Atmos. Chem. Phys. Discuss., 13, C3222–C3225, 2013
www.atmos-chem-phys-discuss.net/13/C3222/2013/


Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Possible effect of extreme solar energetic particle events of September–October 1989 on polar stratospheric aerosols: a case study" *by* I. A. Mironova and I. G. Usoskin

**I. A. Mironova and I. G. Usoskin**

irini.mironova@gmail.com

Received and published: 6 June 2013

## Reply to Referee #2

*We thank Referee #2 for his/her helpful comments and suggestions. The Referee's Comments are noted first and then we give our Reply in italic font. All the changes in text of the paper are highlighted in bold face.*



## General comments

General comments The manuscript describes an attempt to identify the influence of the solar protons on the aerosol layer formation in the lower polar stratosphere. The subject is relevant to the journal scope and interesting for the community because the sensitivity of the aerosol layer to solar related forcing is widely discussed in the recent publications. The authors analyzed the response of the aerosol properties to several solar proton events occurred in the autumn 1989 concentrating on the strongest one (29 September 1989) using the satellite measurements performed with SAGE II and SAM II instruments. The authors identified a significant response of the aerosol UV extinction in the southern polar hemisphere from SAGE II data and less intensive response in the visible and near infrared parts of the spectrum from SAGE II and SAM II data. The authors did not make strong conclusions from their findings because from the analyzed data it is not completely clear whether the enhancement of the aerosol extinction is related to the ionization by solar protons or to the cooling of the considered layer. Despite of this, the manuscript provided interesting insight on the issue and can be published after some minor revisions.

## Specific comments

1. The latitudinal coverage of SAGE II data is described in details, while it is not the case from my point of view for SAM II. The authors mentioned that the measurements were taken at 70 deg., but it would be nice to have more exact information, which can be added to Figure 2 or like this was done in the paper by Watterson and Tuck, 1989 (doi: 10.1029/JD094iD14p16511). Later on in the text the authors mentioned that the "proper longitudes" were selected for SAM II, but it was not defined what it means.

*According to the suggestions mentioned here we have added pictures of the latitudinal coverage by SAM II to Figure 2 as well as an explanation in the text. However we did not add any information on the longitudes analysis of SAM II and SAGE II as done by Watterson and Tuck (1989), for the reason that in our case we just go through all longitudes taking into account all that covered interested for us days/latitudes.*

2. In the introduction and text it is not always properly emphasized that the manuscript describes the influence of solar protons and the effects of galactic cosmic rays were not considered. Potentially, it can lead to the misinterpretation of the results, because the opposite effects from GCR can be expected after major SPE event. Moreover, the introduction reads like the authors are promising to apply some models of the considered processes, which is not actually the case. I suggest to revise the introduction making it more focused on the aim of this particular study.

*Now the Introduction is modified in accordance with suggestions of the reviewer. We revised the introduction making it more focused on the aim of this particular study. And we have added text where we stress the difference between effects from GCR and from major SPE event.*

3. Comparison of the temperature evolution from SAGE II and SAM II data hints on the possible latitudinal shift in the SAGE II results. Figure 2 illustrates that after DOY 270 SAGE II target latitude is gradually changing from 60 deg. south to more than 70 deg south on DOY 275 and goes back afterwards. It means that the data collection points are moving from the peripherals to the center of vortex and back. Could this feature explain cooling and aerosol extinction increase in SAGE II data shown in Figure 3?

*Yes, we agree that the difference in the temperature evolutions from SAGE II and*



*SAM II is connected with latitudinal shift of the satellites. Now the latitudinal coverage by SAM II can be also seen on the Figure 2. However in spite of SAGE II coverage, that seems to be coming from the peripherals to the center of vortex and back during investigated period of time, SAM II coverage during the same DOYs, was more or less stable and persists in the polar vortex. "Could this feature explain cooling and aerosol extinction increase in SAGE II data shown in Figure 3?" - Yes, of course. However it is necessary to notice that we possible could not see the changing of aerosol optical and microphysical properties after increasing of ionization rate without increasing of aerosol extinction after decreasing of temperature. The increasing of aerosol extinction after the DOY 272 was detected by the two satellites and this aerosol extinction increasing, see, for example, red color on the Figure 3(a) by SAGE II and on the Figure 5(a) by SAM II, more promising to be connected with increasing of ions pars in atmosphere. The aerosol extinction increasing connected with temperature changes more clear shown in yellow color on the Figure 3(a) by SAGE II and on the Figure 5(a) by SAM II.*

**Minor comments and technical corrections:**

1. Page 5415, line 26: Altitudes or latitudes?
*We have changed word "altitudes" on "latitudes".*

2. Page 5416, line 5: What does “latitude distance of the orbit” means?
*We have changed this sentence.*

3. Figure 2 caption: “. . .mentioned by lines.” Probably, marked by lines reads better.
*We have changed word "mentioned" on "marked".*

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 5411, 2013.