Responses to Anonymous Referee # 1

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

GENERAL REVIEW

The authors investigate the effects of PMCs on ozone profile retrieval from BUV spectra measured by a nadir-viewing satellite. Their findings clearly show systematic low biases in the ozone profiles retrieved without including the PMC scattering effects. The authors quantify this PMC-induced low bias in ozone profiles retrieved from OMI observations through comparison with MLS ozone profile measurements. Using MLS ozone as a reference, they further demonstrate that the accuracy of OMI ozone profiles are significantly improved by including a MIE particle model to represent PMC in the forward radiative transfer modeling and retrieving the optical depth of PMC simultaneously with ozone. This is a well written paper and I recommend its publications in AMT, with minor revision addressing following items:

COMMENT #1. Page 3, line 58, 'residual albedo' is first mentioned here. A description of this quantity is needed.

RESPONSE#1. We have inserted "(observed-background atmospheric albedo)" after "residual albedo", in the revised manuscript.

COMMENT #2. Lines 87, 368, 623, and 639, repeated acronym definition of POD, which is already defined in line 27.

RESPONSE#2. We have removed the repeated description of POD in the revised manuscript.

COMMENT #3. Page 7, line 161-163, 'The minimum residual albedo value for PMC detection is derived from measurements of clear atmospheric variability, and is adjusted to eliminate false PMC signal due to instrument noise.' Though this statement implies PMC detection threshold is not a fixed value, a mention of or a reference to the typical value would still be helpful here. Based on the results shown figures 3 and 10, it looks like the threshold value is 5 x10-6 sr-1 at 267 nm?

RESPONSE#3. The reference value of the PMC detection threshold is defined as a function of latitude, as shown in Figure 3 of DeLand et al. (2010), and varies between $4.7\text{x}10^{-6}\ sr^{-1}$ and $6.5\text{x}10^{-6}\ sr^{-1}$.

We have revised the associated statement as following: "The minimum residual albedo value for PMC detection is derived from the variability of out-of-PMC season measurements, as described in Section 3 of DeLand et al. (2010). The derived threshold function varies from approximately $6.5\text{x}10^{-6}\ sr^{-1}$ at 40° latitude to $4.7\text{x}10^{-6}\ sr^{-1}$ at 81° latitude (see Figure 3 of DeLand et al. (2010)), and is scaled up by an empirical factor of 1.6 to eliminate false PMC detections at the start and end of the PMC season."

COMMENT #4. Page 7, lines 163-165, ' The false PMC signal due to a negative ozone deviation is screened out using the wavelength-dependence of PMC signals that become stronger at shorter wavelengths.' This statement is not clear. Additional explanation, perhaps pointing to the sensitivity results shown in Fig. 4, would be helpful for a reader.
RESPONSE#4.

The positive signals due to PMC scattering increase at shorter wavelengths, while the positive signals due to negative ozone increase at longer wavelengths up to ~ 307 nm whose ozone weighting function peaks at the ozone density peak (~21 km in this experiment), as shown in Figure 1 of this document. Therefore, PMC signals could be separated from negative ozone signals using different dependence of positive signals on wavelengths. This way is detailed in Deland et al (2003). We have included more statement for this discussion in the revised manuscript, as following: "The false PMC signals due to a negative ozone deviation are screened out using the wavelength-dependence of PMC signals that become stronger at shorter wavelengths, whereas the residuals due to a negative ozone deviation increase at longer wavelengths for PMC detection wavelengths, as shown in Figure 1. The criteria for identifying PMC signals using residual albedo values are described in DeLand et al. (2003) and DeLand et al. (2007)."

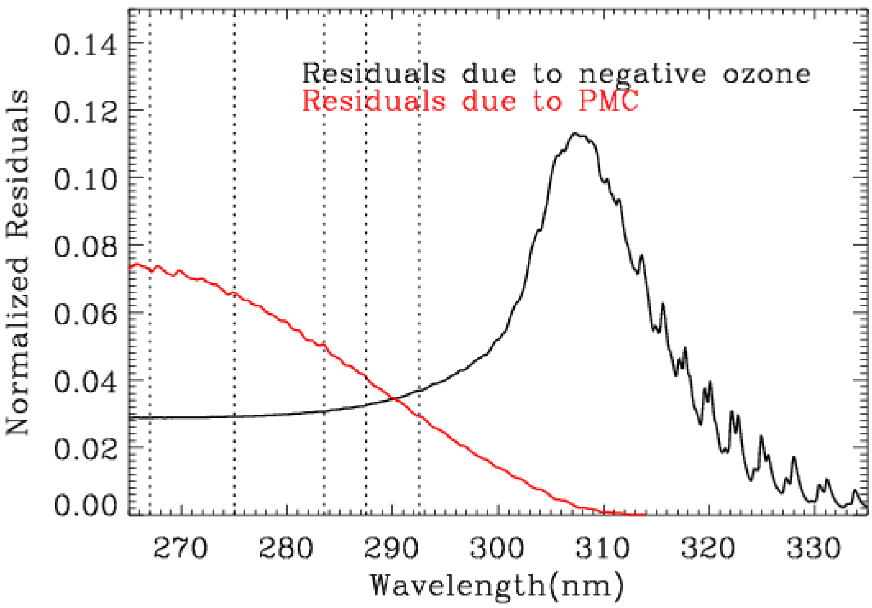

Figure 1. Radiance residuals due to the subtraction of 5 % of background ozone at each layer (black line) and due to PMC scattering with POD of 10^{-3}(red line), normalized to background radiance. The vertical dashed lines represent five wavelengths used in OMI PMC detection.

COMMENT #5. Page 15, lines 384-386, 'It might be explained that positive signal of fitting residuals induced by other factors are misinterpreted to PMC scatterings.' The 'other factors' may need to be specified here. As it is, this statement is too vague to be understood.

RESPONSE#5. We have revised Figures 1-3 of the original manuscript and associated sentences. In this paper, we use 29 layers (24 below 65 and 5 above) for ozone only and ozone/POD retrievals. In the revised manuscript, we retrieved ozone profiles with 24 layers from surface to 65 km for Figures 1-3, in order to clearly specify the positive biases at ~ 1hPa due to the simultaneous ozone/POD retrievals. In addition, in figure 2, the comparison between OMI and original MLS profiles is miss-plotted instead of comparison between OMI and MLS convolved with OMI averaging kernels, so we have corrected them. The effect of the addition of 5 layers above 65 km on OM ozone retrievals is shown in Figure 2 of this doc, causing a bias of ~ 1 % at ~ 2hPa. The revised sentences are followings: “In addition, simultaneous ozone/POD retrievals cause systematic positive biases of ~8% relative to MLS for the layers of 1.21-2.15 hPa, even at non-PMC pixels, which is ~5% larger than that shown in Figure 2a for non-PMC pixels. The addition of 5 layers above 65 km used in Figure 9, but not in Figure 2a causes ~ 1% biases at ~ 2 hPa. The remaining larger bias of 4% at ~ 1-2hPa could be due to correlation between PMC and ozone, simplification of the PMC simulation, and the variability of OMI/MLS differences.

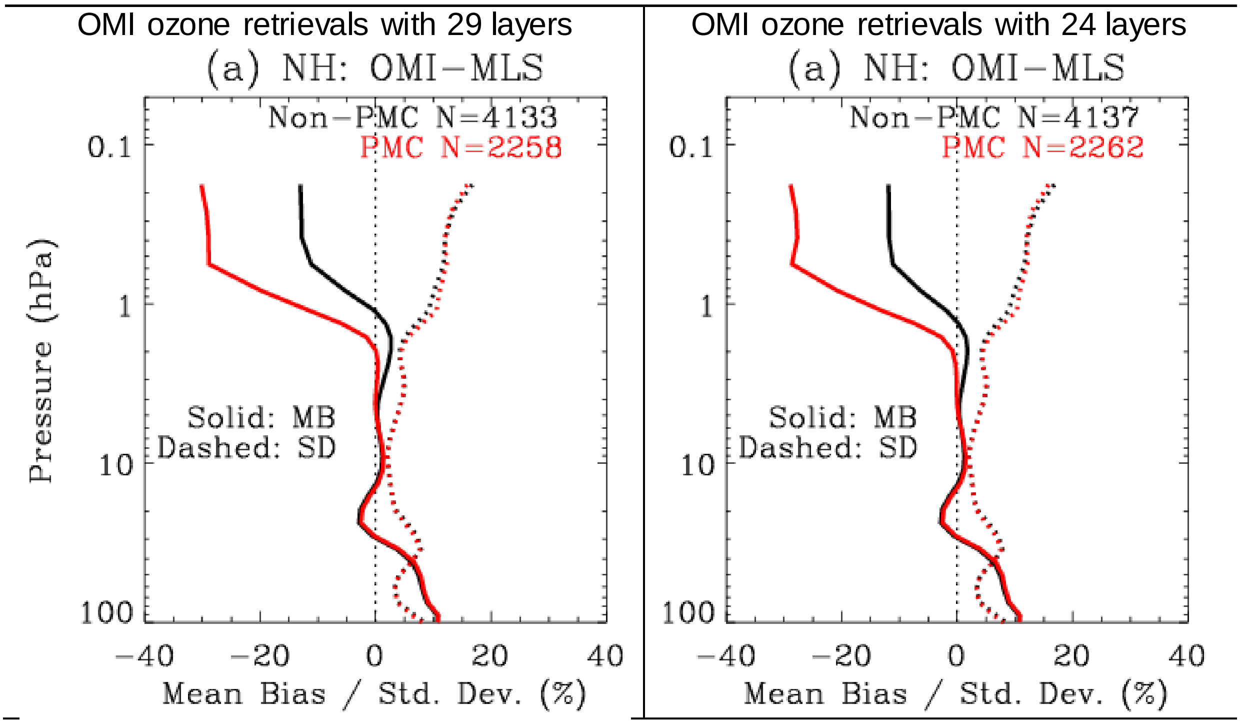

Figure 2. Comparison of OMI and MLS ozone profiles for PMC and Non-PMC pixels. OMI ozone profiles are retrieved with 29 layers (a) and 24 layers (b), respectively.

Reference

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Clouds (PMCs) Observed by the Ozone Monitoring Instrument (OMI) on Aura, J. Geophys. Res., 115, D21301, doi:10.1029/2009JD013685, 2010.

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