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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Chemistry of sprite discharges through ion-neutral reactions" *by* Y. Hiraki et al.

Anonymous Referee #2

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General comments

This paper presents the results of an ion-neutral chemical model used to evaluate the chemical effects of sprites in the mesosphere, with a special focus on the sprite streamer. The authors show that the nocturnal concentrations of NO, H, OH and ozone are increased through the reactions triggered in the sprite streamer head. They calculate the ambient concentrations as a function of time and show significant impact lasting 1 hour after the event. The paper is well-structured, coherent and clear, and offers an important contribution to the field, and I therefore recommend it to be accepted to ACP. I have some questions to the authors which need to be addressed. Additionally, there are a few minor comments (mostly on the style and syntax) which I list in a separate page, and I ask that the authors to make sure are ironed out from the final

version.

Specific Comments

1. Introduction ; this section is well written but lacks data on the temporal aspects of sprites ; please add information on the duration of typical events (See for example Sao-Sabbas et al., JASTP, 2003 or the works by the Stanford group, e.g Inan et al).

2. Section 2.1 ; sprite model: the assumption that the lightning-induced electric field above the thundercloud is directed almost vertically is really an approximation, as it has already been shown that in the lower parts (around altitude 40-50 km) the sprite tendrils tend to curve and converge into the location of the charge center. This had been shown and discussed by Neubert et al. (JASTP, 2004).

3. Section 2.1 ; sprite model: when referring to the values taken from Kulikovsky (1997)please explain what you mean by "neglecting factors of differences". This statement is somewhat confusing.

4. Section 2.2 ; chemical model: Please explain the sentence: "The altitude interaction makes no sense because ... does not coincide with t0". I do not understand what you mean by "makes no sense". Do you mean it is not important? Why so?

5. Section 2.2 ; chemical model, last paragraph in P. 5: please explain the validity of the assumption that the estimation of the secondary sprite impact can be based on horizontal advection. What is the wind speed and how long will the disturbance travel "to the other site"? Some quantitative data is needed here.

6. Section 4 Discussion: p.10 ; what do you mean by "we focus nitric oxide NO of the most possible one"? I find this sentence confusing and unclear. Please re-write and explain.

7. Section 4 Discussion p.11, in comparing with other works, the authors focus solely on the work by Ennel et al. (2005). They should also discuss the latest paper by Pasko (Pasko, V.P., Red sprite discharges in the atmosphere at high altitude: The molecular

ACPD

8, S255–S258, 2008

physics and the similarity with laboratory discharges, Plasma Sources Sci. Technol., 16, S13-S29, 2007) with specific comparison to reported laboratory experiments.

8. Section 5 Summary: the entire section needs re-formulating. It is not clear and some of the sentences are confusing. Also, I expected it to include reference to future work and what improvements the authors think should be added to their model.

Technical comments

1. The level of presentation of this manuscript is mostly acceptable, but in several parts it is insufficient, with some spelling, syntax and style errors. I therefore suggest employing technical editing for improvement of the level of English, style and lucidity of the text.

2. Throughout the Discussion section, please modify the usage of the term "order" to "orders of magnitude" so it conveys the proper meaning in good English. For example instead of writing "is over the order of 6" [Discussion p.10] write "over 6 orders of magnitude". Instead of "instantaneously by the order of 6" [p.11], change to "by 6 orders of magnitude", or in the Summary [p.12]"by the orders up to 8" should be changed to "by 8 orders of magnitude", and so on.

3. P.7. last paragraph: change to "The excited state O(1D) diminishes completely within 1 s through"; In that paragraph, not sure what you mean by "It is summarized" maybe the word "concluded" is better.

4. P.8, right after equation (9) you state that "..both H and OH [concentrations] increase exclusively". What do you mean by "exclusively" are they the only species whose concentration increases? If yes, please simplify the sentence to convey the correct meaning.

5. P.8, 3rd line below equation (12) surely you mean "molecules" rather than "particles"?

6. P.9 4th line from bottom: when you write "uncertainty in rate coefficient is under our

ACPD
8, S255–S258, 2008

estimation" do you actually mean that the value is below your estimation? Which is..?

7. P.11, line 15 from bottom: change "It remembers that" to "It should be pointed out that"

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ACPD

8, S255–S258, 2008