

Minschwaner et al., "Hydroxyl... diurnal variability"

Response to review 2:

We thank reviewer 2 for insightful feedback on the paper.

Response to General Comments:

Objectives: The paper actually has two objectives: 1) to characterize OH diurnal variations seen in the MLS data, and 2) to use the MLS observations to test our understanding of the radiative processes that drive the photochemistry of OH.

These objectives were not made clear in the original manuscript but are now stated more explicitly at the end of the introductory section. Regarding objective 1, which is similar to that identified by the reviewer, it should be noted that while a diurnal parameterization could be developed from "known" chemistry, for example from models, it is not at all obvious that models have been sufficiently tested with OH measurements that are now available from MLS (our objective 2). It can be argued that in light of the paucity of OH data in the stratosphere and mesosphere, the degree to which the photochemistry is really "known" is open to debate.

In response to the reviewer's interpretation "to confirm/check if MLS measurements of OH diurnal variability are consistent with the known chemistry", it should be emphasized that the MLS OH measurements have been fully validated and do not require checking or confirmation, and that it is the *models* that that we wish to confirm/check using the MLS *measurements*.

Regarding the amount of detail in the paper, the comments from reviewer 1 make it clear that the radiative transfer and associated discussions are not obvious, and we feel that shortening the paper in this area will result in a loss of clarity. The reviewer makes an excellent point that the limitations of our analysis (small variability in H₂O and O₃, and SZA < 75) need to be highlighted, and we have revised the text in section 2 and in the conclusion. The recommendation to extend this work to larger SZA is interesting but beyond the scope of our paper, and would also involve more complicated radiative transfer that would not be amenable to a simple analytic form.

Response to Specific Important Comments

1. There are some differences between SLIMCAT and MLS so that some readers may not interpret the agreement as "good". Nevertheless, the important points are that the shape of the profiles are quite similar, and that overall differences are small (the average difference is 6%). We have revised the text include these two points, and to point out that maximum differences may approach 30% in regions where the vertical gradient in β is large. Reference to "good" agreement has been removed to let the readers assess for themselves.

2. First sentence of section 4 has been revised according to the discussion above. There is a comment in the paper on the complexities of the radiative transfer for $SZA > 75$ on the 3rd line of section 3.

3. This comment from the referee is unclear. The paper does not *assume* that OH is controlled by O_3 and H_2O photodissociation, but it uses MLS data to *confirm* that this is the likely case, and furthermore it uses the data to derive the relative importance of each process to the production of HOx.

Response to Minor Comments and Technical Issues

1. We thank the reviewer for confirming eq (1) and we have revised the text to make it clear what is assumed in applying this equation.

2. Agreed. Wording has been revised.

3. Text is now more quantitative in reference to the range in latitude and local time.

4. Assumptions are now emphasized in the text

5. SLIMCAT data was screened exactly as for MLS. This is now pointed out in the manuscript.

6. The fact that the β is smaller than expected does not imply that a loss mechanism is missed. It must be remembered that b describes the magnitude of the diurnal range, and not the absolute OH concentration. If there is a production mechanism that is not photolysis driven (i.e. flat over the course of the day), then this flattens the OH diurnal variation and produces a smaller b . This may a subtle point, especially since it was not obvious to the reviewer, thus we have added a parenthetic remark to clarify the issue.

7. All references to O_2 have now been revised to "molecular oxygen"

8. Fig 2 has been revised with darker and thicker blue symbols.