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Interactive comment on "Linearization of the effect of slit function changes for improving OMI ozone profile retrievals" *by* Juseon Bak et al.

Anonymous Referee #2

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This paper is well organized to describe a methodology for reducing the spectral fit residuals. The subject of the paper is appropriate to AMT. Below are a few comments concerning clarifications / extensions for consideration in the final publication in AMT.

Major comments [1] The PROFOZ algorithm applies the pre-estimated, pixel dependent "soft calibration" factors to the normalized radiances, while conducting the ozone profile retrievals. The "soft calibration" factors seem, by design, accounting for the imperfectness of OMI L1B earth shine radiances and solar irradiances calibration, parameterization of the pixel & wavelength dependent ISRFs, and forward model parameters (absorption cross-sections, surface albedo) etc. The PROFOZ also fits scaling factors for the pre-estimated mean spectral fit residuals (Liu 2010 a, b) for UV1 and UV2 bands accordingly, to account for the remaining systematic errors that were not fully removed

from "soft calibration" process. This work suggests fit additional ISRF PA coefficients is necessary for OMI ozone profile retrievals. It seems there might some degeneracy among these approaches. The authors should elaborate whether employing pixel & temporal dependent 'soft calibration' factors, or fitting the mean spectral residuals could also achieve the goals same to employing the presented PA approach, in terms of reducing the spectral fit residuals. Are the Jacobians of these PA coefficients, orthogonal to the pre-estimated mean fitting residual spectra, or any other Jacobians of parameters in the retrieval vector?

[2] The authors should obtain time serials of retrieved ISRF PA coefficients. Do they show trends similar to Figure 1? At least for Nadir pixel, if not all pixels.

[3] The authors evaluated the impacts of with/without retrieving PA coefficients on the bias/RMS between retrieved ozone and in-situ ozonesonde measurements (Figure 9). However, the evaluation only made for the period of 2005 to 2008, when OMI instrument was within design lifetime. The authors should also evaluate the performances using the satellite-ozonesonde measurements in other time periods including 2010 and 2012-2013, when the ISRF characteristics were significantly different than the earlier years, as shown in Figure 1. The authors should also add some discussions on the possible reasons causing these sharp changes of ISRF characteristics.

Technical comments

[1] Have the authors evaluated the impacts of this methodology on the L2 retrieval throughput/yields?

[2] Line 29, use the statistical numbers on the bias/RMS differences to replace the word "substantial".

[3] Line 47, the authors should consider to revise "by narrow and weak absorption features of the temperature-dependent Huggins bands (320-360 nm)" to "by the 320-330 nm absorption features residing in the temperature-dependent Huggins bands.",

since neither this work nor the referenced studies utilized spectral region > 330 nm in the OMI ozone profile retrievals. "narrow and weak" are general terms and might subjective, e.g., this statement will break down. When comparing within the Chappuis bands, the refereed portion of Huggins bands (>320 nm) is no longer weak.

[4] Line 50, I will suggest to cite the following studies on OMI ozone profile retrievals, since [1] they made use of the ISRFs from Dirksen et al., [2006] cited a few times in this work, [2] the quality evaluation have been conducted by the comparison with in-situ ozonesonde measurements, [3] same to Liu et al., 2010 cited in this work, these studies were conducted prior to the era of including PA coefficients in the retrieval vector.

Kroon, M., de Haan, J. F., Veefkind, J. P., Froidevaux, L., Wang,R., Kivi, R., and Hakkarainen, J. J.: Validation of operationalozone profiles from the Ozone Monitoring Instrument, J. Geo-phys. Res., 116, D18305, doi:10.1029/2010JD015100, 2011.

Mielonen, T., de Haan, J. F., van Peet, J. C. A., Eremenko, M., andVeefkind, J. P.: To-wards the retrieval of tropospheric ozone withthe Ozone Monitoring Instrument (OMI), Atmos. Meas. Tech.,8, 671–687, https://doi.org/10.5194/amt-8-671-2015, 2015.

Fu, D., Kulawik, S. S., Miyazaki, K., Bowman, K. W., Worden, J. R., Eldering, A., Livesey, N. J., Teixeira, J., Irion, F. W., Herman, R. L., Osterman, G. B., Liu, X., Levelt, P. F., Thompson, A. M., and Luo, M.: Retrievals of tropospheric ozone profiles from the synergism of AIRS and OMI: methodology and validation, Atmos. Meas. Tech., 11, 5587-5605, https://doi.org/10.5194/amt-11-5587-2018, 2018.

Fu, D., Worden, J. R., Liu, X., Kulawik, S. S., Bowman, K. W., and Natraj, V.: Charac-terization of ozone profiles derived from Aura TES and OMI radiances, Atmos. Chem. Phys., 13, 3445-3462, https://doi.org/10.5194/acp-13-3445-2013, 2013.

[5] Line 60, might be a typo (radiance repeated twice)?. Do the authors mean "dif-ferences in stray light between radiance and irradiance" or "differences in stray light among OMI measurements"?

[6] Line 61, It seems that "intra-orbit instrumental changes" is duplicating the statement of "the instrument temperature change". Please clarify (or remove one).

[7] Figures 1, 2, 4, 5, 7, 8, 9 and 10, increase the tick length for improving their visibility.

[8] Figures 5, 6, 8, 9 and 10 captions, state the date/time range of the data presented in the figures. It is not where they are all for 1 July 2006, shown in Figure 4 caption.

[9] Figure 9, create a table and move the statistical values to the table. Having all these numbers on the plots resulted in the plots being too busy to read.

[10] Figure 10 # please spell out the "MB" and "SD" in the x axis title, - space suffice to hold the full name and they were not defined in the caption. # Add two panels to show the differences among data sets, as a function of altitude?

[11] Finally, please keep the 'style' of all figures in a similar fashion. e.g., the panel index of Figure 2 (a), (b) and (c) are inside the plots, while the other figures are outside of the plots. I understand that there is no space for the subtitles outside Figure 2b and 2c, due to the x axis labels. The authors should consider to remove those x axis labels, since all panels could share the one of panel c. Similarly, there are unnecessary axis labels in other figures, e.g., Figures 4, 5, 6, 7, 8, 9, and 10, when some subpanels having an identical scale/range across a row and/or a column, authors should consider remove the unnecessary labels in x or y axis, to help readers easily catch key information presented in the figures.