Responses to Reviewer # 2

The authors thank the referee for providing the constructive comments on our paper.

Specific comments:

Comment #1: Page 4334, lines 21- 23, "The third improves the climatology above ozonesonde burst altitudes and in the stratosphere by using climatology derived from many more satellite observations of ozone profiles." Is this really an improvement or merely the same as the existing (LLM) climatology?

Response #2: As we mentioned in Section 3, the dataset for constructing our TB climatology is the same dataset used in Wei et al, 2010. In this dataset, ozonesonde profiles are extended with existing climatology and thereby the standard deviations above ~ 40 km should be very small, as expected, and cannot represent the actual climatological variability. Therefore, we decided to merge our TB and AB climatology with the LLM climatology from 5 km and 10 km above the tropopause and completely replace them with the LLM climatology for altitudes above them. Compared to the previous TB climatology by Wei et al., 2010, we "improve" a very small standard deviation in the stratosphere by merging with LLM climatology. In other word, our climatology at altitudes above 10 km + tropopause is exactly "same" to the LLM climatology.

Page 1, line 21: We have added "compared to the previous TB climatology by Wei et al., 2010" before "three addition processes" in abstract for more clarification.

Comment #2: Page 4335, line 6, "demonstrated"-> corroborated?

Response #2: We have changed "demonstrated by" to "found in" on page 2, line 6 in the revised manuscript.

Comment #3: Page 4337, line 12, "originate from the a priori information", probably it is more clear to state: originate from the mismatch between actual ozone profile and the a priori ozone profile.

Response #3: We have changed the indicated sentence to "originate from the mismatch between actual ozone profile and the a priori ozone profile" in the revised manuscript (page 3, line 26-27)

Comment #4: Page 4339, line 16, "troposphere" -> stratosphere

Response #4: We have changed "troposphere" to "stratosphere" in the revised manuscript (page5, line 12)

Comment #5: Page 4340, line 11, "local and time dependent" -> location and time dependent

Response #5: We have changed the indicated sentence to "location and time dependent" on

page 5, line 31.

Comment #6. Page 4341, lines 10 – 27, (6-1) this paragraph describes the use of variable offset term Zoffset. The algebraic aspect is clearly written here. However, it probably needs a description to help visualize the coordinate mapping process. (6-2) It may also need to emphasize in the paper that this elaborate mapping is done only during the climatology construction from ozonesonde profiles; on the other hand, a vertical shift aligned with the tropopause height is all that is required when using the climatological profile as an a priori in altitude coordinate.

Response #6-1: Comparison of Figure 1 and Figure 3 demonstrated visually that the application of the variable shifting offset combines the strengths of constant shifting in the tropopause region and no shifting outside the tropopause region for reducing the climatological ozone variability. According to the reviewer's comment, we have revised the associated sentence for more clarification.

-Page 6, line 21 – Page 7, line 9: the advantage of using TB coordinate in better representing the climatological ozone variability is confined to within a few km around the tropopause. Therefore, we construct our climatology in such a way that ozone profiles smoothly change from TB means to AB means until the distance is beyond 5 km from the tropopause. This is accomplished using a variable shifting offset in mapping the altitude to TB coordinate as follows:

Z_{tb} and Z_{ab} denote the altitudes defined by the TB and AB coordinates, respectively, $\overline{h_{tb}}$ and h_{tp} are the monthly zonal mean and local tropopause heights, respectively. $\overline{h_{tb}}$ and h_{tp} are the monthly zonal mean and local tropopause heights, respectively. When $\overline{h_{tb}} = h_{tp}$, the mapping of an ozone profile is a uniform shift between TB and AB coordinates without altering the spacing of the sample points. Otherwise, when $\overline{h_{tb}} < h_{tp}$ ($\overline{h_{tb}} > h_{tp}$), an ozone profile is slightly squeezed below (above) and stretched above (below) when mapped into the TB coordinate. The variable offset term Z_{offset} varies with the distance away from the tropopause height ($|Z_{ab} - h_{tp}|$), whereas the traditional offset term is defined as h_{tp} regardless of altitude. Z_{offset} is weighted linearly, from 100 % h_{tp} at tropopause to 100 % $\overline{h_{tp}}$ at 5 km away from tropopause, which essentially results in the weighted average between tropopause and altitude-based ozone profiles in this range. At altitudes beyond 5 km above/below the tropopause, it is fixed to $\overline{h_{tb}}$ which results in profiles similar to altitude-based ozone profiles.

Response #6-2: We have added "It should be noted that the use of variable offset is used only in the construction of the climatology. In the retrieval algorithm, the vertical coordinate of TB climatology is adjusted to AB coordinate using the constant shifting offset." in the revised manuscript (Page 7, line 9-11).

Comment #7: Page 4336, lines 19 – 20, “reducing fitting residuals in the Huggins bands to 0.1–0.2%”. This residual magnitude refers to the accomplishment of earlier works by Liu et al., but how do the fitting residuals change with the use of this improved ozone climatology? Do the improved profile retrieval comes from the better a priori knowledge only, or this also facilitates the extraction of more information from the measurements as well?

Response #7: The improved profile retrieval comes from the better a priori knowledge only. The fitting residuals show an insignificant change due to the change of a priori information from LLM and TB climatology. In the same way, the averaging kernel or Degree of Freedoms for Signal insignificantly changes due to the change of a priori information as discussed in the manuscript. Below is presented this discussion about the fitting residuals in the revised manuscript.

-Page 9, line 1-10: We will show the improvement of ozone profile retrievals using the TB climatology over other AB climatologies in Sections 4 and 5. It should be noted that the improvement mainly comes from the better a priori knowledge only and using the TB climatology does not facilitate the extraction of more information from the measurements. The switch of climatologies has negligible effects on the fitting residuals. In addition, switching from AB climatology to the TB climatology only slightly changes the retrieval sensitivities, as represented by retrieval averaging kernels (AKs). We compared the diagonal elements of OMI AKs, generally called “Degrees of Freedom for Signal (DFS)”, at each layer. Due to smaller TB a priori errors around the extratropical tropopause, the DFS values are smaller by ~0.1 on average with the use of TB a priori than with those of other a priori around the extratropical tropopause. The changes at other altitude ranges and in the tropics are very small.

Comment #8: Page 4348, section 5: This section contains results of comparisons between retrieved profiles (Xretrieved) and ozonesonde profiles (Xt) before and after its convolution with OMI Averaging Kernels (A). Specifically, were the comparisons between Xretrieved and {A • Xt} or {Xa priori + A • (Xt - Xa priori)}?

Response #8: The comparisons shown in strong lines of Figures 9 and 10 were done between OMI-retrieved ozone profiles and ozonesonde profiles convolved with OMI averaging kernels. The ozonesonde profiles convolved with OMI averaging kernels represent $X_{apriori} + A \cdot (X_t - X_{a\ priori})$.

Comments on Figures

Comment #1: In general, the quality of figures is not high (resolution too coarse) in the draft. Especially for Figure 11, the thickness, the color scheme, and the overlapping of lines make it hard to distinguish from each other even when the figure is enlarged with a PDF viewer.

Comment #2: Figure 1: It may be helpful to put the size of latitudinal bands in the caption as well. Since only 3 bands on each hemisphere were plotted here, one may think the 3 bands cover the hemisphere.
Comment #3: Figure 6: Color lines over plotted on color images are really difficult to see from the background in Figure 6. Consider black or white lines with different plotting styles (e.g. dotted, dashed, dot-dash, labeled with symbols, etc…).

Response1-3: We have revised Figure 1, Figure 3, Figure 6, and Figure 11 according to the reviewer's comment. Especially, Figure 11 is separated into Figure 11 and Figure 12; each one shows the ozone gradient driven from the a priori ozone profiles and OMI-retrieved ozone profiles, respectively.