

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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Replies to Reviewer #3

We thank the reviewer for the comments on the manuscript, which helped to improve the revised version.

P. 9817, Line 19: rewrite “i.e. clouds that do not ...” as “hereby defined as clouds that do not ...”

Reply rewritten as suggested

P. 9817, Lines 19-30: This reads very much as a list of references, perhaps this
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could be re-worded ?

Reply The paragraph was rewritten and improved in this respect.

P 9825, lines 1-10: although it is stated that details of the model are presented in B13, some basic information about the model must be included here e.g. horizontal and vertical resolution of gridboxes.

Reply This was added for the revised version: "Note that the vertical coordinate system of CESM1(WACCM) is mostly based on atmospheric pressure, which is very adequate for conductivity and column resistance calculations because of the exponential increase in conductivity. The level spacing is approximately 300 m near the surface and increases to several kilometers in the stratosphere, although this depends on the chosen vertical resolution. The horizontal resolution of CESM1(WACCM) is also very flexible, and can range from 25 km to 500 km in latitude and longitude, depending on the chosen simulation grid. The simulations presented below use a grid with 1.9 degree resolution in latitude and 2.5 degree in longitude."

P 9830, line22: what is the “cloud chord length” – this should be defined, also define x. Section 4

Reply We added “cloud chord length (corresponding to the average cloud diameter, Wood and Field, 2011)”

P9832, line5: define what is being used as the base line for global resistance (for which over and under estimates are compared to)

Reply We clarified this in the revised manuscript: “...underestimates total resistance by 39% compared to the current continuity ...”. The current continuity approach values referred to are discussed on the previous page (Table 1).

P9836, lines 107: This is a particularly interesting observation given that large areas of the world's oceans are covered by broken cumulus/stratocumulus clouds, which are often very close together. It is worth mentioning this in the discussion.

Reply See reply to mutual coupling for reviewer 2.

Although clouds which are horizontally close together are considered in figure 8, can the authors say what happens in the situation in which multiple cloud layers exist (vertically separated). For example it is very common to have a layer of stratocumulus beneath a layer of cirrus – is the current reduction beneath the cloud layers simply a superposition of the individual cloud layers or does coupling exist. This is something that should be included in the discussion section.

Reply Vertical overlap will lead to a mutual coupling that can be modeled for individual clouds with the GEC model. There is not enough global data available to quantify the effect using ISCCP. CESM1 (WACCM) models multiple cloud layers and considers their overlap to give an average cloud cover for any height interval (analogous to the treatment in the radiative transfer part of the model, which also needs to consider overlap). The parametrization then assumes that the three treated height categories of clouds are not overlapping. This is discussed in more detail in the revised manuscript: “Note that the vertical overlap shown here only refers to multiple cloud layers in a grid column, but assumes that the individual clouds are not physically overlapping. Such an overlap would lead to mutual coupling of the layers and would need a more advanced treatment that cannot be considered here.”

Surely an acknowledgement to the ISCCP data set should be included here, as well as a link to where the data was obtained from.

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Reply Thank you for pointing this out, an acknowledgement and link to the data was added.

Figure 1. This is not very clear, the figure quality should be improved and the text made easier to read.

Reply We will provide a clearer vector-graphic for final publication.

Figure 2. define green line in figure 2 (b) in the caption . Consider renaming axis to “horizontal extent (km)”.

Reply Green line in Fig. 2(b) defined in revised manuscript (mean effective cloud current density). Axis renamed as suggested.

Figure 8. It is unclear how the black contour lines indicate cloud cover fraction – is another key required here?

Reply The cloud cover percentage levels are now indicated in the caption.

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

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