

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-319

Anonymous Referee #2

Referee comment on "Evaluating the effects of columnar NO₂ on the accuracy of aerosol optical properties retrievals" by Theano Drosoglou et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-319-RC2>, 2023

Reviewers' comments:

The authors use extensive measurements to investigate the impact of NO₂ concentrations on AOD and AE retrievals. This paper contributes to better understanding that considering NO₂, which is highly diurnal-variable, is important to improve aerosol properties in the spectral range where NO₂ absorption is strong. Since the manuscript is well-written, I think readers may understand your approach and result well. I believe the paper can be published for AMT after addressing the concerned expressed below.

Minor Issues and specific comments:

P4 L104:

In AERONET site information
(https://aeronet.gsfc.nasa.gov/new_web/photo_db_v3/Rome_Tor_Vergata.html),

Rome-Tor Vergata site is located at elevation=130 m but your description is shown as 117 m.

Which one is correct?

P6 L166

Do you use NO₂ VCD (vertical column density) or SCD (slant column density) from Pandora product? For clarification, it might be better to mention you use NO₂ VCD in

Section 2.3.1

P6 L183:

Do Brewer NO₂ and Pandora NO₂ show good agreement? You need to mention how good quality in your Pandora NO₂ measurement since you use Pandora NO₂ to correct AERONET and SKYNET operational AOD, AE, and SSA product. More reliable NO₂ measurements make your study more meaningful. So, add one or two sentences to show how Pandora NO₂ agrees well with NO₂ from other instruments.

P6 L191: The Pandora data -> The Pandora NO₂ data

P7 L198: You did not show the absolute NO₂ difference. However, I think Pandora NO₂ is one of the most essential parts in your method. So, it had better to create this plot in the main or the supplement to show how much absolute difference between Pandora NO₂ and climatology OMI. If so, readers will understand your approach better.

P7 P225: Are there any specific reasons to exclude the COVID-19 lockdown period? If so, please mention briefly.

P9 L262: In AERONET (Eck et al., 1999), AE is ->

The AERONET AE product (Eck et al., 1999) is

P9 L279: the impact of AOD and AE modified retrievals -> the impact of modified AOD and AE retrievals

P9 L280: to investigate the possible effect on the AOD and AE trends ->

to investigate the possible effect of NO₂ absorption on the AOD and AE trends

P10 L299: to investigate the impact of AOD and AE modified calculations on the derived temporal trends ->

to investigate the impact of modified AOD and AE calculations on the derived temporal trends

P11 L311: Any references? Or is this your finding in this research? Then, plot it to explain

or direct the figure you show this. You can show the correlation between NO₂ and AOD.

P11 L336: Do you have any reason to use SKYNET AE for 400-1020 nm?

You use AERONET AE for 440-870 nm. Then, is it more consistent to use similar wavelength pair like SKYNET AE for 400-870 nm?

P11 L338: You show how modified AOD and AE by considering Pandora NO₂ and then show modified AOD and AE by implementing TROPOMI NO₂. Reader can ask how Pandora NO₂ and TROPOMI NO₂ are consistent. It had better to add one or two sentences to show how both NO₂ measurements are in good agreement. You can refer previous studies about this.

P13 L381: The results -> The results in Table 3

P13 L381-388: The description is the analysis in Table 3. Readers may also be curious about the trend itself. AE trends in CNR-ISAC and APL-SAP shows positive and negative, respectively. Do you have any interpretation for this? Is it because inhomogeneous local emission patterns and photochemical destruction you mentioned in P15 L465? Or during your trend analysis period, were there more frequent transports of dust from Africa and caused it negative AE trend in APL-SAP?

P13 L402: Font type looks different.

P14 L432: You used not standard AERONET aerosol retrieval but GRASP algorithm.

If both are the same condition, retrieved SSA from GRASP algorithm is the same with that from standard AERONET retrieval? If not, how much difference of SSA is apparent?

Also, when you use SSA from AERONET, there are quality assurance criteria (Mok et al., 2018). In Figure 12, do you plot SSA when AOD > 0.4? SSA when AOD is small shows large error.

In addition, for SSA calculation, I am wondering you use the consistent surface albedo for SSA retrievals. Incorrect surface albedo makes a systematic bias in SSA retrievals (Mok et al., 2018).

Mok, J., Krotkov, N. A., Torres, O., Jethva, H., Li, Z., Kim, J., Koo, J.-H., Go, S., Irie, H.,

Labow, G., Eck, T. F., Holben, B. N., Herman, J., Loughman, R. P., Spinei, E., Lee, S. S., Khatri, P., and Campanelli, M.: Comparisons of spectral aerosol single scattering albedo in Seoul, South Korea, *Atmos. Meas. Tech.*, 11, 2295–2311, <https://doi.org/10.5194/amt-11-2295-2018>, 2018.

Lastly, overestimation in AOD lead to the underestimation in SSA. When you compare SSA from GRASP/Standard AERONET with that from GRASP/Pandora NO₂, do you use the same AOD?

For this, in figure 12, you should add a plot of difference of SSA as a function of difference of AOD.

P15 L458 or in conclusion:

You may add one or two sentences about the importance of your research to estimate the effect of NO₂ on the spectral dependence of SSA (i.e., absorption Ångström exponent (AAE)) as a future study.

P27 L800 (Table 1)

Why NO₂ values in Table 1 is different in different wavelengths? Is this because the number of data you used for 380 and 440 is different? Why don't you use the same number of data at all wavelengths? Since we look at AE which is the relationship of AOD between wavelengths, I think you should match the data for all wavelengths. In case one event has some information at one wavelength is missing, it is caused by some issues like small fraction of cloud is passing etc.

P41 L890 (Figure 12)

In upper left figure, the number of data shown in the figure is not the same with the legend (N=32). Also, there is no explanations for different color (e.g., green and red dots). It is hard to recognize the dots in the plot. Please modify them with increasing size.