Review #2

We thank the referee for helpful comments that have improved the manuscript. We respond to each comment below.

> **Referee:** page 2553, line 24: 'PMF' is used here for the first and only time in this paper. In such a case, don't use an abbreviation, but write it out fully.

Response: We added: "PMF (Product Master File)".

> **Referee:** p. 2553, l. 29: "The mzm profiles are calculated ...". How are they calculated? Is the mzm profile the mean of all individual retrievals, or is it retrieved using the monthly mean radiances? It's probably explained in the algorithm description by Bhartia (2012, see paper reference list), but a small explanation would be useful.

Response: We added the following explanation: "The mzm profiles are calculated in 5º latitudinal bins with midpoints starting at 87.5º S by simply averaging all individual profiles in the specific month and latitude bin".

> **Referee:** p. 2555, l. 4–5: Some explanation on the 'Integrated Kernels' would be welcome. Later on p. 2560 averaging kernels are briefly mentioned. How are integrated kernels and averaging kernels related, and how would you calculate an AK for a monthly mean profile?

Response: Thank you for the comment. To avoid confusion we added: "Reported Averaging Kernels ($\mathbf{A_{IK}}$) are applicable to ozone profiles in SBUV native units of layer amount (DU/layer), and Bhartia et al. (2012) refer to them as Integrating Kernels. To get the traditional bell-shaped Averaging Kernels – which are applicable to profiles of fractional ozone changes - the following expression can be used:

$$\mathbf{A(i,j)} = \mathbf{A_{ik}(i,j)} * \boldsymbol{x_a(j)/x_a(i)} \qquad (1)$$

where $\boldsymbol{x_a}$ - the SBUV a priori profiles, and *i* and *j* - layers indices."

> **Referee:** p. 2558, l. 16: the lidars are operated only at night, while the SBUV instruments measure backscattered solar light. Doesn't this introduce errors due to the diurnal variation?

Response: We compared SBUV and lidar profiles in altitude range between 40 hPa and 1.6 hPa, where we assume that the error due to the diurnal variation is small. We briefly discussed the diurnal variation in section 2.4.3. Above 1 hPa diurnal ozone variation plays a significant role (e.g. Connor et al., 1994; Haefele et al., 2008), thus we limited our validation to below 1 hPa. A recent study by Parrish et al. (manuscript in preparation, 2013) shows the differences up to 2-3% between day-night measurements in the altitude range 10-1 hPa, however, the analysis is limited by only one location (Mauna Loa). Further study of the ozone diurnal variation using multiple observations and model results is highly desirable to properly account for this effect in the validation, but it is not possible to do that at this stage.

Referee: p. 2559, l. 12: include a line on how many pressure levels the SBUV retrievals are performed and what the altitude of those levels is.

Response: We included two tables in the Supplement (tables S1 and S2) that show pressure scales for 21 partial ozone layers and 15 vmr levels. We put references to the tables in the text where appropriate (p. 2553 l. 19, p. 2555 l. 9 and p. 2559 l. 12).

Referee: p. 2559, l. 13–14: if there are errors given on the vmr profiles, how are they translated into errors on the layer amounts?

Response: The native coordinates for SBUV instruments are partial ozone columns (DU/per layer). Thus in this study we made all comparisons in DU rather than mixing ratios. We did not estimate errors specifically for vmr profiles, but for monthly zonal mean vmr profiles errors are expected to be the same order as the errors for partial ozone columns reported in this study.

Referee: p. 2560–2561, section 2.4.2 "Vertical resolution". Smoothing errors are discussed in Bhartia (2012) and Kramarova (2013), but the latter paper is in preparation. So a little more explanation on why the 1–2% limit for the smoothing error is used would be useful.

Response: We added the following text (section 2.4.2, p.2561, l 11): "Smoothing errors of the order of 1-2% can be neglected compared to other sources of random and systematical errors". In addition, the mentioned paper is now available on AMTD (Kramarova, N. A., Bhartia, P. K., Frith, S. M., McPeters, R. D., and Stolarski, R. S.: Interpreting SBUV smoothing errors: an example using the Quasi-Biennial Oscillation, Atmos. Meas. Tech. Discuss., 6, 2721-2749, doi:10.5194/amtd-6-2721-2013, 2013).

Referee: p. 2571, l. 14: "recommended layer combinations", recommended where?

Response: We added: "Figure 9 shows the mean biases and standard deviations as a function of latitude for two recommended in section 2.4.2 layer combinations: 250-25 hPa and 250-16 hPa."

Referee: p. 2572, l. 18–21: it's not ±5%, but it should be ±6% (see page 2571, line 16 an figure 9). But more importantly, I disagree with this conlusion for two reasons. The first is that looking at plots 10-11, it's the thick black line (12 month moving average) that doesn't exceed the ±5reach values of ±15% for the Umkehr instruments and −10 ˜+15%for the sonde stations. Second, the column from the surface up to 31.6 hPa is only validated for northern hemisphere stations between 40_N and 52_N. It is correctly described in the conclusions section on p. 2577, l. 8–11, although line 11 should read "±5% for the 12 month moving average".

Response: Our goal was to estimate the mean biases. Figures 10 and 11 show the time series of differences between SBUV and UMKEHR/sonde integrated columns. For any individual SBUV instrument the mean bias (mean difference over the overlapping time period) is less than ±5. However, as the reviewer correctly pointed out, the mean biases with Aura MLS are up to -6 %. We corrected "±5%" to "±6%" and changed the text on page 2572 l18-21: "Results shown in Fig. 9-11 demonstrate that despite the limited SBUV vertical resolution in the lower stratosphere and

troposphere, the mean biases for partial ozone columns obtained from SBUV instruments and from independent satellite and ground-based instruments are within ±6%."

Technical corrections:

Response: We accepted all technical corrections suggested by the referee. Thank you very much for your detailed review.