Evolutionary Characteristics of Lightning and Radar Echo Structure in Thunderstorms based on the TRMM Satellite

This manuscript aims explore the TRMM PR radar characteristics of RPFs with and without lightning over the steep terrain gradient from the Himalayan Plateau east to the South/East China Sea, and examining these characteristics from the perspective of convective lifecycle.

From a composition standpoint, there are numerous construction and grammar errors, and several instances of text copied from other articles, teetering on plagiarism. Although much of the authors' scientific argument hinges on the classification of RPFs into different lifecycle stages, the authors do not use consistent nomenclature throughout the text, which becomes exceedingly confusing.

From a scientific standpoint, I have strong reservations about using the convective/total precipitation ratio to classify storms by lifecycle stage, especially when comparing storms with lightning and without, and over diverse terrain. Convective mode will vary extremely widely by geographic regime, and the 'maturity' of storms in each regime is not universal.

Throughout the text there are many instances of gross understatement and overgeneralization of electrified convection and orographic enhancement/forcing of precipitation, and arguments made for the primitivity of the field of meteorology in these areas that is very much so not the case now. I have grave concerns about this manuscript's composition, scientific argument, and methodology, for these reasons, I find this manuscript to be substandard for this publication and suggest rejection.

<u>Major/Thematic Comments:</u>

The use of the convective/total precipitation ratio as a rough measure of an MCS's maturity dates back to Houze's 1997 paper, but its application requires the inherent assumption that you are comparing features of a same morphology, and perhaps even stricter, only comparing MCSs at different lifecycle stages. Bang and Zipser (2015) employ this ratio on RPFs with lightning only. To apply that methodology to very different geographical regimes and apply it to the entire convective spectrum is misleading. And, while I strongly do not believe that you should, there is not a point in the manuscript where you use the differing ratios explicitly to confine the RPFs into lifecycle stages, despite mentioning the different stages multiple times. This method of determining maturity is flawed, and even then, is not described clearly. I suggest looking at the recent works of Roca, Fiolleau, and Bouniol for an alternate approach to describing the lifecycle of convection.

Satellites in low earth orbit, such as TRMM, only get an instantaneous 'snapshot' of the precipitation, and therefore there are likely many cases of RPFs that were electrified and did produce lightning, especially over the ocean, where flashrates are low, that were not observed by the LIS. This is likely not very rare, as the authors argue, and may cause problems with this line of argument.

In examining the radar reflectivity heights and profiles of RPFs with and without lightning over terrain, and over land vs. ocean, this manuscript provides little new insight beyond what Zipser, Cecil, and Liu have done in years past with the TRMM PF/RPF dataset. I find little new scientific progress accomplished by this manuscript, nor do I believe the work is a good fit for the ACP journal.

Composition Comments:

Throughout the manuscript, especially in the earlier introduction and methodology sections, there are large portions of text that appear from their sources (cited or otherwise) largely without or with barely minimal paraphrasing. I present a handful of examples below:

3. 24 "Thunderstorms are responsible for the development and formation of many severe weather phenomena"

"Thunderstorms are responsible for the development and formation of many severe weather phenomena."

https://en.wikipedia.org/wiki/Thunderstorm

4.54 ". . . mesoscale convective systems with the most robust stratiform regions occur primarily in the rainiest season and regions"

"Convective systems exhibiting broad stratiform regions occur primarily in the rainiest season and regions"

(Romatschke et al., 2010; p. 419)

4.62 ". . . the juxtaposition of updraft and mixed-phase microphysics (0 to −40C) provides favorable conditions where non-inductive charging can efficiently occur via collision and separation between graupel/hail and ice crystals in the presence of supercooled liquid water in thunderclouds"

"This juxtaposition of updraft and mixed phase microphysics provides a region where noninductive charging can efficiently occur via rebounding collisions between graupel/hail and ice crystals in the presence of supercooled liquid water"

(Deierling and Peterson, 2008; p. 16210)

8.154 "This study followed the logic used in previous studies (e.g., Houze, 1997; Romatschke and Houze, 2010; Zuluaga and Houze, 2015) that as a convective system evolves, the young, vigorous convective region matures into widespread convection coexisting with a stratiform region, and finally into mostly stratiform precipitation. A ratio value of 1 means that the storm is 100% convective, which is commonly typified as 'young' convection, whereas a value close to 0 means that the dominant radar precipitation feature (RPF) is stratiform precipitation, which is typified as 'mature' convection."

"A value of 1 means that the RPF is 100% convective, which is commonly typified as "young" convection, whereas a value close to 0 means that the RPF is dominantly stratiform precipitation, which is typified as "mature." This logic is put forth in numerous papers [e.g., Houze, 1997; Romatschke and Houze, 2010; Zuluaga and Houze,2015] in that as a mesoscale convective system (MCS) evolves, the young, vigorous convective region matures into widespread convection coexisting with a stratiform region and finally into mostly stratiform precipitation."

(Bang and Zipser, 2015; p 6845)

Several of these instances were detected using the similarity software, as below:

(e.g., Houze, 1997; 153 **Romatschke and Houze, 2010; Zuluaga and Houze, 2015) that as a convective system** 154 **evolves, the young,** vigorous **convective region matures into widespread convection** 8 **coexisting with a stratiform region, and finally into mostly stratiform precipitation.**

I do not believe that inserting the word "vigorous" into an otherwise unchanged sentence - including the references - constitutes paraphrasing.

16.325 "The convective intensity can be defined by the properties of the convective updrafts in a storm"

". . . intensity can be defined by the properties of the convective updrafts in a storm . . ."

(Zipser et al., 2006; p. 1060)

<u>Other Composition Comments:</u>

There are massive overgeneralizations in the text, such as thunderstorms usually occur randomly in time and space," which is simply not true. Also comments like "the stronger the convective intensity of a thunderstorm, the more the lightning," made without citation or context, is a gross overstatement. ". . . lightning discharge is produced when the electric field in thunderclouds break through a certain threshold" is also a massive oversimplification of the noninductive ice-ice collision mechanism and the dieletric threshold.

Despite a large portion of scientific argument resting upon lifecycle classification, and it not being made explicitly clear as to how this classification is conducted using the convective/total ratio – the naming convention of the lifecycle stages is not consistent throughout this manuscript. The first stage is described as "initiation," "cumulus," and "triggering" and at one point, "mature" is broken up into "pre-mature, mature, and post-mature," which already is confusing, an add to the fact that the original term is included within the new term's subdivision. This makes it very difficult for readers to deduce the points you are trying to make about each.

The authors use the terms "non-sun-synchronous" and "non-geostationary" interchangeably to describe the low earth orbit of TRMM, and while TRMM is in fact neither of those types of satellite, they also mean two very different things for spaceborne observations.

I find the phrase "hilly land" to be too colloquial for formal scientific writing.

The figures, in general, are well-made and well-captioned. I would suggest in future to make the panels of figures such as 4 and 5 larger, as at present they are too small for readers' eyes to resolve the white count contours and the finer detail in the gradients of the probability of lightning colors.