

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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We thank Prof. Noone for his encouraging comments. Our detailed answers to his comments are as follows:

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?

The reviewer's concern is justified: the geomagnetic cutoff indeed exceeds the atmospheric cutoff of about 1 GV for the German sites. For Hohenpeissenberg, the geomagnetic cutoff in the eccentric dipolar field approximation (IGRF 2000 epoch) is
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about 3.5 GV and for Melpitz about 2.6 GV (e.g., <http://www.cosmicrays.org/muon-cutoff-rigidity.php>). However, the overall temporal variability of CR11 is very similar for both the German and Finnish sites, only the absolute values of CR11 and the amplitude of their variability being slightly different. Furthermore, we make direct comparisons of CR11 and nucleation only for the Finnish site so none of the conclusions of the manuscript is affected by this. We have, however, modified the sentence on lines 21-23 to take this comment into account.

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 the section, not just a reference to a web site. Are the aa, Kp and deltaB parameters independent?

Geomagnetic field variations are responses to ionospheric/magnetospheric currents that are driven by interaction of the geomagnetic field with the solar wind and heliospheric magnetic field. Geomagnetic activity modulates the global electric circuit and this has been proposed as one of the extra-terrestrial mechanisms possibly affecting climate (see, e.g., Tinsley 2000). The physical processes causing the geomagnetic variations are numerous, and we feel that their in depth explanations are beyond the scope of the present study. The main point is that the connection between climate and geomagnetic activity (as represented by mostly the indices used in this study) has been actively studied in the recent years. While the main focus of our study is the connection between nucleation and CR11, we wanted to make a preliminary analysis of the other possible extra-terrestrial effects as well, as suitable data are easily available. The geomagnetic activity parameters are not, of course, completely independent. The deltaB parameter is a measure of local geomagnetic disturbances at the Hyytiälä site, whereas the aa and KP indices give a global measure of the mid-latitude geomagnetic field variations. We wanted to use all of these parameters in our study to address the possibility of local and/or global geomagnetic effects on nucleation. Another reason for the use of index data in addition to local measurements is that these data sets are

publicly available and, thus, facilitate easier comparisons with other previous and future studies of geomagnetic activity connection to atmospheric / climate parameters. Some text has been added to this section to better motivate the use of geomagnetic indices in our study.

Page 21532, line 20 Wave length should be wavelength.

We have corrected this to the revised manuscript.

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

This is a valid point. However, we think that our approach describes the brightness level well enough from the point of view of studying nucleation mechanisms, since nucleation is typically not observed after 4 pm.

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?

The term "naturally charged" refers to, as correctly pointed out by the reviewer, particles that have been charged through ionization in the atmosphere rather than in the charger of an instrument (such as the corona charger of the NAIS). The presence of the charger is the main difference between the NAIS and the AIS instruments. In the revised version of the MS we have replaced the term "naturally charged particles" with the more commonly used term "air ions" to avoid confusion.

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

Some of the main limitations include 1) possible changes in air masses during nucleation periods which might influence the interpretation of the data; 2) the 3 nm lower

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size cut-off of the DMPS instrument, which thus prohibits the observation of nucleation events that start but might not show sufficient growth. We have modified the revised manuscript to clarify these points.

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

The remaining fraction of J2 is accounted for by neutral nucleation processes. We have added an equation clarifying this point to the revised manuscript.

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 cm⁻³ s⁻¹. It exceeds 1% for only 15 of more than about (hard to read from the plot) measurements where nucleation rates are below 0.5 cm⁻³ s⁻¹. The maximum fraction observed was about 10%; all others were about 3% or less.

We agree with the reviewer. We have emphasized this conclusion in the revised MS.

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.

The reviewer is correct; it should read "concentration". We have corrected this to the revised MS.

References:

Tinsley, B. A. : Influence of Solar Wind on the Global Electric Circuit, and Inferred Effects on Cloud Microphysics, Temperature, and Dynamics in the Troposphere. Space Sci. Rev. 94, 231-258, 2000.

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