We thank the reviewer for his/her constructive comments and suggestions to improve the quality and clarity of our manuscript. Item-by-item responses to the specific comments are provided below, in which the reviews' comments are in blue, our responses in **black**, and modifications of the original manuscript are indicated by highlight in yellow.

Report #1

The authors have improved the manuscript and answered all previous questions. However, I still have three comments that need to be answered.

General comments:

1) You have changed the a priori for all retrievals to a fixed CO profile. But how do you account for difference in seasonality in your a prior profile? You mention that a fixed a prior profile might help interpreting the results, but what are the uncertainties associated with this fixed a prior profile compared to a variable a prior profile? A variable a prior profile might better capture variability and seasonality at different latitudes. Further discussion should appear regarding the use of the fixed a prior profile compared to a variable a prior profile.
It is not clear also if your a priori profile is a spatial mean of the whole region of interest (Figure 1.a) or if you have different a prior profile for each specific region over land?

The fixed a priori CO profile is assumed for different time and locations. So, there is no seasonality in the a priori profile. The uncertainty of the a priori profile is determined by the data variability (one standard deviation) from CO simulations, shown as the error bar in Figure 2(a). The a priori profile is a spatial mean of the targeted regions of interest. Although a variable a prior profile might better capture variability and seasonality at different latitudes, it may not reflect the information existed in the observed spectra.

Related statements have been added to the revised manuscript (Section 3.2.1).

2) For the comparison between IASI and GIIRS, such as in Figure 13, you adjusted the a prior CO profile with consideration of the AVK. (equation 6). You mention that the vertical sensitivities of both sensors are similar, but according to Figure A.2, they do have difference, particularly around 200 hPa. Additionally, vertical sensitivity in Mongolia peaks at different pressure between the 2 sensors. For precision and comparison, should not be better to use the averaging kernel of IASI in equation 6? As they do have some differences, why not using the AVK smoothing for the comparison between IASI and GIIRS?

Although there is systematic difference in AK around 200 hPa, the impacts on the CO columns are very small, since the CO partial column at around 200 hPa is much smaller than the lower atmosphere. Please see the result from the comparison experiment below:

To compare the smoothing effects of the averaging kernel (AK) matrix from GIIRS and IASI retrievals, we applied the AK smoothing to the IASI retrieved CO partial column profile retrievals which are assumed to be close to the truth. Following **Luo et al. (2007)**, we smooth the partial column profiles using the GIIRS or IASI AK matrix, given by:

$$x^*_{smoothed} = A^* x^{IASI}_{ret} + (I - A^*) x^{IASI}_a \quad \text{(S1)}$$

where A^* is either the GIIRS or the IASI AK matrix, and $x^*_{smoothed}$ is the corresponding smoothed result. Since GIIRS and IASI have different footprint sizes and spatial resolutions, for every IASI data, the closest GIIRS AK matrix is used. The comparison results are shown in **Figure S9**. We can see the AK smoothed CO columns are high consistent, suggesting that the small difference in AK between IASI and GIIRS are not significantly affecting the comparison of the retrieved CO columns.

Related statements have been added to Section 6.4 in the revised manuscript.

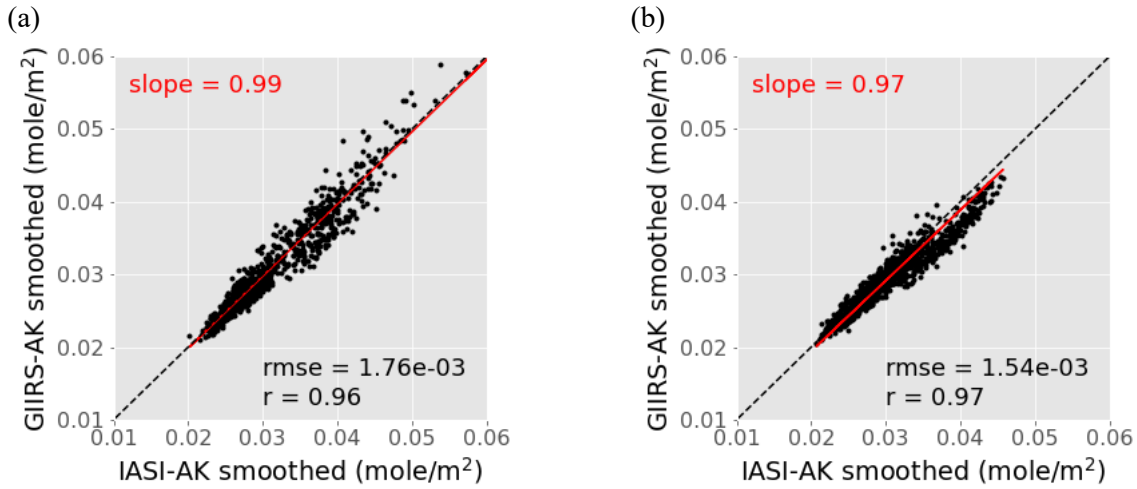

Figure S9. Comparison of AK-smoothed CO columns between GIIRS and IASI for (a) daytime and (b) nighttime data corresponding to Figure 13. The linear fit slopes, correlation coefficients (r), and root-mean-square-error (rmse) are also indicated.

3) ECMWF EAC4 reanalysis was used to construct a fixed CO a prior profile. It is mentioned nowhere in your paper that this reanalysis do assimilate MOPITT and IASI (which can consequently capture fire information) as precise in your author's reply. The fact that MOPITT and IASI are assimilated in the reanalysis used for constructing your CO a prior profile which is then used for GIIRS should be mentioned in your manuscript. Additionally, you compare readjusting GIIRS profiles and IASI for evaluation, but could this evaluation be biased since you are using IASI information in your GIIRS a prior profile? Please develop.

The a priori profile is a spatial mean of the targeted regions of interest, and it is static for different time and locations. So, the wildfire information will be washed out when averaging from a large number of simulated profiles with the majority not affected by wildfire emissions.

We added the following statements in the revised manuscript:
Noted that the EAC4 has assimilated MOPITT and IASI retrievals which can capture wildfire information. However, such information has almost completely reduced in the resulted a priori profile which is averaged from a large number of simulated profiles with the majority not affected by wildfire emissions.

Technical comments:

1) Figure 10. The caption should be corrected. The error bars are not represented in figure 10.c. Additionally, there is no figure 10.d.

The caption error has been corrected.

Report #2

The authors have made substantial changes that led to large improvements of the manuscript:
- change of a diurnal varying a priori to a fixed one to document the diurnal information really contained in the measurements
- addition of boundary layer height from ECMWF and CO columns from EAC 4 reanalysis
- change from 0-1 km layer with little information to 0-3 km with more relevant information
- improved comparisons between GIIRS and IASI

These changes improve the content of the paper and better document the abilities of the GIIRS retrievals. Nevertheless, the abstract and conclusions have not been changed accordingly.

Abstract :
The last sentence « This study demonstrates the capability of GIIRS in observing the diurnal CO changes in East Asia. » is misleading and does not really correspond to what is demonstrated in the paper. Indeed Fig. 10 shows that GIIRS enable the detection of the absence of diurnal variability in the CO total column over large East Asian regions but the sentence makes the reader believe that it enables to detect the expected ground level CO diurnal variations linked to emission diurnal variations.
I suggest to mitigate this statement as follows:
« This study demonstrates that GIIRS correctly reproduces the low diurnal variability of CO total columns over large East Asian regions. Nevertheless, the GIIRS retrievals does not enable to detect the larger ground level CO diurnal variability linked to surface emissions changes. The CO retrievals are indeed impacted by BLH and information content diurnal changes entangled with the CO ground level variability. »

We changed the last sentence to:
"This study demonstrates that the GIIRS retrievals are able to reproduces the temporal variability of CO total columns over East Asia in the daytime in July. Nevertheless, the retrievals have low detectivity in the nighttime due to their weak sensitivity to the ground level CO changes limited by low information content. Model assimilation that takes into account the retrieved diurnal CO profiles and the associated vertical sensitivity will have potential in improving local and global air quality and climate research over East Asia."

Conclusion :
The corrections and mitigations made to the paper should also be included in the conclusion.
The conclusion has to mention the unability of the GIIRS measurements to detect the diurnal variability of surface CO linked to emission variations over industrialized regions because of BLH and DOFS diurnal variations (section 6.3).
Specifically, the sentence « These results demonstrate the capability of GIIRS in constraining the diurnal CO changes in East Asia. » is misleading and rather an overstatement. It makes the reader believe that GIIRS is able to constrain the CO changes close to the ground and therefore the emissions which is not the case as demonstrated by the paper. This statement should therefore be mitigated as proposed for the abstract.

We have made the following changes:
"This study demonstrates that the GIIRS retrievals are able to reproduces the temporal variability of CO total columns over East Asia in the daytime in July. Nevertheless, the retrievals have low detectivity in the nighttime due to their weak sensitivity to the ground level CO changes limited by low information content. Since CO plays an important role in tropospheric atmospheric chemistry and is an effective tracer of CO_2, the CO **profile** retrievals at a spatial resolution of 12 km and a temporal resolution of 2 hours from GIIRS have great potential in improving local and global air quality and climate research **through model assimilation that takes into account the associated vertical sensitivity."**

Minor comments :
There are a number of typing and syntax errors that have to be corrected.
L371 : « solar zenith angles less than 70° » : this means only part of the daytime measurements but the results show 24 hrs results.
We changed “solar zenith angles” to “viewing zenith angles”

Fig 10 : « the error bars for (c) .. »
The caption error has been corrected.