

Interactive comment on “Key drivers of ozone change and its radiative forcing over the 21st century” by Fernando Iglesias-Suarez et al.

Anonymous Referee #2

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Review of 'Key drivers of ozone change and its radiative forcing over the 21st century' by Iglesias-Suarez et al.

This paper attempts to evaluate the contributions of different drivers in the radiative forcing of future ozone. The specific factors are expected future changes in climate, ODS levels, and methane levels for the worse-case scenario pathway (RCP8.5). The ozone changes are calculated with a chemistry-climate model (CESM1-WACCM) forced with different elements of the RCP8.5 scenario. The radiative forcings of the model-calculated ozone fields are estimated with an off-line version of a well-established radiative transfer model. The stratospherically adjusted radiative forcing is calculated using the fixed dynamic heating approximation. The authors estimated using a radiative transfer model authors find that the large methane increase planned

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in RCP8.5 is the most important factor among these 3 factors. The paper is reasonably well written. The results are interesting and relevant to JGR community. They will be very useful to scientists studying the climate impact of ozone changes and their drivers. Nonetheless, the authors can certainly improve the presentation of their work. The two parts that need to be improved are the introduction and the description of the simulations. The sections on results and conclusions are satisfactory. Overall, I recommend publication after a number of minor points are addressed. This would substantially improve the clarity of the paper.

In the introduction, the authors should state explicitly the important drivers of ozone that are covered here. They could discuss more extensively these key drivers and, more importantly, how important they might be for radiative forcing. For instance, the changes in anthropogenic emissions, notably emissions of ozone precursors, have been and will be fundamental for changes in tropospheric ozone. There are also quite a few useful papers that provide estimates of the radiative forcing from tropospheric or stratospheric ozone changes (including works from some of the co-authors) that could be cited. This will give some ideas about the significance of the radiative forcings calculated here. p3, l3: There is something missing sentence to link and introduce the second sentence. Perhaps, However, tropospheric ozone is also significantly affected by the change in UV reaching the troposphere brought about by the thicker stratospheric ozone layer . . . l29, p3: "in the lower stratosphere (through enhanced heterogeneous ozone destruction)". It is certainly the case in the polar regions, but not the tropics. Add 'polar'.

p1, p4: "associated to an increase of relatively ozone-poor air entering from the troposphere". It is a misunderstanding. The loss in tropical lower stratospheric ozone has nothing to do with ozone-poor air entering the tropical stratosphere. It is the fact that air is moving faster and so less ozone is produced. The concentration of ozone in the tropical pipe is determined by the ascent rate and mixing and not by the initial concentration at the tropical tropopause which is in effect extremely small compared to

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stratospheric values. I suggest that the authors read Avallón and Prather, JGR, 1996

l12, p4: A reference for this value should be provided.

l31, p4: add 'tropospheric'

l1, p5: Rephrase. Perhaps diagnose the contribution of change in ozone. . .

l32, p5: 'processed-based' sounds good. But I don't know what it means because there is no explanation.

l4, p6: I don't think that they have just identified the forcing.

l3-l30, p6: somewhere, it should be stated explicitly which ozone drivers are not considered and whether they are important for radiative forcing.

l14, p6: "provide a gauge". Do it mean estimate? if yes, why not use estimate.

l4-8, p7: Add that it is a chemistry-climate model.

l26-32, p7: A bit confusing. Do you first run the stratospheric ozone tracer O3S without deposition and then you modify the O3S output fields by removing some of it based on an additional run where the deposition mass fluxes are calculated and stored?

l6, p8: numerical experimental set up or modelling set up.

l14-16, p8: The emissions are fixed so the importance of this driver for tropospheric ozone and radiative forcing is not explored. I was not sure up to that point.

Section 2.2, p8-9: There is a table provide about the list of runs but there is no explanation and rationale provided about the runs CLIMATE, LIGHTNING, O3-RECOVERY, and METHANE. The reader has to guess but it can be confusing. Can the authors explain the different runs and the reasoning behind the choice of these runs?

l7-9, p10: The Tilmes et al paper states: Tropospheric column ozone is reproduced within +/-10 DU of the observations, with a close agreement to the satellite climatology within less than +/- 5 DU in low and mid-latitudes in spring and summer. Add in spring

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and summer.

l22, p10: add tropospheric

l9, p11: "Constrained"? do you mean confined. l8, p16: it is at the upper end, not mid-upper.

l16, p16: It should be pointed that this estimation assumes that the relationships between changes in methane, ozone and radiative forcing are linear.

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