higher than the typical cruising altitudes of commercial airliners. We therefore agree that the anticyclonic feature would be better visualized if we plotted the wind vectors at the pressure surfaces of ~200 hPa. However, in this study, it has been our intention to show that our observations by commercial airliners can scan part of the anticyclone and its CO_2 characteristics down to the cruising altitudes. Therefore, we would like to keep the wind vectors at 250 hPa, the pressure surface corresponding to the typical cruising altitude. We have added the following sentence to mention the contribution by Chandra et al. (2017):

"The high CH_4 values in the Asian summer monsoon anticyclone, its formation mechanism, and outflow from the anticyclone were recently discussed by Chandra et al. (2017)." (P11 L5)

Figure 3 and 4. The histogram panel looks too messy. The author can consider 10o latitudinal band instead of 5o for plotting histogram.

We thank the referee for the suggestion. However, we would like to keep the histogram as is for the following reasons. As discussed in the text, the shape of the histograms to some degree reflects the nature of the CO_2 variations, like the spreading of the histograms found over boreal Eurasia in the summer and those around Japan in the spring. We agree that the histograms are bit "messy" due in some cases to limited number of measurement flights (i.e. sampling bias). However, one of the objectives of this manuscript is to disclose the full extent, graphically at least, of the currently available dataset. To this end, we think it is important to display as much as possible the density of the data points in space and time (and data at which locations could be sampling biased). In the future, we will make measurement data available in a different format for data users, but we think it is good that some parts of the available data are also visible in the current manuscript.