<u>**Response to Reviewer's comments**</u>

Comment #1: The revised version of this manuscript is greatly improved from the first draft. However I feel that there is an over-emphasis on the mega-city and industrialized locations in this paper and not enough mention of the small AOD and AE differences due to accurate NO2 (versus satellite climatology) that occur in smaller cities and rural locations. Therefore I detail below what I think needs to be added to the paper before it is published in AMT.

Response #1: We thank the reviewer for and have tried to accommodate all the following comments and suggestions in the updated version of the manuscript (the changes made are highlighted in red).

Comment #2: Line 32: Insert 'at highly urbanized/industrialized' locations' locations here before 'even larger AOD differences'.

More importantly a sentence or two needs to be added to the Abstract that give the summary statistics for rural stations, since currently there is an over-emphasis in this manuscript on the largest biases which occur in mega-cities and highly urbanized locations/regions.

Similarly this information about rural site statistics need to be added to the Results sections plus Conclusions sections. A new small subsection in the Results (section 3.X) is needed to summarize the rural sites differences in both AOD and AE, since these rural sites are such a significant fraction of the AERONET network total site locations. This is important since there are many more AERONET rural stations than implied here in these co-located AERONET and Pandora instrument comparisons, due to the fact that few Pandora sites were established in rural areas. The average and extreme differences for all 9 rural sites (in this study) should be summarized along with including the fact that most AERONET sites are located in the 'rural' category with lower NO2 amounts and not the mega-city and highly urbanized locations which have high NO2 column amounts.

Response #2: We thank the reviewer for the suggestions following which we have added

1. "**at highly urbanized/industrialized locations**" in the abstract in Line 32.

2. a new subsection 3.4 in the updated manuscript in Line 431-441 as below

"**3.4 Assessment of NO_2 correction on AOD measurements and AE retrievals in rural sites**
For the rural sites considered in this analysis, as presented in Fig. 2 and Fig. 5, the mean NO_2 underestimation (case 1 as described in Section 2.2.2) and overestimation (case 2) between OMIc and PGN were found to be below 0.50 x 10^{-4} mol-m^{-2} and 0.40 x 10^{-4} mol-m^{-2}, respectively that reached to an underestimation of 1.56 x 10^{-4} mol-m^{-2} for INN and an overestimation of more than 0.40 x 10^{-4} mol-m^{-2} but below 1.00 x 10^{-4} mol-m^{-2} for WAL, BOU and LDB in extreme NO_2 loading scenario. The corresponding impact on AOD mean in case 1 and case 2 was found to be as an overestimation and underestimation below 0.002 and 0.001, respectively at 380 nm and below 0.001 at other wavelengths. Under extreme NO_2 scenarios, the overestimation reached to 0.005 at 380 nm and 440 nm, and 0.004 at 340 nm for INN, while the underestimation was above 0.001 but less than 0.003 for WAL, BOU and LDB at 380 nm, 440 nm and 340 nm. The mean AE440-870 difference was found to be positive and within 0.07 for case 1 and negative and within 0.12 for case 2. While mean AE340-440 difference was found to negative and within 0.06 for case 1 and positive and within 0.07 for case 2."

3. Following lines are added to the Abstract summarizing the statistics for rural stations in Line 42-45,

"For rural locations, the mean NO_2 differences was found to be mostly below 0.50 x 10^{-4} mol-m^{-2} with the corresponding AOD differences being below 0.002, and in extreme NO_2 loading scenarios, it went

above this value and reached about 1.50 x 10^{-4} mol-m^{-2} for some stations leading to higher AOD differences but below 0.005.”

4. We have also added the summary statistics to the Conclusion section in Line 520-523 as

“**The rural locations considered in this analysis showed mean NO_2 differences mostly below 0.50 x 10^{-4} mol-m^{-2} for both case 1 and case 2. The effect of AOD differences was found to be mostly below 0.001 at all wavelengths except 380 nm which had these differences below 0.002. Slightly higher (as compared to the all-dataset scenario for rural locations) NO_2 and AOD differences were observed in extreme NO_2 loading scenarios to about 1.50 x 10^{-4} mol-m^{-2} and 0.005, respectively for some stations.**”

Comment #3: Line 540, last sentence of Conclusions: This is mis-leading to suggest that in the future all AERONET sites will have co-located Pandora instruments. The current set of sites you have analyzed is ~5-7% of all AERONET sites globally and it is unlikely that the Pandonia network will expand to cover even half of the AERONET sites in the future (new AERONET sites are also continuously being added).
Response #3: We agree with the reviewer and hence have removed this line from the Conclusion where last paragraph is modified as below in Lines 557-560

“This analysis highlights the importance of accurate NO_2 optical depth representation with the best possible scenario (i.e., high frequency and accurate available NO_2 measurements from Pandora instruments), however, concerning the implementation into the global AOD networks (such as AERONET, GAW-PFR or SKYNET), **utilization** of satellite data is required to account for **all** the stations **in the network**."

Comment #4: Table A4: In Table A4 the value of mean AOD at the Beijing site of 0.083 seems very odd, as these low values of AOD are quite rare in Beijing. These are "extreme NO2 cases" and therefore you should emphasize in the text that they are quite rare and therefore of relatively low significance.
Response #4: We thank the reviewer for the comment. The results presented in Table A4 are for extreme NO_2 loading cases which are 10% of the total comparison points selected based on the highest NO_2 differences (as presented in Section 3.2) that may or may not be associated with high AOD loads as indicated in this table. And these AOD differences become more significant for low AOD cases as is seen in the case of Beijing where the highest NO_2 differences were found $\leq$ 3.75 x 10^{-4} mol-m^{-2} and mean AOD differences being -0.013 for mean AOD values of 0.083 i.e., high NO_2 differences in Beijing are observed for low AOD cases. It has been added in the updated manuscript in Lines 368-375 as

“It is to be noted that for BEI, the mean AOD underestimation between OMIc and PGN reached to 0.013 and 0.011 at 380 nm and 440 nm, respectively **for mean AOD values of 0.083 and 0.076, respectively. This indicates that high NO_2 differences in BEI are observed for low AOD cases (Table 3 and Table A4) where OMIc overpredicts NO_2 values as measured by PGN (Figure 3g) (Beijing is case 2 of this analysis). Hence, the highest NO_2 differences occur for low pollution scenario (i.e., PGN measured NO_2 is lower than OMIc NO_2) and hence, probably leads to low mean AOD. These cases are about 10% that we have considered for extreme scenario cases where we have considered top 10% of highest NO_2 differences (for case 1 (90 percentile) and case 2 (10 percentile)).**”

We have also rearranged this table to be consistent with the other tables (previously the stations were arranged as per the decreasing % AOD differences).

We are thank the reviewer for providing valuable comments and suggestions that helped us further improve the manuscript.