The authors study two lightning cases (the first and fourth cloud of a thunderstorm event) using a dual frequency radar (with unfortunately only one usable frequency of 35 GHz). The authors combine polarimetry and Doppler spectra to present an interesting and novel study which looks at the presence of different hydrometeor types and their alignment in thunderstorm clouds around the times when lightning is occurring. Other processes such as turbulence are also considered.

Although the manuscript is interesting and novel, I think it will benefit from the edits described in this document. In particular, I believe some of the analysis is based on scattering simulations which are not representative of the problem. I would like to see improvements related to that, or at least some clarification on why the authors believe conclusions can be drawn from these scattering simulations. Because of this, my recommendation is a major revision.

General comments

1- I feel like the section/subsection organisation in section 5 could be better. The current organisation is:

5 Case analysis
- 5.1 First cloud
  - 5.1.1 Alignment of particles
  - 5.1.2 Supercooled liquid water
- 5.2 Fourth cloud
  - 5.2.1 Evidence of conical graupel
  - 5.2.2 Alignment of particles
  - 5.2.3 Strong updraft and turbulence
  - 5.2.4 Possibility of chains

In terms of the subsections (5.1 and 5.2) I find it slightly confusing to refer to the first and fourth cloud. Without reading the paper in depth, one might expect to find sections for the second and third clouds too. Perhaps it's worth changing to something like cloud A and cloud B rather than first cloud and fourth cloud, and then just pointing out which clouds they are.
Moreover, I think it might be better if the subsubsections were consistent in subsections 5.1 and 5.2. For example, something along the lines of:

5 Case analysis
- 5.1 Cloud A
  - 5.1.1 Alignment of particles
  - 5.1.2 Interesting microphysical properties
- 5.2 Cloud B
  - 5.2.1 Alignment of particles
  - 5.2.2 Interesting microphysical properties

Or maybe 3 subsubsections like particle properties, particle alignment, other interesting findings…

2- In various places you refer to “Mie scattering” and the “Mie scattering regime”. I understand that you are talking about non-Rayleigh scattering, and to me describing this as the “Mie scattering regime” is ok (although you could consider “resonance regime”). Referring to “Mie scattering” on its own is slightly questionable to me, as Mie theory is applicable only to spheres. I recommend that in places where you say “Mie scattering” you could change to resonance or non-Rayleigh scattering (unless you are talking about spheres in any of these places…).

Specific comments

Line 11: these thunderstorm clouds, or all thunderstorm clouds?

Consider adding Saunders and Wahab reference for lab measurements of chains forming due to electric fields at -12C and -8C:
Saunders, C. P. R. and N. M. A. Wahab, 1975: The influence of electric fields on the aggregation of ice crystals. J. Meteorol. Soc. Jpn., 53, 121–126.

Also Stith et al 2002 for chains observed in clouds:
Stith, J. L., J. E. Dye, A. Bansemer, A. J. Heymsfield, C. A. Grainger, W. A. Petersen, and R. Cifelli, 2002: Microphysical Observations of Tropical Clouds. *J. Appl. Meteor. Climatol.*, **41**, 97–117, https://doi.org/10.1175/1520-0450(2002)041<0097:MOOTC>2.0.CO;2.

54/55: Riming doesn’t necessarily form large, dense, near spherical particles. For example, if you have a single dendrite monomer which experiences light riming, it won’t become much bigger or “near spherical”. Perhaps you could rephrase this in a less extreme way, such as “…generally resulting in increased particle size, density and sphericity”.

60 and 63: You refer to aggregates as spherical. The appropriate shape approximation of aggregates is something that is still debated (e.g. see the introduction of this paper: https://doi.org/10.5194/amt-14-6851-2021), but usually a spheroidal or ellipsoidal shape would be assumed rather than a sphere. Anyway, in this instance it is probably sufficient to make very slight edits like:
- On line 60 you could maybe just make it more general, e.g. “…form larger particles that *tend to be* more spherical in shape”. On line 63 you could just remove the word “spherical”.

81: “, which also implies the existence of collisions of hydrometeors.” I’m not sure what you mean here. Do you mean that collisions are more likely because there are mixtures of particles with different velocities?

118: Is the 94 GHz completely un-usable? The combination of 35 and 94 would be beneficial for determination of particle size. In fact, unless you are referring to something else, this is

precisely thanks to “complications due to Mie scattering”. Can you not just correct for attenuation; I think you can correct for liquid water attenuation because you know the LWP?

112 (Section 2): In Figure 2 you have numbered clouds to identify which ones you are referring to. In the other figures (Figs. 3-5) it would be useful if you highlighted the regions of interest somehow, e.g. by drawing lines or a box around the specific times/heights you are looking at.

150: does the high SLDR occur slightly later than the negative ZDR? Hard to tell on this axis.

240-244: it would be helpful to include approximate values such as Doppler velocities close to 0m/s rather than just referring to the right and left part of the spectrum.

245/470: Your references Lu et al 2016 a and b are the same paper
Did you extract the conical graupel from the database, or does it have the information about negative ZDR and conical graupel in the reference you give?

Maybe the Aydin and Seliga (1984) paper could be useful for you:
https://journals.ametsoc.org/view/journals/atsc/41/11/1520-0469_1984_041_1887_rpbpoc_2_0_co_2.xml

255: could you add some references for “This part of the spectrum is often referred to as the Rayleigh plateau”?

285: as you are saying m_eff can be determined, would it be better for the equation to be m_eff=sqrt(eps_eff)?

291: “different types of particles” is a bit vague, please elaborate

295: Why did you choose these particular values of axis ratio and ice fraction? E.g. aggregates are often considered to have aspect ratio 0.6.

313: Can you provide an explanation of how a horizontally aligned prolate spheroidal model is different to an oblate spheroid?

319 (and elsewhere): Figure caption – change “scatterers” to spheroids

320: Figure 9 and Figure 10 - You don’t seem to refer to the reflectivity plots here, either include a reference to them in the discussion, or remove them. This could even be something simple like pointing out that the Mie minimums can be seen in the reflectivity plots.

325: You are talking about ice fractions of 0.8 and 1, right? Thus, I think “For a radius of larger than 2.5 mm representing large aggregates such as graupel” is a bit misleading, as presumably such large ice fractions would *only* represent graupel / some heavily rimed particle and not any other unrimed aggregate type? If you agree, you could just rephrase e.g. “Particles of this size and ice fraction could represent graupel…”.

366: why small but not large? Do you just mean that large particles usually aren't oriented by the field? Please elaborate.

368: What is the temperature here, can you get any information on the particles from that? Perhaps you only have temperature measurements in the vertical.

381: this is interesting, how did you obtain the "lightest 10%"?

387: Be consistent with units, either m or km

390: You mention Fig. 16 here but I think you have not yet discussed Figs 14 or 15, maybe the figures should be reordered.

406/408: make the vertical wind shear units the same.

417: here and in the rest of the subsubsection, you refer to "a lightning" or "lightnings". I believe these should be "a lightning stroke" and "lightning strokes".

450: What frequency? The caption of Fig 18 says 94 GHz but line 130 says LWP comes from 31.4GHz?

468: Can you explain what you mean by "Since small particles are more easily aligned by an electric field and they are not aligned in this case,"? Do you just mean that the part of the spectrum corresponding to small particles has sZDR close to zero, implying that the negative sZDR corresponding to the larger particles is not caused by vertical alignment?

There is also lower correlation coefficient in this region, implying mixture of particle shapes.

477: You hypothesize conical graupel, but you then model conical graupel with a spheroid. Please provide an argument for why you think you can get any information about conicality if you are using a spheroid. Perhaps you could just refer to results/simulations in the literature for conical graupel.

486: supported by low correlation coefficient

Figs 22 and 28: It's quite hard to compare the measurements and simulations here due to different y-axis scales and different variables on x-axis. Consider at least making the scale of the y-axis the same for observations and simulations. Can you calculate the fall speeds of your model particles and plot that on x-axis? Also, are your labels and units accurate? E.g. are you plotting reflectivity [dBZ] or spectral reflectivity [dBsZ]?

578: I think you should rephrase this or expand it a bit. At the minute it might be misinterpreted as if chains can only be found if the temperature is below -40. I think what you are trying to say is that although aggregation is usually associated with slightly warmer temperatures (maybe above -25), the presence of electric fields allows chains to form in colder temperature regions, which has been observed at temperatures below -40 (Stith et al

2002; Connolly et al 2005; Gayet et al 2012)? Maybe this could be mentioned around line 65 when you are discussing chains in cold temperatures.

581 onwards: Chains are modelled as prolate particles with axis ratio 7 and ice fraction 0.3. Can you put a reference here as to why you think 0.3 is suitable.

At 17:22, From high ZDR and positive ZDR spectrum you hypothesize that there may be chain-like aggregates. The low correlation coefficient suggests a mixture of particles. If small particles and chains co-exist here, could you comment on why sZDR in Fig 28e would be positive. Do you think if there was a high E-field forming the chains, the small particles would be oriented vertically by the field giving negative sZDR?

You say that you should use axis ratio much greater than 1, but that the maximum you can use is 7 otherwise the code cannot converge. Can you provide more specific details on sizes and axis ratios here please? For example, what are the maximum sizes that have been observed before? You have an example in Fig 1 which is 721 microns. You also say that the individual monomers could be 15-20 microns. Are you then calculating the axis ratio as, for example, 721/15=48? I don't think you can get much information about a chain with axis ratio 48 by modelling it as a prolate particle with axis ratio 7, which you also point out in the next paragraph. You show simulations in Fig. 28 for particles with a much larger maximum dimension of up to 3mm, and then point out that chains of this size have not been observed. Can the code converge if you use smaller sizes less than 1mm with a larger axis ratio?

I personally think the section is not very useful because the scattering simulations kind of go nowhere, then you say an alternative would be to look at data which isn't possible. I think you should either repeat simulations using more representative particles, or just remove the section and add a line saying that the high ZDR could be caused by chains.

640: Is there any scope to track thunderstorm evolution using steerable radars, like they did with weather radars during the WOEST campaign in the UK?

Technical corrections

Line 2: a cloud radar
Line 3: a thunderstorm case
Line 4/5: maybe "in the millimeter band", or something similar…kind of sounds like its exactly 1mm now
Line 5: studies *of* thunderstorm clouds
Line 18: phenomenon
Line 38: pellets
Line 70: when *the* ice particle number
High concentration*s*
Line 73: Evidence
Line 101: need brackets around citations
Around line 276: sometimes use 1 sometimes one
Line 151: associated *with*

Line 216: dealias
Line 232: change *would* align to *can* align?
Line 240: spectra
329 Fig 9 caption: change (a-c) to Panels (a-c). Same for (d-f)
365: ~~is~~ are close to zero and do not show much variation~~s~~
473: Scattering simulation*s are* (or *a* scattering simulation is)
578: In the case being studied, *the* temperature
580: Scattering simulation*s are*
592: *in* Fig 28c or (Fig 28c)