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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric data over a solar cycle: no connection between galactic cosmic rays and new particle formation" *by* M. Kulmala et al.

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General Comments

The role of cosmic rays as a driver of changes in the Earth's climate has been long debated. A number of theories relate cosmic ray flux and various cloud properties, with the postulate that clouds are the intermediary between cosmic rays and climate control. Cloud formation requires aerosol particles; thus, at the root of the debate is a plausible physical/chemical mechanism that relates cosmic ray flux, aerosol particle formation, and cloud droplet or ice particle nucleation on these particles. This mechanism is yet to be convincingly demonstrated.

This manuscript is a very important contribution to this topic. The authors present a combination of a number of different measurements – some of which are very novel – at different locations and at one location for a decade-long time period to arrive at the contribution of ions created by cosmic rays to new particle formation. Without this mechanism being dominant (or at least effective), a number of the cosmic ray – climate theories would lack a sound physical basis. In this respect, the paper treats a very important (and previously only incompletely explored) topic.

The results show that ion-induced particle formation accounts for at most 10% of the new particle formation, and for the vast majority of the observations, for less than 1%. Additionally, they find no significant links between new particle formation and geomagnetic activity. Given these observations, they conclude that galactic cosmic rays appear to play a minor role in particle formation, and that the postulated cosmic rays-aerosol-cloud mechanism for climate control is not dominant.

In my opinion, this manuscript is a very important contribution to resolving the debate on this topic. It is very well written, clear, and concise. I have only a small number of minor comments and suggestions for the authors. I feel that the paper is acceptable as-is; my comments refer to a few places where I feel the text could be clearer or additional explanations would help. None of my comments raise any substantive issues.

Specific comments

Page 21531, lines 21-23 The geomagnetic cutoff rigidity is below the effective atmospheric cutoff for the Hyytiälä site due to its latitude. Is this also the case for the two German sites?

Section 2.1.4 I found this section hard to digest. To what physical properties or processes do the various indicators in this section correspond? I feel that a more detailed description of the physics behind these indicators is appropriate in thei section, not just a reference to a web site. Are the aa, Kp and deltaB parameters independent?

Page 21532, line 20 Wave length should be wavelength.

Page 21533, lines 1-5 Why integrate from local sunrise to 16:00 local time? Why not integrate from local sunrise to local sunset?

Page 21533, line 19 What does the term “naturally charged” particles mean? Does this mean that the particles became charged through natural processes (as opposed to what other kinds?) Does it mean that they retain a charge for some time? Is the only difference between the AIS and the NAIS instruments the increased size range of the latter?

Page 21537, line 11 In what way can intensity frequency measurements be biased? What are some of the limitations?

Page 21537, line 22-24; Figure 8 What are the other components of J2(total) besides J2(ions) and J2(recombination)?

Page 21538, lines 1-2 I think that the conclusion here should be much stronger than “typically less than 10%”. From Figure 8, ion nucleation is less than 1% for total nucleation rates greater than 0.5 cmˆ-3 sˆ-1. It exceeds 1% for only 15 of more than about 70 (hard to read from the plot) measurements where nucleation rates are below 0.5 cmˆ-3 sˆ-1. The maximum fraction observed was about 10%; all others were about 3% or less.

Figure 3 Is the data in the lower panel a concentration or a fraction? Given the color coding I assume it is a concentration, but the caption text says fraction.

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