

### Response to review 1:

First, we wish to thank reviewer 1 for a thorough analysis and useful comments on the paper.

1. Abstract: Wording in abstract has been changed to a more quantitative statement:

“Values of  $\beta$  from SLIMCAT model simulations show the same vertical structure as those from MLS and generally match the observed values to within 25%.” (See also response to review 2 and corresponding changes to text in section 3).

2.  $H+O_3 \rightarrow OH+O_2$ : This reaction is important in the middle and upper mesosphere, near the top limit of our analysis, but it is a *partitioning* reaction for HOx and not a *production* reaction. It should not be included in a steady-state expression for HOx (see following response), and we have revised the discussion of equation (1) in an effort to clarify this.

3. Equation 1 is based on an equilibrium concentration of HOx ( $OH+HO_2+H$ ). That is,

$$d(\text{HOx})/dt = 2k_1[\text{H}_2\text{O}][\text{O}(^1\text{D})] + 2J[\text{H}_2\text{O}] - 2k_3[\text{OH}][\text{HO}_2]$$

and therefore factors of 2 appear in every term (both production reactions and loss reaction involve 2 HOx species). It is also assumed that  $[\text{HO}_2]/[\text{OH}]=\text{constant}$ , and equation 1 follows. Reviewer 2 commented that equation 1 is correct. However, we recognize that the discussion leading up to this equation was not as clear as it should have been. The text has been revised accordingly.

4. Equation 3: We thank the reviewer for bringing our attention to this issue. Even though scattering is not important for the wavelengths and over most of the altitude range of interest, this point was not made clear in the manuscript. Figure 4.38 of Brasseur and Solomon does show an important contribution (40% max) from scattering at the lowest altitudes considered in our study (30 km). However, this figure is for the *overall* photolysis rate of  $\text{O}_3$ , and not just the photolysis below 320 nm that is primarily responsible for generating  $\text{O}(^1\text{D})$  above 30 km altitude. (The quantum yield for  $\lambda > 320$  is 0.1 or less at stratospheric temperatures [Matsumi et al, JGR, 2002], which makes a negligibly small contribution to  $\text{O}(^1\text{D})$  production above 30 km). A previous figure in that book shows an approximate equal contribution from the Chappuis and Hartley bands at this altitude. Thus, the maximum impact of scattering should be less than 20% at 30 km and decrease rapidly at higher altitudes. We completed radiative transfer calculations that better quantify this effect and now discuss the results immediately after equation 3.

5. Profile averaging: Figure 1 shows mean vertical profiles as the reviewer correctly notes. Each vertical profile was retrieved using a standard optimal estimation method as described by Livesey et al (*IEEE Trans Geosci Remote Sens*, 44, 1144-1155, 2008). However, as shown by Pickett et al (JGR, 113, doi:10.1029/2007JD008775, 2008), the a

priori contribution to the retrieved profile is very small, less than one percent during the day and over the pressure range of interest for our paper. Figure 10 of Pickett et al shows some sensitivity results bearing on this issue. The a priori profiles are exaggerated, but the retrieved profiles show minimal impact of such a priori. Thus, differences between an optimal mean and the average of the optimal estimates should be very small. We have added more discussion as suggested by the reviewer.

6. We appreciate this suggestion to make the paper more useful. A table has been added to the paper.

6. p22319, line 17: Period added at end of line

7. p22319, line 21: Secant function is now defined explicitly

8. p22320, line 22: Text revised as suggested

9. p22320, line 14/15: This paragraph has been completely revised (see review 2). References to specific sections are omitted.

10. Figures: approximate altitude labels are now included in Figs 1, 4, 5, and 6.