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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cosmic rays, aerosol formation and cloud-condensation nuclei: sensitivities to model uncertainties" *by* E. J. Snow-Kropla et al.

Anonymous Referee #2

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General:

In this manuscript, the so-called ion-aerosol clear-air mechanism connecting cosmic rays and climate is investigated using global model simulations. The investigation expands over the previous studies on the subject 1) by using a global model having very detailed description for aerosol microphysics, and 2) by considering both Forbush decreases and typical changes between solar maximum and minimum. The paper is very well written and easy to follow. I do not find any scientific mistakes. After the authors have addressed the few minor issues given below, the paper can be accepted for publication in Atmospheric Chemistry and Physics.

Scientific comments:

Section 2.1: Two minor issues: 1) Was there some specific reason for averaging the results over 8 simulated Forbush decreases as done in the paper, 2) Why were the wavelengths 340 and 440 nm chosen as the basis for calculating the Angstrom exponent? Was it because of model size resolutions? How does it correspond to respective calculations made from AERONET or satellite retrievals?

Section 2.2: The authors should explain how the additional SOA in xSOA-experiments is distributed over the particle size spectrum. I suppose it is done similarly to other SOA. How is gas-particle portioning of organic vapors taken care of in the model? This is important since it is expected to affects greatly the relation between CN and CCN formation.

Section 3.1: Can the authors pinpoint reasons for the substantially weaker prediction of Angstrom exponent as compared with total particle number concentrations (CN10), as indicated by Figure 3? Intuitively, one would expect that CN10 values are substantially more sensitive to various model assumptions than accumulation mode particle concentrations which determine the value of Angstrom exponent.

Section 3.1: Besides aerosol number concentrations and Angstrom exponents, it would be very interesting to know how large growth rates of nucleated particle the model predicts in the boundary layer and free troposphere, and how this compares with observed growth rates. As the authors certainly know, the growth rate is a very essential quantity in determining the relation between modeled CN and CCN concentrations.

Sections 3.2.1 and 3.2.2: The changes in CN and CCN concentrations resulting from changes in cosmic ray-induced changes in nucleation are logical and well explained in the paper. How about changes in Angstrom exponent? How and by which atmospheric processes do cosmic ray flux variations influence the value of Angstrom exponent? A brief discussion on this issue would be very helpful for the reader.

Section 4, last paragraph: The authors appear to demonstrate very convincingly that the ion-aerosol clear-air mechanism is too weak to affect the connection between cosmic rays and climate. Yet they leave the door open for this mechanism by saying that they might have misinterpreted some processes. I am not very much favor in this kind of a statement. What could possibly change the conclusion about the weakness of the ion-aerosol clear-air mechanism? The authors correctly point out that we know too little about other potential mechanism, such as the near-cloud mechanism, too say anything definite for the overall connection between cosmic rays and climate.

Technical issues:

Page 2701, line 7: "coagulation a larger particle"; grammatical error

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 2697, 2011.