

Interactive comment on “Will climate change increase ozone depletion from low-energy-electron precipitation?” by A. J. G. Baumgaertner et al.

Anonymous Referee #3

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The paper of Baumgaertner et al. evaluates the impact of modified circulation patterns (in particular: Brewer-Dobson circulation) in a climate change scenario on EEP-NO_x intrusions into the stratosphere and related ozone loss. This is an interesting topic of high relevance for the understanding of future ozone trends which, to my knowledge, has not been addressed so far in published work. The methodology used by the authors for evaluating the trends in EEP-induced composition changes is valid in principle, however, their analysis could be by far more detailed. Particularly, their assessment of changes in the circulation patterns in the 2100 scenario compared to present day is very brief and limited to the analysis of modeled O₃ distributions. Several aspects of the impact of changed dynamical conditions on the efficiency of stratospheric NO_x de-

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position (see comments below) should be treated in more detail. Further, the evaluation should be extended to both hemispheres. I recommend publication after addressing the specific comments listed below.

Specific comments:

1. The authors state that the strengthening of a future BD-circulation is related to increased planetary wave drag. This, however, would also result in modified filtering conditions for gravity waves which might affect the meridional circulation. This effect could be even of higher importance for the EEP-NO_x deposition into the stratosphere since descent from the EEP source region into the lower mesosphere during polar winter is driven by the meridional circulation. The authors should comment on the ability of their model to account for this effect and - if so - describe the modeled circulation changes.
2. What are the implications of the modified BD circulation patterns on the polar vortex, particularly in the mesosphere? From increased planetary wave activity, I would expect a weakening of the vortex and a tendency to encounter vortex air masses at illuminated lower latitudes resulting in increased photochemical NO_x losses. The authors should comment on /analyze the possible modification of the net NO_x flux into the stratosphere by changed vortex characteristics in the future scenario.
3. Stratospheric warming events (SSWs) have an important impact on the efficiency of EEP NO_x deposition by decelerating mesospheric descent and increased mixing to mid-latitudinal regions where NO_x loss occurs (in the mesosphere). On the other hand, enhanced descent occurred in the aftermath of SSWs in several recent NH winters (2004, 2006, and 2009, see Randall et al., GRL, 2009). Is the EMAC model able to generate SSWs (in the NH)? If so, is a change in SSW frequency (related to enhanced planetary wave activity) observed in 2100 compared to present day? The authors should comment on possible implications for EEP NO_x descent (particularly in the NH), even if no SSWs occurred in their simulations.

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4. Why do the authors restrict their analysis to the SH? It would be very interesting to see the effects in NH winter, although the overall magnitude of EEP NO_x deposition might be less then in the SH.

5. Apart of catalytic ozone destruction, enhanced NO_x might also lead to a reduction of chlorine-related ozone loss in the lower stratosphere by formation of ClONO₂. The magnitude of this "inverse" EEP effect depends among others on the chlorine loading which should be different to present day in 2100. However, nothing on chlorine is mentioned in description of the 2100 model setup (Sec. 2.3).

6. Evaluation of circulation changes (p 9902 l22f): Ozone is not an ideal tracer to evaluate circulation changes between 2100 and present day. As the authors state on p 9903, chemical losses and productions of ozone differ in the two scenarios due to temperature differences, etc. The use of CH₄ or N₂O distributions would probably be a better choice. It would also be very interesting to see CO distributions, particularly in the mesosphere, in order to evaluate possible changes in mesospheric descent.

Minor comments:

Figs. 7 and 8: Significant areas of NO_x changes (enhancements?) and ozone loss are also found in the lower mid-latitude lower stratosphere. However, their magnitude can hardly be assessed from these plots due to the choice of contour lines (particularly in the case of NO_x). Note that the small ozone vmr decreases in the lower stratosphere might be of importance for evaluation of the effect on total ozone!

Fig. 5: middle boxes should state EEP NO_x off.

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