Author's response

We would like to thank the topic editor Guoqing Ge for his helpful comments. Please find our point-by-point reply highlighted in blue below.

The manuscript received favorable comments from reviewers. The editor has the following minor comments:

Line 81: "emphasize" -> "emphasizes"

As we understand it, "emphasize" is grammatically correct here, because "Morrison et al. (2020)" is considered plural. That said, we now feel like the sentence could benefit from rephrasing anyway and changed it to:

> *As highlighted by Morrison et al. (2020) in one of their main conclusions, the critical evaluation of model performance necessitates statistically robust remote-sensing approaches.*

Line 100; and Line 117: So C-band reflectivity observations are raw obs without any attenuation mitigation?

Yes, that is true. There are two ways two compare real radar signals under the effect of attenuation with simulated radar signals from model output:

1. Attenuation effects are subtracted from the **real** signal by applying an attenuation correction algorithm so that in the end, signals **unaffected** by attenuation are compared.
2. Simulated attenuation is added to the **simulated** radar signal so that in the end, radar signals **affected** by attenuation are compared.

We opted for option 2 because we think that in our case, simulating attenuation yields a fairer comparison, since the atmospheric state — that is, the variables affecting attenuation — is well defined in the model. On the other hand, the exact atmospheric state along the beam path during the real radar observations is not known.

We added a sentence to make this more clear in the manuscript:

> *In this study, we solely focus on raw Z and Zdr data, i.e., without any attenuation correction applied.*

Line 115-117: Melting layer is a key radar observed feature. It is worthy more explaining why this is not simulated and how this may affect the results of this manuscript.

While the melting layer is a key feature for many radar applications, it is not important at all within the scope of our manuscript as we focus on two altitudes (5500 and 1500 m), which are a significant distance away from the melting layer (which was very roughly at about 3 to 3.5 km altitude during our summer cases).

We added two sentences in the manuscript to elaborate on this:

> *This makes it impossible to simulate melting layer effects such as the "bright band" (Austin and Bemis, 1950), and hence the analysis in this study is focused on heights above and below the melting layer.*

Line 119 and 124: (1) The first sentence is redundant as it is already described in line 107; (2) One may wonder why we convert model grids to radar grids and then back to model grids here. Although it is covered in later parts, it is better to briefly mention here why this is needed to help readers follow the manuscript.

1) Thank you for this comment. We removed the first sentence.

2) Radar data and model data are available on different grids. Thus, a fair comparison requires regridding. Adding simulated attenuation to the simulated signal along the beam path requires a spherical grid, which is why we first regrid the simulated radar signals to a spherical grid. However, the cell-tracking algorithm requires a Cartesian grid, which is why we regrid the data again to a Cartesian grid. We changed the sentence to make this more clear to the reader:

> *To allow the application of a cell-tracking algorithm that operates on a Cartesian grid (see Sect. 2.1), the resulting data is then interpolated back to the Cartesian grid using the same inverse distance interpolation as for the radar data.*

The manuscript only covered one type of polarimetric radar observations (i.e ZDR). Suggest making this clear and explicitly either in the title or in the manuscript. Also, it is good to provide a brief discussion about how other type of polarimetric radar observations may be used for a similar work (no need to conduct extra experiments).

Thank you for this comment. You are right that we do not use all polarimetric variables and focused only on differential reflectivity. To make this more obvious to the reader, we changed parts of the manuscript at multiple instances:

1) In the abstract, line 8:

> *The aim is to assess the distribution of precipitation into convective and stratiform regions, and the microphysical properties in these regions based on* ***radar reflectivity and differential reflectivity.***

2) In the introduction, line 85:

> *Within the scope of this study, we solely focus on the differential reflectivity (Zdr) and radar reflectivity (Z). Other polarimetric variables, such as specific differential phase (Kdp) and correlation coefficient (RHOhv) could provide further insight into the microphysical properties, but will be left for future studies.*

3) In Section 2, line 103:

> *In this study, we solely focus on raw Z and Zdr data, i.e., without any attenuation correction applied.*

4) In Section 3.4, line 381:

> *This provides confidence in our conclusions regarding the rain drop size distributions based on the simulated* ***differential radar reflectivity Zdr.***

5) In the conclusions:

Line 394:

> *The simulations are then compared to polarimetric radar observations from the German Meteorological Service (DWD) radar network,* ***i.e., reflectivity (Z) and differential reflectivity (Zdr).***

Line 456:

> *Analysis of the underlying simulated rain drop size distributions (DSDs) supports these interpretations of the Zdr signals.*

In the conclusions, we also added a part that discusses what other polarimetric variables could add to the analysis in line 466:

> *However, within the scope of this study, we focused only on one polarimetric radar variable, Zdr. Future research could expand the analysis to include additional polarimetric radar variables, such as specific differential phase (Kdp) or correlation coefficient (RHOhv), which could provide further insights into the microphysical properties of the different microphysics schemes. Kdp, for instance, can provide information on number concentration of rain drops in the radar beam volume, while RHOhv can provide information on the presence of mixed-phase precipitation (Bringi and Chandrasekar, 2001, chapter 7). Kdp and RHOhv in combination with Zdr and Z could also be used for hydrometeor classification (e.g., Dolan et al., 2013).*

Other changes:

We noticed inconsistencies in our use of ZDR/KDP vs Zdr/Kdp and changed everything to Zdr/Kdp throughout the manuscript.

References

Austin, P. M. and Bemis, A. C.: A QUANTITATIVE STUDY OF THE “BRIGHT BAND” IN RADAR PRECIPITATION ECHOES, Journal of Atmospheric Sciences, 7, 145 – 151, https://doi.org/10.1175/1520-0469(1950)007<0145:AQSOTB>2.0.CO;2, 1950.

Bringi, V. N. and Chandrasekar, V.: Polarimetric Doppler Weather Radar, Cambridge University Press, ISBN 9780521623841, https://doi.org/10.1017/cbo9780511541094, 2001.

Dolan, B., Rutledge, S. A., Lim, S., Chandrasekar, V., and Thurai, M.: A Robust C-Band Hydrometeor Identification Algorithm and Application to a Long-Term Polarimetric Radar Dataset, Journal of Applied Meteorology and Climatology, 52, 2162–2186, https://doi.org/10.1175/jamc-d-12-0275.1, 2013.