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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Possible effect of extreme solar energetic particle event of 20 January 2005 on polar stratospheric aerosols: direct observational evidence" *by* I. A. Mironova et al.

Anonymous Referee #3

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The paper correlates a major solar energetic particle (SEP) event in January 2005 with spatially resolved polar stratospheric aerosol/cloud data from satellites. It is hypothesized that strong ionization in the polar stratosphere caused by the SEP event leads to strong changes in the observed stratospheric aerosol extinction.

For the troposphere, similar correlations have been hypothesized for several years and there it is argued that the influence of galactic cosmic ray ionization facilitates aerosol nucleation and a fraction of the freshly nucleated aerosol particles may grow to CCN size influencing cloud microphysics and eventually climate. In the present paper, a

connection is sought for polar stratospheric aerosol being influenced by ionization from a major SEP event. While such a correlation would be quite interesting I have major difficulties with the presented evidence from the interpretation of satellite data. Very similar to reviewer #2, I suspect that all the enhancements in the NH data from Jan 2005 can be explained by the occurrence of Polar Stratospheric Clouds (PSCs) without ions from the SEP event having to play a role. Therefore, the paper cannot be published in its current form and I am sceptic that it can be published at all.

Formation of PSCs is a question of vortex temperature, air mass history, abundance of HNO3, etc., and PSC formation processes are quite complex (see, e.g., Peter, 1997; Carslaw et al., 1997). Different types of PSCs exist. PSCs are expected to occur exactly in the low temperatures of late January 2005 and for the altitudes, latitudes and longitudes where enhancements in the SAGE III data were observed. Therefore it would have to be proven by detailed analysis that the SAGE III observations cannot be explained by PSC formation. The current discussion at the end of Section 4.1. (p 14013) is clearly not sufficient in this respect.

The SH data from the OSIRIS satellite shows only one day of $\sim$30% enhancement, which is, to me, insufficient to validate the claims of the paper.

Another alternative explanation for the enhancements in the satellite AEC data could be volcanic injections into the lowermost stratosphere. This possibility also needs to be discussed and checked with available volcanic emission inventories.

Another fact that speaks against the offered interpretation is that in the stratosphere aerosol growth (except for situations of PSC formation or for fresh volcanic injections) is generally a slow process as only very small amounts of condensable material are present. H2SO4 from the photolysis and oxidation of COS is thought to be the most important condensable species. Even if the SEP would lead to the nucleation of numerous ultrafine particles, it would then take much longer than 3 days for such particles to grow to sizes observable by SAGE III as there is just not enough condensable material

present to grow the aerosol. Furthermore, once formed, such particles should persist for months in the stratosphere and should not disappear after a few days (Figs. 2 and 3).

References

Carslaw, K. S., T. Peter, and S. L. Clegg, Modeling the composition of liquid stratospheric aerosols, Rev. Geophys., 35, 125–154, 1997.

Peter, T., Microphysics and heterogeneous chemistry of polar stratospheric clouds, Annu. Rev. Phys. Chem., 48, 785–822, 1997.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 14003, 2011.