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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of stratospheric ozone recovery on tropospheric chemistry and air quality" *by* H. Zhang et al.

Anonymous Referee #1

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The manuscript uses a chemical transport model (GEOS-Chem) to examine how stratospheric ozone recovery will affect radiation reaching the troposphere and the resulting impacts on photolysis rates, tropospheric ozone, and hydroxyl radical concentrations including at the surface. While there are several recent studies projecting future changes in stratospheric and tropospheric ozone, to my knowledge none isolate the role of solely stratospheric ozone recovery, in the absence of climate change, on tropospheric ozone and OH. Further isolating the impact of thicker stratospheric ozone columns on the tropospheric ozone lifetime from the impacts via strat-to-trop exchange is interesting and worth pursuing. However, more work is needed to bring the paper to a level appropriate for ACP. Most notably, the interpretation of results is quite thin, e.g., with four figures discussed in one sentence in Section 3.3. The figures are repet-

itive and careful thought should be given to what is needed to communicate the key findings.

Suggestions for improving the manuscript:

1. The methodology needs clarification. Given the stratospheric residence time, one year is not sufficient for spinning up if the stratospheric ozone distribution depends on transporting the ozone produced by LINOZ. It is stated that stratosphere-troposphere exchange is held constant but it is not explained how this is accomplished when the stratospheric ozone distribution is changing. Also, this information belongs in Section 2 rather than in the final paragraph of the conclusions.

2. The model should be evaluated, at minimum to show that the present-day stratospheric ozone distribution simulated with LINOZ is sufficiently accurate to diagnose the impacts from the relatively small changes found here, especially in the tropics where the changes are a few percent at most according to Table 1, and yet this is where we'd expect to have the largest impact on tropospheric OH.

3. The authors should place their results in the broader context of findings in several recent papers addressing topics related to findings here.

Lang, C., D. W. Waugh, M. A. Olsen, A. R. Douglass, Q. Liang, J. E. Nielsen, L. D. Oman, S. Pawson, and R. S. Stolarski (2012), The impact of greenhouse gases on past changes in tropospheric ozone, J. Geophys. Res.

Hegglin, M. I., and Shepherd, T. G.: Large climate-induced changes in ultraviolet index and stratosphere-to-troposphere ozone flux, Nature Geosci, 2, 687-691, http://www.nature.com/ngeo/journal/v2/n10/suppinfo/ngeo604_S1.html, 2009.

Voulgarakis, A., Naik, V., Lamarque, J.-F., Shindell, D. T., Young, P. J., Prather, M. J., Wild, O., Field, R. D., Bergmann, D., Cameron-Smith, P., Cionni, I., Collins, W. J., Dalsøren, S. B., Doherty, R. M., Eyring, V., Faluvegi, G., Folberth, G. A., Horowitz, L. W., Josse, B., MacKenzie, I. A., Nagashima, T., Plummer, D. A., Righi, M., Rumbold,

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S. T., Stevenson, D. S., Strode, S. A., Sudo, K., Szopa, S., and Zeng, G.: Analysis of present day and future OH and methane lifetime in the ACCMIP simulations, Atmos. Chem. Phys., 13, 2563-2587, doi:10.5194/acp-13-2563-2013, 2013.

4. The sensitivity of OH to changes in stratospheric ozone columns could be compared with e.g. Table 6 of Spivakovsky, C. M., et al. (2000), Three-dimensional climatological distribution of tropospheric OH: Update and evaluation, J. Geophys. Res., 105(D7), 8931–8980, doi:10.1029/1999JD901006.

5. Impacts on air quality are emphasized but the largest changes in surface ozone appear to be over the oceans, so is this really important? An interesting point is raised with respect to impacts on intercontinental transport but is not explored. This could be expanded upon and placed in the context of a recent paper looking at climate change impacts on intercontinental pollution: Doherty, R. M., et al. (2013), Impacts of climate change on surface ozone and intercontinental ozone pollution: A multi-model study, J. Geophys. Res. Atmos., 118, 3744–3763, doi:10.1002/jgrd.50266.

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