Reply to the review of "Long-term Climatology of Vertical Profiles of Polarimetric Variables and Ice-microphysical Retrievals at X-band. Part I: Radar Calibration" by Tobias Scharbach and Silke Trömel, egusphere-2026-493.

Response to reviewer 1
Thanks a lot for your time and the careful inspection of our paper. In the following, we comment/reply point by point.

Concern 1: "The Z – ZDR dependence in rain is very nonlinear and it looks that the best results for Z(ZDR) retrieval can be achieved only for ZDR within the range between 0.5 – 2.0 dB where a slope of the ZDR(Z) dependence is maximal. I doubt that any reliable estimate of Z is possible outside of this ZDR range."

Thanks for raising this important point, but our results would suffer from the large spread of ZH within the ZDR range between 0.5 dB and 2 dB. Instead, the reverse ZH-ZDR method would work best in the range from around 0 dB to around 0.75-1 dB, where most data is available for theT-matrix simulations (see Figs. 2 and 3). However, we decided to make use of the full range of ZDR (from 0 dB to 2 dB) in the observations. A spearman correlation >0.4 between corrected ZDR and uncorrected ZH is requested to restrict to days with the expected positive correlation in pure rain, but to exclude e.g. size sorting. Additionally, only days with identified, reliable ZDR offset (with light rain conditions) are considered to determine the ZH offsets, which reduces the occurence of high ZDR values. Resulting daily ZH offsets are filtered again using only data between the 20th and 80th percentiles and subsequently excluding days with a standard deviation > 4 dBZ. Finally, the median (instead of the mean) is used to further reduce the impact of any outliers.
In summary, the stringent filtering chain is applied as a compromise to take the whole distribution into account, but limit the influence of large ZDR values, which could result in unrealistic ZH offsets.

Concern 2: "Certain criteria should be satisfied to select appropriate values of ZDR for retrieval of Z and for utilizing the self-consistency relationship. One of the requirements is ΦDP < 30°. The bias of ZDR caused by differential attenuation in rain at X band is equal to the product β ΦDP where the factor β strongly increases with ZDR and often assumed to be 0.05 dB/deg. This means that ΔZDR can be as high as 1.5 dB for ΦDP = 30° that is not acceptable if correction for differential attenuation is not performed. Should the ΦDP requirement be stricter? Was the ZDR correction for differential attenuation performed in the study?"

Thank you very much for this interesting question. No, we did not apply any (differential) attenuation correction. High ΦDP due to propagation effects is highly unlikely and not expected in light rain and at an 18° elevation. Other studies exploiting higher elevations and light rain condititions for calibration avoided attenuation corrections as well (see e.g. Sanchez-Rivas and Rico-Ramirez, 2022). Filtering with ΦDP < 30° is a precautionary measure designed to effectively rule out highly unlikely brief episodes of heavy rain or hail should other thresholds fail. Of course, hail, for example, cannot have values between 0 and 20 dBZ, but since we use an uncalibrated ZH to calibrate ZDR, this additional ΦDP threshold is intended for the unlikely event that the abs(ZH offset) is very large (e.g., > 15 dBZ).
Nevertheless, to verify the impact of (differential) attenuation correction on the resulting ZDR and ZH offsets, comparative calculations are performed for the year 2013 with the climatological attenuations parameters α = <0.28 dB/deg> and β = <0.05 dB/deg> (Ryzhkov and Zrnić 2019).

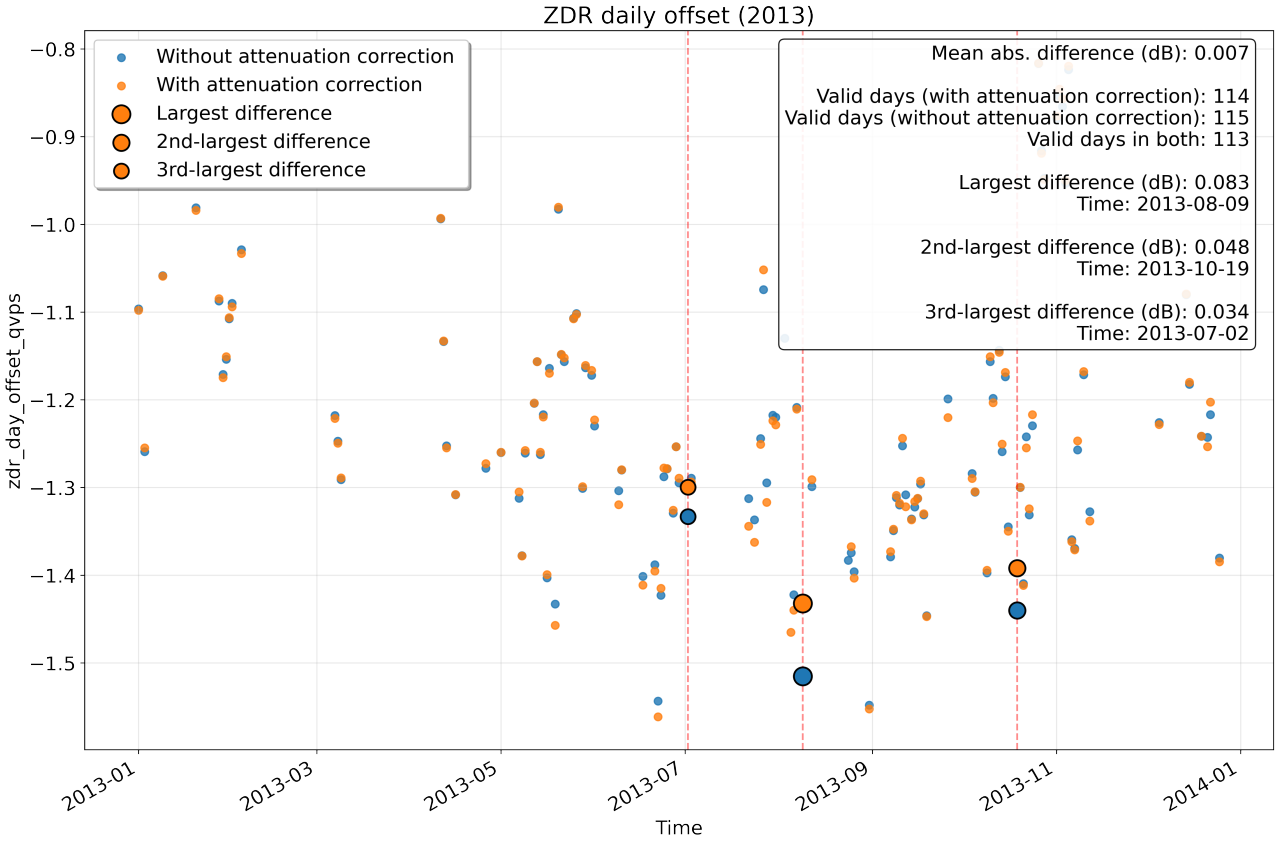

Figure A: Daily ZDR offset values for 2013 using QVPs, both with and without applied (differential) attenuation correction. The three largest absolute differences are highlighted.

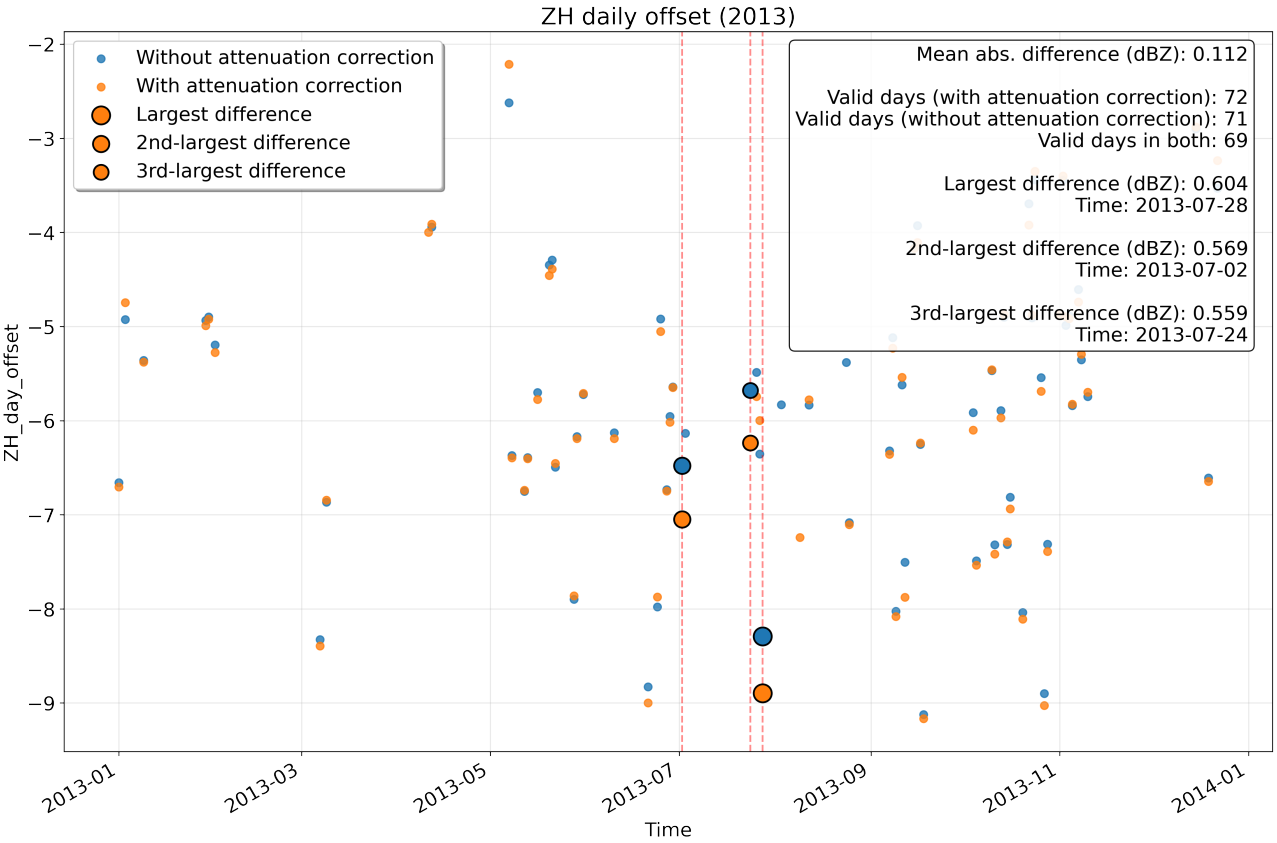

Figure B: Daily ZH offset values for 2013 using the reverse ZH-ZDR method, both with and without applied (differential) attenuation correction. The three largest absolute differences are highlighted.

As illustrated in Fig. A, the largest absolute difference of daily ZDR offset is only 0.083 dB and the mean absolute difference is with 0.007 dB negligibly small. Similarly, the impact on the ZH offset is negligible. The mean absolute difference is 0.112 dBZ (see Fig. B).

Concern 3: "The authors do not mention a situation with wet radome if it rains over the radar. Were these measurements excluded from the statistics? The problem is that Z bias associated with wet radome can be very high (up to 20 dB) and ZDR can be heavily biased as well."

BoXPol was operated without a radome, i.e. according effects can be excluded. We include this information in the revised manuscript (introduction of the technical radar characteristics).

References:

Ryzhkov, A. V. and Zrnić, D. S.: Radar Polarimetry for Weather Observations, Springer International Publishing, https://doi.org/10.1007/978-3-030-05093-1, 2019.

Sanchez-Rivas, D. and Rico-Ramirez, M. A.: Calibration of radar differential reflectivity using quasi-vertical profiles, Atmospheric Measurement Techniques, 15, 503–520, https://doi.org/10.5194/amt-15-503-2022, 2022.