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Atmospheric Chemistry and Physics Discussions

Interactive comment on "New insights into OH airglow modelling to derive night-time atomic oxygen and atomic hydrogen in the mesopause region" *by* Tilo Fytterer et al.

Anonymous Referee #1

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This paper is another piece in the puzzle of OH(v>0) deactivation. It uses satellite data from SABER and SCIAMACHY in conjunction with a chemical box model to empirically determine optimal branching ratios and reaction rates for the reactions OH(v>0) + O2 → OH(v'<v) + O2 and OH(v>0) + O(3P) → OH(v'<v) + O(1D). The model is then used to show that it can be used to derive reasonable profiles of [O] and [H] in the mesopause region. It is a well written paper and the results are discussed in a very clear and methodical way, which makes it easy to follow the steps taken. As the results tend to strike a balance between many previous studies that have often been in opposition with each other, it seems like this would be a good fit for publication in ACP. I would recommend publication only after a few, relatively minor, issues have been properly

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Discussion paper

addressed, listed below.

General comments:

I know it's a bit persnickety, but throughout the paper you need to be careful distinguishing between X and [X], as is done in the equations. X is not being derived, you are deriving X densities, or deriving [X].

If O3 is also a variable in the airglow model, could you not compare the resulting O3 with SABER values as a further constraint, in addition to the SABER VER? Either way, it would be interesting to see how the best fit model O3 compares to the SABER values, since those are not related to OH (although if it is expected that SABER O3 values are too large, maybe this wouldn't work. Or could you compare to SABER O3 1.27 μ data?).

Also, please comment on how initial conditions of the target species affect the results of the model, i.e. have you tested this, what are the scale of any uncertainties the first guesses can add?

Specific comments:

Abstract should specifically indicate that the [O] and [H] profiles derived in this study are from the SABER observations using an OH model informed by SCIAMACHY and SABER observations.

L24: "high" should be "large" (as to not confuse with altitude)

L45 and onward: What is meant by "OH(v)"? Do you mean vibrationally excited OH? It should be defined when it is first used as "vibrationally excited OH" or "OH(v>0)".

L58: "last decades" sounds ominous. Should be specific, i.e. last three to four decades.

L64: "of" should be "from"

L74: "individually" doesn't sound right. Maybe, "Both airglow emissions were used to

derive separate data sets of O(3P) profiles"?

L75: "profiles" makes it sound as if only one profile was retrieved for each airglow feature. Should probably be "data sets".

L84: should be OH(v=9). Or define that OH(x) means OH(v=x).

L117: please fix the significant digit mismatch for "837.5-848"

L153: by "issues" do you mean uncertainties?

L176-177: should specify that the three-body reaction is the production of O3.

L179: M is not the total density of air, M represents an air molecule. [M] is the total density.

L184-185: The wording makes it sound as if the SABER O3 was derived via the ideal gas law. Did you mean to say that you're using SABER derived O3?

L202-203: would suggest "well suited" as opposed to "very suited".

L216-217: the way this sentence is worded means that the equation should be v=9. If that's not the case, it should read something like "OH at all vibrational levels $v \leq 9$"

L232: I assume that by "added" you mean "applied" and not literally added.

Figures 1-4: Why are there no error bars on the SABER observations?

L338: "probably" is not needed

L343-344: They also seem to match within the error bars above $\sim$92 km.

L344-345: I believe this sentence is missing an altitude value and a very important comma. Are you intending to say, "The model still overestimates the measurements in the altitude region above xx km, which might be related to O(3P) quenching."?

R8: this claims that you're only considering $0 \leq v' \leq v\text{-}5$, for $v \geq 6$. If that were the case, then the branching ratios for 8-4, and 7-3 should be 0, which, according to Table

2, they are not. Should it be 0 $\leq$ v' $\leq$ v-4?

L374: "Including R10b in the model..." is confusing. In the v-4 scenario, are you including R10a and R10b, or are you including only R10b and not R10a. If it's the former, that would seem to imply that v'=v-4 can't occur at all (for v $\geq$ 6), and then, again, the branching ratios for 8-4, and 7-3 should be 0. If it's the latter, then I agree that the implication is that v'=v-5 (and not v'=v-4) is the predominant pathway, which fits with the values in Table 2. Please make the explanation of this case clearer. (It's even more confusing in the context of R8, which already says this pathway isn't being considered.)

L402: Should be "that implied" instead of "which implied". Also, "implied" is somewhat vague and makes it sound like you might not be sure (same with "seems reasonable").

Table 3: Reactions 11a-d seem to indicate that k11 doesn't entirely decrease with v, which goes against what's written in the text. This is touched on a bit later, but not explicitly stated.

L459: "higher" should be "larger" as not to be confused with the discussion of altitude.

Figure 5: These plots would be much easier to read with boxed axes (ticks on the top and right). Also, this would be a good spot to compare O3 and show that the model O3 is (presumably) lesser than SABER values.

L540-541: Have you considered doing a similar study incorporating OH(9-4), (8-3), and (5-1) band VERs from OSIRIS?

Summary: needs a bit more description at the end of how [O] and [H] compare to the SABER results and explaining the differences.

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