

## ***Interactive comment on “A semi-empirical model for mesospheric and stratospheric NO<sub>y</sub> produced by energetic particle precipitation” by Bernd Funke et al.***

### **Anonymous Referee #1**

Received and published: 18 April 2016

General comments: The manuscript continues the series of publications devoted to the analysis nitrogen oxides produced by precipitating energetic particles (EPP-NO<sub>y</sub>) and describes semi-empirical model (SEM) designed to represent EPP-NO<sub>y</sub> concentration and fluxes as a function of geomagnetic activity index  $A_p$ . The SEM is also able to treat enhanced downward transport caused by the elevated stratopause (ES) events. The described model is extremely valuable for the scientists interested in the influence of the EPP on the ozone layer and climate, which does not possess a chemistry-climate model (CCM) extending to the lower thermosphere (up to 130 km or higher). The SEM is also important for the development of the EPP-NO<sub>y</sub> scenarios for the distant past and future. The subject of the manuscript is perfectly appropriate for ACP, because

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it provides not only the description of the model, but also analyses the evolution of EPP-NO<sub>y</sub> in the past. The manuscript is well written, the most of relevant publications are cited, the figures are clear. Therefore, I can recommend the manuscript for the publication with minor to moderate revisions (see below).

Main issues: 1. I suggest adding a small section describing very practical aspects of the model applications. In particular I did not find clear description of how to apply ES treatment for free running CCM. It will make easier model use by the interested groups.

Minor issues: 1. Page 1, Line 3: I would rephrase “used in a previous study”

2. Page 2, Lines 12-16: The authors mentioned that correlation with A<sub>p</sub> is high for SH and unperturbed NH winters. After they said that EPP source dominates. I feel some not perfect logic here. If the geomagnetic activity dominates why to work on ES cases later on?

3. Page 2, Line 27: And probably the availability of the solar light plays a role.

4. Page 2, Line 30: “To be submitted” is not appropriate and confusing for the reader.

5. Page 2, Line 35: I suggest adding something more recent publications by Malliniemi et al. (2013 or 2014).

6. Page 3, Line 1: “A large number” is too optimistic, I think.

7. Page 3, Line 9: It sounds like the model provides all components of NO<sub>y</sub> balance. Please, clarify.

8. Page 4, Line 1: Rephrase, in the present form it does not sound good.

9. Page 4, lines 18-19: For some cases the contribution from radiation belt electrons can be important (Andersson et al., 2014; Arsenovic et al., 2016)

10. Page 27, Line 20: Please, specify pressure level where the not EPP related effects are not negligible. Does it also depend on the season?

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11. Page 30, lines 21-30: I do not clearly understand the paragraph describing the treatment of the ES events. How they can be used this in free running models?
12. Page 31, line 13: Does model takes into account changing N<sub>2</sub>O mixing ratio?
13. Page 31, line 25: I think using “to be submitted” is not appropriate.
14. Page 31, line 26: IDL code is not there.

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