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Discussions

Interactive comment on "Observing relationships between lightning and cloud profiles by means of a satellite-borne cloud radar" by Martina Buiat et al.

Anonymous Referee #2

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The article proposes to use ClouSat (CPR) measurements to explore the electrification processes within 5 thunderstorms. Coincident CloudSat profiles with atmospheric discharges are used to depict the main characteristics of cloud ice water content (IWC) and ice particles effective radius (ER) distributions associated with lightning strikes. The results show that lightning strokes have maximum IWC values around 7 and 10-11 km in addition to large RE. Later based on a selected case, these two regions have IWC above 1g/m3 and ER lower than 1mm at 10 km and higher values at 7 km, which is attributed to the presence of graupel. For non-lightning cases though, only one IWC maximum is found at 10 km height. Based on that they conclude that this confirms the establishment of dipole structure and effectiveness of the non-inductive mechanisms

that promotes positive charger aloft and negative in the lower part of the cloud.

The proposed methodology is unique but caution is required because CPR is a W band radar that has strong attenuation, in addition to be affected by Mie scattering when particles are larger than 1 mm in diameter. Furthermore, the study relies on 2B-CWC-RVOD product that retrieves IWC and ER based on radar reflectivity profiles. Thus if the profile is attenuated those estimates are compromised. As a matter fact, the main charging mechanism relies on the presence of ice particles, graupel and super-cooled droplets that can reach diameters above 1-2 mm in the mixed region (between 0 and -20C, or 3.5-7 km height), thus we would expect considerable attenuation and Mie scattering effects especially when liquid droplets are present. As these effects have not been addressed in the article it is hard to confirm the validity of the conclusions. Based on that, the authors need prove that the IWC and ER values are not affected by attenuation neither by Mie scattering. Furthermore, the authors also need to address the general comments below to be considerate for publication.

General comments:

Lines 20-37 - Consider re-doing the introduction because there are a lot of studies showing how much charge is transfered in different electrification mechanisms. So, it is not a debate but we can say that we don't have a consensus.

The non inductive process, graupel-ice collisions, is the most efficient process in transferring charges, and not "is one of the most accredited" as in the text. Therefore, use the compilations on "The Electrical Nature of Storms from MacGorman and Rust and Microphysics of Clouds and Precipitation from Pruppacher" to explain better the electrification process.

Toracinta 1995 did not make any charge transfer studies, He looked in the relations between radar reflectivity, microwave Tb and lightning.

Not just Jayaratne found a temperature dependence, but also Takahashi, Saunders,

Avila and many others. Furthermore, charge gain is not related to +CG. Consider revising the following sentences that are analyzing the observation of +CG with hail, tornados and severe weather..

Line 65 – Petersen computed integrated ice content from 2A25-PR radar reflectivity profiles based on some assumptions, because TRMM does not make available "cloud ice microphysics information" as stated. Revise.

Line 68-70. It is true that TRMM-PR does not detect small ice particles, mainly because its sensitivity that is 17 dBZ, but it does detect graupel and super-cooled water droplets. Nonetheless, the W band CloudSat radar detects small ice particles and water droplets, but near 15-20 dBZ begins to have strong attenuation. Therefore, work on this paragraph to show what CPR sees, what are the limitations to support what you are about show on the results otherwise your results could be meaningless.

Lines 89-94. Present the limitation and errors of the retrieved ice content and effective radius on 2B-CWC-RVOD product. Moreover, this product does not take into account graupel, therefore you need to explore and explain how you will be able to state that you measured such particles in the profile.

Line 96 – 104 – Focus only on LINET technology, don't need to explore other technologies. Consider removing this paragraph, otherwise do a better revision because you need to explain better VLF, LF, HF and VHF emissions, propagation of E and B fields and etc.

Line 105-106 – TOA was not invented because we can not discriminate IC and CG on peak current and E/B field amplitudes. To do that we use waveforms to discriminate IC and CG. Revise your statements.

Results

As CPR suffers from attenuation, it is really important to constrain the analysis up to the level that there is no significant attenuation, because IWC and Reff retrievals might

me erroneous. Despite that, you need to explain how you can detect graupel in the presence of super-cooled water droplets because as those particles have diameter above 1 mm you are in the Mie scattering regime and radar reflectivity values differ from the Rayleigh scattering approximation.

Moreover, as this study wants to investigate the cloud electrification process, it is important to show what it is in the mixed phase region where we do have the presence of ice particles, graupel and super-cooled water droplets, mainly within 0 and -20oC. According to Milano radiosondes on the day of your study, the mixed regions was between 3.5 and 7 km height. Therefore, check first if you don't have any attenuation in this region, then pull some statistics in the mixed phase and add a temperature axis on your figures (Figure 6).

It is a fact that LINET measures both IC and CG strokes, mainly the end channel position (return stroke). These lightning discharges propagate differently, i.e., IC can be assumed to be almost horizontal in height while CG it is a vertical propagation. Thus, if you are looking to see the charge regions, vertical profiles are only suitable for CG not IC. Therefore, you need to redo your analysis only for CG events. For IC though, you might need to do a different approach.

Based on the above arguments you need to redo the results of Figure 1 and 2 to take into account the effects of attenuation and only CG strokes. In addition compute specific statistics over the mixed region only. Furthermore, as you have very few measurements you need to show statistical tests that can confirm your results.

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