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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the role of non-electrified clouds in the Global Electric Circuit" *by* A. J. G. Baumgaertner et al.

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Before reading this interesting paper, I suggest that it would be valuable for the reader to be familiar with the study conducted by Baumgartner et al., published in JGR, volume 118, pages 9221-9232, in 2013. In this present discussion paper, the authors extend that study to consider the effects of clouds in the semi-fair weather part of the global circuit. As this paper shows, these clouds are definitely electrified, but only mildly so, nowhere near as much as are thunderclouds or electrified shower clouds, which act as batteries in the circuit. Thus I consider that the phrase "non-electrified clouds" in the title of the paper is very misleading. I suggest the term "semi-fair weather clouds". These clouds are found in the load part of the circuit, not in the generator part.

In line 1 of the Abstract, I suggest "Slightly electrified clouds in the semi-fair weather parts of the Global Electric Circuit" ... . When there are no clouds present, the term "fair weather" applies.

I would prefer the authors to start with Gauss' law, one of Maxwell's four fundamental equations, and then to consider Poisson's equation. Then, considering the reduced conductivity inside a cloud, there have to be electric charges on the top and bottom of the cloud. How large the charge density is depends on the thickness of the cloud edge. What charge densities are calculated here? Therefore the paper should also discuss clearly what is the vertical resolution of the model. Is there a standard layer separation in the model? From Figure 6, I might surmise that the vertical resolution used is 1 km. Am I correct? Or is there a more complicated type of mesh, the size of which varies according to the details of the problem considered? This issue needs to be explored clearly in this paper, in my opinion.

I like the diagrams shown in Figure 1. However, it is not clear why some arrows are of different lengths from others. Does the length represent the magnitude of the current density flowing? It could beneficially do that, I think; if so, that should be stated. In Figure 1 b), I think that the current density flowing through the cloud should be the same as that flowing in the fair weather region to the sides of the cloud. In Figure 1 c), discussed on page 8, the curved arrows should thus be shortened.

On page 6, please spell out how the curvature of the currents illustrated is calculated. What assumptions, if any, are made? It would be a good idea here to introduce here the concept of the conductivity inside the cloud (see page 12) being a factor of about 10 (or 50) less than the conductivity of cloud free air. Somewhere in the paper, referring to the literature, these numerical values should be justified.

Section 2 is written from the viewpoint of a mathematician, rather than a physicist. Whilst there is nothing wrong with that approach, I believe that the paper would be more valuable to chemists and physicists if the equations (16) and (19) were explained

physically too.

The feature which strikes me from Figure 2 is that the effective radius of this cirrus cloud at this height is about twice its actual radius. This suggests that the current density inside the cloud should be about a quarter of its value outside, as the numerical values presented demonstrate. Is there any experimental evidence for such a variation of current densities? This topic is also mentioned toward the bottom of page 14. How could such different current densities be detected?

By way of contrast, Figure 3 shows that the effective stratus cloud size is about the same as its actual size, because it is - comparatively - so close to the ground.

The numerical values for the resistances stated for different conditions are valuable, for modellers and experimenters alike. Both Figure 5 and Table 1 show clearly the magnitudes of the expected effects of different clouds. The authors might like to discuss how the results shown in Figure 7 could be used by other researchers.

I feel that the discussion in section 5 could be "sharpened up" a bit, to advantage. The Conclusions section should be rewritten to specify slightly electrified clouds (and not non-electrified clouds). The discussion on page 22 is a sound summary of the results presented here. "Allowing to assume" (on line 10) is not a very elegant expression.

There are a few errors in the references list.

The Figures and captions are clear.

Other parts of the paper clearly express what is assumed, and what is happening.

In line 4 of page 5, I suggest that it should read: Note, however, that the ... .

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 9815, 2014.