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Atmospheric Chemistry and Physics Discussions

Interactive comment on "NO_y production, ozone loss and changes in net radiative heating due to energetic particle precipitation in 2002–2010" *by* Miriam Sinnhuber et al.

Anonymous Referee #1

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Summary:

This paper uses three models nudged to reanalysis data to simulate electron and SPE propton effects on chemical composition of the middle atmosphere and the associated radiative impact. In particular, there is comparison of modeled and observed NOy as well as the impact of EPP on ozone. The authors show that the EPP indirect effect can account for some of the warming and cooling signal previously attributed to dynamics.

I recommend that the article be published subject to additional discussion of the issues raised below.

Major Comment:

On page 26 (around line 20) the authors speculate that application of the boundary condition in EMAC at 80 km may be resulting in excessive ozone loss. Semeniuk et al. (2011) using CMAM simulated large ozone losses around 50% at 80 km in the winter polar caps (70-90) South and North due to EPP HOx. Peak loss values were over 70% which agrees with the EMAC predicted losses averaged over the same period. CMAM did not use a boundary condition to drive EPP NOx but used the Jackman scheme for EPP NOx production and the Solomon scheme for EPP HOx production. So author's speculation about excessive O3 destruction based on excessive activity of the NO + O3 reaction does not apply to the CMAM and hence appears to be dubious. I suggest the authors either change the discussion of this aspect or conduct a more detailed chemistry analysis.

At the same time the ozone loss in the stratosphere aside from the peak years (2004-2005, 2006-2007) in the northern hemisphere is below 10% (closer to 5%) which agrees with CMAM as well. The CMAM EPP energy deposition was nonlocal extending below 80 km in a rapidly evanescent tail unlike in EMAC where an upper boundary condition was used. So it appears consistent with the vertical transport in EMAC being hyperactive at least in the mesosphere.

However, it is not clear that electron EPP is zero below 80 km during winter. In fact, there is likely to be a substantial energy deposition between 70 and 80 km associated with relativistic electrons. Differences in transport above 80 km between the two high lid models likely account for the large NOy differences compared to MIPAS. In some sense the boundary condition approach in low-lid EMAC may be better since the EPP NOy (and HOx) production is not as affected by model transport pathologies above 80 km. Both KASIMA and EMAC have better NOy distribution patterns in the upper mesosphere compared ot 3dCTM (e.g. 2003-4, 2009-10 in both hemisphere) but EMAC appears to be best.

The differences in terms of ozone loss shown in Figures 8 and 9 do not necessarily reflect problems with EMAC. There is sufficient reason to question the realism of chemical conditions in the upper mesosphere in 3dCTM and KASIMA.

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