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Atmospheric Chemistry and Physics Discussions

Interactive comment on "What would have happened to the ozone layer if chlorofluorocarbons (CFCs) had not been regulated?" *by* P. A. Newman et al.

Anonymous Referee #3

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Summary: This study addresses the question of what the response of the ozone layer, and of middle-atmosphere climate, would have been had ozone-depleting substances not been regulated under the Montreal Protocol and amendments. This question has been studied before, however using much simpler tools and not to the same width and depth as in this paper, and the conclusions reached in the paper are mostly new. In particular, the non-linear interactions that lead to a sharp decline of tropical ozone when a certain level of EESC is reached, have not been discussed before. It's a well-written, concise contribution to the field and will be widely cited. It also illustrates anew the importance of the Protocol in averting what would have been quite catastrophic consequences of inaction and business-as-usual. The references cover the more rele-

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vant publications. The topic is clearly appropriate for ACP, so I recommend publication subject to minor revision.

Details: p 20570 l 13-28: These are valid questions but I think the answers to these questions as coming out of the paper could be more concise. (a) Can you formulate quantitatively what people in the 1980s thought the ozone loss might be, and compare to the GEOSCCM results? (b) Can you formulate "theoretical expectations" of how the model should behave in a high-chlorine world, and validate these using the model results? (c) Indeed plotting EESC vs total ozone is a good way to display the result which can partially be validated against observations, albeit for a much more limited range of values. (d) Did you actually discover "subtle non-physical model problems"? If so, please tell us. I think on the whole these questions are slightly out of balance with the rest of the paper, so I would restrict them here to what you actually address in the paper.

p 20574 l 5-7: This way of defining EESC may be inappropriate as you move into a high-chlorine world. In the present-day atmosphere, possibly adding a small amount x of bromine has got a similar effect on ozone depletion to adding $60x$ of chlorine. However, the BrO + ClO cycle links the effects of bromine to the amount of chlorine in the system, so in a high-chlorine atmosphere bromine becomes more efficient at depleting ozone. I accept that this is not the main focus of the paper, but a few words about the limitations and simplifications involved in defining EESC would be in order. Also, what do you do to bromine in the simulation? Does it grow with chlorine or remain at present-day levels?

p 20575 l 16: Some readers may be perplexed to find that ozone depletion is linear in EESC when the dominant reaction involved in ozone depletion is quadratic in chlorine. Could you expand why there is this linearity?

p 20581 l 19 etc: Presumably the age tracer is kept at 0 at the Earth's surface? And by "time difference" you mean "age difference" between any given point in the atmosphere

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and the tropical tropopause.

The figures are easy to read and very helpful in understanding the paper. In figure 2, in the EESC vs ozone insert, observational data could be included for comparison. The same goes for the insert into figure 7 (T versus ozone).

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 20565, 2008.