Comment on acp-2021-346
Anonymous Referee #1

Referee comment on "Overview: Fusion of Radar Polarimetry and Numerical Atmospheric Modelling Towards an Improved Understanding of Cloud and Precipitation Processes" by Silke Trömel et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-346-RC1, 2021

Title: Overview: Fusion of Radar Polarimetry and Numerical Atmospheric Modelling Towards an Improved Understanding of Cloud and Precipitation Processes.

General Comments: As the overview article for the PROM special issue, this manuscript provides a well-rounded description of the constituent PROM projects. Preliminary results and updates for each of the projects are included along with some context for where they fit into the current state-of-the-art understanding of combining radar polarimetry with models. Overall, the writing is clear and well-organized, with concise summaries of what has been found so far and what is planned for phase 2 of the project, although there are at times awkward phrasings and sentences that should be re-organized (some of which are addressed in the technical corrections). In general, given the scope of how many topics, projects, and data sources are covered in the paper, the large majority of comments are merely clarifying in nature, although some work is needed to make some of the formatting of the manuscript consistent throughout (e.g., abbreviations, date formatting, references, etc). Otherwise pending some of the requested clarifications I believe the manuscript can be published in the special issue.

Specific Comments:

Line 24 (and 40): Is there evidence that can be provided that cloud and precipitation processes are “the” main source of uncertainty in NWP, or one among many? Consider changing "the” to "a”.

Line 53: I understand what the authors mean by "the triangle" of polarimetry, models, and DA, but this phrasing is a bit awkward. Perhaps “tripartite” might work better here, or "the triangle between radar polarimetry...”

Line 62: Can the authors expand a bit on what is meant by “quantitative process detection”? Is this referring to things like Hydrometeor Classification Algorithms or more like a quantitative analysis of polarimetric fingerprints?

Line 76 and elsewhere: Inconsistent abbreviation for Section (e.g., Sec. vs. Sect.). I
would tend toward not abbreviating it at all, but it should be consistent.

Line 99: Do the authors mean fronts themselves or frontal precipitation being composed of these filaments? Please clarify. It is also not immediately clear to the reviewer how this portion relates to the rest of the paragraph/work.

Line 104: Please define the acronym ECHAM.

Line 113: I find the reference to the “ICON variants” confusing. Do the authors mean the NWP-scale ICON versions (i.e., those that inherited the COSMO microphysics)? Or do they mean the ICON model in general vs. either ECHAM or COSMO? Please clarify.

Line 118: Can the authors expand just a bit on what is meant by “intricate” here? Is it that the actual distributions are more intricate as is inherent to all spectral bin approaches or are there additional numbers of ice categories, etc?

Line 132: This may be a bit pedantic, but I don’t think it should be said that weather radars sample precipitation processes -- rather, they sample precipitation-sized particles from which ongoing microphysical processes can be inferred. Consider revising.

Line 144: While I understood the point, the phrasing “allow even more to zoom in” is a bit awkward. Consider “allow for a more granular look at”

Line 158 and elsewhere: There are various inconsistent date formats throughout the manuscript (e.g., line 917). Please make these consistent in “DD Month YYYY” format throughout.

Line 159 and elsewhere: There are repeated definitions of certain acronyms like JOYCE-cf, which has already been defined. Please revise so that each acronym is only defined once.

Line 166: By “above -15C” I assume the authors mean (physically) above the -15C level rather than at temperatures above -15C, correct? Please clarify.

Line 176: Please define acronyms “POLDIRAD”, “DLR”, “miraMACS”, and “LMU”.

Line 185: While it is still being developed, can a bit more be said about this retrieval algorithm -- what is it retrieving? IWC? Dm? Etc. What type of algorithm is it?

Line 191: What is meant here by “sound” statistical basis? Can more detail be provided?

Section 3.1: Overall, it is not entirely clear to me the differences between IMPRINT and IcePolCKa, as they both utilize DWR and multi-frequency measurements (while IMPRINT admittedly also uses spectral polarimetry) and focus on ice microphysical processes. Is the primary difference the wavelengths used (e.g., Ka-W vs. Ka-C), or the fact that models are only a component in IcePolCKa? I believe there is easily room for both projects to exist given outstanding uncertainties in ice microphysics, but it might be helpful if they were explicitly contrasted so readers can understand where each of them fits in. (This is done well in the HydroColumn section on lines 199-203, which specifically notes the use of spectral analysis at C band which makes that project unique).

Line 263: Is this cross-section reconstructed from a PPI or a true RHI? It appears to be the former but this should be added.

Line 266: I am a bit confused by the sudden introduction of B-PRO, especially given the subsequent space dedicated to the polarimetric EMVORADO in 4.1. What are their differences and why would one be used over the other (e.g., in section 4.2.1)? A bit more
info might be helpful here and explain why they are switched between.

Lines 275-277: Please move this information up to line 265 where the perturbed CN and INP are first mentioned.

Lines 273-275, 277-279: These are interesting results -- can the authors add a bit about what they might imply, as is done for the subsequent ZDR column discussion? I would have expected higher CN to result in higher Z due to suppressed warm rain processes and enhanced growth of hail due to the availability of SLW which would cause higher Z as earlier studies have implied, but it seems this is not the case here. Also, the finding that IN doesn’t seem to change the simulated polarimetric variables while Continental vs. maritime does (lines 277-279) is interesting and deserves further exploration, even if brief.

Line 305-306: This sentence (“An example...”) seems out of place with the surrounding discussion since an example is already referenced in an earlier sentence.

Line 330: What is meant by “reflectivity weighting” here?

Line 354: “Typical features” is a bit vague. Can the authors describe the features in Fig. 7 a bit more specifically?

Line 380: Isn’t the DGL typically defined with its center around -15C (as stated on line 210)?

Line 382: The polarimetric variables (e.g., ZDR and KDP) were defined early on but then occasionally re-defined throughout the manuscript (E.g., lines 382, 948, 959). These should be made consistent to (generally) always use the abbreviation once introduced.

Lines 391-393: Am I understanding correctly that this then implies a deficiency in the radar operator? That is, if the model is actually simulating significant graupel (even if erroneously) but the HMC applied to the simulated polarimetric observations does not identify graupel, that implies that there is an incongruence between the operator and the model physics, correct? This is an interesting finding but a bit more detail might be helpful.

Lines 406-407: The relevant letters in the full name of the project should be capitalized with the acronym wrapped in parentheses to match the other projects.

Line 477: Can the issues encountered with KDP data be briefly explained?

Line 488-489: This again may be pedantic, but I would rephrase this slightly. We have had 3- and 4-D mosaics of Z for a while now which do contain microphysical information about hydrometeors’ size, concentration, and phase -- these are just severely underconstrained and underdetermined. Perhaps instead of “for the first time” the authors can say something like, “modellers now hold an unprecedented amount of microphysics-related...”

References: There are some inconsistencies regarding the formatting of the references (e.g. journal abbreviations (Monthly Weather Review vs. Mon. Wea. Rev, lines 836 vs. 840.), occasionally “pp.” before the page ranges, missing trailing periods, missing commas (E.g., line 740), etc).

Figure 2: I believe the caption here is wrong, with b) and c) switched compared to the figure labeling.
Figure 5: It was hard for me to see the grey lines in panel (a). Can these be made much bolder/wider?

**Technical Corrections:**

Line 26: Remove comma after “hypothesis”

Line 28-29: “C band” □ “C-band”

Line 32: “still considerable knowledge gaps exist” □ “considerable knowledge gaps still exist”

Line 37: “it” □ “this manuscript” or “this article”

Line 42: Remove “Since several years”

Line 46: “parallel to” □ “parallel with”

Line 53: “called” □ “call”

Line 56: “started” □ “began in”

Line 83, 117: “cloud-” □ “cloud”

Line 93: “still rudimentary” □ “still-rudimentary”

Line 105 and elsewhere (e.g., line 423): “of the order” □ “on the order”

Line 107 and elsewhere (e.g., line 418, 457): “currently replaced” □ “currently being replaced”

Line 108: Add “the” before Max-Planck.

Line 118: “Hebrew University cloud model” □ “Hebrew University Cloud Model”

Line 120: “by” □ “to”

Line 136: Think an “and” is needed before “their observations”.

Line 142: Consider changing “strength” to “magnitude”.

Line 143: “differential change” □ “differential phase” or “differential phase shift”

Line 149: “at improving” □ “to improve”

Line 153: “polarimetric” □ “polarimetry”

Line 155: Should “Ze” be “Ze” here (as on line 232)?

Line 160: “in about” □ “at about”

Line 161: “in case” □ “in the case”

Line 179: “23 km long” □ “23-km-long”
Line 182: “wavelength” □ “wavelengths”
Line 191: Remove “E.g.”
Line 191: “Predicted Particle Properties” should be capitalized.
Line 210: No hyphen needed between Z and increase.
Line 221: “thrives” □ “seeks”
Line 237, 240, 255: “allow(s)” □ “allow(s) us”
Line 238: Should “slanding” be “slanting” or “shifting”?
Line 268: Should 3.1 refer to section 4.1 instead?
Line 280, 282, 283, etc: No hyphen needed in ZDR column. Also remove “those”.
Line 307: “interaction” □ “interactions”
Line 311: “Central” □ “The central”
Line 315: “up to now” □ “up-to-now”
Line 320: Should “access” be “accesses”?
Line 331: “fall speed” □ “hydrometeor fall speeds”
Line 349: “as” □ “are”
Line 356: “in large” □ “into large”
Line 373: “grid-point” □ “gridpoint”
Line 375: “within and below the melting layer (ML)” to the end of sentence
Line 377: “leading in” □ “leading too”
Line 380: “centred” □ “centered”
Line 383: hyphenate “COSMO-simulated”
Line 387: “NWC” □ “NWP”
Line 401: Change hyphen to comma.
Line 466: Remove comma after “Both”
Line 485: Hyphenate “as-complete-as-possible”
Line 486: Missing “-art”
Line 494: “microphysic” □ “microphysics”
Line 496: Add “The” before “Developed”
Line 505: “made progress” □ “progress made”
Line 958: “imulated” □ “simulated”
Line 960: “together” □ “together with”