The authors would like to thank the reviewer for his comments that helped us to improve our manuscript. We have tried to address all comments appropriately.

Anonymous Referee #2:

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General Comments. . . This paper addresses the chemical contribution to future tropical ozone change in the lower stratosphere. The authors have done an exceptional job detailing the chemical processes that impact odd-oxygen loss due to climate change and reduced ODS abundances in the future. They have used the EMAC chemistry climate model and two methods for deriving ozone budget information (i.e., ProdLoss and StratO3Bud). This work is acceptable as is from publication in ACP. I have a few comments below that the authors may want to consider.

Abstract: General – I really like this paper, but the abstract needs to be rewritten. Please tell the reader why this is something new and worth their time to read.

Lines 5-10. "The dominant role of transport for future ozone changes is confirmed, but it is found that changes in ozone destruction and especially changes in the production of ozone do contribute to the relative ozone changes in the tropical lower stratosphere." The authors should be more quantitative in what "do contribute" means.

Lines 12-16 "It is shown that changes in the production are mainly due to changes in the overlying ozone column which are determined by both chemistry and transport. Changes in the ozone destruction can be attributed to a modified efficiency of the ClOx and NOx loss cycles in the lower and middle stratosphere and of the HOx loss cycle in the lower- most tropical stratosphere." Before reading the paper I could have stated this sentence. If you are going to state the obvious, at least back it up with the paper results.

Lines 16-19. "The role of ozone transport in determining the ozone trend in this region is found to depend on the changes in net production, with a smaller contribution from transport to the ozone changes if the net production decreases." If I hadn't read the paper, I would have no idea what you are talking about. You need to expand on this sentence.

We have rewritten the whole abstract and tried to address all concerns (see below).

Main text. . . Line 25 – if you are going to mention, "super recovery" – please define it.

We removed 'super-recovery'

Line 62 – typo. . . "carbon dioxide"

done

Line 68 – "The impact of a temperature decrease on ozone is found to result primarily from the acceleration of the three-body reaction $O + O2 + M \rightarrow O3 + M$ which leads to a changed partitioning of odd oxygen in favor of ozone instead of atomic oxygen (Jonsson et al., 2004)." I believe Rosenfeld et al. discussed this issue first. See JGR, VOL. 107, NO. D6, 4049, 10.1029/2001JD000824, 2002.

Yes, it's true. Thank you for pointing this out. We have added the reference.

Lines 79-81. “Additionally, a change in the ozone column above a certain layer will modify locally the downward flux of shortwave (SW) solar radiation and will therefore affect the ozone production via photolysis in the underlying layers (e.g., Revell et al.,2012).” You are talking about the self-healing process (or reverse self-healing). This has been discussed in the ozone perturbation literature for decades. I’m not exactly sure who first discussed this process, but Revell et al., would not be my choice for a reference.

We have included the reference Haigh and Pyle (1982) instead of Revell et al. (2012)

Line 125-128. “Natural forcings such as solar variability (e.g. the 11-year solar cycle), the QBO, ENSO or volcanic eruptions are not included in the simulations.” I understand why you would leave out solar variability, volcanic eruptions, and even ENSO. However, in model simulations I’ve seen that include a QBO, the secondary circulation does strongly modify the tropical vertical velocity and affect the isolation of the tropics from the mid-latitudes; essentially modifying the base transport of the tropical stratosphere. Since you mention later (line 264) that. . . “a significant enhancement of the tropical upwelling in the lower stratosphere between 2000 and 2095 can also be identified in the timeslice simulations with EMAC used in this study (not shown). This leads to a stronger net export of ozone in the tropical lower stratosphere.” I wonder if your results would be significantly affected if you ran timeslices with a repeating QBO. I realize this is most likely beyond the scope of this paper, but if you have any idea on how NOT including a QBO would impact this study it would be interesting to mention.

We have thought about this concern as well (see Introduction, Page 2, Lines 51-54). We know that compared to our transient simulations with QBO (and ENSO, solar cycle) the interannual variability of tropical ozone and of the vertical velocity is considerably reduced in the timeslice simulations while the mean state is similar. Since we are interested in the long-term changes and with the assumption that the QBO will not change in the future, we expect that the results would not be largely affected by the QBO. We have added a short discussion to the Section “Model and Experimental Setup”.

Line 188. “Therefore, the reactions of NO+HO2 and NO+CH3O2 are considered for ozone production in StratO3Bud.” Just a note: I believe that Johnston and Kinnison also showed that NO + HO2 (=> OH + NO2) has a null cycle component; that is, not the entire rate for this reaction goes to odd-oxygen production. That is if the OH reacts with CO, odd-oxygen is produced. If OH reacts with O3, it is a null process for odd-oxygen production.

Thank you for this note. We looked at the reaction rate coefficients of the reactions OH+CO and OH+O3 (as included in our chemistry module) and a rough estimate for the lower stratosphere shows that the reaction rate coefficient of OH+CO is larger than the rate coefficient of OH+O3. Therefore we assume that the null cycle is less likely and the inaccuracy of considering only NO+HO2 is relatively small.

Page 8 and Figure 3. I really like how you broke down the R_T, R_P, and R_D in figure 3 using the three time slice simulations. Why not bring some of the quantitative details forward from discussion of this figure into the abstract? This is clearly what is new about this study.

Ok. We have rewritten the abstract accordingly.

Line 366, “As in the lower stratosphere. . .” – did you mean “In the lower stratosphere. . .”? Or are you talking about 30-10hPa region, which you mention in the next sentence? Please clarify.

Actually we are talking about the lower stratosphere in the first sentence. We have reformulated this sentence.

Page 11, line 369. There is no Figure 4c, you must mean Figure 4b.

Done

Line 370, "Here, two processes might balance each other: on the one hand the increased tropical upwelling reduces the release rate of NOy (see above). On the other hand a reduced formation of the reservoir species chlorine nitrate due to the decline in chlorine will increase the NOx abundance (not shown) and compensate the effect of a reduced release." This seems too speculative for this paper. Can you not be more quantitative – I never like reading words like "might".

You're right! Since our simulations show both effects quite clear, we don't need to be speculative. Thus, we have reformulated the sentence:
(…) It is found that the NOx abundance increases by up to 10% due to the decline in the chlorine abundance and hence a reduced formation of the reservoir species chlorine nitrate (not shown). This increase is compensated by the increased tropical upwelling which reduces the release rate of NOy (see above).

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Abstract.

The future evolution of tropical ozone in a changing climate is investigated by analyzing timeslice simulations made with the Chemistry-Climate Model EMAC. Between the present and the end of the 21st century a significant increase in ozone is found globally for the upper stratosphere and the extratropical lower stratosphere, while in the tropical lower stratosphere ozone decreases significantly by up to 30 %. Previous studies have shown that this decrease is connected to changes in tropical upwelling. Here the dominant role of transport for the future ozone decrease is confirmed, but it is found that both, changes in chemical ozone production and destruction do contribute to the ozone changes in the tropical lower stratosphere. Between 50 and 30 hPa the dynamically induced ozone decrease of up to 22 % is amplified by 11-19 % due to a reduced ozone production. This is counteracted by a decrease in the ozone loss causing an ozone increase by 15-28%. At 70 hPa the large ozone decrease due to transport (~-50 %) is reduced by an enhanced photochemical ozone production (+28 %) but slightly increased (-5 %) due to an enhanced ozone loss. It is found that the increase in the ozone production in the lowermost stratosphere is mainly due to a transport induced decrease in the overlying ozone column while at higher altitudes the ozone production decreases as a consequence of a chemically induced increase in the overlying ozone column. The ozone increase that is attributed to changes in ozone loss between 50 and 30 hPa is mainly caused by a slowing of the ClOx and NOx loss cycles. The enhanced ozone destruction below 70 hPa can be attributed to an increased efficiency of the HOx loss cycle. The role of ozone transport in determining the ozone trend in this region is found to depend on the changes in the net production as a reduced net production also reduces the amount of ozone that can be transported within an air parcel.